FISCAL DECENTRALIZATION AND DISASTER MITIGATION: EVIDENCE FROM THE PHILIPPINES

A thesis submitted in partial fulfillment of the requirements
for the Master's Degree in Public Policy

DELOS SANTOS Reynaldo Jr. Beluso
51-218206

Academic Supervisor:
Professor Naomi Aoki

Graduate School of Public Policy
The University of Tokyo

August 2023

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Fiscal decentralization has for the longest time been touted as the policy of choice, widely claimed to improve the delivery of public services, including that of disaster risk reduction and management. However, existing research have yet to establish consistent and conclusive evidence of the beneficial influence of fiscal decentralization on disaster mitigation. This thesis is an attempt to empirically examine the impact of fiscal decentralization on disaster mitigation performance as measured by mortality and affected population due to disasters across the Philippine provinces. This thesis contributes to the empirical work on decentralization and disaster impacts by investigating the correlation through the use of Generalized Linear Models to statistically control for other factors which may determine disaster mitigation performance at the sub-national government level in a country setting. Fiscal independence, or the ability of local governments to generate its own revenue, is used as the measure of fiscal decentralization. Using provincial level data from 2017 to 2021, this study finds that provinces which are more fiscally decentralized have experienced more human losses from typhoons, earthquakes, and floods, with results consistent across model specifications. The positive association between fiscal decentralization and disaster mortality and affected population can be explained by interjurisdictional spillover effects of providing disaster mitigation, the moral hazard from a decentralized fiscal structure, and the challenges in intra- and inter-governmental coordination. These findings contrast those from previous cross-country studies and are consistent with results from country-specific research. Results from this thesis contribute to helping policymakers assess whether further decentralization is the correct direction in disaster risk reduction and management for countries facing high disaster risk such as the Philippines.

Keywords: fiscal decentralization, disaster mitigation, local government, public service delivery

ACKNOWLEDGMENTS

This thesis is dedicated to my family, without whom I would not be where I am today, and to the Filipino people, for whom I have chosen to serve through my work in government. I am indebted to the Government of Japan and the Government of the Philippines for the opportunity to pursue a master's degree in public policy at the University of Tokyo. I would also like to thank my academic supervisor, Professor Naomi Aoki, whose expert guidance, patience, and support helped me develop my ideas and get through the entire process of writing this body of work. Last but not least, I am grateful to the staff and colleagues at the Graduate School of Public Policy at the University of Tokyo and friends in Tokyo who have made living in Japan a more meaningful and unforgettable experience.

1. INTRODUCTION

Natural hazards such as typhoons, floods and earthquakes may turn into destructive and deadly disasters if they take place in vulnerable areas. In this study, disaster is defined as in the Sendai Framework as "*a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts*" (Disaster, n.d.). The exposure of vulnerable populations living in hazard-prone areas to extreme natural events can lead to economic and human losses. Exposure includes the frequency and intensity of extreme natural events such as typhoons, floods, and earthquakes. Government prevents or minimizes disaster losses through policies geared towards natural disaster risk reduction and management. This study builds upon empirical research on the impact of decentralization on public service delivery by using quantitative analysis to determine whether fiscal decentralization is beneficial or detrimental to disaster management in a country setting. It also contributes to disaster literature by investigating the importance of fiscal decentralization as a determinant of human losses from disaster.

This thesis examines the impact of decentralization in the Philippines. In the Philippines, addressing natural disasters and its effects is a shared intergovernmental responsibility that starts at the local level (Uchimura, 2012). When a major disaster event occurs and overwhelms local governments, the higher levels of government are involved to provide assistance (Bahl & Linn, 1994; Jha et al., 2018). The intergovernmental system for disaster governance routinely comes to the forefront of policy discussions whenever a devastating natural disaster hits the country, such as Typhoon Ondoy in 2009 that brought in a month's volume of rain in just nine hours, causing massive flooding in Metro Manila that affected around 4.9 million people and put 30 percent of all provinces in the Philippines under a state of calamity, and Typhoon Yolanda in 2013 that was among the strongest and deadliest typhoons ever recorded, making landfall in the Visayas island group with a rare public storm signal no. 4 and killing 6,300 people (NDRRMC, 2017).

Mainstream approaches to reducing disaster risks emphasize the importance of decentralization. The Hyogo Framework for Action (UNDRR, 2005) and its successor, the Sendai Framework for Disaster Risk Reduction (UNDRR, 2015), both promote the idea of empowering local authorities. The role of local government was discussed as a prerequisite for effective disaster mitigation at the UN World Conference on Disaster Reduction held in Japan in 2005. El Salvador and donors signed a declaration after Hurricane Mitch in 1999 which called for the government's decentralization program to be strengthened (Iqbal & Ahmed, 2015). Decentralization has been supported by multilateral donors such as the World Bank as a crucial component of a strategy to reduce disaster risk (Iqbal & Ahmed, 2015).

Decentralization, simply defined, is a transfer of authority from central to local government (Pollitt, 2005; Uchimura, 2012). Fiscal decentralization is implemented as a part of the larger decentralization effort since fiscal authority is the substantive foundation of governmental power. It is not easy to define the various types and forms of decentralization, because in many countries it is the case that some degree of authority is assigned to local governments, and centralization and decentralization cannot be treated as a dichotomy but as a spectrum. Nevertheless, numerous ways to define the different kinds and forms of decentralization exist. Aoki and Schroeder (2014) defined the three forms of decentralization – political, administrative, and fiscal. Political decentralization involves the selection of local leaders through popular elections, ensuring they are chosen by the people rather than being independently appointed by leaders of the central government. In administrative decentralization, local governments are granted decision-making powers in the provision of public services. Lastly, fiscal decentralization pertains to granting local governments the authority to make decisions regarding the allocation and management of public funds, including revenue generation, expenditure responsibilities, and financial autonomy (Aoki & Schroeder, 2014). In fiscal decentralization, subnational governments are given the power to raise revenues through local taxes, charges, or fees. Along with revenue-raising authority, subnational governments are entrusted with the responsibility of planning, budgeting, and executing public expenditures within their jurisdiction. This includes allocating funds for public services, infrastructure development, education, healthcare, and other local needs (Uchimura, 2012).

Decentralization in the Philippines is deemed to be comprehensive and has one of the most substantial legal bases in Southeast Asia. Moreover, each tier or each type of local government has a rather direct relation to the central government, especially in the context of fiscal relationships, and are relatively independent compared to other countries in the region (Uchimura, 2012). Many years after the law granting local government units (LGUs) more resources through unconditional grants and taxing powers was first enacted, it appears that there has been no significant improvement in local public service delivery, and LGUs are observed to have become more dependent on internal revenue allotments (Diokno, 2012). Among the main reasons cited for the seemingly lack of success in decentralization is that there is a lack of proper cooperation among local governments in addressing interjurisdictional problems, as well as the inability to efficiently perform all the responsibilities devolved to them by the central government. In 2019, the Supreme Court granted the Mandanas-Garcia petition[1], which effectively increased the tax

[1] The Mandanas-Garcia Supreme Court (SC) ruling refers to the SC's final decision on two filed petitions which challenged the manner in which the National Government (NG) computed the Internal Revenue Allotment (IRA) shares of local government units (LGUs). The petitioners appealed that the IRA be computed based on the "just shares" of the LGUs. In its July 3, 2018 Decision, the SC granted the Mandanas-Garcia petition, declaring as unconstitutional–and deleting– the phrase "internal revenue" appearing in Section 284 of the Local Government Code (LGC) of 1991.

base[2] on which the share of LGUs is computed from in the Internal Revenue Allotment (Department of Budget and Management, 2021). The fiscal implication of the Supreme Court ruling is equivalent to a 38 percent increase from the FY2021 IRA shares of LGUs, thereby granting more fiscal resources to LGUs from the national budget (DBM, 2021).

This thesis investigates the role of fiscal decentralization in disaster risk reduction and management in the Philippines. Significant casualties and damages from the increasing frequency and magnitude of natural disasters brought about by climate change necessitates an in-depth analysis of the factors that influence disaster outcomes at the sub-national level, where disasters usually strike. With disaster risk reduction and management as an important component of minimizing damages and casualties when natural hazards turn into disasters, and local government becoming more fiscally independent, analyzing how fiscal decentralization influences disaster outcomes in the Philippines provides inputs for policy direction.

This thesis proceeds as follows: Chapter 2 gives an overview of the Philippines context by describing salient legislation and governance structures pertinent to fiscal decentralization, the country's disaster risk profile, and the role of local governments in disaster risk reduction and management (DRRM) in the country; Chapter 3 discusses the relevant theories linking decentralization and public service delivery, with a focus on fiscal decentralization and the local government's provision of disaster management as a public service, then presents previous studies and their findings on the topic; Chapter 4 presents the variables and estimation methods used; Chapter 5 shows the estimation results; Chapter 6 provides an interpretation of the results, the limitations of the study, implications for policy, and ways to move forward.

[2] The impact of the SC decision significantly increased the tax base on which the share of the LGUs is computed from, and thus, strengthened fiscal decentralization. It clarifies the distinction between "national internal revenue taxes" and "national taxes" as base in the computation of the IRA of LGUs. National internal revenue taxes include only taxes collected by the Bureau of Internal Revenue (BIR) while "National taxes," consists of all taxes and duties collected by the NG through the BIR, the Bureau of Customs (BOC), and other collecting agencies.

2. THE PHILIPPINES CONTEXT

2.1 Fiscal Decentralization in the Philippines

- ***The Local Government Code of 1991***

Considered as among the earliest to adopt decentralization in East Asia (Balisacan & Hill, 2008), the Philippines bases its current local government structure on the Local Government Code, Republic Act 7160, enacted in 1991 (hereafter referred to as the 1991 Code). Currently, the country is organized into four sub-national units or local government units (LGUs): provinces, cities, municipalities, and village-level barangays (*Refer to Appendix A for the Philippine provincial map*). The 1991 Code devolved to the LGUs the national government's responsibility for the delivery of basic services, as well as the enforcement of certain regulatory powers. Devolved services include health such as hospital services, social welfare services, environment and natural resources, agriculture, and public works. Devolved regulatory powers include: the reclassification of agricultural lands, the enforcement of environmental laws, the inspection of food products, the enforcement of the national building code, and the processing and approval of subdivision plans, among others (Brilliantes, 1998). Municipalities and cities are the LGUs that directly provide and implement basic services regularly needed by the residents in the community, such as: primary health care, collection and disposal of waste, and construction of roads. Provinces assist with these devolved services and perform developmental and coordinative functions for their cities and municipalities. When the Code was enacted in 1991, the Philippines had 73 provinces, 61 cities, and 1,496 municipalities. By 2020, there were 81 provinces, 146 cities, and 1,488 municipalities (Philippine Statistics Authority, 2020).

Among the various regulations in the Code pertaining to the financial matters of local governments, the most significant ones are related to the internal revenue allotment (sections 284–288) and the allocation of national wealth (sections 289–284). These sections establish a method for calculating the combined and individual portions of local governments in the internal tax revenues and proceeds derived from natural resources, which are collected or generated by the national government. Out of the two provisions, the internal revenue allotment (IRA) is of larger value both in terms of the overall amount and the number of local governments covered. Additionally, the share of local governments in internal tax revenues had already been in effect prior to the enactment of the 1991 Code. Conversely, the allocation of 40 percent of the earnings or returns from national wealth is only granted to those regions that possess the relevant natural resources. Table 3 presents a summary of the LGU allocation formula, comparing the differences before and after the 1991 Code was enacted.

Table 1. Formula for computing the local government shares in internal tax revenues

Allocation Criteria	Before the LGC of 1991 (under Presidential Decree 144, c. 1973)	Under LGC of 1991 (RA 7160)
A. Total LGU share		
Total internal tax revenues for allocation	Net general funds* collected by the national government in the third year preceding year the allotment is given	Gross national internal revenues based in the collection in the third year preceding the year the allotment is given
Share of the local governments in the total	Maximum of 20%	30% in the first year of the LGC, 35% in second year, and 40% in the third year and thereafter
B. Share by LGU level		
Provinces	27% of the total LGU share	23% of the total LGU share
Cities	22% of the total LGU share	23% of the total LGU share
Municipalities	41% of the total LGU share	34% of the total LGU share
Barangays	10% of the total LGU share	20% of the total LGU share
C. Shares of individual LGUs (in the same LGU level)		
Population share	70%	50%
Land area share	20%	25%
Equal sharing	10%	25%

Sources: Presidential Decree 144 c.1973, Local Government Code of 1991.

**Net general funds comprise revenues collected net of budgetary funds created by law to facilitate the planning and execution of activities by earmarking specific tax and non-tax earnings for their use.*

The 1991 Code increased the financial resources available to LGUs by increasing their taxation powers and automatic fiscal transfers. Revenues of local governments come from two sources: local sources that are composed of local tax revenues and non-tax revenues, and external sources that mainly consist of intergovernmental transfers. As more responsibilities are devolved to sub-national governments under fiscal decentralization, local capacity to cover the increased expenditures using local own revenues may be insufficient. Hence, intergovernmental transfers are used to bridge the fiscal gap between a local government's own revenues and its expenditures. In the Philippines, transfers from the central government to local governments can be one of the following : (1) Internal Revenue Allotments (IRA), which are formula-based unconditional fiscal transfers directly distributed from the national government to each local government unit; (2) Congressional allocation, which is allocated to devolved functions in the form of programs and projects; (3) Government-funded programs and projects which government agencies support

devolved functions from internally generated revenues as part of the regular agency budget; (4) ODA loans and grants-funded transfers from national government agencies; and (5) off-budget budgeting. Among the five, IRAs comprise the bulk of government transfers. The Philippines' transfer system is formulated to automatically allocate 40 percent of national internal revenues to local governments.

- ***Decentralization's beneficial public service delivery impacts remain inconclusive***

In his assessment of the performance of LGUs over twenty years, Diokno (2012) made important observations reflecting the results coming short of the promises of fiscal decentralization in the Philippines since the implementation of the 1991 Local Government Code. One is that the dependence of the LGUs on the automatic national transfers or the IRAs has increased. Diokno (2012) had observed that in 2008, IRA accounted for 73.6 percent of total revenues for provinces. Greater reliance of LGUs on the IRA is the consequence of the grant system's higher, more predictable, formula-based, and mandated nature. For many local governments, the IRA has substituted for increasing their own taxes. This departs from the original intent of using the IRAs as a "stimulus" to encourage local authorities to raise additional local resources to fulfill central government grants. A pattern of utter dependency has formed. In several provinces, the IRA provides for more than 90 percent of provincial funds. A review of more recent data on revenue sources breakdown of LGUs from 2012 to 2021 shows that provincial governments are still heavily dependent on transfers from the national government. In 2012, the IRA accounted for 75.5 percent of total revenues for provinces. In 2021, the percentage share increased to 77.8 percent.

Table 2. Sources of provincial government funds (% of total revenues)

	2012	2015	2018	2021
Local Sources	19.5	19.4	18.1	15.1
Business	4.8	4.7	3.9	2.8
External Sources	81.7	80.6	81.9	84.9
IRA	75.5	78.5	74.4	77.8

Source of basic data: Bureau of Local Government Finance

Diokno (2012) also argued that there is some evidence of an overall deterioration in public service delivery after the legislation of the 1991 Local Government Code. Citing a 2011 World Bank Public Expenditure Review, an assessment of health performance, among the devolved functions, suggested that immunization rates have not been converging. Progress in human development across provinces were observed to be sluggish and regional income convergence has been slow. Provinces grouped by their Human Development Index (HDI) scores in 1990 according to whether they progressed, regressed, or

stagnated over the next ten years showed that of the 74 provinces analyzed only eight have increased their HDI scores enough to graduate to the next higher cohort, while three provinces recorded lower HDI scores (World Bank, 2011). Another study revealed that decentralization had no influence on provincial income growth, suggesting that local government units were unable to use provincial income growth to reduce poverty by providing better services (Balisacan et al., 2008).

Evidence supporting the idea of decentralization leading to better delivery of public services remain inconclusive. Despite the theoretical claims about the positive effects of decentralization on governance, empirical findings from a study conducted in the Philippines and Indonesia indicate that decentralization has not fulfilled the optimistic predictions regarding governance outcomes. According to Campos and Hellman (2005), neither country has experienced the expected public service delivery improvements attributed to decentralization. In the case of the Philippines, which has a longer history of decentralization, the results are mixed. Spending on social services as a share of total provincial expenditures have increased from 26 percent in 2012 to 36.4 percent in 2021, reflecting the increase in services and assistance programs addressing poverty and public health issues (*see Table 3*). While perceptions of corruption have decreased and there have been some improvements in service delivery standards, the connection between these outcomes and enhanced accountability of local politicians is not strong (Campos & Hellman, 2005).

Table 3. Provincial government funds by expenditure item (% of total expenditures)

	2012	2015	2018	2021
General public services	48.5	46.3	45.0	43.9
Social services	26.0	28.4	31.7	36.4
Education	3.8	2.8	2.7	2.8
Health, nutrition & pop.	16.7	18.8	22.0	25.5
Labor & Employment	0.1	0.1	0.1	0.3
Housing & Community Dev't	0.7	0.8	0.6	0.7
Social services, welfare	4.7	5.9	6.3	7.0
Economic services	23.8	23.9	22.2	18.5
Debt servicing	1.7	1.3	1.2	1.2

Source of basic data: Bureau of Local Government Finance

The allocation system described earlier in Table 1 reveals three key observations regarding the determination of IRA shares before and after the LGC as discussed by Capuno (2017). Firstly, the allocation criteria disregard expenditure obligations of local governments. Secondly, LGUs now receive a larger IRA in terms of both percentage share and total amount. Lastly, the new formula favors barangays, local governments with bigger land areas and equity. A simplistic comparison between the IRA percentage shares and the cost of devolved functions (CODEF) suggests that provinces and municipalities incurred losses,

while cities and barangays gained significantly. However, a proper comparison should consider the amounts of CODEF and incremental IRA received, as these are directly attributable to the Code. This puts to question whether the LGUs receive sufficient additional funds to cover their increased spending obligations under the 1991 LGC.

Capuno (2017) also argued that public service delivery has not improved from decentralization due to the functional conflicts that arose among local governments following the reassignment of functions and relocation of facilities. Conflicts are inherent in a multilevel government structure and arise when the jurisdiction of local public services extends across multiple areas, allowing some to benefit without contributing, while discouraging the source LGU from reducing its provision. Another conflict arises when a local public service achieves its most efficient scale by serving a large population residing in different jurisdictions, leading to higher social costs if each jurisdiction provides the service separately instead of jointly. Disagreements over the division of cost savings can hinder cooperation. The impact of these problems on decentralization was described by Capuno (2017) in the case of health services, facilities, and personnel: instead of maintaining the integrated provincial health system, decentralization resulted in its fragmentation. Devolved health services were confined to limited administrative jurisdictions instead of being empowered to serve their natural catchment areas and operate as part of a province-wide health system. Rural health units and barangay health stations, along with their personnel, were transferred to municipalities, while cities were given some health centers instead of hospitals. District and provincial hospitals, along with their personnel, were placed under the control of provincial governments. Consequently, disease surveillance and health information flow within local government units (LGUs) ceased. In many areas, there were issues with inconsistent and costly drug supply. Numerous LGUs remained without doctors, medical technologists, and other specialists due to concerns about the politicization of their careers and limited professional opportunities within the local bureaucracy. Some LGUs were dissatisfied with the location and capacity of their devolved hospitals (Capuno, 2017).

2.2 Philippines Natural Disaster Risk Profile

The Philippines is an archipelago located off Indochina in the western Pacific and consists of more than 7,100 islands. Due to its location along the Pacific Ring of Fire, the country faces frequent seismic and volcanic activities. With over 20 active volcanoes, the Philippines is prone to landslides and volcanic hazards. Additionally, its position in the western Pacific Ocean exposes it to powerful typhoons, bringing heavy rainfall, strong winds, and storm surges. This, combined with its extensive coastline, steep slopes, and river systems, increases the risk of flooding. With a coastline stretching over 36,000 kilometers, the Philippines is highly susceptible to coastal hazards such as erosion and tidal floods. Furthermore, the

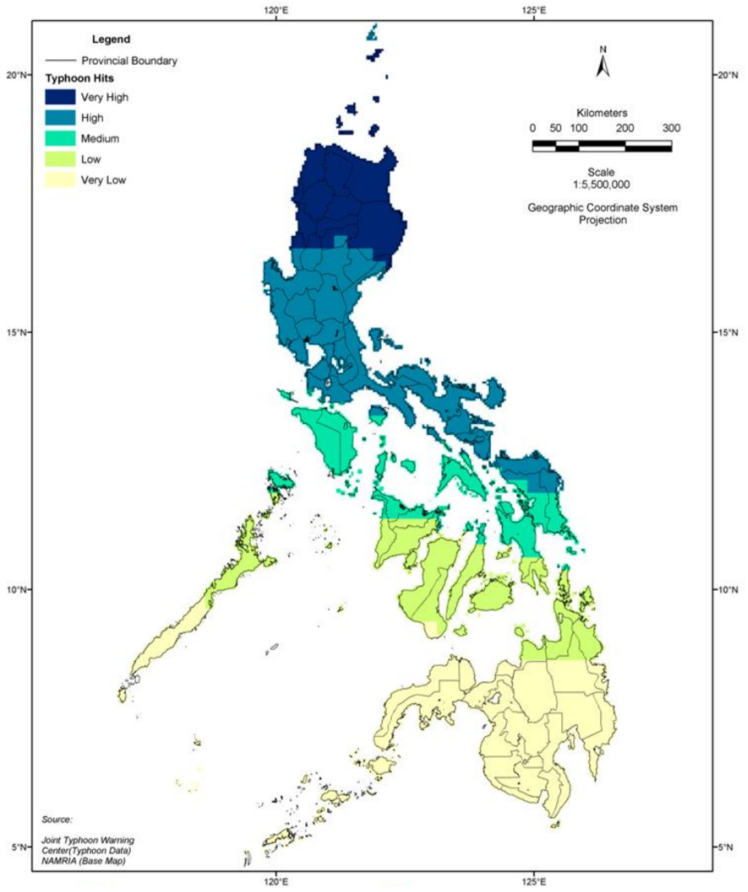
country's mountainous terrain and inadequate infrastructure contribute to flash floods and riverine flooding during intense rainfall (Bankoff, 2003).

Hazards become disasters when the vulnerable population and resources are exposed to them. People in poor socioeconomic conditions are particularly vulnerable to disasters, especially if they reside in hazard-prone locations. Some parts of the country are more vulnerable to certain risks than others because they are exposed to more risks. A study on global risk analysis by the World Bank identified the Philippines as one of the nations with high percentages of population living in disaster prone areas and was ranked as one of the countries with the highest number of hazards in the world (Dilley et al., 2005). In 2022, the World Risk Index ranked the Philippines as the country with the highest risk of disasters out of 181 countries, reflecting the complex interactions of multiple exposures and high intensities of natural hazards (World Risk Report, 2022).

The Philippines is especially prone to hydrometeorological events such as typhoons and floods, making up over 80 percent of the natural disasters in the country during the last half-century (Jha et al., 2018). Its extensive coasts, dense population and economic activity, and significant reliance on agriculture and natural resources all contribute to the high risk. The most frequent natural disaster are typhoons. Each year about 20 typhoons, tropical cyclones with very strong winds, equivalent to over 25 percent of the total number of such events in the world, occur in the Philippine Area of Responsibility (Bankoff, 2003). About 95 percent of these originate in the Pacific Ocean and so mainly affect the northeastern half of the archipelago, with the remainder coming from across the South China Sea. Figure 1 shows the Philippines typhoon incidence map based on hydrometeorological events monitored by the Department of Science and Technology. It can be observed from the map that typhoons in any given year are more likely to occur in the northern areas of the country in Luzon Island.

Flood dangers are increased by environmental factors like depleted forests. Since the 1930s, the rate of deforestation has increased during the 1950s and 1960s, then gradually decreased during the 1980s. Even at present, numerous landslides and floods result from the loose soil and diminished forest cover caused by previous deforestation efforts. The yearly monsoon season has caused serious floods in most locations. Although severe flooding also results from human activities like deforestation and the expansion of low-lying areas, the yearly monsoon season is the primary cause of flooding in many areas.

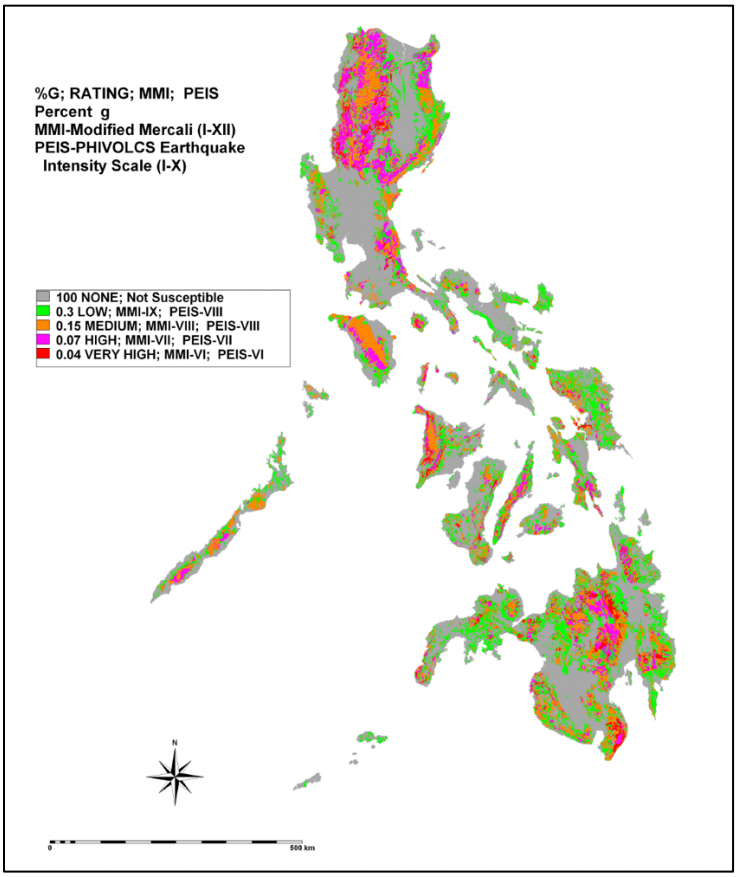
Figure 1. Philippines Typhoon Incidence Map



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration Department of Science and Technology

The Philippines is also very earthquake-prone because it is located in a seismically active region of the Pacific Ring of Fire. The country experiences an average of five (5) earthquakes every day, according to the Philippine Institute of Volcanology and Seismology (PHIVOLCS). The Philippines experiences typhoons and flooding more frequently than earthquake disasters. However, the effects of a high-magnitude earthquake on the affected communities are frequently enormous and catastrophic. Increasing disaster intensity and the difficulty forecasting them further raises exposure to these natural disasters. Figure 2 shows the landslide susceptibility map in the Philippines which are triggered by earthquakes. From the map it can be gleaned that areas with high risk are situated in all the major island groups: Luzon, Visayas, and Mindanao.

Figure 2. Philippines Earthquake-triggered Landslide Susceptibility Map



Source: Philippine Institute of Volcanology and Seismology
Department of Science and Technology

As typhoons are the most frequent type of natural disasters that occur in the country per year, it also records the largest economic and human damages. As shown in Tables 4 and 5, the worst disasters of all time in terms of cost of damage and number of people affected are predominantly typhoons. On top of the list is Typhoon Yolanda (international name: Haiyan), said to be the strongest typhoon to make landfall in the Philippines. Yolanda made first landfall on the Province of Eastern Samar in 2013, and affected multiple provinces until it left the Philippine Area of Responsibility three days later. The national government reported that the typhoon affected 3.4 million families (around 16 million people), killed more than six thousand people, and exacted USD 2 billion in economic damages in 44 provinces, 591 municipalities, and 57 cities (NDRRMC, 2013). Over 1.14 million houses were damaged, including 550,928 completely destroyed and 589,404 partially damaged in nine regions. In the first year following the disaster, approximately 500,000 families transitioned from evacuation centers to family tents and eventually to temporary shelter in displacement sites (NDRRMC, 2013). Typhoon Yolanda hit the country

less than a year after another destructive disaster, Typhoon Pablo (international name: Bopha) made landfall on the island of Mindanao. Bopha was a powerful and devastating storm, reaching Category 5 strength with sustained winds of up to 280 kph and gusts reaching 320 kph (PAGASA, 2012). Pablo affected more than six million people in 34 provinces, 318 municipalities and 40 cities, killing more than a thousand and costing USD1.7 billion in economic damages (NDRRMC, 2013). Table 4 lists the top five worst disasters in terms of cost of damage, and Table 5 presents the top five disasters in terms of the number of people affected. It is noteworthy that a single disaster event can affect millions of people in a span of only a few days and cost billions of dollars in damaged properties, crops, and infrastructure.

Table 4. Worst disasters in the Philippines in terms of cost of damage

Disaster (International Name)	Date	Estimated Cost of Damage ('000 USD)
Typhoon Yolanda (Haiyan)	08 Nov 2013	2,051,711
Typhoon Pablo (Bopha)	04 Dec 2012	1,692,961
Typhoon Sisang (Nina)	04 Sep 1995	700,300
Typhoon Pepeng (Parma)	29 Sep 2009	585,379
Mt. Pinatubo eruption	15 Jun 1991	443,000

Table 5. Worst disasters in the Philippines in terms of number of people affected

Disaster (International Name)	Date	Number of Affected People
Typhoon Yolanda (Haiyan)	08 Nov 2013	16,106,807
Typhoon Pablo (Bopha)	04 Dec 2012	6,246,664
Typhoon Ruping (Mike)	12 Nov 1990	6,159,569
Typhoon Ondoy (Ketsana)	26 Sep 2009	4,901,763
Typhoon Frank (Fengshen)	21 Jun 2008	4,785,460

Sources: Asian Disaster Reduction Center (ARDC), National Disaster Risk Reduction and Management Council (NDRRMC), Philippine Institute of Volcanology and Seismology (PHIVOLCS)

Between 1990 and 2022 natural disasters in the Philippines affected about 212 million people and resulted in 41,000 deaths. The associated economic damage was about USD36 billion with average annual damages of USD1.1 billion (Emergency Events Database, 2023). Losses to public and private assets from typhoons and earthquakes are estimated to exceed 1 percent of Philippines GDP annually on average (World Bank, 2020).

2.3 Role of Local Governments in Disaster Mitigation

When a disaster occurs, emergency management is implemented in four stages: preparedness, mitigation, response, and recovery (Col, 2007). Preparedness is the state of being ready to respond to an emergency as a result of prior planning, training, and exercises. Mitigation is a systematic effort to reduce risk to people and infrastructure. Response are the actions to provide fundamental human necessities, such as relief items and evacuation facilities. The final phase addresses economic recovery and restoring livelihoods. These four stages may not always occur chronologically, and may instead overlap (Col, 2007). Cognizant of the crucial role of preparedness and mitigation in preventing deaths and damages from disaster events, the Philippine government has an elaborate legislative and planning system which assigns important roles to local government units.

- ***The National Disaster Risk Reduction and Management Plan***

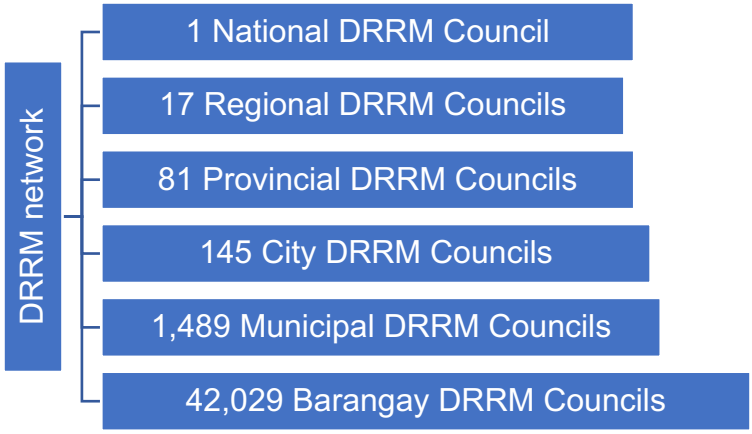
A long-term national sectoral plan, the National Disaster Risk Reduction and Management Plan (NDRRMP) aims to address four primary priority areas: (1) disaster prevention and mitigation, (2) disaster preparedness, (3) disaster response, and (4) disaster rehabilitation and recovery. Among its long-term goals, objectives, and actions, the NDRRMP contains comprehensive measures on disaster risk prevention, mitigation, and preparedness. The NDRRMP outlines the initiatives intended to increase the ability of the national government, local government units (LGUs), and partner stakeholders to create disaster-resilient communities, institutionalize plans and strategies for lowering disaster risks, including projected climate risks, and improve disaster preparedness and response capabilities at all levels. It emphasizes, among other things, the significance of incorporating disaster risk reduction and management as well as climate change adaptation into the development processes such as policy creation, socioeconomic development planning, budgeting, and governance, particularly in the areas of the environment, agriculture, water, energy, health, and education, as well as the reduction of poverty, land use and urban planning, public infrastructure, and housing, among others. The Plan outlines several implementation strategies, including advocacy and information, capacity building, education on disaster risk reduction and management, institutionalizing climate change, mainstreaming, involving research, technology development, and knowledge management. Strategies also involve monitoring, evaluation, and learning, networking, and partnerships building among stakeholders, the media, and government.

- ***Disaster Risk Reduction and Management Act***

Republic Act 10121, also known as the Philippine Disaster Risk Reduction and Management Act of 2010, (hereafter DRRM Law) is considered as the most significant development in disaster governance

in the Philippines, as it diverged from the traditional approach of regarding natural disasters as unforeseeable events and ignoring the source of casualties and adversities that comes from vulnerable populations and inadequate development capacity. The law defined the responsibilities of disaster risk reduction and management offices at the local government levels – province, city, and municipality. Section 11 of the DRRM Law provides for the organization at the local government level, creating the Provincial, City, and Municipal Disaster Risk Reduction and Management Councils (DRRMCs). The Governor chairs the provincial DRRMCs. The Local DRRMCs assume the following functions: (1) handle the implementation and review of the local DRRM plans, (2) incorporate disaster risk reduction and climate change adaptation into local development plans, (3) recommend the evacuation of residents when needed, and (4) convene the local council as frequently as necessary. As a result, the DRRM Law also called for the creation of the "DRRM Network," which mirrors the National Disaster Risk Reduction and Management Council (NDRRMC) from the national level down to the regional, provincial, city, municipal, and barangay levels as depicted below. Figure 3 presents the organizational structure of the DRRM Network.

Figure 3. DRRM Network



Section 12 of the DRRM Law established the Local Disaster Risk Reduction and Management Office (LDRRMO) in each barangay, city, municipality, and province. The LDRRMOs are responsible for the design, programming, and coordination of DRRM activities consistent with the national plans and the local DRRM plan in their respective LGUs. Their primary tasks include the following:

1. Implement local risk assessments and emergency preparation efforts;
2. Keep a local risk map consisting of information on local vulnerabilities, natural disasters, and risks related to climate change;
3. Create and put into effect an extensive and integrated Local DRRM Plan in line with the framework and DRR policies at the federal, regional, and provincial levels, working closely with local development councils (LDCs);

4. Create the yearly LDRRMO plan and budget, the planned LDRRMF programming, other specialized DRRM resources, and other regular financial source(s) and budgetary support of the LDRRMO;
5. Carry out ongoing disaster surveillance;
6. Identify, evaluate, and manage any potential area risks, vulnerabilities, or hazards;
7. Public information and increase awareness;
8. Identify and put into practice cost-effective risk reduction techniques;
9. Keep a database of human resources, equipment, directories, and local vital infrastructures, including hospitals and evacuation centers, and their capacity;
10. Create, enhance, and implement methods for networking or partnering with the private sector, CSOs, and volunteer organizations.

As stipulated in the RA 10121, each LGU must create a Local Disaster Risk Reduction and Management Plan (LDRRMP) that aligns with the NDRRMP. The plan should encompass disaster preparedness, response, prevention, and mitigation, as well as rehabilitation and recovery. Close coordination between the National and Local DRRM Councils is crucial, with the RA 10121 outlining their respective responsibilities and jurisdictions. The lead agency depends on the scale of impact: NDRRMC takes charge when two or more regions are affected, regional DRRMCs for two or more provinces, provincial DRRMCs are responsible for two or more cities / municipalities, and city / municipal DRRMCs manage situations involving two or more barangays. Local DRRM Councils are tasked with integrating disaster risk reduction and climate change adaptation into development programs to combat poverty and promote sustainable development and possess the authority to declare forced or preemptive evacuation of residents if necessary. The councils include representatives from the private sector and civil society groups.

Integrating disaster preparedness into local governance requires comprehensive planning and institutional organization. This includes incorporating preparedness principles and broader DRRM principles into major local planning documents. These documents should include the Local DRRM Plan, local climate change action plan (LCCAP), and climate and disaster risk assessment (CDRA). The CDRA is particularly important for mainstreaming climate change and disaster risk initiatives into planning documents, such as enhancing the comprehensive land use plan (CLUP) and the comprehensive development plan (CDP). Short-term, medium-term, and long-term aspects of disaster preparedness should be reflected in planning, decision-making, and local investments. However, many LGUs have observed misalignment in their local plans with missing or inconsistent goals and visions, and the executive-legislative agenda not being consistent with larger planning documents (Domingo & Manejar, 2018).

In terms of funding, LGUs are required by the DRRM Law to allocate at least five percent of revenues to a Local Calamity Fund; however, compliance and fund utilization have been a consistent

challenge (Capuno, 2017). In the past, calamity funds were almost exclusively tapped for immediate response and relief in the wake of disasters; Local Calamity Funds may only be utilized for circumstances when the LGU's legislative body officially declared a state of calamity. In 2003 the national government began allowing the use of the Local Calamity Funds for pre-disaster projects and programs (Brower et al., 2014). The DRRM Law renamed the appropriation as the Local Disaster Risk Reduction and Management Fund (LDRRMF), and a portion of it was allocated to a Quick Response Fund (QRF) as a standby fund for immediate disaster response and relief. In accordance with Section 21, the LDRRMF was established to support disaster risk management activities, including but not limited to, pre-disaster preparedness programs, training, purchasing life-saving rescue equipment, supplies, and medications, for post-disaster activities, and the payment of premiums on disaster insurance. Relying on the local disaster management plans as incorporated into the local development plans and annually work and financial plan, the LDRRMC should monitor and assess the utilization and disbursement of the LDRRMF.

Apart from the LDRRMF, the central government also provides aid to LGUs for post-disaster response and rehabilitation through the National Disaster Risk Reduction and Management (NDRRM) Fund[3], as part of annual national budget appropriations. The NDRRM Fund shall be utilized for pre-disaster risk reduction or mitigation, preparedness, and risk prevention activities such as personnel training, equipment procurement, and capital expenditures. It may also be used for post-disaster activities such as relief, recovery, reconstruction, and related work that addresses natural or human-induced calamities which may occur during the budget year or have occurred within the past two years from the budget year. The NDRRM Fund of each local government unit are approved by the President of the Philippines following the recommendation of the NDRRMC.

The past years have seen a paradigm shift in how countries deal with disasters – from being largely post-disaster-focused (response, relief, and rehabilitation efforts) to increasing resources directed towards pre-disaster risk reduction efforts. The Philippine DRRM Law is anchored in a decentralized form of government, mandating the adoption and implementation of "a coherent, comprehensive, integrated, efficient and responsive disaster risk reduction program incorporated into the development plan at various levels of government" (RA 10121, 2010). It also stipulates that disaster risk reduction and climate change must be mainstreamed into policy formulation and socioeconomic development planning (RA 10121, 2010).

[3] The passage of Republic Act (RA) 10121 or the Philippine Disaster Risk Reduction and Management Act of 2010 transformed the previous Calamity Fund to the National Disaster Risk Reduction and Management (NDRRM) Fund. This Fund, contrary to its previous version which focused on post-disaster efforts, expanded its intended use for activities towards "disaster risk reduction or mitigation, [and] prevention and preparedness."It can also be utilized for relief, recovery, and reconstruction efforts for calamities that occurred during the budget year or two years prior to the budget year. More than 10 years following the implementation of RA 10121, the allocation and utilization of the NDRRM Fund are still not aligned with its strategic priorities of risk reduction, specifically building disaster resilience among communities and enhancing preparedness capacities of LGUs.

3. LITERATURE REVIEW

This section attempts to explain the several ways in which decentralization may influence public service delivery. In this thesis, the general theory of decentralization is applied to the disaster context, where the effect of transferring authority from the national to local governments can be observed in the provision of protection from the harmful impacts of disasters through the implementation of disaster risk reduction and management measures across all levels of government.

3.1 Theories of decentralization and disaster management

The decentralization – public service delivery nexus

Arguments linking decentralization to improved public service delivery are founded on the *first generation theory (FGT) of fiscal federalism* that assumes government as a benevolent agent and posits that the provision of public goods and services under a decentralized government system allows better adjustment of local services to locally heterogeneous demands, hence bringing about allocative efficiency and better policies. Efficiency gains may also be achieved, and arguably such decentralization leads to higher accountability of public officials (Musgrave, 1959; Oates, 1972).

There seems to be a consensus that DRRM is more effective when brought to the local level. The localized nature of most natural hazards may put local governments in an advantageous position to provide disaster protection as part of local public goods. Aspiras and Santiago (2016) argue that decentralization results in better DRRM because it promotes community-level participation in the identification of appropriate and cost-effective solutions, an endeavor made more successful when problems (hazards, exposure, and vulnerabilities) are identified and analyzed by the same people who experience them. Similarly, interventions and alternative solutions may be designed based on local context and capabilities, factors that the local government units are assumed to be more knowledgeable in than the central or national government. Relatedly, decentralization is argued to build local capacities that may respond to disaster events more quickly than the national government.

Many of the arguments supporting decentralization in general are also applicable to disaster risk reduction and management. Decentralization is believed to enhance participation, responsiveness, and accountability among different sectors and levels of government, which are crucial for effective vertical collaboration in disaster management. Strengthening local capacity is particularly important as localized services such as fire services, the police, critical infrastructure investment, and building code enforcement play a significant role in minimizing casualties during disasters (Toya & Skidmore, 2013). Decentralization can also contribute to improving local disaster governance capacity, facilitating preparedness activities, and

increasing public participation in disaster planning by incorporating local knowledge and granting greater control over resource allocation at the local level. However, national governments play a vital role in providing leadership, ensuring adequate financial resources, and raising the political profile of disaster issues. This necessitates close relations and vertical collaboration between central and local actors involved in disaster management, a factor that is frequently lost in a decentralized local government. Moreover, DRRM as a public service differs from economic and social services in terms of means of effective local delivery. The following section provides a detailed discussion about how the unique nature of DRRM in a country setting may invalidate the proposed benefits of fiscal decentralization as earlier posited in theory.

Fiscal decentralization and Disaster risk reduction and management

- ***The interjurisdictional nature of DRRM complicates the achievement of allocative efficiency under a decentralized setup.***

The first generation of the fiscal decentralization literature traces its origins to the seminal work from Musgrave (1959) and Oates (1972), who argued that goods and services provided in a decentralized manner will be better tailored to meet the needs of those affected by such expenditures. Allocative efficiency is achieved when each local government is given the freedom to customize its own spending and revenue plan in alignment with local preferences. In a decentralized system, decisions are made in closer proximity to the consumers of government services, resulting in greater responsiveness to their needs. By assuming that local governments possess more detailed knowledge about the requirements of their citizens, decentralization of public service provision improves targeting and enhances the adaptability of service delivery to specific localities. This decentralization also accelerates decision-making processes by alleviating the information overload that typically hampers centralized hierarchies. Ultimately, faster decision-making contributes to greater efficiency. However, the interjurisdictional nature of DRRM prevents the achievement of efficiency gains under decentralization.

Disaster mitigation often involves externalities across jurisdictions, which consequently invalidates a key assumption of the efficiency argument. For instance, flood control facilities located in one LGU may provide protection benefits to that LGU's residents and, at the same time, affect residents living outside that LGU's borders. In disaster-prone areas, local governments may compete for limited resources such as emergency response equipment, personnel, or funding. This competition leads to inefficiencies when local governments prioritize their own needs over collaborative and coordinated efforts. For example, if neighboring LGUs compete for the same resources without coordination, it can result in misallocation of resources, duplication of efforts, or gaps in coverage, ultimately hindering effective disaster risk reduction and management. Moreover, there exists an inequitable sharing of burdens: disasters often require significant financial resources and expertise to mitigate and manage effectively. In a fiscally decentralized

system, if certain jurisdictions bear a disproportionate burden in terms of disaster risks or costs, while others benefit without contributing proportionally, it can create inequitable sharing of the disaster management burden. This imbalance can result in inadequate funding for disaster preparedness, response, and recovery efforts in jurisdictions that are more vulnerable or have limited fiscal capacity, leading to inefficiency in overall DRRM (Miller & Douglass, 2016).

- ***Decentralization fosters competition, resulting in better public services provision. However, the political incentive to prioritize DRRM in the local provision of services is low.***

A notable theme in fiscal federalism literature is the pursuit of budget maximization by public agents, driven by objectives like power, influence, staff size, and salaries. Brennan and Buchanan (1980) expanded this concept, viewing the public sector as a unified "Leviathan" that seeks to grow by maximizing revenues from the economy. According to Brennan and Buchanan, fiscal decentralization serves as a mechanism to curb the expansionary tendencies of the government. Similar to competition in the private sector, competition among decentralized governments can restrict the abilities of a monopolistic central government to gain more control over the economy's resources. In their view, competition between governments within a decentralized fiscal system, accompanied by mobile households and businesses, can serve as substitutes, either partially or completely, for explicit fiscal constraints on the taxing power of the government. Households with unrestricted mobility can "vote with their feet," relocating to jurisdictions that offer public goods corresponding to their preferences (Tiebout, 1956). This enhances the benefits of fiscal decentralization. When individuals have the freedom to choose their residence based on public goods provision, competition among jurisdictions emerges. Public officials are considered benevolent decision makers who cater to residents' needs, leading to innovation and better allocation of public resources. Fiscal decentralization, combined with household mobility, allows individuals to select localities that suit their desired public goods, which supposedly improves efficiency and responsiveness in the fiscal system.

The *second-generation fiscal federalism theory* has challenged this assumption of benevolent public officials and asserts that political actors are more driven by their own political interests (Oates, 2005). Hence, decentralization tends to favor policy issues that are more appealing to voters, such as health, education, and economic growth. Compared to economic and social sectors, natural disasters receive much less attention given their low frequency. Bo (2022) gives a rationale behind this: investing in pre-disaster prevention and control is crucial for enhancing the region's resilience to natural disasters and in minimizing disaster losses. Providing financial support for disaster relief after a calamity also aids in the economic recovery of affected areas. However, within a decentralized system, local governments often prioritize economic public goods and services, resulting in an increased opportunity cost for investing in disaster prevention and control measures. Consequently, the allocation of funds towards disaster mitigation

decreases. Burby (2006) describes this as the *local government paradox*, where local officials perceive natural disasters as secondary concerns and are reluctant to allocate resources for disaster mitigation.

Local government officials pay less attention to DRRM in local policies and projects since funding for these efforts does not result in obvious advantages that could manifest while they are in office. Local decisions on DRRM may sometimes conflict with development objectives. For example, LGUs that prioritize economic growth may intentionally relax their land use regulation and expand housing development in areas prone to floods, thereby raising the risk of flooding losses.

- ***Decentralization brings government 'closer to the people' but runs the risk of fragmentation in highly collaborative inter-governmental functions such as DRRM.***

Efficiency gains in service delivery can also be attained through accountability. Decentralization enhances accountability by bringing decision-makers closer to the citizens they serve. This proximity is thought to establish a direct link between public officials and constituents, fostering a sense of responsibility and responsiveness. Public officials are more directly accountable to the local population, as citizens can observe and evaluate their performance, promoting transparency and reducing the risk of power abuse. Furthermore, decentralized systems facilitate citizen participation through local elections and community engagement, empowering the electorate to select and monitor their representatives. Overall, decentralization strengthens accountability through increased proximity, transparency, and citizen participation (Pollitt, 2005).

This increased proximity may result in the fragmentation of disaster management. Without collaboration between the national government and the local government units, decentralized governments fail in DRRM. By their nature, disaster-related issues transcend single governmental jurisdictions, which calls for the integration of central and local actors. In disaster risk reduction and management, intergovernmental coordination between various jurisdictions is pivotal to avoid fragmentation which hampers disaster response (Hermansson, 2019). However, as previously mentioned, decentralization may lead to fragmentation, which makes it harder to attain efficient coordination of policies and programs.

According to global disaster policy frameworks, it is necessary that national governments take the lead in disaster policy to ensure sufficient funding and attention to the issues (Hutchcroft, 2001; Miller & Douglass, 2016). This emphasizes the importance of collaboration between different actors within the disaster management system. Hutchcroft (2001) argues that decentralization reforms should consider the existing central-local relationships in order to be effectively implemented. Moreover, studying the vertical relations between states' central and local authorities helps us comprehend the implications of decentralization processes (Hutchcroft, 2001). Since disasters often overwhelm local authorities and require assistance from the central level, these vertical relationships are crucial in disaster management on their

own. To enhance the handling of hazards and disasters, there is a recognized "need for greater understanding of the linkages between national and local governance systems" (Miller & Douglass, 2016, p. 2).

In the Philippines, this resulting fragmentation from decentralization has been observed in disaster risk reduction and management. In investigating the disaster governance in the three metropolitan areas in the country – Metro Manila, Metro Cebu, and Metro Davao – through case studies, Gera (2018) found evidence of political and bureaucratic fragmentation in DRRM. National government agencies responsible for implementing projects at the local level are required to coordinate with LGUs to ensure their participation in project planning and implementation. LGUs are also mandated to prepare comprehensive land use plans that integrate the requirements of national agencies, aligning local plans with national priorities. However, in the cases of Metro Manila and Metro Cebu, national line agencies often develop and implement programs without full coordination with local authorities. Investment programs submitted for national funding are predominantly conceived by central agencies, disregarding the integration of local development plans into regional and metropolitan plans. This results in separate urban master plans commissioned by entities like MMDA[4], MCDCB[5], or DPWH[6]. Outside Metro Manila, integrating local plans from municipalities, cities, and provinces into regional plans is a complex and time-consuming process. Highly urbanized and independent component cities have their own separate plans that must also be integrated into the regional plan. This poses challenges in reconciling disjointed plans that have been independently prepared with the assistance of various consultants and organizations.

The problem of integrating local development plans at the regional and metropolitan level extends to the planning of DRRM. Despite the bottom-up planning process, the fragmentation continues due to simultaneous planning by different national agencies involved in national DRRM councils. LGU development plans, including DRRM planning and investment programming, often prioritize projects based on the short-term goals of mayors or governors, rather than adhering to mandated long-term plans. This disregard for long-term plans stems from the lack of direct incentives for local officials (Gera, 2018).

The tradeoffs between centralization and decentralization

The *second-generation theory (SGT)* of fiscal federalism (Oates, 2005) differs from the first-generation theory in its approach to the electoral dimension of public sector structure. While the FGT tends to treat the vertical structure of the public sector like that of a firm, ignoring the electoral aspect, the SGT considers the electoral dimension and recognizes the role of central and decentralized governments as principal-agent relationships. In the SGT, the central government acts as the principal and aims to shape

[4] Metro Manila Development Authority
[5] Metro Cebu Development and Coordinating Board
[6] Department of Public Works and Highways

intergovernmental fiscal relations in a way that aligns with its objectives. It seeks to influence the behavior of regional or local governments, viewed as the agents, by designing fiscal arrangements that serve the interests of central officials. However, the central government faces challenges in gathering accurate information and exerting control over the fiscal activities of decentralized public agents (Oates, 2005). This approach highlights the importance of understanding the electoral dynamics and the imperfect information and control faced by the central government in achieving its objectives. The SGT recognizes the need to consider the incentives, motivations, and behaviors of both central and decentralized governments in designing effective fiscal arrangements and intergovernmental relations. The succeeding discussion on the tradeoffs between decentralizing and centralizing government were based on the work of Seabright (1996) and Oates (2005):

Tradeoff between local accountability and coordination. While decentralization empowers local and regional authorities and arguably increase their accountability, it can lead to fragmentation and coordination issues. Seabright (1996) defines accountability as the likelihood that the government's election would depend on the welfare of a specific jurisdiction. The decision to centralize or decentralize depends on weighing the impact of interjurisdictional spillover effects against the potential loss of accountability under central control. With decision-making powers dispersed across various jurisdictions, achieving coordination and harmonization of fiscal policies becomes more challenging. Inconsistent or conflicting fiscal measures among decentralized governments can result in macroeconomic imbalances, hindering overall economic stability and hampering the ability to respond effectively to economic shocks. The dispersal of decision-making power across multiple jurisdictions can hinder cohesive planning, resulting in inefficiencies and overlaps in the provision of public goods and services. The lack of central coordination may impede the realization of economies of scale and hinder cost efficiencies.

Tradeoff between competition and inequality. The benefit of decentralization in terms of creating a competitive environment among local governments carries with it the effect of exacerbating existing disparities and inequalities across local jurisdictions. Those that lag behind in terms of service provision will see an out-migration of households given our assumption that mobile households “vote with their feet.” Poor regions get poorer, while rich regions become richer, widening the interregional divide. Without a centralized redistribution mechanism, areas with limited fiscal capacity or fewer resources may struggle to meet the needs of their population adequately. This can lead to uneven access to essential public services and exacerbate regional disparities, undermining the goal of equitable resource allocation.

Decentralization may impede the provision of public goods with wide spillover effects. Spillover effects occur when the costs or benefits of a particular activity extend beyond the immediate entities involved and impact a wider community. The provision of public goods with spillover effects requires coordination, collective action, and sufficient resources. In a decentralized system, decision-making power is dispersed among several governing bodies, which can make reaching consensus more difficult. Where centralized authority is lacking, coordination and financing of critical infrastructure projects, environmental protection initiatives, or national defense efforts become more complex. Each body may prioritize its own interests over broader societal benefits, leading to underinvestment in public goods (Seabright, 1996). The fragmented decision-making and potential lack of resources at the local level can hinder the ability to address issues that transcend local government boundaries, leading to suboptimal outcomes and inefficient resource allocation. Moreover, capacity constraints and intergovernmental conflicts arise as challenges in a decentralized setup. Local governments may lack the expertise, resources, or administrative capacity to effectively manage complex policy issues. Interjurisdictional disputes and competition for resources can arise, impeding cooperation and hindering the achievement of collective goals (Seabright, 1996).

Fiscal decentralization incentivizes transfer dependency of local governments in funding DRRM. In the context of fiscal decentralization, "raiding the fiscal commons" refers to a phenomenon where lower levels of government, such as provincial or local authorities, exploit the fiscal resources or funds that are commonly shared or allocated among various government entities. It involves these lower-level governments excessively relying on financial support or bailouts from higher-level authorities, often the central government, without taking sufficient responsibility for their own fiscal management (Oates, 2005). Intergovernmental transfers, especially the local governments' expectation of bailouts by the central government, adversely affects the local incentives for investing in DRRM (Toya & Skidmore, 2013). Fiscal transfers from the central government to the local governments, specifically disaster-specific aid and assistance, may distort the incentives of LGUs to invest in disaster preparedness and mitigation, creating the *moral hazard problem* (Goodspeed, 2013; Wildasin, 2008). Increased decentralization then may inadvertently incentivize LGUs with more fiscal autonomy to intentionally limit their pre-disaster expenditures in anticipation of aid from the central government during future disasters. The dependency of LGUs for national government aid in the aftermath of disasters is supported by national government agency reports of the allocation of NDRRM Funds to predominantly post-disaster reconstruction and rehabilitation efforts for FY2016-2021 (*National Disaster Risk Reduction and Management Council Disaster Archives*, 2022).

Oates (2006) explains that instead of maintaining fiscal discipline and ensuring that their own financial houses are in order, these lower-level governments operate with the expectation that any fiscal

deficits they incur will be covered by the higher-level authority. This behavior can lead to a misallocation of resources, inadequate fiscal accountability, and a lack of incentive for efficient financial management at the lower levels of government. Ultimately, "raiding the fiscal commons" undermines the principles of fiscal decentralization by eroding the autonomy and responsibility of lower-level government entities. This problem extends beyond mere corruption and is deeply rooted in the incentives created by the political and fiscal systems for both public officials and the general population. In many cases, the specific structure of intergovernmental finance practically guarantees the occurrence of such destructive behavior.

The underlying cause of these "raids" can be attributed to the presence of the so-called "soft budget constraints" (Kornai, 1980). Initially used to describe the situation in state-owned enterprises within socialist nations, where managers could rely on the central government to rescue them from financial difficulties, it fostered an environment where these managers could oversee continuous financial losses without facing repercussions from higher authorities. Over time, the term has been expanded to include various economic entities whose financial losses are safeguarded by a "supporting organization." In contrast to hard budget constraints, "soft budget constraints" describe the phenomenon wherein lower levels of government operate with the expectation that their fiscal deficits will be covered by a higher-level government, often the central government. Consequently, provincial governors or local mayors can anticipate financial bailouts from higher authorities, absolving them from the need to maintain fiscal responsibility.

The situation becomes more complex due to the potentially significant role of the central government in providing "insurance." As argued by Lockwood (1999), there are times when decentralized governments face financial distress caused by external factors beyond their control. In such circumstances, the central government can offer valuable assistance to mitigate the impact of these external "shocks." However, similar to challenges faced in the private insurance sector, a genuine moral hazard problem arises. Especially in a politically contentious environment, it can be difficult to clearly distinguish between fiscal deficits resulting from external shocks and those arising from poor fiscal management (Oates, 2006).

Soft budget constraints are more prevalent when lower levels of decentralized government have inadequate tax systems and heavily depend on higher levels of government for fiscal transfers. Rodden et al. (2003) refer to this situation as "transfer dependency." To make difficult fiscal choices and carefully evaluate the advantages and drawbacks of new or expanded programs, public officials should be empowered to generate funds from their constituents through their own state and local tax systems. However, an excessive reliance on transfers creates incentives to seek an expansion of these transfers instead of raising taxes within their own jurisdiction (Oates, 2006).

3.2 Empirical Findings

Empirical evidence supporting the efficacy of decentralization as a general policy solution has been inconclusive so far. There is a multitude of studies that have analyzed the impact of decentralization on variables as diverse as investment and economic growth (Akai and Sakata, 2002), foreign direct investment (Kessing et al., 2007), corruption in government (Yamamura, 2012), health outcomes (Uchimura, 2012), quality of education (Faguet & Sanchez, 2008), and public happiness (Gao et al., 2014), among others. As discussed previously in this thesis, there are opposing arguments about the assumed benefits of decentralization in terms of the delivery of public goods and services, and the body of literature on this sector have so far produced results that are far from consistent. This discrepancy across research may be due to several factors, such as different samples, different definitions and measures of decentralization, different outcome measures, different empirical techniques, or something similar. Also, decentralization may simply be more successful in resolving some issues than others.

This thesis focuses on investigating the relationship between fiscal decentralization and disaster mitigation. Current research on the impact of fiscal decentralization on disaster outcomes are predominantly cross-country studies that investigate human and economic losses from disasters and decentralization at the national level using econometric panel regression techniques. Since governments are crucial to the management of natural disaster effects, statistics on disaster impacts offer a chance to assess the role that government structure plays in reducing disaster losses.

A frequently cited study in the field, Escaleras and Register (2012) analyzed the relationship between disaster death rate and total affected rate across 79 countries using data spanning the period 1972 to 2000 and found that fiscal decentralization is negatively correlated with disaster deaths. Local expertise and delegated spending power appear to be especially helpful in minimizing the risks associated with natural hazards and so lowering the number of fatalities and injuries caused by catastrophes. Escaleras and Register's empirical study produced two findings that are in line with this viewpoint. First, there is a general negative and statistically significant relationship between a nation's level of fiscal decentralization and the number of people who die in natural disasters, and this relationship holds across a range of criteria. The same holds true when disaster victims other than the fatalities are included in the study. Second, while both developed and developing countries showed negative correlations between federalism and the number of disaster-related fatalities, the association is statistically significant only for the developing countries.

Skidmore and Toya (2013) took off from the analysis of Escaleras and Register (2012) and added more control variables in the mix as they investigated fatalities from earthquakes, floods, landslides, volcanic eruptions, and windstorms across 78 countries over a three-decade period and came to a similar conclusion with its predecessor. Main findings suggest that countries with more fiscally decentralized

governments experience fewer disaster-related deaths. Using fiscal, economic, demographic, and geographic data with data on disaster-induced mortality, Skidmore and Toya (2013) also tested the possible effect of the degree of vertical imbalance between national and subnational governments, civil liberty, and human capital – as measured by educational attainment – on disaster deaths. Findings indicate the significant role of human capital in driving the effectiveness of decentralization in improving public service delivery, in this case, disaster mitigation: when accompanied by higher levels of educational attainment, decentralization works better at protecting life.

In another cross-country study, the impact of fiscal and political decentralization on the number of fatalities caused by earthquakes and floods for up to 46 developing and transitional economies between 1974 and 2004 was examined by Iqbal and Ahmed (2015). The results show that the effect of decentralization on disaster outcomes varies with the type and tiers of the decentralized governments. The effect of fiscal decentralization was not robust, but the result changes when interacted with political decentralization. Iqbal and Ahmed (2015) emphasized the significance of the combined effects of various forms of decentralization and suggests that when political and fiscal decentralization go hand in hand, the overall number of deaths from natural disasters for the lowest level of government is significantly decreased. Iqbal and Ahmed (2015) also argued that greater fiscal responsibility makes local governments more responsive to the vulnerable people. Yamamura (2012) tested the decentralization-disaster loss relationship across 44 countries over the period 1990 to 2001, and found that decentralization reduces deaths, with the effect more pronounced in countries with lower corruption and better functioning legal systems. Yamamura (2012) further observed that disaster-induced deaths decline more in developed countries where decentralization is coupled with high quality institutions.

It is important to note that one possible issue with cross-country research is its inability to fully address the possibility of omitted variable bias resulting from unobserved cross-country heterogeneity that may affect fiscal decentralization and disaster losses at the same time. Over the past few decades, disaster mortality has decreased significantly in many developing countries while growing more fragmented. Therefore, it may pose a challenge to present that the apparent link between fiscal decentralization and mortality brought on by disasters is causative. Given this challenge, studies which focus on a single country may offer an advantage in analyzing the fiscal decentralization-disaster losses relationship.

Miao et al. (2020) diverted from the cross-country approach commonly used in this strand of work and conducted a sub-national quantitative analysis of fiscal decentralization and disaster mitigation in the United States. Using state-level data on natural resource expenditures and economic losses from floods, the study found that states which are more decentralized in natural resource expenditures have experienced more economic losses from floods and storms. It is interesting to note that this result contrasts with previous studies which saw indication of a favorable effect of decentralization to disaster outcomes. Sub-national

data of a single country enables the estimation of the effect of fiscal decentralization more objectively than international data because it consists of minimal cultural, historical , and institutional variation – a challenge that comes with using cross-country datasets in quantitative research. Miao et al. (2020) explain that decentralized disaster mitigation can be ineffective due to interjurisdictional externalities. When one locality's mitigation efforts, like upstream dams, inadvertently increase risks for neighboring areas, it hampers the overall effectiveness. This is especially problematic in flood-prone regions, where the spillover effects are more pronounced. Fiscal decentralization worsens the situation by creating perverse incentives. For example, states vulnerable to floods may rely heavily on federal disaster relief, reducing their willingness to take proactive mitigation actions (Miao et al., 2020).

In another country-specific study, Hermansson (2016) investigated the inner workings of the decentralization of disaster management in Turkey, and found several factors that challenge decentralization processes, the most notable of which is the increased difficulty in achieving coordination and collaboration between the national and local governments in conducting disaster mitigation projects and programs. Also, the failure of the central government to match the expanded roles of local government in DRRM with their financing has challenged the decentralization process. The same problems were cited in a study of the disaster management in Indonesia, where Putra and Matsuyuki (2019) identified coordination and harmonization issues that followed decentralization. After decentralization, several challenges have emerged in building local institutions for disaster management in Indonesia. Inconsistencies within regulations have made it difficult for local governments to establish effective local disaster management institutions. Insufficient funding and capacity at the provincial level to support the establishment of such institutions also pose challenges. The limited involvement of experts in the preparation of disaster management plans hinder their effectiveness. Moreover, local governments are heavily reliant on central government bailouts, leading to a high dependence that can impede local decision-making and autonomy. Lastly, there has been an increase in corruption rates specifically in disaster management at the local level, posing additional challenges and compromising efficient disaster response and recovery (Putra & Matsuyuki, 2019).

In the Philippines, much of the discussion regarding disaster risk reduction and management has concentrated on the implication of decentralization on intergovernmental relationships as revealed by several case studies. For example, in assessing government response to Typhoon Washi that ravaged the Province of Misamis Oriental in Region 10 in 2010, Jovita et al. (2018) found that the prescribed tall structure and lead organization approach of network governance outlined in the DRRM Law is not effective in the regional and local disaster management networks of Region 10. Specifically, during Typhoon Washi in 2010, this structure failed to establish interdependencies among agencies at the regional level. The weak collaboration in the regional government network resulted in minimal information sharing among actors

and ineffective disaster response. Additionally, bureaucratic protocols limited the effectiveness of disaster response operations within local disaster management networks. Jovita et al. (2018) went further to recommend the re-centralization in DRRM at the regional level: “At the regional level, where many agencies and organizations are involved, the existing less centralized structure of decision-making should be transformed into a highly centralized structure” (p. 1).

In another case study, Gera (2018) argues that the Philippines' construction of local political boundaries fails to address the integration and scale required for urban disaster management in metropolitan regions. This is due to a political tug-of-war between central and local structures of power. The decentralization system embeds metropolitan governance within regional administrative governance, leading to limitations in centralized agencies' ability to effectively manage urban disasters. For example, integrated flood management reforms hinge on spontaneous collaborations among local entities, which are susceptible to changes in political alliances and the potential for deadlock in negotiations between jurisdictions. As a result, ad hoc collaborations among local entities are relied upon for integrated flood management, which can be hindered by jurisdictional negotiations. The study suggests reconfiguring the intergovernmental system and adopting appropriate scales for metropolitan structures to promote local capacity for urban resilience and sustainability. Gera (2018) posits that the current framework of decentralization in the Philippines is limiting local governance. Decentralization has reinforced local political rivalries and conflicts over the allocation of service delivery responsibilities, without effectively establishing corresponding fiscal authorities.

The challenge of coordination across all levels of government seems to be a common feature in the Philippine disaster response stories. A study which examined the coordination challenges during Typhoon Haiyan which devastated the Philippines in 2013 (mortality count: at least 6,300; affected population: more than four million) revealed that while there exist institutional approaches for DRRM in the law and policies, the capacity for implementation widely varies across sub-national governments (Dy & Stephens, 2016). National government entry and exit protocols were lacking in the Haiyan response, leading to a gap in response when overwhelmed local governments, who were also survivors, struggled to fulfill their role as first responders. The field offices of national line agencies faced challenges in providing technical assistance to municipal governments and could have played a more active role in advising the humanitarian cluster system's coordination hubs. While every town in the Philippines is supposed to have a local disaster management council and officer, many councils were inactive, and officers often held dual appointments due to resource limitations. Some communities had vacant positions or temporary political appointees in these roles. Provincial governments were largely overlooked in the Haiyan response, despite their potential to coordinate humanitarian assistance, address gaps, and act as intermediaries between national and municipal governments (Dy & Stephens, 2016).

Given that most disasters are sub-national in character, local governments may be in a better position to offer disaster protection as a local public good. Although this local advantage sounds appealing, it overlooks some unique characteristics of natural hazards and disaster mitigation. For one, this situation barely satisfies the traditional decentralization theory's no-externality premise. Cross-jurisdictional spillovers can result from many mitigation strategies, including the construction of protective infrastructure, when disasters occur. Decentralized disaster protection may not be provided effectively if there are interjurisdictional spillovers.

This thesis contributes to the literature on investigating the effect of fiscal decentralization on disaster damage at the sub-national level in the Philippines. Previous research on decentralization in the Philippines focused on sectors such as education and health, while disaster studies in the Philippines and elsewhere concentrated on the socioeconomic impacts of disasters. This thesis is an effort to bring attention to disaster risk reduction and management as it adds to the growing body of research on the effect of fiscal decentralization on public service delivery. Moreover, these strands of literature predominantly employ cross-country analyses, which involve unobserved differences in culture, history, and institutions among nations. This thesis offers a different approach by using smaller political units within a single (developing) country, which could help reduce the cross-sectional heterogeneity and provide insights into the role of decentralization in disaster management in the Philippine context. As the country is bound for increased fiscal decentralization, findings from this thesis can help inform policy on government structure and the devolution of responsibilities to local governments.

Fiscal decentralization is thought to impact the delivery of public services through attaining efficiency gains, fostering competition, and building accountability as it brings the government closer to the people. It is important to consider, however, the tradeoffs involved in becoming less centralized and becoming more decentralized. In a more decentralized setup coordination and collaboration across all levels of government becomes more difficult. Also, the institutional environment that is formed from decentralization can lead to increased inequality among jurisdictions. Providing public goods and services characterized to have wide spillover effects becomes more challenging in a decentralized setting due to a myriad of issues with the local government which includes capacity, fragmentation, and horizontal and vertical political conflicts. Relatedly, the problem of soft budget constraints and fiscal bailouts are moral hazards for local governments, further compromising the provision of public services such as disaster risk reduction and management.

Arguments supporting fiscal decentralization's positive and negative impacts on public service delivery in general may also apply to the provision of disaster risk reduction and management (DRRM) services in particular. The characteristic of DRRM of having externalities across jurisdictions makes the supposed efficiency gains from decentralization difficult to achieve. Moreover, DRRM usually falls behind in the prioritization of local government programs due to the perceived more immediate political effects of investing in economic public goods. Lastly, the resulting fragmentation from decentralization exacts significant costs in DRRM. Considering the first and second-generation fiscal federalism theories and how they apply to disaster management, and supplemented by anecdotal evidence from case studies in the Philippines exploring how fiscal decentralization resulted into challenges in DRRM of specific disaster events, this thesis proposes the following hypothesis:

Hypothesis: In the Philippines, fiscal independence of the provincial governments influences disaster impacts at the provincial level. More fiscal independence translates to more human losses from disaster.

4. METHODOLOGY

Data relating to human losses due to disaster, such as mortality and affected population, fiscal decentralization, capacity of local governments to prepare for disasters, social vulnerability, and hazard exposure were first gathered. Poisson and negative binomial (NB), which are General Linear Models, were employed to analyze the relationship between fiscal decentralization and disaster losses.

4.1 Variables

The unit of observation is a province-year for each of the 81 provinces[7] in the Philippines during the period 2017 to 2021. The panel is rather unbalanced, due to missing data or unreported data in some provinces for some indicators, resulting into 386 observations used in the regression models.

- ***Disaster mitigation***

The performance of providing disaster mitigation as a public service by the local governments is operationalized by using the data on human losses from disasters. Based on the reasoning that better disaster management tends to result in less deaths and less affected people from disasters, this study uses mortality and affected population as measures of disaster mitigation by the provincial governments. Disaster-induced deaths and the affected population are the two dependent variables used in this study. Disaster losses data were collected from the Situation Reports or sitreps compiled and reported by the National Disaster Risk Reduction Management Council (NDRRMC) of the Philippines. The sitreps contain information such as hazard information, affected population, and mortality per disaster event. The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) releases an annual report on tropical cyclones which lists down all typhoons, tropical storms, and tropical depressions that occurred within the Philippine Area of Responsibility. The PAGASA annual report was used to verify the meteorological events included in the disaster dataset. While these natural events have technical differences, accounting for these differences is inconsequential in this study. Henceforth, typhoons, tropical storms, and tropical depressions shall be referred to under the umbrella term *typhoon*. Disaster types included in this study are typhoons, earthquakes, landslides, and flooding incidents resulting from rainfall brought about by monsoons and low-pressure area, among other weather disturbances. For each disaster event, mortality, and the number of affected population (described in the sitreps as those who were displaced by the disaster event) were collected at the provincial level. The international emergency database EM-DAT archive maintained by the

[7] The Philippines currently has 82 provinces. In September 2022, Maguindanao del Norte was separated from the former province of Maguindanao (now Maguindanao del Sur) and became a province of its own. The dataset used in this thesis lists only 81 provinces due to the applicable statistics during the period covered (2017-2021).

non-profit institution Centre for Research on the Epidemiology of Disasters (CRED) was also used to cross-reference the disaster events in the Philippines.

- ***Fiscal decentralization***

The main independent variable of interest, fiscal decentralization, was measured using the *fiscal independence* of each province per year – with fiscal independence defined as own-sourced revenues expressed as a share of total revenues of the provincial government. Total revenues refer to the sum of total current operating income and non-income receipts. This measure of fiscal decentralization was based on Canare (2020) who identified a measure of fiscal decentralization that would fit the Philippine context.

While cross-country empirical studies utilized varying indicators of decentralization, most use the ratio of local government to central government expenditures or revenues (Akai & Sakata, 2002; Bo, 2022; Escaleras & Register, 2012; Iqbal & Ahmed, 2015; Skidmore & Toya, 2013; Yamamura, 2012). These are straightforward measures of decentralization since they specify how much of the revenue-raising and spending responsibilities are allocated to both the central and local governments. However, it can be more challenging to compare fiscal decentralization across local governments versus comparing across countries. Local governments in a country are subject to the same national regulations, and local governments may have very little control over finances. Nevertheless, literature offers some indicators that can be employed in country-specific decentralization research. One such fiscal decentralization indicator that may be used for the Philippines is *fiscal independence*, or the ability of local governments to generate revenue on its own rather than depending too much on the national government for transfers (Canare, 2020; Faguet & Sanchez, 2008). In this study fiscal decentralization is measured using own-source local government revenues expressed as the percentage of total revenues of the provincial government.

This indicator suits the Philippine context for several reasons. First, this indicator gauges the local government's ability to generate income on its own. The local government does not need to rely heavily on the national government for funding if it can create its own income and own-sourced earnings make up a significant portion of its total revenues. Manasan (1992) and Capuno (2017), two studies that were done two decades apart, observed that many local governments in the Philippines still rely largely on transfers from the national government for funding, which has an impact on their performance in providing public services. Second, Akai and Sakata (2002) contend that even while local government spending makes up a relatively small portion of overall government expenditures, the local government can still be considered independent provided its financial requirements can be met internally. Third, the IRA has become virtually the only source of revenues for some local governments in the Philippines. Even though significant duties have been delegated to local governments, some still heavily rely on the IRA to pay for these obligations. Fourth, having more locally generated revenue suggests that the local government can carry out more

initiatives independently, lowering the reliance of its residents on centrally funded initiatives. Manasan (1997) and Capuno (2017) demonstrated that certain local governments were unable to adequately carry out their decentralized duties after the 1991 decentralization because their local revenue was insufficient to cover their increased costs. Provincial government revenue data used to calculate the values for fiscal decentralization were obtained from the Annual Statement of Receipts and Expenditures of local government units provided by the Bureau of Local Government Finance.

- ***Other fiscal variables***

The vertical imbalance data was used to measure the dependence of LGUs to transfers from the national government. Vertical imbalance was computed by taking the ratio of national government transfers to total provincial government expenditures, following Skidmore and Toya (2013). Fiscal data were compiled from the provincial Annual Statement of Receipts and Expenditures provided by the Bureau of Local Government Finance. The variable Local Disaster Risk Reduction and Management (DRRM) Fund was included to account for the possibility of these funds being used for pre-disaster preparedness such as infrastructure and community projects that contribute to minimizing the harmful impacts of natural disasters. The local DRRM fund of the provincial governments were obtained from the annual Audit Reports of DRRM Funds by the Commission on Audit.

- ***Social vulnerability variables***

The social vulnerability indicators utilized in this study were obtained from the 2015 Philippines Census of Population and Housing, which is conducted and published by the Philippine Statistics Authority (PSA) every five years. The 2015 census represents the most recent publicly accessible data disaggregated at the provincial level. These indicators were selected based on a comprehensive review of existing studies on social vulnerability and the availability of data in the census. Previous research has shown that a community's vulnerability to disasters is influenced not only by the hazard itself but also by various social vulnerability factors, including socioeconomic status and housing conditions (Chen et al., 2021; Gray et al., 2022; Mavhura, 2017). Table 6 presents the five chosen social vulnerability indicators.

Table 6. Social vulnerability indicators

Vulnerability dimension	Indicators	Sources
Poverty	Poverty Incidence (%)	Gray et al. (2022), Fatemi et al. (2017)
Education	% of Population who are literate	Canare (2020), Yamamura (2012), Baharom et al.(2013), Skidmore and Toya (2007)
Provision of Amenities	% of Households with electricity for lighting	
	% of Households with access to safe water source	Yust et al. (1997), Gray et al. (2022)
Land Tenure	% of Households with secure land tenure	Ignacio (2015), Morin et al. (2016)

The social vulnerability indicators used in this study are poverty, education, provision of amenities, and land tenure. Previous literature has shown that disasters adversely impact poor communities disproportionately due to their limited financial resources, assets, and social networks, which impede their ability to adequately prepare for potential disasters. Education is associated with income and poverty, such that people with higher levels of education are likely to have greater access to, and act upon, hazard information. Higher educational attainment may enable citizens to make a series of choices ranging from engaging in safe construction practices to assessing potential risk that result in fewer deaths when a disaster strikes (Skidmore & Toya, 2007). The extent of information people comprehend about the consequences of disasters contributes to reducing damage costs. Well informed citizens are more sensitive to preparations against any ill-effect because of disasters. For instance, they would choose to live in areas less prone to floods or be more prepared in facing future disasters (Baharom et al., 2013).

The proportion of households with access to electricity and safe drinking water were used to assess provision of amenities, which is also a sign of a higher socioeconomic status (Gray et al., 2022; Yust et al., 1997). Households with secure land tenure generally face reduced vulnerability compared to renters, as renters often encounter difficulties in accessing the necessary funds for home maintenance, improvement, and repairs. Furthermore, secure land tenure decreases the risk of post-disaster displacement, as renters lack legal rights to influence the process of rebuilding or redevelopment (Ignacio, 2015; Morin et al., 2016).

- ***Hazard exposure***

Exposure to hazards is measured by using the data on the frequency of the occurrence of disasters in the Philippines collated from the individual sitreps published by the NDRRMC, which tags the provinces where typhoons make landfall and which areas were affected per disaster event. Communities exposed to more typhoons in a year would find it more difficult to mitigate the adverse effect of the next disaster. Frequency of disaster occurrences per year as a measure of hazard exposure has been widely used in

previous research, exhibiting a positive relationship with disaster mortality and number of affected population (Escaleras & Register, 2012; Iqbal & Ahmed, 2015; Kahn, 2005).

- ***Other control variables: urbanization, population data, and governance***

Risk from urbanization is seen to affect emerging urban areas, with concentrated losses in isolated rural regions (Gray et al., 2022). Vulnerability in these areas is heightened due to lower incomes and reliance on local resource economies such as agriculture and fishing. Urban municipalities benefit from greater access to institutional support networks and disaster preparation. While high population density in highly urbanized provinces can be seen as a potential source of risk, it can also be argued that densely populated urban areas are often better equipped to withstand the impact of tropical storms compared to rural areas. These areas tend to have stronger infrastructure and resources to cope with such disasters. Population is included to control for the size of the province. The quality of institutions or governance may also help mitigate disaster impacts. Better institutions may be better suited to achieve political accountability, taking proactive measures to adapt to disaster shocks and minimizing adverse effects when they occur. Local governments with better institutions have more capacity in providing public service such as local disaster risk reduction and management.

Urbanization and population per province were taken from the Census of Population and Housing, while the governance proxy used in this study is the Good Governance Index (GGI) published in 2008 by the Philippine Statistics Authority. The GGI assess key aspects of good governance, including: (1) effective resource management and ensuring sufficient financial resources, (2) upholding the rule of law, improving law enforcement, and administration of justice, (3) efficient provision of healthcare, education, and power supply services, and (4) civil participation in government (Philippine Statistical Yearbook, 2012). The observed effects of the predictor variables in previous research and their expected effects on disaster losses in this study is summarized in Table 7.

Table 7. Expected Effects of Variables on Disaster Losses

Predictor Variable	Expected Effects	Observed effects (References)
Fiscal decentralization	Positive	Positive (Miao et al., 2020) Negative (Escaleras & Register, 2012) Not significant (Iqbal & Ahmed, 2015)
Vertical imbalance	Ambiguous	Not significant (Skidmore & Toya, 2013)
Local DRRM Fund	Negative	No estimated effect to date
Exposure	Positive	Positive (Iqbal & Ahmed, 2015; Escaleras & Register, 2012; Gray et al., 2022)
Urbanization	Negative	Positive for earthquakes and negative for other disaster types (Kellenberg & Mobarak, 2007) Negative (Gray et al., 2022)

Predictor Variable	Expected Effects	Observed effects (References)
Education (Literacy)	Negative	Negative (Skidmore & Toya, 2013) Not significant (Miao et al., 2020; Yamamura, 2012)
Poverty	Positive	Positive (Gray et al., 2022; Fatemi et al., 2017)
Access to Electricity	Negative	Negative (Yust et al.,1997; Gray et al., 2022)
Access to Safe Water	Negative	Negative (Yust et al.,1997; Gray et al., 2022)
Secure Land Tenure	Negative	Negative (Ignacio, 2015; Morin et al., 2016)
Institutional quality (Good Governance Index)	Negative	Negative (Kahn, 2005)
Population	Positive	Positive (Kahn, 2005; Escaleras & Register, 2012; Skidmore & Toya, 2013; Baharom et al., 2013)

Data for variables that are not available every year have been imputed (*refer to Appendix B*).

- ***Variable descriptive statistics***

The descriptive statistics are shown in Table 8. The highest mortality count was 57 and was recorded in the Province of Benguet. Between 2017 and 2021 the number of disaster-induced deaths at the provincial level was 735, with 86.25 percent of provinces having mortalities. As for populations affected by disaster, all provinces recorded counts, with the province of Cebu having the highest count at almost 2.5 million people due to the onslaught of supertyphoon Odette in 2021. The standard deviation in disaster losses data were large, indicating the wide dispersion of data and potential outliers.

Table 8. Descriptive Statistics

Variable	Code	Mean	Std Dev	Min	Max
Dependent Variables					
Deaths (count)	*deaths*	1.8760	6.1043	0	57
Affected population (count)	*affected*	108,313.1000	247,581.2309	0	2,489,318
Independent Variable					
Fiscal Independence (%)	*fiscind*	0.1409	0.0938	0.0009	0.5593
Control Variables					
Vertical Imbalance (%)	*vi*	1.0649	0.3141	0.4303	3.0478
Local DRRM Fund (PhP million)	*ldf*	63.5950	85.4177	0.0000	997.2410
Disaster Exposure (count)	*exposure*	1.8260	1.4624	0	6
Urbanization (%)	*urban*	30.4200	21.2115	0.3600	94.8000
Literacy (%)	*literacy*	97.4400	2.8261	83.0000	99.7000
Poverty (%)	*pov*	17.3830	12.0001	1.7440	75.2810
Electricity (%)	*electric*	0.8388	0.1274	0.3309	0.9869
Safely Managed Water Source (%)	*water*	0.4703	0.2120	0.0294	0.9761
Secure Tenure (%)	*tenure*	0.5847	0.1234	0.3287	0.8172
Good Governance Index (continuous)	*gov*	123.8300	23.5209	79.0600	182.9200
Population (count)	*pop*	1,062,665	922,421	17,880	4,478,135

4.2 Estimation Technique

- ***Generalized linear models (GLM)***

Due to the non-normal distribution of the data on deaths and affected population, which violates the assumption of ordinary least squares (OLS) regression, a generalized linear model (GLM) was employed to allow for more flexible assumptions (*Refer to Appendix C for the OLS assumption checks*). An extension of OLS regression, GLM explores the relationship between the explained variables and potential explanatory variables. In this study, the dependent variable consisted of deaths and affected population count data, necessitating the use of count regression models that can accommodate non-negative and integer values. Based on previous research (Anbarci et al., 2005; Gray et al., 2022; Iqbal & Ahmed, 2015; Yamamura, 2012) that have investigated on the determinants of human losses from disasters and used the same estimation techniques, this study used Poisson and negative binomial regression models. The Poisson and negative binomial (NB) regression models were fitted using the R statistical software. To determine the best-fitting GLM, several metrics such as the log-likelihood (LL), Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC) were employed.

Two dependent variables were used: number of deaths and number of affected population due to disaster. The primary independent variable of interest was fiscal independence. Other fiscal data such as vertical imbalance and local DRRM fund were used as control variables. Social vulnerability indicators were included in the models as control variables as well. Exposure to disasters, urbanization, and governance were also used as control variables. Population per province served as an offset[8] in the model to account for differences in provincial population size, based on the same approach in the estimation models used in Gray et al. (2022). The use of an offset variable allows the modeling of the rate of incidence of the outcome variable, which provides a meaningful interpretation of the results later. Including population as an offset variable has the effect of dividing the predicted counts or rates by the corresponding population size, effectively standardizing the estimates across different population sizes. This allows for fair comparisons and interpretation of the relative impact of the independent variables on the outcome variable.

[8] Population is commonly used as an offset variable in negative binomial regression because it represents the underlying population or at-risk population for each observation. By including population as an offset variable, the regression model estimates the rate or incidence of the outcome variable per unit of population, which provides a meaningful interpretation of the results. The offset variable in a negative binomial regression is used to adjust for exposure or population size, and population is often used as the offset variable to estimate rates or incidences per unit of population.

- ***Poisson regression***

The Poisson regression model assumes a Poisson distribution error structure and uses the natural log(ln) link function, expressed as $\ln(\hat{\mu}) = b_0 + b_1X_1 + b_2X_2 + \ldots + b_pX_p + \ln(t)$

Where $(\hat{\mu})$ refers to the predicted count on the outcome variable given the values on the predictors $X_1, X_2, \ldots, X_p$. The natural logarithm is denoted by *ln*, the intercept by b_0 , and b_n is the regression coefficient for the predictors X_n. $\ln(t)$ is the offset variable. In Poisson regression, the outcome variable represents the count of events occurring in a fixed time interval or within a specific area. The offset variable is typically used to represent the exposure or length of the time interval or the size of the area. Thus, the models to be used in this study follows the equations:

$$\ln(deaths_{py}) = \beta_0 + \beta_1(fiscind_{py}) + \beta_2(vi_{py}) + \beta_3(ldf_{py}) + \beta_{SV}(X_{kpy}) + \beta_4(exposure_{py}) + \beta_5(urban_{py}) + \beta_6(gov_{py}) + \ln(pop_{py})$$

$$\ln(affected_{py}) = \beta_0 + \beta_1(fiscind_{py}) + \beta_2(vi_{py}) + \beta_3(ldf_{py}) + \beta_{SV}(X_{kpy}) + \beta_4(exposure_{py}) + \beta_5(urban_{py}) + \beta_6(gov_{py}) + \ln(pop_{py})$$

where $\boldsymbol{deaths_{py}}$ and $\boldsymbol{affected_{py}}$ refer to the human losses (mortality and affected population, respectively) from disasters in province *p* during year *y.* All the independent variables follow the same naming system, with the socioeconomic vulnerability control variables grouped together as *SV*. The offset variable *pop* adjusts for population size. The variables in the control vector $\boldsymbol{X_{kpy}}$ as well as the other control variables used in the equation—vertical imbalance (*vi*), local DRRM fund (*ldr*), hazard exposure (*exposure*), urbanization (*urban*), and Good Governance Index (*gov*)—are important because they allow for the isolation of the relationship between disaster outcomes and the fiscal decentralization indicator. The population variable has a coefficient of 1, serving as an offset variable that theoretically allows its use to convert the mortality count into a rate. The exponential coefficients represent the ratio of mortality incidence rates, also known as the incidence rate ratio (IRR).

One limitation of Poisson regression is the requirement of equidispersion, meaning that the conditional mean and conditional variance of the dependent variable should be equal. However, when this assumption is violated, a phenomenon called overdispersion occurs, where the variance of the actual counts is greater than the mean. To address overdispersion, negative binomial (NB) regression is commonly employed in mortality studies.

- ***Negative binomial regression***

Negative binomial (NB) regression extends the Poisson regression framework by incorporating a negative binomial distribution. Unlike the Poisson distribution, the negative binomial distribution assumes that the mean parameter follows a gamma distribution instead of being constant. By introducing an estimated dispersion parameter, NB regression effectively handles unobserved variability in count data, addressing the issue of overdispersion and allowing for independent specification of the mean and variance. When comparing regression models, it is important to assess the distribution of the data to identify the best-performing model. Overdispersion can be detected by examining the values of deviance/df or Pearson/df. If these values exceed 1 in the Poisson model, it indicates the presence of overdispersion, suggesting the consideration of the negative binomial approach.

Equidispersion in the two Poisson models was assessed using the deviance-degrees of freedom ratio. Results showed the deviance/df value to be significantly greater than 1, indicating the Poisson model experiences overdispersion, and the assumption of equidispersion is violated. Hence, the negative binomial model is deemed more suitable to the distribution of the data on deaths and affected population. The negative binomial model is also more appropriate in studies involving zero inflation, or an excess of zeroes in the data, meaning a substantial proportion of the observations are zero counts. Given the large number of data entries where disaster-induced deaths are zero (*Refer to Appendix D*), the negative binomial model is a better option in fitting the equations. The negative binomial model can handle both overdispersion and zero-inflation, making it a suitable choice in such cases.

- ***Goodness of fit and model selection***

In order to evaluate the fit of the models and determine the most suitable one, variables were tested for multicollinearity. Multicollinearity was assessed through calculating the variance inflation factor (VIF) for each variable to further investigate correlation (*Refer to Appendix E for the multicollinearity test results*). The VIF measures the extent to which the variance of the estimated regression coefficients is increased due to multicollinearity. VIF values below 5 were considered acceptable[9], and the VIF results for the variables considered were all below this threshold. Therefore, all variables were included in the models.

[9] A VIF value below 5 suggests a weak correlation between the predictor variable and other predictors. If the VIF falls between 5 and 10, it indicates a moderate level of correlation. When the value exceeds 10, it indicates a high degree of correlation among the predictors, which is considered unacceptable.

The NB model calculates a mortality incidence rate ratio (IRR) for each independent variable, denoted by Exp(β). In a negative binomial model, the rate ratio is used to interpret the effect of a predictor variable on the rate of an event or outcome. The rate ratio represents the multiplicative change in the rate of the outcome for a one-unit increase in the predictor variable while holding other variables constant. In the negative binomial model, the rate of the outcome variable is modeled using a linear predictor that combines the effects of predictor variables. The coefficients estimated for the predictor variables represent the logarithm of the rate ratio. The effect of a one-unit increase in X on the rate of the outcome variable is expressed as exp(β), which represents the multiplicative factor by which the rate changes. If exp(β) is greater than 1, it indicates a positive association between X and the rate of the outcome. A one-unit increase in X leads to a higher rate of the outcome by a factor of exp(β). If exp(β) is less than 1, it indicates a negative association, meaning a one-unit increase in X leads to a lower rate of the outcome. This multiplicative relationship on the rate scale allows for a more flexible and interpretable representation of the effects of predictor.

5. REGRESSION RESULTS

Regression results from the Poisson and negative binomial models with and without time fixed effects are presented in Table 9 (coefficients) and Table 10 (rate ratios). Both tables contain the incidence rate ratio and its associated upper and lower 95% Wald confidence interval (CI) and p-values for the Poisson and Negative Binomial regression models. Measures of goodness of fit were also included in the same table, where lower values mean a better fit for log-likelihood (LL), Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). The deviance/df of the Poisson models greatly exceeds 1, which means that the Poisson models suffer from overdispersion and the assumption of equidispersion is violated. Therefore, the NB models are more appropriate to use considering the distribution of the data on deaths and affected population.

The model evaluation metrics for goodness of fit further supported the superiority of the negative binomial (NB) model over the Poisson model. The negative binomial model exhibited significantly lower values for metrics such as log-likelihood (LL), Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC). Based on these metrics, it was evident that the NB model outperformed the Poisson model. Hence, the NB model was chosen as the preferred model because of its better performance. As previously mentioned, given its better goodness of fit and performance, this thesis focuses on the results of the negative binomial models.

In terms of disaster-induced deaths, five independent variables turn out to be significant explanatory variables, including our main independent variable of interest, fiscal independence. Model 3 in Table 9 shows the positive correlation between fiscal independence and deaths, which is consistent with the hypothesis earlier presented in this thesis. Hazard exposure and the Good Governance Index both exhibit positive relationship with disaster deaths, while urbanization and secure land tenure show negative relationship with disaster deaths. When checked for robustness using time fixed effects, as in Model 4 in Table 9, the same set of variables remained statistically significant and generally kept their coefficient values.

For the number of affected people, the following variables appear to be sound predictors of disaster-affected population per province based on Models 7 and 8 in Table 9: fiscal independence (+), vertical imbalance (+), local DRRM fund (+), hazard exposure (+), secure land tenure (-), urbanization (-), and Good Governance Index (-) of the province. However, it is interesting to note that vertical imbalance and secure land tenure were not consistently statistically significant in the two models. Nevertheless, our main variable of interest, fiscal independence, remain as a significant predictor of disaster-affected population throughout all versions of the models.

To allow for an interpretable representation of the effects of the predictor variables, the models used in this study calculated for the rate ratio or exp(β), which represents the multiplicative factor by which the rate changes. Using the rate ratio enables a more convenient description of effect sizes of the independent variables in our models. The regression results showing the rate ratios are summarized in Table 10.

The negative binomial models (Models 3 and 4, Table 10) show a strong positive association between fiscal independence and disaster-induced deaths. Specifically, for every one-unit increase in fiscal independence, the rate of deaths increases by a factor of 30.34 for the NB time FE model (confidence interval: 0.973-945.496). With time fixed effects (Model 4, Table 10), the other independent variables displayed strong explanatory power in the rate of deaths: hazard exposure (rate ratio: 2.06; confidence interval: 1.730-2.441), urbanization (rate ratio: 0.98; CI: 0.962-0.996), secure land tenure (rate ratio: 0.07; CI: 0.004-1.069), and Good Governance Index (rate ratio: 1.02; CI: 1.005-1.033). Based on these rate ratio values, it can be interpreted that hazard exposure has a moderate effect on deaths, while the GGI has a small positive effect on deaths. It is important to note that rate ratios that are below 1 indicate a negative correlation between the predictor and dependent variable. Hence, it can be said that urbanization has a weak negative impact on deaths, while secure land tenure has a strong negative effect on deaths.

For the model using disaster-affected population as the dependent variable (Model 8, Table 10), fiscal independence is observed to exhibit a stronger impact on mortality rate compared to the model using deaths as dependent variable (Model 4, Table 10). For every one-unit increase in fiscal independence, the rate of deaths increases by a factor of 86.65 (CI: 2.665-2817.343), suggesting a very strong positive association between the two variables. Vertical imbalance (rate ratio: 2.039; CI: 0.898-4.630), local DRRM fund (rate ratio: 1.004; CI: 1.001-1.007) hazard exposure (rate ratio: 3.85; CI: 3.228-4.588) exhibit a strong relationship with disaster-affected population, while GGI (rate ratio: 0.98; CI: 0.967-0.995) decreases a little bit. Urbanization maintains its rate ratio of 0.98 (CI: 0.963-0.996) and is more or less consistent across the model specifications.

- ***Robustness Checks***

Time fixed effects were included in the Poisson and NB models to serve as a robustness check to control for time-related factors, address time-invariant omitted variables and unobserved heterogeneity. If the estimated coefficients remain stable and statistically significant after controlling for time fixed effects, it provides confidence that the observed relationships between fiscal independence and disaster losses are not driven by time effects, strengthening the validity of the findings and increases the reliability of the

model. Using provincial fixed effects was not feasible due to the use of independent variables whose values do not vary over time.

Results of the models with time fixed effects show that fiscal independence remained a significant predictor of disaster-induced deaths and affected population in both the Poisson and NB models. Hazard exposure, urbanization, and good governance also remained significant as determinants of disaster losses. Appendix E presents the simple correlation plots of each independent variable with the dependent variable. Appendix F shows the detailed Poisson and negative binomial models results, including the confidence intervals, among others.

Table 9. Regression Results (Coefficients)

β	(1) Poisson	(2) Poisson	(3) Negative Binomial	(4) Negative Binomial	(5) Poisson	(6) Poisson	(7) Negative Binomial	(8) Negative Binomial
fiscal independence (*fiscind*)	3.555 ***	3.169 ***	3.953 **	3.412 *	1.490 ***	2.794 ***	5.097 ***	4.462 **
vertical imbalance (*vi*)	0.333 ***	0.369 ***	0.340	0.343	0.536 ***	0.602 ***	0.672	0.712 *
local DRRM fund (*ldf*)	0.002 ***	0.001 ***	0.002 *	0.001	0.001 ***	0.000 ***	0.006 ***	0.004 **
hazard exposure (*exposure*)	0.505 ***	0.463 ***	0.775 ***	0.720 ***	0.468 ***	0.431 ***	1.189 ***	1.348 ***
urbanization (*urban*)	-0.018 ***	-0.016 ***	-0.025 ***	-0.021 **	-0.008 ***	-0.008 ***	-0.024 ***	-0.021 **
education (*literacy*)	-0.164 ***	-0.156 ***	-0.097	-0.075	-0.007 ***	-0.014 ***	0.100	0.102
poverty incidence (*pov*)	0.002	0.000	-0.024	-0.024	0.013 ***	0.015 ***	-0.001	0.005
access to electricity (*electric*)	-0.061	-0.038	-1.291	-1.168	1.767 ***	1.650 ***	0.848	1.692
safe water source (*water*)	-0.411 *	-0.492 *	-0.232	-0.418	-0.542 ***	-0.560 ***	-0.937	-0.959
secure land tenure (*tenure*)	-4.187 ***	-3.932 ***	-3.233 **	-2.686 *	-0.643 ***	-0.578 ***	-2.414 *	-1.103
Good Governance Index (*gov*)	0.030 ***	0.030 ***	0.022 ***	0.019 ***	-0.013 ***	-0.012 ***	-0.018 **	-0.019 ***
(intercept)	13.366 ***	12.865 ***	8.294	6.509	10.185 ***	11.348 ***	0.745	-0.481
Dependent Variable	*deaths*	*deaths*	*deaths*	*deaths*	*affected*	*affected*	*affected*	*affected*
Time Fixed Effects	no	yes	no	yes	no	yes	no	yes
Log-Likelihood (LL)	(1,202.150)	(1,168.290)	(525.750)	(521.687)	(36,055,810)	(31,614,128)	(3,837.535)	(3,830.298)
Akaike Information Criterion (AIC)	2,430.300	2,370.600	1,079.500	1,079.400	72,111,646	63,228,290	7,703.100	7,696.600
Bayesian Information Criterion (BIC)	2,481.725	2,437.830	1,134.881	1,150.579	72,111,698	63,228,357	7,758.453	7,767.802
Deviance/df	5.420	5.295	0.713	0.720	193,319.400	171,340.800	1.308	1.319

*** *Significant at the 1% level*

** *Significant at the 5% level*

* *Significant at the 10% level*

Table 10. Regression Results (Rate Ratios)

Exp(β)	(1) Poisson		(2) Poisson		(3) Negative Binomial		(4) Negative Binomial		(5) Poisson		(6) Poisson		(7) Negative Binomial		(8) Negative Binomial	
fiscal independence (*fiscind*)	34.982	***	23.776	***	52.114	**	30.336	*	4.436	***	16.354	***	163.524	***	86.649	**
vertical imbalance (*vi*)	1.395	***	1.446	***	1.405		1.409		1.709	***	1.825	***	1.958		2.039	*
local DRRM fund (*ldf*)	1.002	***	1.001	***	1.002	*	1.001		1.001	***	1.000	***	1.006	***	1.004	**
hazard exposure (*exposure*)	1.658	***	1.588	***	2.171	***	2.055	***	1.597	***	1.538	***	3.285	***	3.848	***
urbanization (*urban*)	0.982	***	0.984	***	0.975	***	0.979	**	0.993	***	0.992	***	0.976	***	0.979	**
education (*literacy*)	0.849	***	0.855	***	0.907		0.928		0.993	***	0.986	***	1.106		1.107	
poverty incidence (*pov*)	1.002		1.000		0.977		0.976		1.014	***	1.015	***	0.999		1.005	
access to electricity (*electric*)	0.941		0.962		0.275		0.311		5.853	***	5.207	***	2.336		5.432	
safe water source (*water*)	0.663	*	0.611	*	0.793		0.659		0.581	***	0.571	***	0.392		0.383	
secure land tenure (*tenure*)	0.015	***	0.020	***	0.039	**	0.068	*	0.526	***	0.561	***	0.089	*	0.332	
Good Governance Index (*gov*)	1.031	***	1.030	***	1.022	***	1.019	***	0.987	***	0.988	***	0.982	**	0.981	***
(intercept)	6.38E+05	***	3.86E+05	***	4.00E+03		6.71E+02		2.65E+04	***	8.48E+04	***	2.106		0.618	
Dependent Variable	*deaths*		*deaths*		*deaths*		*deaths*		*affected*		*affected*		*affected*		*affected*	
Time Fixed Effects	no		yes		no		yes		no		yes		no		yes	
Log-Likelihood (LL)	(1,202.150)		(1,168.290)		(525.750)		(521.687)		(36,055,810)		(31,614,128)		(3,837.535)		(3,830.298)	
Akaike Information Criterion (AIC)	2,430.300		2,370.600		1,079.500		1,079.400		72,111,646		63,228,290		7,703.100		7,696.600	
Bayesian Information Criterion (BIC)	2,481.725		2,437.830		1,134.881		1,150.579		72,111,698		63,228,357		7,758.453		7,767.802	
Deviance/df	5.420		5.295		0.713		0.720		193,319.400		171,340.800		1.308		1.319	

**** Significant at the 1% level*

*** Significant at the 5% level*

** Significant at the 10% level*

6. DISCUSSION AND CONCLUSION

Fiscal decentralization has long been thought to play a role in enhancing the quality of delivering public services by granting local governments the authority to make decisions that better cater to the needs of their citizens. Specifically, regarding disaster mitigation, previous research indicates that countries with more decentralized government systems tend to experience fewer casualties resulting from natural disasters (Escaleras & Register, 2012; Skidmore & Toya, 2013). This thesis offers a fresh perspective as it challenges the conventional belief that decentralization is beneficial to Disaster Risk Reduction and Management. The merits of fiscal decentralization in this context are subject to debate, as discussed earlier, due to various factors such as the spillover effects between jurisdictions, the moral hazard that comes with the availability of national government bailouts, and the challenges associated with intergovernmental coordination. Moreover, the influence of decentralization on disaster mitigation can be further complicated by its impact on the quality of governance and other related factors. Given these complexities, this thesis takes a sub-national view in analyzing the effect of fiscal decentralization on natural disaster-induced human losses across the provinces in the Philippines. Using a panel study of provincial data over the period 2017 to 2021, results suggest that higher levels of fiscal independence are associated with more disaster deaths and a higher number of affected people, when controlling for the size of the provinces' local DRRM funds and national government-to-provincial government fiscal transfers as well as other provincial characteristics. These findings contrast those of previous cross-country research which have found a negative relationship between fiscal decentralization and disaster fatalities (Escaleras & Register, 2012; Skidmore & Toya, 2013; Yamamura, 2012), and are consistent with the findings in country-specific research (Miao, 2020).

Overall, the findings suggest that fiscal decentralization may lead to inefficient protection against disasters and may even increase the risk of disaster losses in provinces more prone to hydrometeorological and geological hazards. The positive correlation between fiscal independence and disaster losses at the provincial level were consistent across the model specifications, confirming the hypothesis that provinces which are more fiscally decentralized tend to suffer more deaths and have more affected people when disasters strike. In accordance with empirical literature, hazard exposure is strongly correlated with disaster losses. More urbanized provinces, provinces with more households having secure land tenure, and provinces with higher Good Governance Index scores are more likely to record higher human losses from disasters.

The positive relationship between fiscal decentralization and disaster losses reflects the tradeoffs that come with having more decentralized government, as explained in the second-generation theory of fiscal federalism. In the Philippines, local government units such as the provinces allocate significantly less resources on pre-disaster activities (preparedness projects, disaster-resilient infrastructure, for example)

than on post-disaster needs (rescue, rehabilitation, recovery, etc.). This explains for a large part why the rates of mortality and affected population tend to be high in provinces which are more fiscally independent. Due to the expectation that the national government will come to their rescue when a disaster occurs in their jurisdiction, provincial governments choose to allocate its limited financial resources to more productive (and popular) endeavors such as economic activities and social support programs. Public officials are more likely to spend on projects that post results within their term of office. Disaster risk reduction and management planning has been observed to be city mayor or provincial governor-centric, with ad hoc prioritization of projects designed to be co-terminus to the three-year term of office of the officials (Gera, 2018). In this sense, infrastructure programs and projects whose effects are expected to materialize in the longer term beyond the politicians' term of office – but may be crucial in avoiding floods, for example – get placed on the backburner. Previous studies which assessed the performance of LGUs after the 1991 Local Government Code unanimously concluded that after enacting the law providing for more fiscal decentralization, LGUs in general have exerted low efforts in raising their own local revenues and have been heavily dependent on the IRA or automatic transfers (Capuno, 2017; Diokno, 2012; Manasan, 2005). Even though the 1991 Code provided local governments with greater financial capabilities to generate revenue, they still rely on the IRA, which offer a consistent and increased opportunity for local chief executives to distribute favors and benefits. This transfer dependency is a moral hazard problem (Goodspeed, 2013; Wildasin, 2008) that jeopardizes pre-disaster investment – a very important factor in saving lives and in minimizing the number of affected households in the wake of a disaster.

Another factor explaining the positive relationship in the regression results is the externality involved in the provision of DRRM at the provincial level. Without an effective mechanism that would allow local government units to collaborate in terms of disaster planning and response for disaster events that usually affect multiple provinces at a time, a decentralized fiscal system would fail to deliver satisfactory outcomes. For example, the effectiveness of integrated flood management reforms in metropolitan areas in the Philippines depends on ad-hoc partnerships among neighboring localities that are susceptible to changes in political affiliations and potential stalemates in negotiations between different jurisdictions (Gera, 2018). This is consistent with the view that in a system where fiscal responsibilities are decentralized, an inequitable sharing of the burden of disaster management can arise if certain jurisdictions disproportionately bear the risks and costs while others benefit without making proportional contributions. This imbalance can lead to inadequate funding for disaster preparedness, response, and recovery efforts in jurisdictions that are more vulnerable or have limited fiscal capacity, thereby resulting in inefficiencies within the broader framework of disaster risk reduction and management (Miller & Douglass, 2016).

Due to the nature of disaster-related concerns, they extend beyond the boundaries of individual governmental jurisdictions, necessitating the collaboration and integration of both the national government

and the LGUs. In the realm of disaster risk reduction and management, effective intergovernmental coordination between different jurisdictions is crucial to prevent fragmentation that hinders efficient disaster response. However, decentralization can potentially contribute to fragmentation, making it more challenging to achieve effective coordination of policies and programs.

The findings of this study have important policy implications for determining the appropriate allocation of disaster management responsibilities among different levels of government in the Philippines. Despite local governments often being at the forefront of dealing with natural disasters, they may not necessarily be the most suitable entities for providing effective disaster protection, even with increased fiscal autonomy. The empirical results suggest that provinces experience fewer human losses when a greater proportion of financial resources is controlled by the national government. From a theoretical perspective, while centralized provision of public services may not allow for tailored outputs that account for local circumstances (Oates, 2006), centralized disaster management by provincial governments may not lead to significant efficiency losses if within-province heterogeneity is minimal. In fact, it may even result in welfare gains by addressing spillover effects and enhancing intergovernmental coordination. Therefore, provincial governments can be well-positioned to allocate resources and coordinate disaster-related activities across local jurisdictions. In the event of compound disasters resulting into several causalities and implications that go well beyond the current crisis, the study's findings highlight the need to pay more attention to the links and interactions between governance regimes at various sizes and across sectors. Decentralization provides a helpful tool through which to examine how the politics of disasters may be used in the pursuit of more equitable and inclusive policy choices. Collaboration, coordination, and cooperation across all levels of government are frequently cited as the main prerequisites to effective DRRM.

In this study it was observed that LGUs are heavily dependent on transfers from the national government and have very low own-sourced revenues. The concept of a sound financial resource base refers to the capacity of LGUs to generate revenue. As per the Local Government Code of 1991, provinces have limited authority in terms of taxation, yet they bear the significant responsibility of handling disaster risk reduction and management in their jurisdictions, which require substantial financial resources. Considering this, it is crucial to reevaluate and amend the taxation powers of provinces. Additionally, it is important to review and revise the distribution formula for the IRA to address the mismatch between the costs associated with building disaster-resilient infrastructure, addressing flooding in prone areas, protecting agriculture from typhoon impacts, and the available resources of LGUs. This issue has persisted for a majority of LGUs over a considerable period of time. The urgency of this call becomes even more pronounced due to a recent development, namely the Supreme Court's ruling on IRA which took effect in 2022, which mandates that the computation of LGUs' IRA share should be based on all national government tax revenues rather than solely on the revenues collected by the Bureau of Internal Revenue.

While care has been taken in conducting a sound analysis, the researcher acknowledges the limitations of this thesis. First, it is pertinent to mention that the measure of fiscal decentralization based on the LGU's own sourced revenues' share in total revenues is imperfect because this may not accurately and completely reflect all government investment in disaster mitigation. Another reason is that these revenues may be allocated by each LGU to other various public services such as social and economic services. Thus, results should be interpreted with caution. It is important to recognize that previous quantitative resarch on fiscal decentralization have used different ways of measuring fiscal decentralization based on cross-country data availability as well as on country contexts for sub-national decentralization analyses. Second, dealing with the potential endogeneity of fiscal decentralization is a recurring challenge in decentralization studies. Time fixed effects were included in the regression models to capture the effects of time that are constant across all provinces in the panel and help control for unobserved time-varying factors that may influence the disaster loss variable but have no bearing on the fiscal decentralization variable. However, the researcher notes that additional explanatory factors, such as the local DRRM fund and vertical imbalance, may not adequately resolve the endogeneity problem with this strategy.

This study contributes to the existing scholarship on investigating the relationship between fiscal decentralization and disaster losses at the sub-national level by employing a quantitative analysis, a method which is not commonly used in sub-national analyses mainly due to constraints in the availability of disaggregated data at the lowest levels of government in many countries. The findings from this study on the Philippines are generalizable to other country contexts which may have a similar government structure. The use of sub-national government level – the province – as the unit of analysis provides valuable insights into the fiscal decentralization-disaster losses nexus. Nevertheless, it is important to recognize that the generalizability of these findings might be influenced by other contextual factors specific to disaster-prone regions or different governance systems. The use of sub-national data in a single country setting in this thesis may limit the generalizability of the findings to the specific context of DRRM in the Philippines.

This thesis is intended to spark discussion about the extent to which decentralization helps improve public service delivery such as disaster management. As decentralization is commonly viewed as a "universal remedy" by international organizations and governments to countries struggling with governance, this thesis provides room for critical thought on this view. Without classifying decentralization as inherently good or bad, this thesis attempted to assess its influence on disaster outcomes using data measuring the degree of decentralization in a sub-national setting. While the results of this thesis show that higher fiscal decentralization may not necessarily contribute to the betterment of DRRM in the Philippines, it does not provide comprehensive basis for specific policy recommendations regarding the detailed design of complex disaster risk reduction governance. The LGUs' institutional and staff capacity, as well as the

autonomy given to LGUs, determine administrative effectiveness and efficiency. The design of non-fiscal responsibilities of the LGUs is also indispensable in this regard. This thesis represents a significant advancement as it prompts future research on the interplay between capacity, fiscal and non-fiscal autonomy at the local government level in relation to providing high-quality public services.

Given the limitations and generalizability considerations of this study, there is opportunity for further discourse on the topic. Future research may build on this thesis and delve deeper into the roles played by the hierarchical structure, decision-making, politics, and culture of the subject country, in the disaster governance of countries prone to natural hazards such as the Philippines. Nuanced policy recommendations may be arrived at by future studies through a more comprehensive and detailed view of the decentralization and DRRM nexus. In terms of unit of observation, future research may concentrate on even lower jurisdictional levels, such as cities or municipalities, to detect the regional spillover impacts of natural disaster and DRRM more accurately. Replication studies in diverse settings may enhance the applicability of the findings of this study to other countries with similar or contrasting characteristics. Future studies may investigate how local decisions about zoning regulations, housing development, and the expenditures on defense infrastructure are influenced by decentralized government structures. Looking at the interactions between provincial and municipal governments in terms of hazard mitigation strategies and aid distribution may also be of interest. Other wealthy or developing nations can carry out comparable analyses at the sub-national level to assess the external validity of earlier study findings.

REFERENCES

Akai, N., & Sakata, M. (2002, July). Fiscal decentralization contributes to economic growth: evidence from state-level cross-section data for the United States. *Journal of Urban Economics*, *52*(1), 93–108. https://doi.org/10.1016/s0094-1190(02)00018-9

Anbarci, N., Escaleras, M., & Register, C. A. (2005, September). Earthquake fatalities: the interaction of nature and political economy. *Journal of Public Economics*, *89*(9–10), 1907–1933. https://doi.org/10.1016/j.jpubeco.2004.08.002

Aoki, N., & Schroeder, L. (2014, January 2). An Approach to Measuring Subnational Administrative Autonomy in Education. International Journal of Public Administration, 37(1), 10–19. https://doi.org/10.1080/01900692.2013.809588

Baharom, Padli, & Habibullah. (2013, September). Determinants of Flood Fatalities: Evidence from a Panel Data of 79 Countries. *Pertanika Journal of Social Science and Humanities*. https://www.researchgate.net/publication/260096101_Determinants_of_Flood_Fatalities_Evidence_from_a_Panel_Data_of_79_Countries

Bahl, R., & Linn, J. (1994). Fiscal Decentralization and Intergovernmental Transfers in Less Developed Countries. *CrossRef Listing of Deleted DOIs*, *24*(1), 1. https://doi.org/10.2307/3330701

Balisacan, A. M., Hill, H., & Piza, S. F. (2008, December). Regional Development Dynamics and Decentralization in the Philippines: Ten Lessons from a " Fast Starter." *Asean Economic Bulletin*, *25*(3), 293–315. https://doi.org/10.1355/ae25-3d

Balisacan, A. M., Hill, H., & Piza, S. F. (2008, December). Regional Development Dynamics and Decentralization in the Philippines: Ten Lessons from a " Fast Starter." *Asean Economic Bulletin*, *25*(3), 293–315. https://doi.org/10.1355/ae25-3d

Bankoff, G. (2003, August 27). Cultures of Disaster: Society and Natural Hazards in the Philippines. https://doi.org/10.1604/9780203221891

Bo, W. (2022, October 8). Fiscal Decentralization and Natural Disaster Relief in China. *Advances in Politics and Economics*, *5*(4), p20. https://doi.org/10.22158/ape.v5n4p20

Brennan, G., & Buchanan, J. M. (1980, October 31). *The Power to Tax: Analytic Foundations of a Fiscal Constitution*. https://doi.org/10.1604/9780521233293

Brilliantes. (1998). Five-year Assessment of the Implementation of Devolution in the Local Government Code. In *Local Government in the Philippines: A Book of Readings* (Vol. 2, pp. 521–536). University of the Philippines.

Burby, R. J. (2006, March). Hurricane Katrina and the Paradoxes of Government Disaster Policy: Bringing About Wise Governmental Decisions for Hazardous Areas. *The ANNALS of the American Academy of Political and Social Science*, *604*(1), 171–191. https://doi.org/10.1177/0002716205284676

Campos, & Hellman. (2005). Governance gone local : does decentralization improve accountability? *World Bank*. https://www.researchgate.net/publication/237259246_Governance_Gone_Local_Does_Decentr_alization_Improve_Accountability

Canare. (2020, December). Decentralization, Local Government Fiscal Independence, and Poverty: Evidence from Philippine Provinces. *Southeast Asian Journal of Economics*, *8*(2), 77–108.

Capuno. (2017). Tugs of War: Local Governments, National Government. *UP-Center for Integrative and Development Studies*, *XVI–XVII*, 99–116. https://serp-p.pids.gov.ph/publication/public/view?slug=tugs-of-war-local-governments-national-government

Chen, Y., Liu, T., Ge, Y., Xia, S., Yuan, Y., Li, W., & Xu, H. (2021, August). Examining social vulnerability to flood of affordable housing communities in Nanjing, China: Building long-term disaster resilience of low-income communities. *Sustainable Cities and Society*, *71*, 102939. https://doi.org/10.1016/j.scs.2021.102939

Col, J. M. (2007, December 7). Managing Disasters: The Role of Local Government. *Public Administration Review*, *67*, 114–124. https://doi.org/10.1111/j.1540-6210.2007.00820.x

Department of Budget and Management. (2021, November 9). FAQs Mandanas-Garcia SC Ruling. In *www.dbm.gov.ph*. Retrieved January 28, 2023, from https://www.dbm.gov.ph/wp-content/uploads/Mandanas-Garcia-Case/IEC-Materials/FAQs-Mandanas-Garcia-Ruling.pdf

Dilley, Chen, & Deichmann. (2005). *Natural Disaster Hotspots: A Global Risk Analysis*. The World Bank Hazard Management Unit. Retrieved March 10, 2023, from https://documents1.worldbank.org/curated/en/621711468175150317/pdf/344230PAPER0Na101official0use0only1.pdf

Diokno. (2012, June). Fiscal decentralization after 20 years: What have we learned? Where do we go from here? *The Philippine Review of Economics*, *XLIX*(1), 9–26. https://econ.upd.edu.ph/pre/index.php/pre/article/viewFile/670/776

Disaster. (n.d.). Disaster | United Nations Office for Disaster Risk Reduction. https://www.undrr.org/terminology/disaster

Domingo, & Manejar. (2018). *Disaster Preparedness and Local Governance in the Philippines*. Philippine Institute for Development Studies. Retrieved May 21, 2023, from https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps1852.pdf

Dunn, P. K., & Smyth, G. K. (2018, November 11). *Generalized Linear Models with Examples in R*. Springer. https://doi.org/10.1007/978-1-4419-0118-7

Earthquake- & Volcano-Related Maps | GeoHazards Portal | PHIVOLCS | DOST. (n.d.). Earthquake- & Volcano-Related Maps | GeoHazards Portal | PHIVOLCS | DOST. https://gisweb.phivolcs.dost.gov.ph/gisweb/earthquake-volcano-related-hazard-gis-information

EM-DAT | The international disasters database. (n.d.). EM-DAT | the International Disasters Database. https://www.emdat.be

Escaleras, & Register. (2012, April). Fiscal decentralization and natural hazard risks. *Public Choice*, *151*(1/2), 165–183. https://www.jstor.org/stable/41406921

Faguet, J. P., & Sánchez, F. (2008, July). Decentralization's Effects on Educational Outcomes in Bolivia and Colombia. *World Development*, *36*(7), 1294–1316. https://doi.org/10.1016/j.worlddev.2007.06.021

Fatemi, F., Ardalan, A., Aguirre, B., Mansouri, N., & Mohammadfam, I. (2017, June). Social vulnerability indicators in disasters: Findings from a systematic review. *International Journal of Disaster Risk Reduction*, *22*, 219–227. https://doi.org/10.1016/j.ijdrr.2016.09.006

Gao, S., Meng, X., & Zhang, L. (2014, January 8). Fiscal Decentralization and Life Satisfaction: Evidence from Urban China. *Social Indicators Research*, *119*(3), 1177–1194. https://doi.org/10.1007/s11205-013-0552-z

Gera, W. (2018, December 20). Scalar politics in Philippine urban disaster management: reframing metropolitan governance for local resilience and sustainability. *Erdkunde*, *72*(4), 287–311. https://doi.org/10.3112/erdkunde.2018.04.03
Gera, W. (2018, December 20). Scalar politics in Philippine urban disaster management: reframing metropolitan governance for local resilience and sustainability. *Erdkunde*, *72*(4), 287–311. https://doi.org/10.3112/erdkunde.2018.04.03
Goodspeed, T. (2013). Decentralization and Natural Disasters. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2244825

Gray, J., Lloyd, S., Healey, S., & Opdyke, A. (2022, April). Urban and rural patterns of typhoon mortality in the Philippines. *Progress in Disaster Science*, *14*, 100234. https://doi.org/10.1016/j.pdisas.2022.100234

Hermansson, H. (2016, November 24). Disaster Response in Turkey: Conditions Promoting Cross-Sectoral Collaboration and Implications for Effectiveness. *Administration & Society*, *51*(7), 1051–1078. https://doi.org/10.1177/0095399716680058

Hutchcroft, P. D. (2001, January). Centralization and Decentralization in Administration and Politics: Assessing Territorial Dimensions of Authority and Power. *Governance*, *14*(1), 23–53. https://doi.org/10.1111/0952-1895.00150

Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disasters - full text. (n.d.). Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters - Full Text | UNDRR. https://www.undrr.org/publication/hyogo-framework-action-2005-2015-building-resilience-nations-and-communities-disasters

Ignacio. (2015). Measuring social vulnerability to climate change-induced hazards in the Philippines. In *Université De Namur*.

Iqbal, & Ahmed. (2015). Are Decentralised Governments More Effective in Mitigating Disaster Risks? *The Bangladesh Development Studies*, *38*(3), 1–24. https://www.jstor.org/stable/26538810

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013, June 24). *An Introduction to Statistical Learning: With Applications in R* (Vol. 103).

Jha, S., Martinez, Jr., A., Quising, P., Ardaniel, Z., & Wang, L. (2018). Natural Disasters, Public Spending, and Creative Destruction: A Case Study of the Philippines. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3204166

Jovita, H. D., Nurmandi, A., Mutiarin, D., & Purnomo, E. P. (2018, November 12). Why does network governance fail in managing post-disaster conditions in the Philippines? *Jàmbá: Journal of Disaster Risk Studies*, *10*(1). https://doi.org/10.4102/jamba.v10i1.585

Kellenberg, & Mubarak. (n.d.). The Economics of Natural Disasters. *Annual Review of Resource Economics*, *3*, 297–312. https://doi.org/10.1146/annurev-resource-073009-104211

Kessing, S. G., Konrad, K. A., & Kotsogiannis, C. (2007, January 1). Foreign direct investment and the dark side of decentralization. *Economic Policy*, *22*(49), 6–70. https://doi.org/10.1111/j.1468-0327.2007.00172.x

Kornai, J. (1980, January 1). *Economics of Shortage: Vol. Vol. 131*. North Holland. https://doi.org/10.1604/9780444860583

Lockwood, B. (1999, April). Inter-regional insurance. *Journal of Public Economics*, *72*(1), 1–37. https://doi.org/10.1016/s0047-2727(98)00088-7

Love Yust, B., Hadjiyanni, T., & Ponce, L. B. (1997, January). Exploring Housing Quality Measures in a Rural area of the Philippines. *Housing and Society*, *24*(1), 59–74. https://doi.org/10.1080/08882746.1997.11430260

Manasan. (1992). Fiscal implications of the Local Government Code of 1991. *Journal of Philippine Development*, *19*(1), 1–58.

Manasan. (1997). Local government financing of social service sectors in a decentralized regime: Special focus on provincial governments in 1993 and 1994. *Philippine Institute for Development Studies Discussion Paper Series No. 97-04*.

Mavhura, E., Manyena, B., & Collins, A. E. (2017, November). An approach for measuring social vulnerability in context: The case of flood hazards in Muzarabani district, Zimbabwe. *Geoforum*, *86*, 103–117. https://doi.org/10.1016/j.geoforum.2017.09.008

Miao, Q., Shi, Y., & Davlasheridze, M. (2020, October 7). Fiscal Decentralization and Natural Disaster Mitigation: Evidence from the United States. *Public Budgeting & Finance*, *41*(1), 26–50. https://doi.org/10.1111/pbaf.12273

Miller, M. A., & Douglass, M. (2016, March). Introduction: Decentralising disaster governance in urbanising Asia. *Habitat International*, *52*, 1–4. https://doi.org/10.1016/j.habitatint.2015.08.028

Morin, V. M., Ahmad, M. M., & Warnitchai, P. (2016, January 8). Vulnerability to typhoon hazards in the coastal informal settlements of Metro Manila, the Philippines. *Disasters*, *40*(4), 693–719. https://doi.org/10.1111/disa.12174

Musgrave. (1959). *The Theory of Public Finance*. McGraw-Hill.

National Disaster Risk Reduction and Management Council Disaster Archives. (n.d.). Office of Civil Defense. Retrieved February 16, 2023, from https://ndrrmc.gov.ph/19-ndrrmc-disaster-archive/4154-2017-disaster-archives.html

NDRRMC. (2011). *National Disaster Risk Reduction and Management Plan* . Retrieved December 13, 2022, from https://www.adrc.asia/documents/dm_information/Philippines_NDRRM_Plan_2011-2028.pdf

Oates, W. E. (2005, August). Toward A Second-Generation Theory of Fiscal Federalism. *International Tax and Public Finance*, *12*(4), 349–373. https://doi.org/10.1007/s10797-005-1619-9

Oates. (1972). *Fiscal Federalism*. Harcourt Brace Jovanovich.

Philippine Atmospheric, Geophysical & Astronomical Services Administration. (n.d.). Government of the Philippines. Retrieved January 17, 2023, from https://www.pagasa.dost.gov.ph

Philippine Statistical Yearbook 2012. (2012). In *Philippine Statistics Authority*. Philippine Statistics Authority. Retrieved January 10, 2023, from https://psa.gov.ph/content/2012-philippine-statistical-yearbook

Pollitt. (2005). Decentralization. In *The Oxford Handbook of Public Management* (pp. 371–397). Oxford.

Publication: Philippines - Public Expenditure Review : Strengthening Public Finance for More Inclusive Growth. (2011). World Bank. Retrieved February 2, 2023, from https://openknowledge.worldbank.org/entities/publication/b9041fc0-fb3e-570c-8644-350c54c3e7e1

Putra, D. I., & Matsuyuki, M. (2019, February 1). Disaster Management Following Decentralization in Indonesia: Regulation, Institutional Establishment, Planning, and Budgeting. *Journal of Disaster Research*, *14*(1), 173–187. https://doi.org/10.20965/jdr.2019.p0173

Republic Act No. 10121 | GOVPH. (2010, May 27). Republic Act No. 10121 | Official Gazette of the Republic of the Philippines. https://www.officialgazette.gov.ph/2010/05/27/republic-act-no-10121/

Rodden, J. A., Eskeland, G. S., & Litvack, J. I. (Eds.). (2003, February 14). *Fiscal Decentralization and the Challenge of Hard Budget Constraints*. https://doi.org/10.1604/9780262182294

Seabright, P. (1996, January). Accountability and decentralisation in government: An incomplete contracts model. *European Economic Review*, *40*(1), 61–89. https://doi.org/10.1016/0014-2921(95)00055-0

Sendai Framework for Disaster Risk Reduction 2015-2030. (n.d.). Sendai Framework for Disaster Risk Reduction 2015-2030 | UNDRR. https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030#:~:text=The%20Sendai%20Framework%20for%20Disaster,Investing%20in%20disaster%20reduction%20for

Skidmore, M., & Toya, H. (2013). Natural Disaster Impacts and Fiscal Decentralization. *Land Economics*, *89*(1), 101–117. https://doi.org/10.3368/le.89.1.101

The Typhoon Haiyan Response: Strengthening Coordination among Philippine Government, Civil Society, and International Actors. (2016). *PCL Discussion Paper Series*, 21–56. https://www.hks.harvard.edu/sites/default/files/centers/research-initiatives/crisisleadership/files/Dy_and_Stephens.pdf

Tiebout, C. M. (1956, October). A Pure Theory of Local Expenditures. *Journal of Political Economy*, *64*(5), 416–424. https://doi.org/10.1086/257839

Uchimura, H. (Ed.). (2012, January 1). *Fiscal Decentralization and Development: Experiences of Three Developing Countries in Southeast Asia*.

Wildasin, D. E. (2008, July). Disaster Policies. *Public Finance Review*, *36*(4), 497–518. https://doi.org/10.1177/1091142107306286

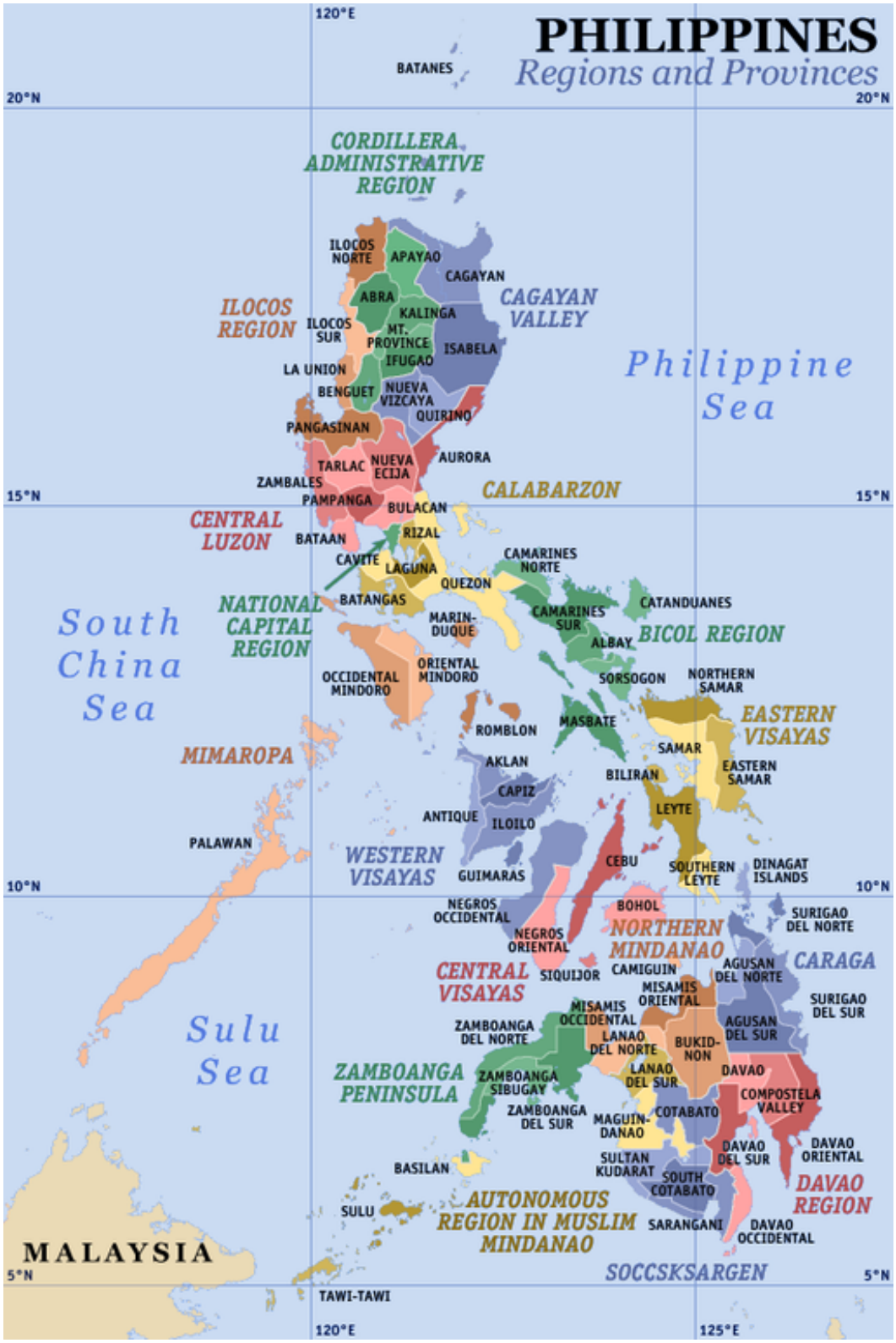
Wooldridge, J. M. (2019, January 4). *Introductory Econometrics: A Modern Approach*.

World Risk Report 2022. (2022, January 1). World Risk Report 2022. https://repository.gheli.harvard.edu/repository/10930/

Yamamura. (2012). Death tolls from natural disasters: Influence of interactions among fiscal decentralization, institutions, and economic development. *EERI Research Paper Series*. https://ideas.repec.org/p/eei/rpaper/eeri_rp_2012_08.html

APPENDICES

Appendix A. Philippines Provincial Map

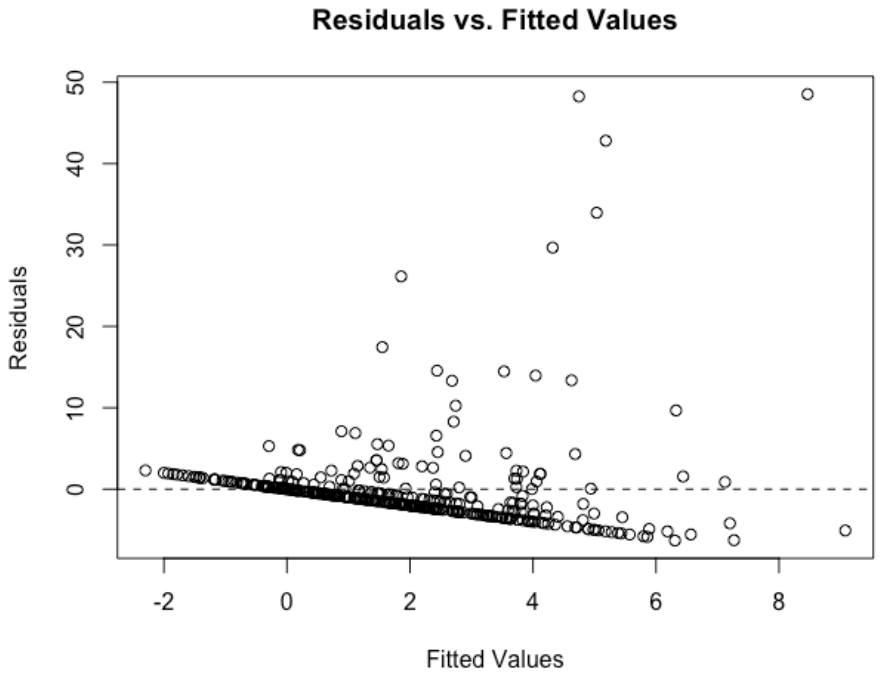


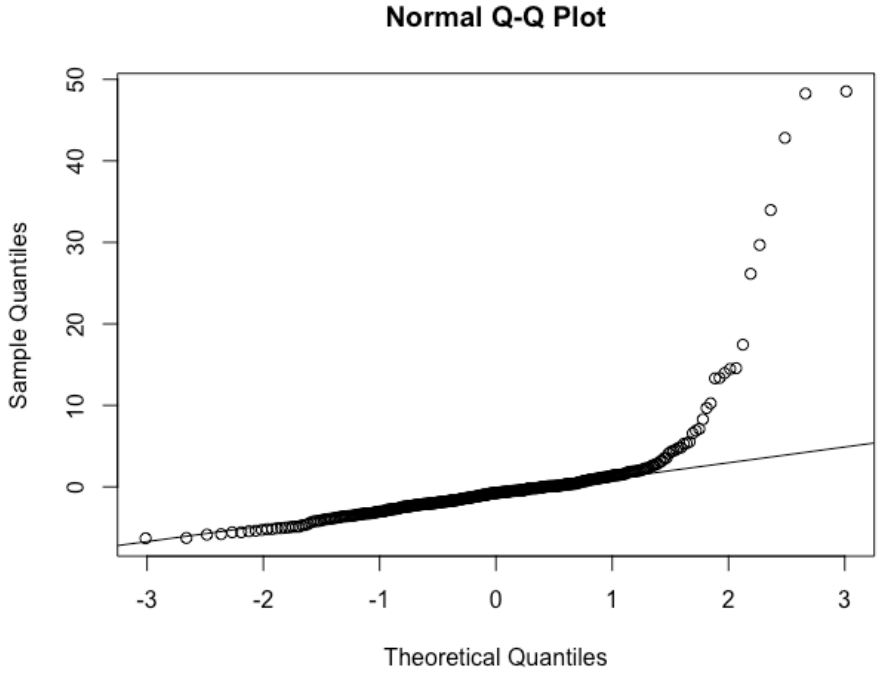
Source: Eugene Alvin Villar (seav), CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons

Appendix B. Summary of Imputed Values

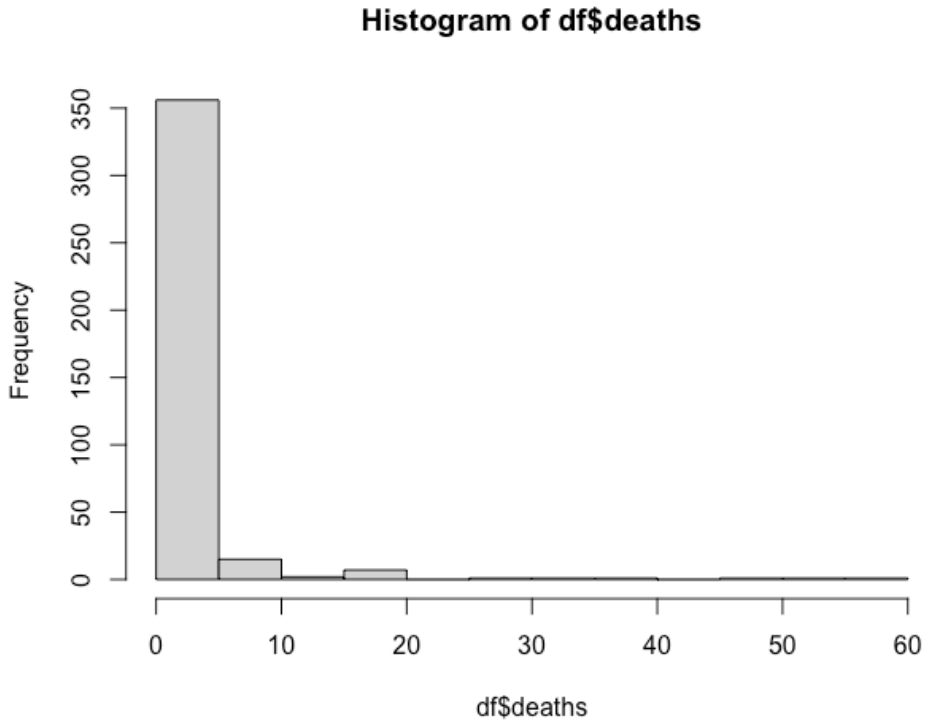
Variable	Source	Data Available (Years)	Data used	Years with Imputed Values
Deaths (count)	NDRRMC Sitreps	2017 - 2021	2017 - 2021	none
Affected population (count)	NDRRMC Sitreps	2017 - 2021	2017 - 2021	none
Fiscal Independence (%)	Computed from BLGF SRE	2017 - 2021	2017 - 2021	none
Vertical Imbalance (%)	Computed from BLGF SRE	2017 - 2021	2017 - 2021	none
Local DRRM Fund (PhP million)	COA Annual Report on DRRM Funds	2017 - 2021	2017 - 2021	none
Disaster Exposure (count)	Computed from NDRRMC Sitreps	2017 - 2021	2017 - 2021	none
Urbanization (%)	PSA Census of Population and Housing	2015, 2020	2015, 2020	2016 - 2019, 2021
Literacy (%)	PSA Census of Population and Housing	2015	2015	none
Poverty (%)	PSA Census of Population and Housing	2015, 2018, 2020	2015, 2018, 2020	2016, 2017, 2019, 2021
Electricity (%)	PSA Census of Population and Housing	2015	2015	none
Safely Managed Water Source (%)	PSA Census of Population and Housing	2015	2015	none
Secure Tenure (%)	PSA Census of Population and Housing	2015	2015	none
Good Governance Index (continuous)	PSA Census of Population and Housing	2008	2008	none
Population (count)	PSA Census of Population and Housing	2010, 2015, 2020	2015, 2020	2016 - 2019, 2021

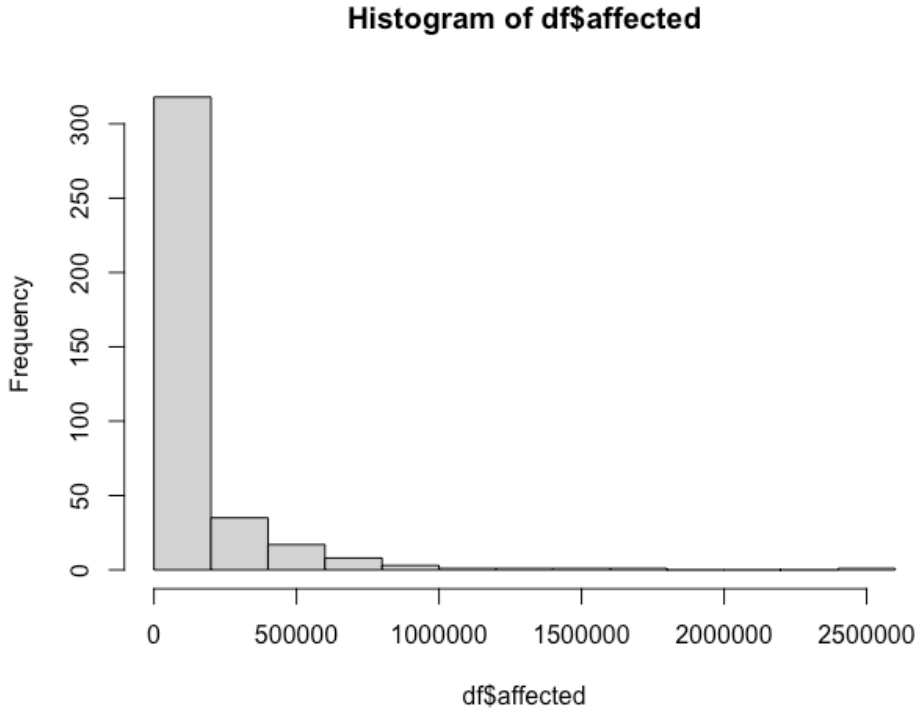
Appendix C. OLS Linearity Assumption Checks

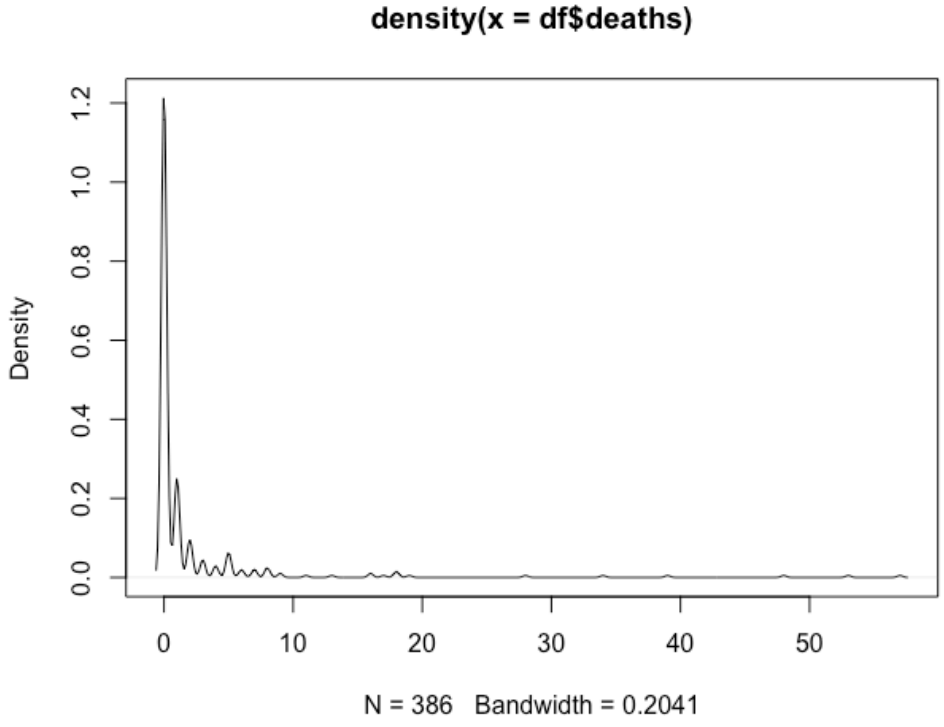


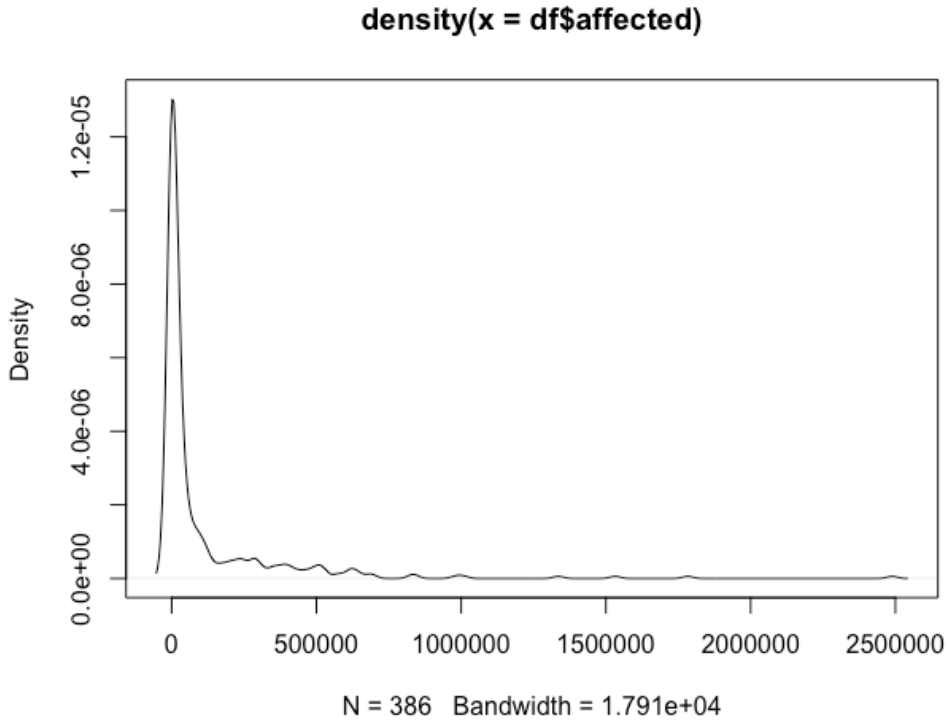


Appendix D. Dependent variables Histograms and Density Plots






density(x = df$deaths)
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
10
20
30
40
50
N = 386 Bandwidth = 0.2041


density(x = df$affected)
Density
0.0e+00
4.0e-06
8.0e-06
1.2e-05
0
500000
1000000
1500000
2000000
2500000
N = 386 Bandwidth = 1.791e+04

APPENDIX E. Multicollinearity Test (VIF) Results

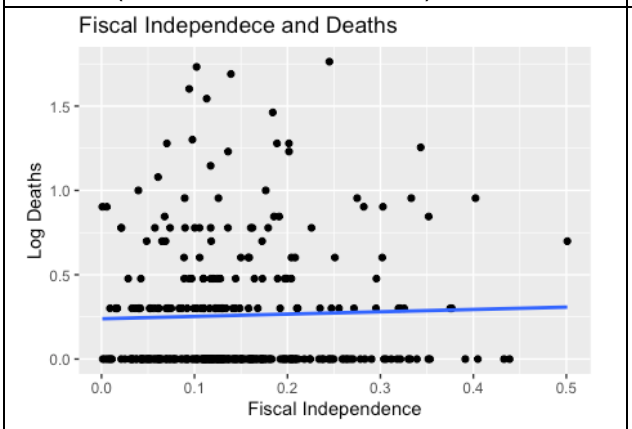
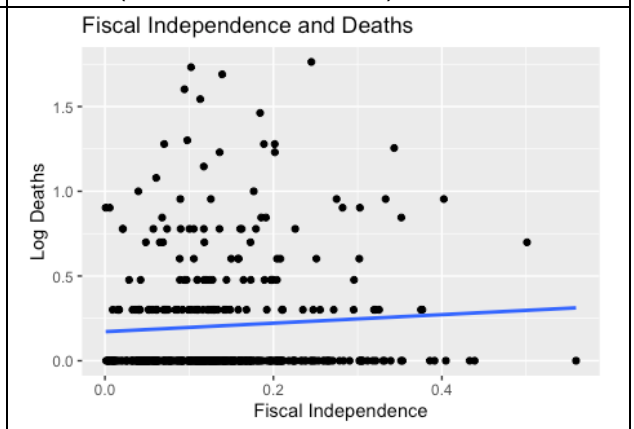
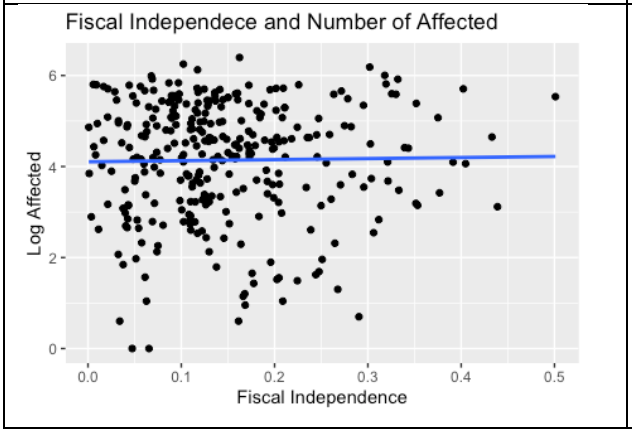
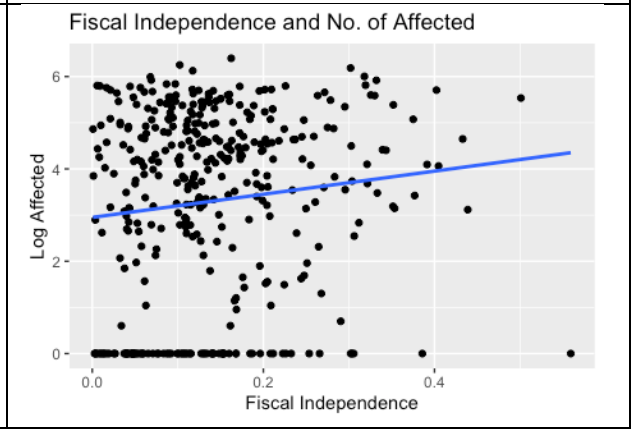
- Negative Binomial Model

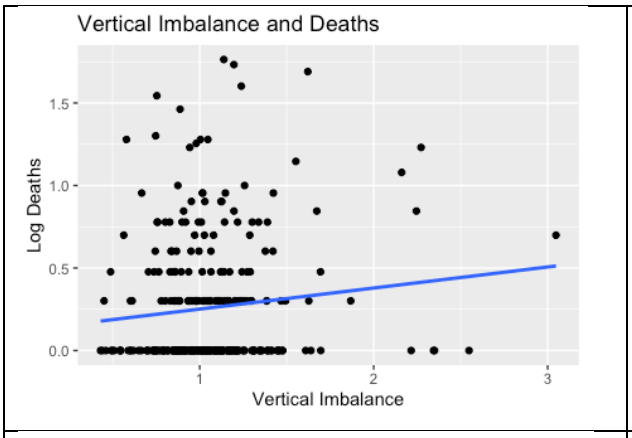
```
 fiscind       vi      ldf exposure    urban literacy      pov electric    water
1.835817 1.180625 1.153559 1.100310 2.585175 3.046503 2.457522 2.688670 1.605539
  tenure      gov      pop
2.140790 2.023440 2.247115
```

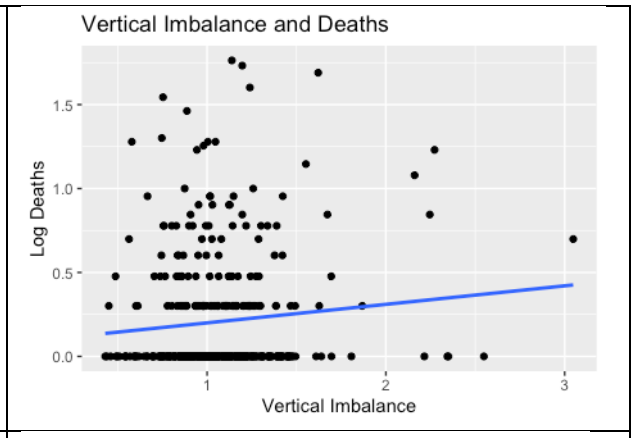
- Poisson Model

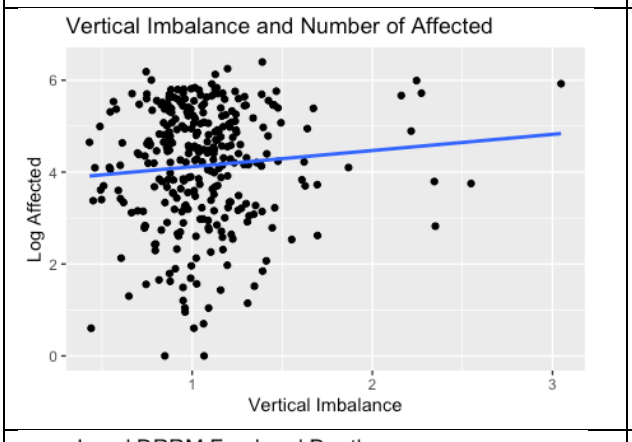
```
 fiscind       vi      ldf exposure    urban literacy      pov electric    water
2.092501 1.299946 1.121445 1.276134 3.510967 3.762903 2.943007 3.406435 1.854028
  tenure      gov      pop
2.414583 2.378855 2.503047
```

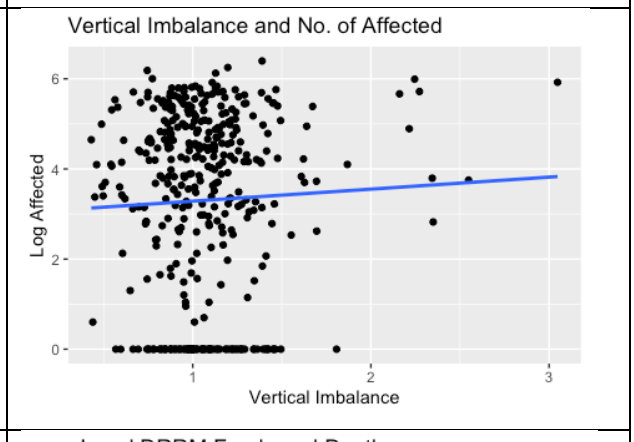
APPENDIX F. Correlation Plots

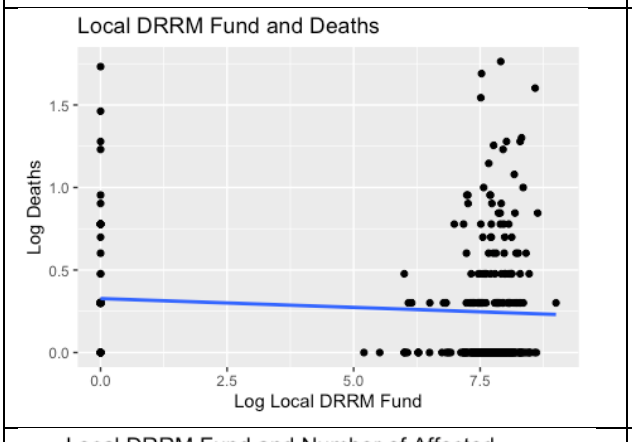
N=308 (without zero DV values)	N=386 (with zero DV values)
	
	

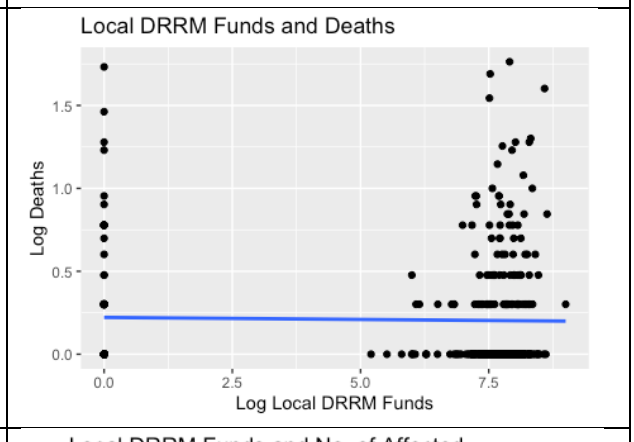

Vertical Imbalance and Deaths
Log Deaths
Vertical Imbalance

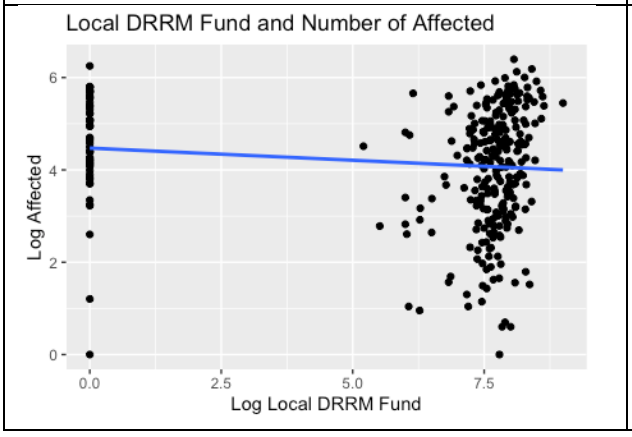

Vertical Imbalance and Deaths
Log Deaths
Vertical Imbalance

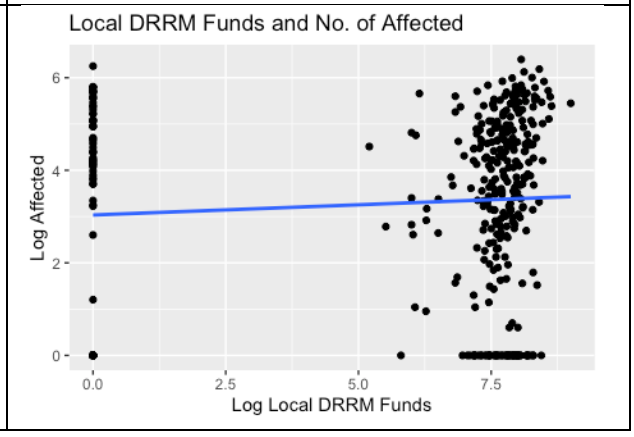

Vertical Imbalance and Number of Affected
Log Affected
Vertical Imbalance

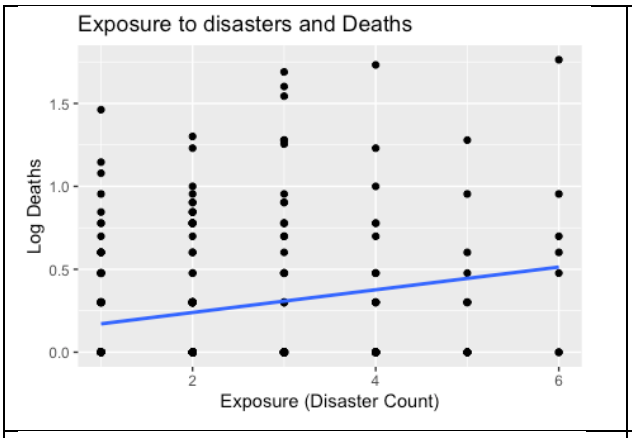

Vertical Imbalance and No. of Affected
Log Affected
Vertical Imbalance

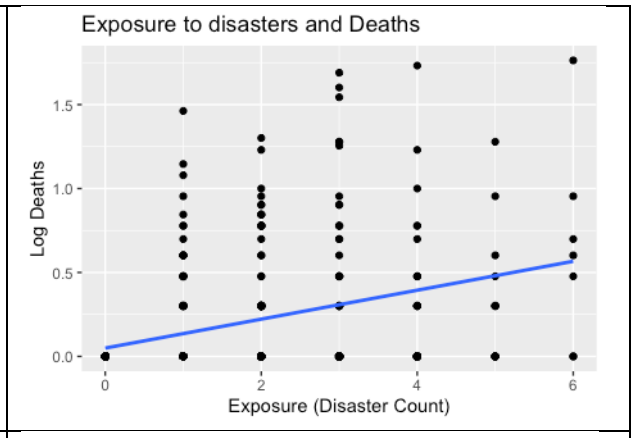

Local DRRM Fund and Deaths
Log Deaths
Log Local DRRM Fund

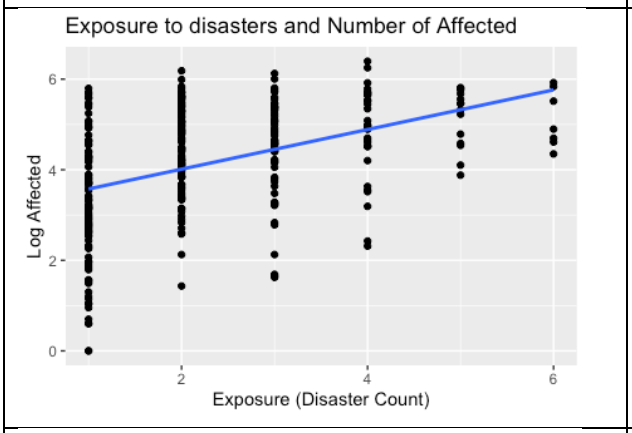

Local DRRM Funds and Deaths
Log Deaths
Log Local DRRM Funds

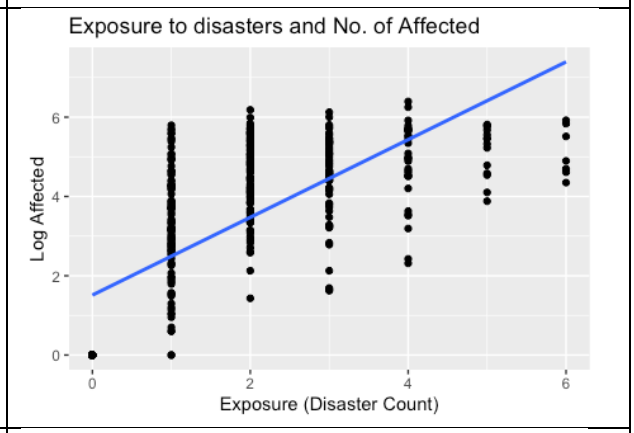

Local DRRM Fund and Number of Affected
Log Affected
Log Local DRRM Fund

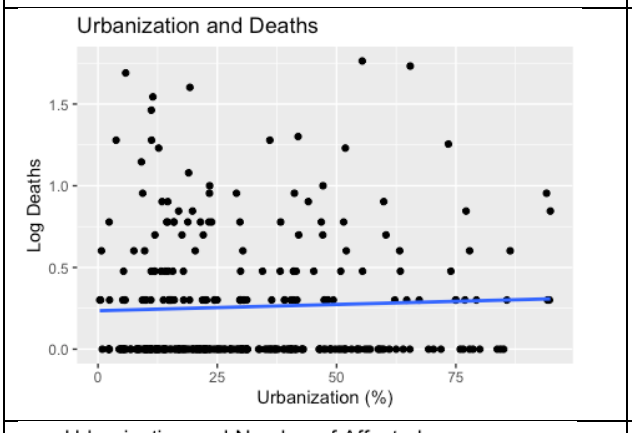

Local DRRM Funds and No. of Affected
Log Affected
Log Local DRRM Funds

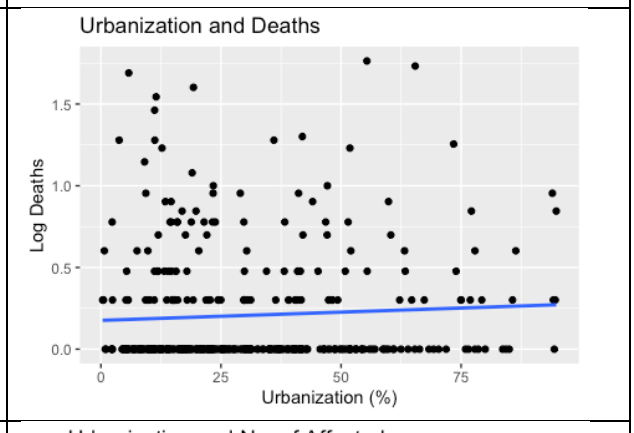

Exposure to disasters and Deaths
Log Deaths
Exposure (Disaster Count)

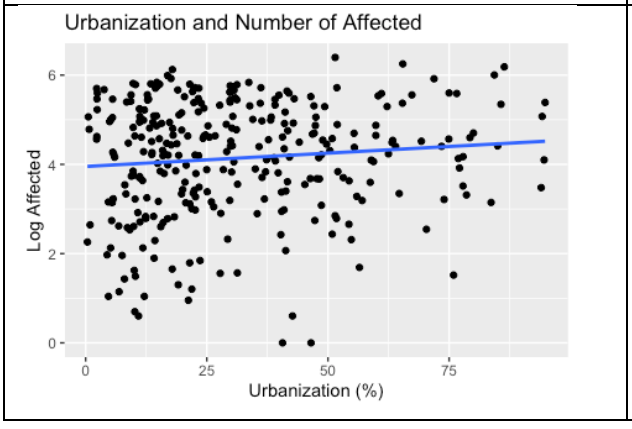

Exposure to disasters and Deaths
Log Deaths
Exposure (Disaster Count)

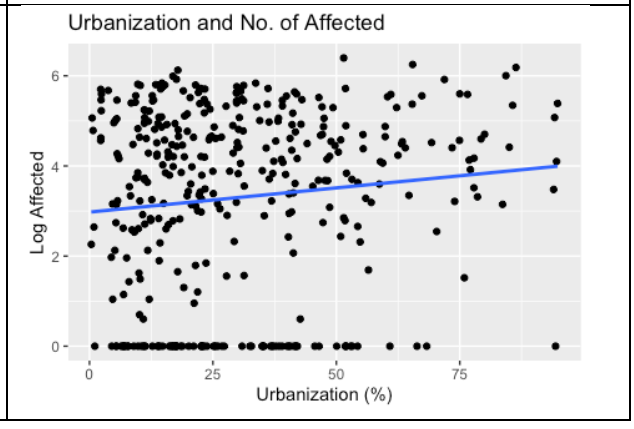

Exposure to disasters and Number of Affected
Log Affected
Exposure (Disaster Count)

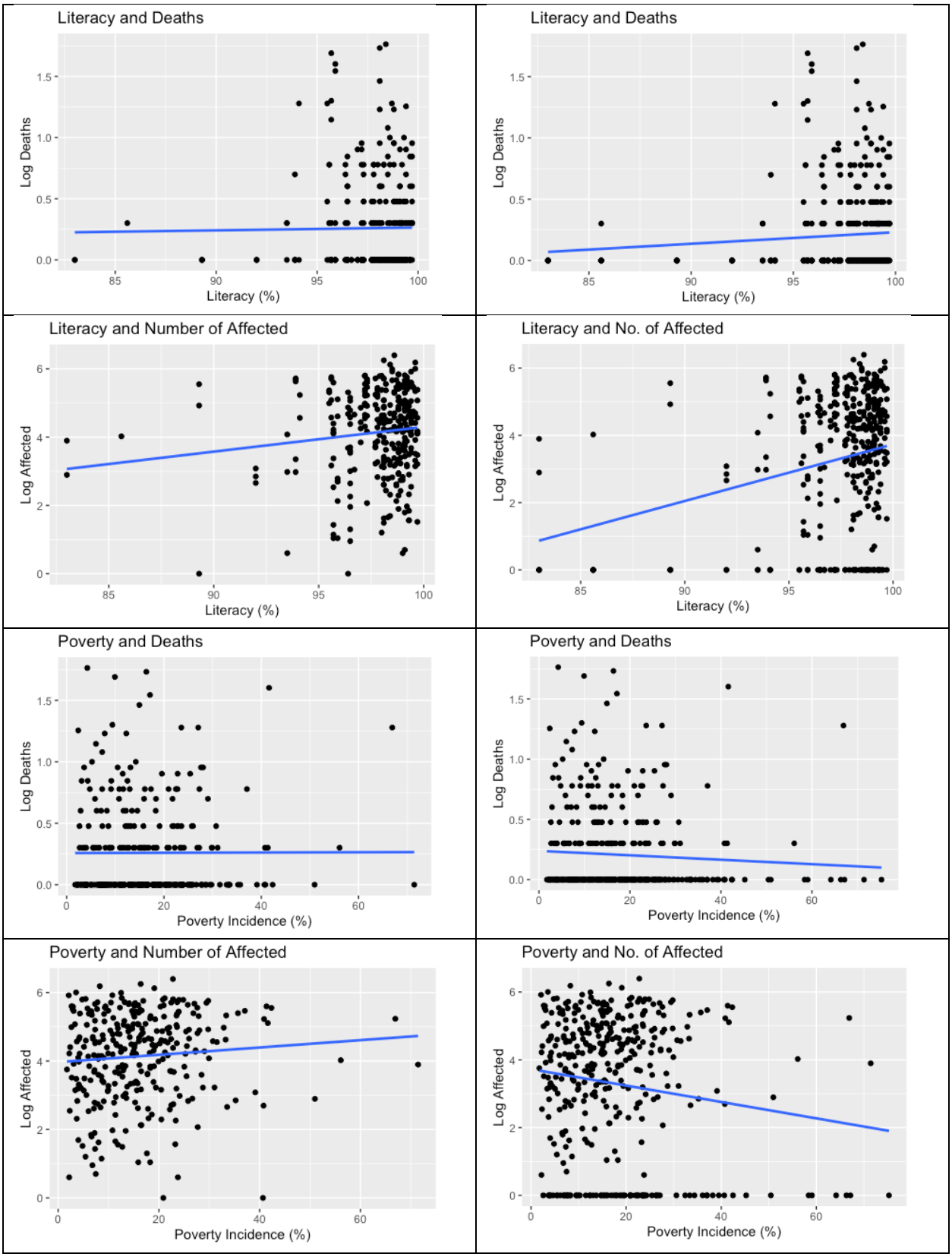

Exposure to disasters and No. of Affected
Log Affected
Exposure (Disaster Count)

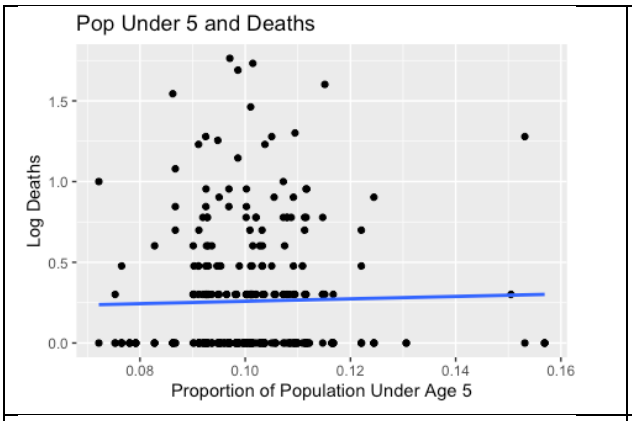

Urbanization and Deaths
Log Deaths
Urbanization (%)

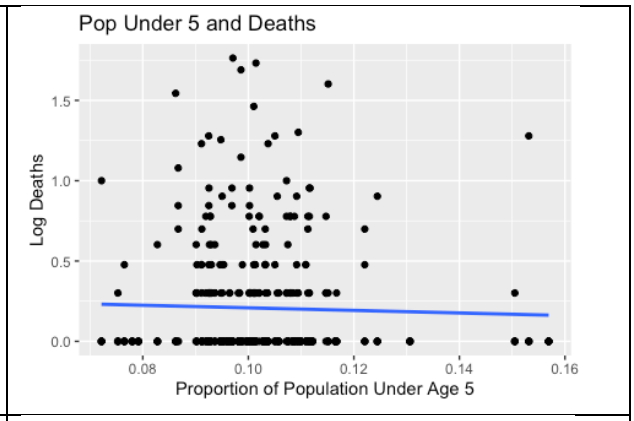

Urbanization and Deaths
Log Deaths
Urbanization (%)

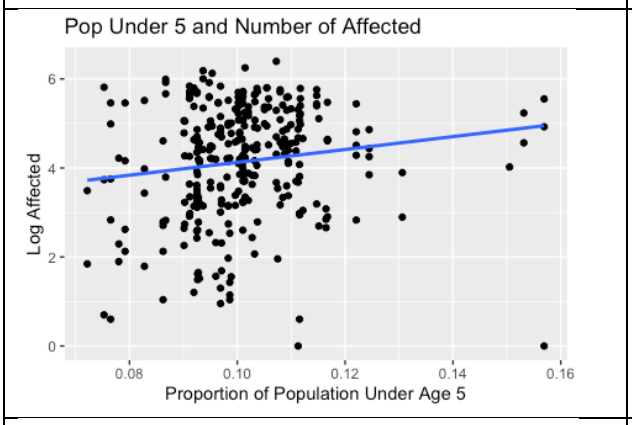

Urbanization and Number of Affected
Log Affected
Urbanization (%)

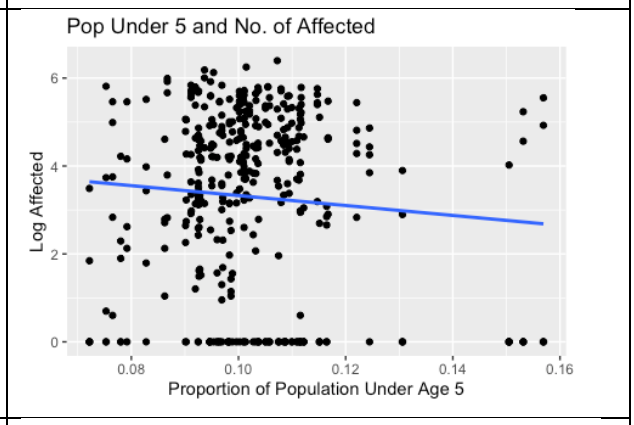

Urbanization and No. of Affected
Log Affected
Urbanization (%)

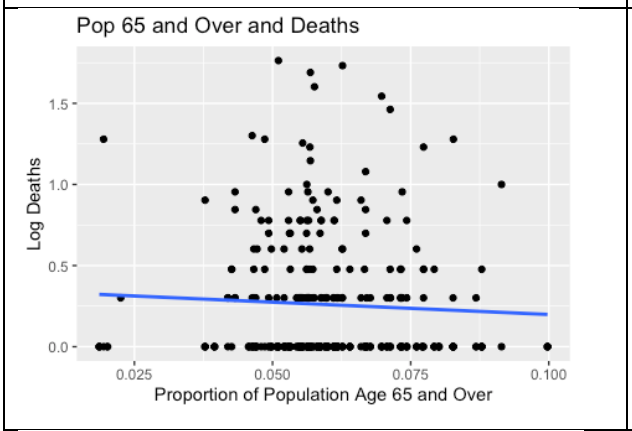

Literacy and Deaths
Log Deaths
Literacy (%)
Literacy and Deaths
Log Deaths
Literacy (%)
Literacy and Number of Affected
Log Affected
Literacy (%)
Literacy and No. of Affected
Log Affected
Literacy (%)
Poverty and Deaths
Log Deaths
Poverty Incidence (%)
Poverty and Deaths
Log Deaths
Poverty Incidence (%)
Poverty and Number of Affected
Log Affected
Poverty Incidence (%)
Poverty and No. of Affected
Log Affected
Poverty Incidence (%)

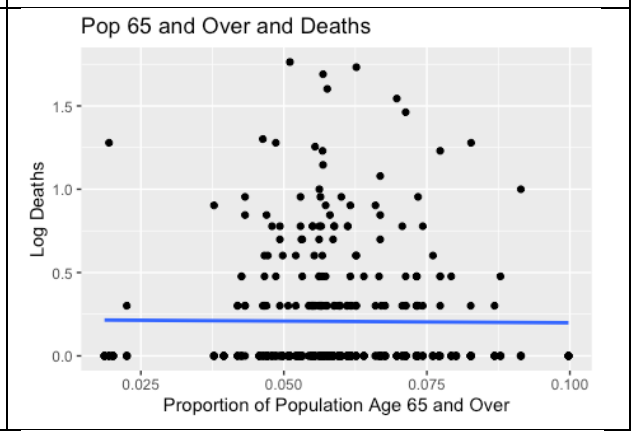

Pop Under 5 and Deaths
Log Deaths
Proportion of Population Under Age 5

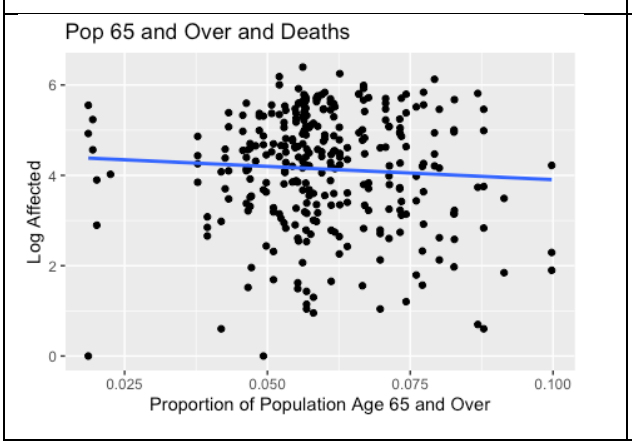

Pop Under 5 and Deaths
Log Deaths
Proportion of Population Under Age 5

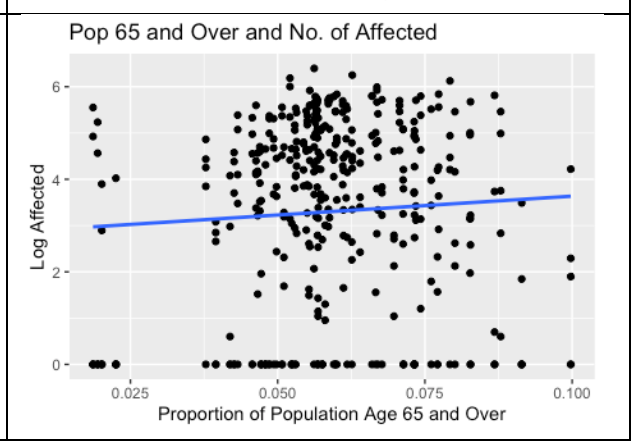

Pop Under 5 and Number of Affected
Log Affected
Proportion of Population Under Age 5

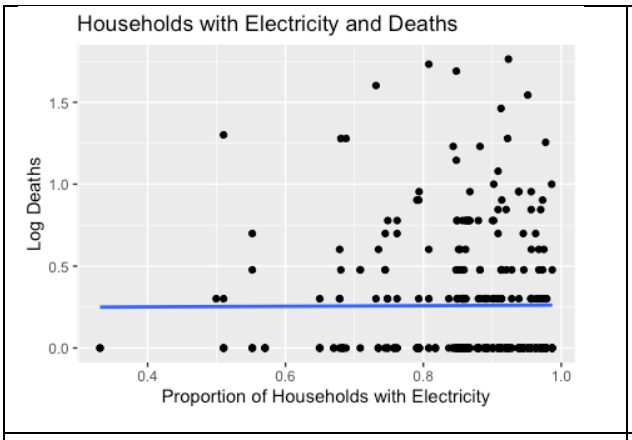

Pop Under 5 and No. of Affected
Log Affected
Proportion of Population Under Age 5

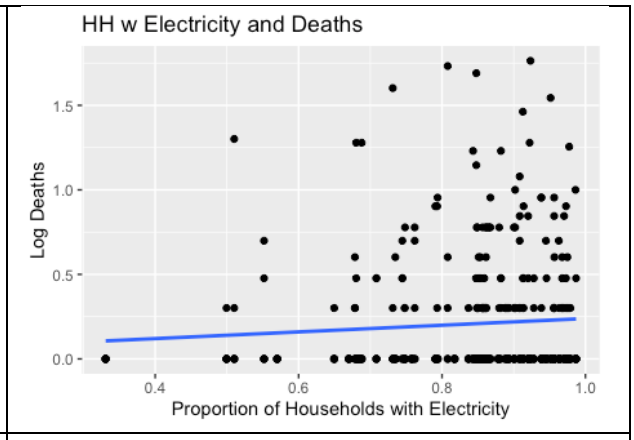

Pop 65 and Over and Deaths
Log Deaths
Proportion of Population Age 65 and Over

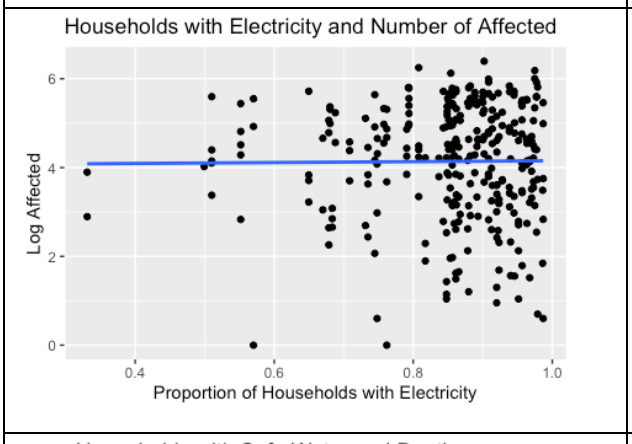

Pop 65 and Over and Deaths
Log Deaths
Proportion of Population Age 65 and Over

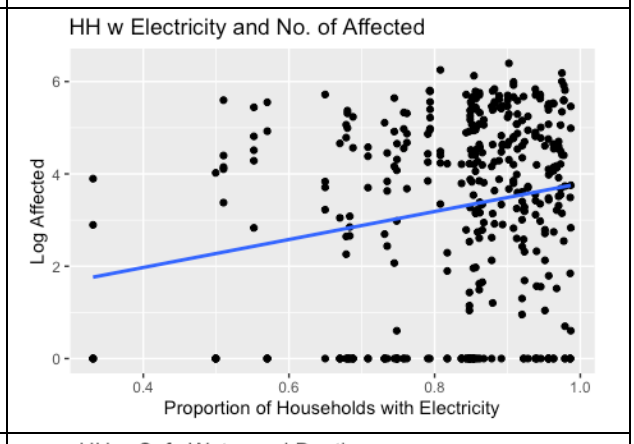

Pop 65 and Over and Deaths
Log Affected
Proportion of Population Age 65 and Over

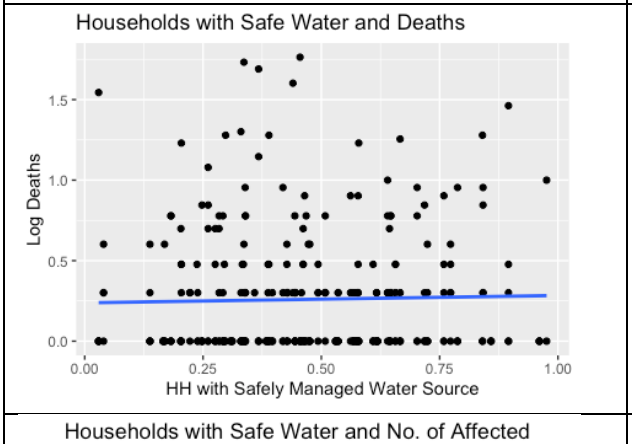

Pop 65 and Over and No. of Affected
Log Affected
Proportion of Population Age 65 and Over

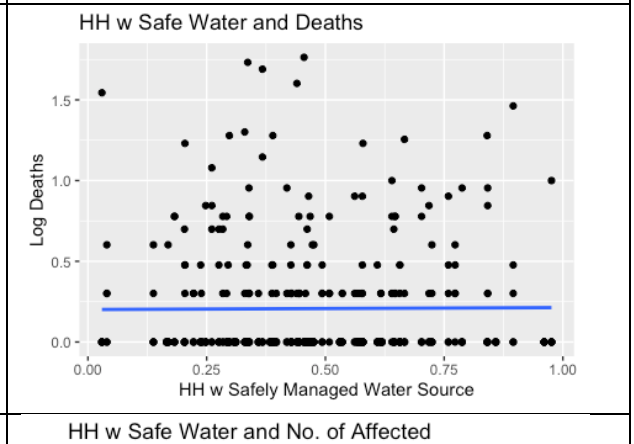

Households with Electricity and Deaths
Log Deaths
Proportion of Households with Electricity

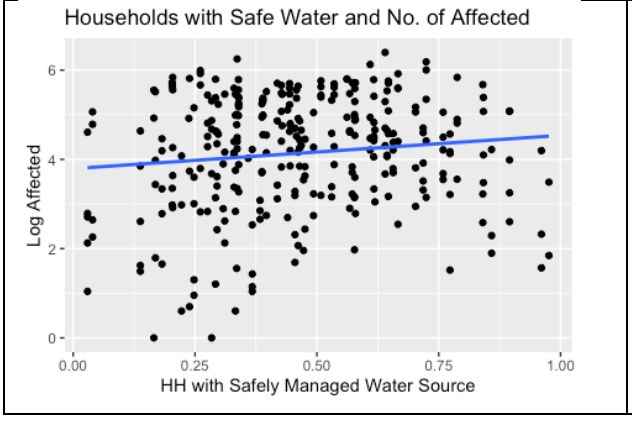

HH w Electricity and Deaths
Log Deaths
Proportion of Households with Electricity

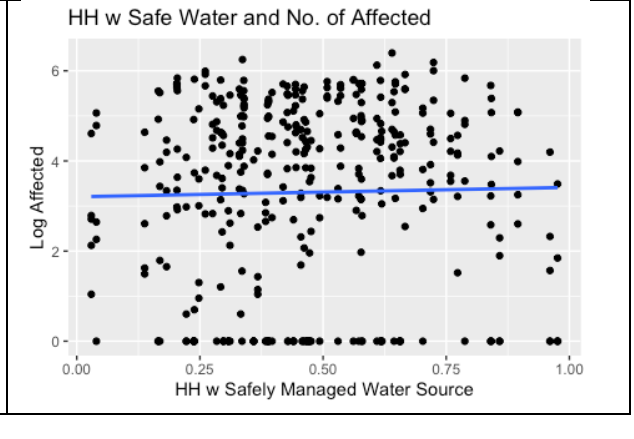

Households with Electricity and Number of Affected
Log Affected
Proportion of Households with Electricity

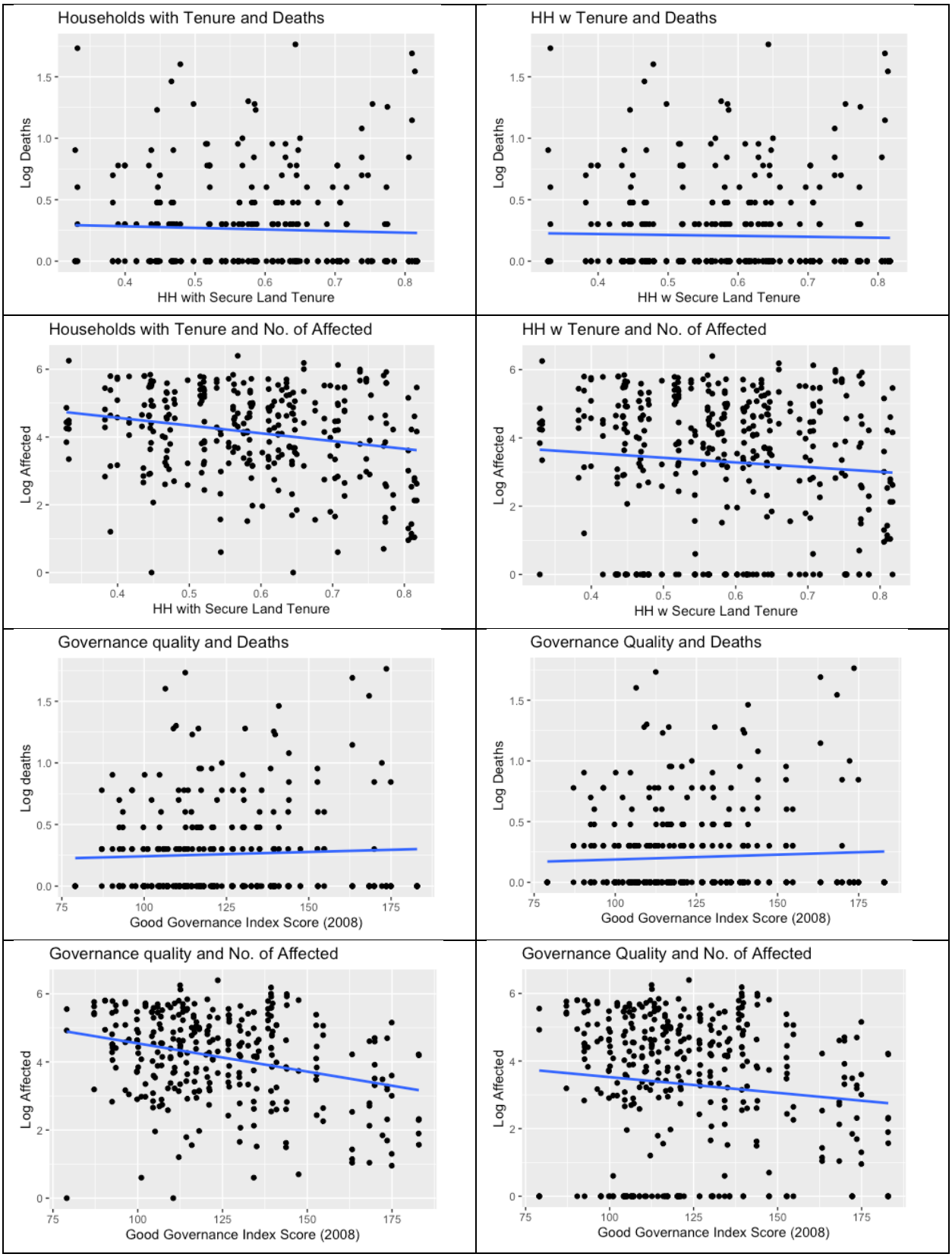

HH w Electricity and No. of Affected
Log Affected
Proportion of Households with Electricity

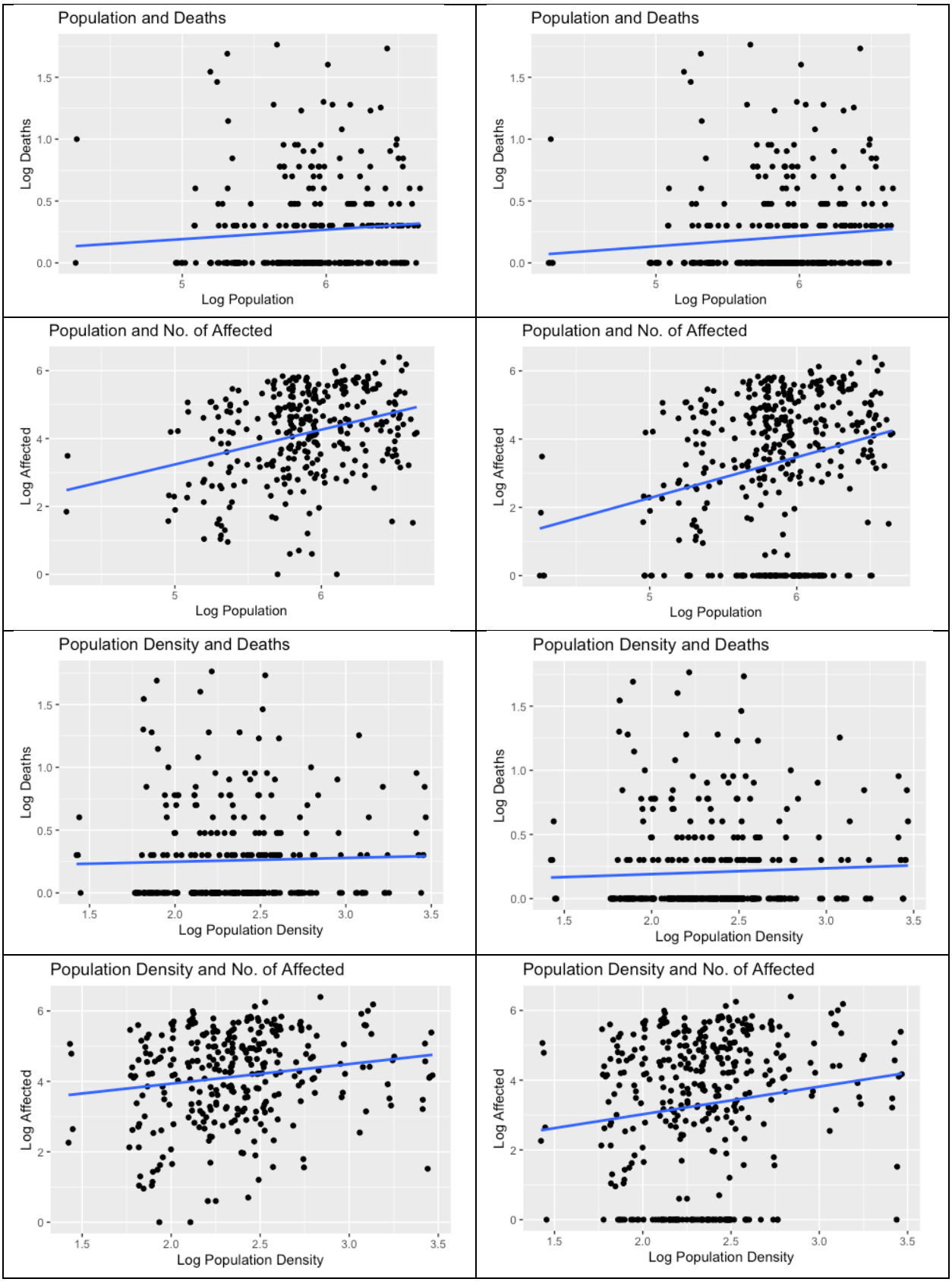

Households with Safe Water and Deaths
Log Deaths
HH with Safely Managed Water Source


HH w Safe Water and Deaths
Log Deaths
HH w Safely Managed Water Source


Households with Safe Water and No. of Affected
Log Affected
HH with Safely Managed Water Source


HH w Safe Water and No. of Affected
Log Affected
HH w Safely Managed Water Source


Households with Tenure and Deaths
Log Deaths
HH with Secure Land Tenure
HH w Tenure and Deaths
Log Deaths
HH w Secure Land Tenure
Households with Tenure and No. of Affected
Log Affected
HH with Secure Land Tenure
HH w Tenure and No. of Affected
Log Affected
HH w Secure Land Tenure
Governance quality and Deaths
Log deaths
Good Governance Index Score (2008)
Governance Quality and Deaths
Log Deaths
Good Governance Index Score (2008)
Governance quality and No. of Affected
Log Affected
Good Governance Index Score (2008)
Governance Quality and No. of Affected
Log Affected
Good Governance Index Score (2008)


Population and Deaths
Log Deaths
Log Population
Population and Deaths
Log Deaths
Log Population
Population and No. of Affected
Log Affected
Log Population
Population and No. of Affected
Log Affected
Log Population
Population Density and Deaths
Log Deaths
Log Population Density
Population Density and Deaths
Log Deaths
Log Population Density
Population Density and No. of Affected
Log Affected
Log Population Density
Population Density and No. of Affected
Log Affected
Log Population Density

APPENDIX G. Detailed Regression Results

Disaster Mortality Models

Predictor variable	Poisson						Negative Binomial					
	Coeff = β	Incidence Rate Ratio = Exp(β)		95% Wald confidence interval for Exp(β)		p-value	Coeff = β	Incidence Rate Ratio = Exp(β)		95% Wald confidence interval for Exp(β)		p-value
				Lower	Upper					Lower	Upper	
fiscind	3.555	34.982	***	11.456	106.824	0.000	3.953	52.114	**	1.753	1549.053	0.02235
vi	0.333	1.395	***	1.143	1.702	0.001	0.340	1.405		0.636	3.103	0.40054
ldf	0.002	1.002	***	1.001	1.002	0.000	0.002	1.002	*	1.000	1.005	0.08291
exposure	0.505	1.658	***	1.579	1.740	0.000	0.775	2.171	***	1.832	2.572	0.00000
urban	-0.018	0.982	***	0.977	0.988	0.000	-0.025	0.975	***	0.959	0.993	0.00524
literacy	-0.164	0.849	***	0.806	0.894	0.000	-0.097	0.907		0.768	1.072	0.25227
pov	0.002	1.002		0.992	1.012	0.722	-0.024	0.977		0.945	1.010	0.16493
electric	-0.061	0.941		0.316	2.807	0.914	-1.291	0.275		0.011	6.861	0.43162
water	-0.411	0.663	*	0.419	1.050	0.080	-0.232	0.793		0.194	3.239	0.74622
tenure	-4.187	0.015	***	0.006	0.038	0.000	-3.233	0.039	**	0.002	0.633	0.02242
gov	0.030	1.031	***	1.026	1.036	0.000	0.022	1.022	***	1.007	1.036	0.00284
(Intercept)	13.366	6.38E+05	***	4969.446	8.20E+07	0.000	8.294	4.00E+03		0.001	2.62E+10	0.30036

Disaster Affected Population Models

Predictor variable	Poisson						Negative Binomial					
	Coeff = β	Incidence Rate Ratio = Exp(β)		95% Wald confidence interval for Exp(β)		p-value	Coeff = β	Incidence Rate Ratio = Exp(β)		95% Wald confidence interval for Exp(β)		p-value
				Lower	Upper					Lower	Upper	
fiscind	1.490	4.436	***	4.416	4.457	0.000	5.097	163.524	***	5.303	5042.661	0.00357
vi	0.536	1.709	***	1.707	1.710	0.000	0.672	1.958		0.855	4.484	0.11189
ldf	0.001	1.001	***	1.001	1.001	0.000	0.006	1.006	***	1.003	1.009	0.00010
exposure	0.468	1.597	***	1.597	1.598	0.000	1.189	3.285	***	2.767	3.899	0.00000
urban	-0.008	0.993	***	0.992	0.993	0.000	-0.024	0.976	***	0.959	0.993	0.00571
literacy	-0.007	0.993	***	0.993	0.993	0.000	0.100	1.106		0.938	1.303	0.23143
pov	0.013	1.014	***	1.013	1.014	0.000	-0.001	0.999		0.966	1.033	0.96968
electric	1.767	5.853	***	5.823	5.883	0.000	0.848	2.336		0.085	64.001	0.61541
water	-0.542	0.581	***	0.580	0.583	0.000	-0.937	0.392		0.094	1.638	0.19918
tenure	-0.643	0.526	***	0.524	0.528	0.000	-2.414	0.089	*	0.006	1.453	0.08961
gov	-0.013	0.987	***	0.987	0.987	0.000	-0.018	0.982	**	0.968	0.996	0.01149
(Intercept)	10.185	2.65E+04	***	25943.350	27097.159	0.000	0.745	2.106		3.93E-07	1.13E+07	0.92494
Log-Likelihood (LL)		-36,055,810						-3837.535				
Akaike Information Criterion (AIC)		72,111,646						7,703.100				
Bayesian Information Criterion (BIC)		72,111,698						7,758.453				
Deviance/df		193,319						1.308				

*Note: *** 0.01 significance level, ** 0.05, * 0.1*

Disaster Mortality Models (Time Fixed Effects)

Predictor variable	Poisson						Negative Binomial					
	Coeff = β	Incidence Rate Ratio = Exp(β)		95% Wald confidence interval for Exp(β)		p-value	Coeff = β	Incidence Rate Ratio = Exp(β)		95% Wald confidence interval for Exp(β)		p-value
				Lower	Upper					Lower	Upper	
fiscind	3.169	23.776	***	7.465	75.734	0.000	3.412	30.336	*	0.973	945.496	0.052
vi	0.369	1.446	***	1.178	1.777	0.000	0.343	1.409		0.643	3.090	0.392
ldf	0.001	1.001	***	1.001	1.002	0.000	0.001	1.001		0.998	1.004	0.357
exposure	0.463	1.588	***	1.510	1.671	0.000	0.720	2.055	***	1.730	2.441	0.000
urban	-0.016	0.984	***	0.978	0.989	0.000	-0.021	0.979	**	0.962	0.996	0.018
literacy	-0.156	0.855	***	0.811	0.901	0.000	-0.075	0.928		0.786	1.096	0.379
pov	0.000	1.000		0.990	1.010	0.987	-0.024	0.976		0.944	1.010	0.162
electric	-0.038	0.962		0.323	2.867	0.945	-1.168	0.311		0.013	7.613	0.474
water	-0.492	0.611	*	0.389	0.961	0.033	-0.418	0.659		0.162	2.683	0.560
tenure	-3.932	0.020	***	0.008	0.048	0.000	-2.686	0.068	*	0.004	1.069	0.056
gov	0.030	1.030	***	1.026	1.035	0.000	0.019	1.019	***	1.005	1.033	0.010
(Intercept)	12.865	386362.100	***	2861.966	52158433.000	0.000	6.509	671.428		0.000	4.588E+09	0.418

Disaster Affected Population Models (Time Fixed Effects)

Predictor variable	Poisson						Negative Binomial					
	Coeff = β	Incidence Rate Ratio = Exp(β)		95% Wald confidence interval for Exp(β)		p-value	Coeff = β	Incidence Rate Ratio = Exp(β)		95% Wald confidence interval for Exp(β)		p-value
				Lower	Upper					Lower	Upper	
fiscind	2.794	16.354	***	16.274	16.433	0.000	4.462	86.649	**	2.665	2817.343	0.012
vi	0.602	1.825	***	1.823	1.826	0.000	0.712	2.039	*	0.898	4.630	0.089
ldf	0.000	1.000	***	1.000	1.000	0.000	0.004	1.004	**	1.001	1.007	0.014
exposure	0.431	1.538	***	1.538	1.539	0.000	1.348	3.848	***	3.228	4.588	0.000
urban	-0.008	0.992	***	0.992	0.992	0.000	-0.021	0.979	**	0.963	0.996	0.015
literacy	-0.014	0.986	***	0.986	0.986	0.000	0.102	1.107		0.941	1.302	0.220
pov	0.015	1.015	***	1.015	1.015	0.000	0.005	1.005		0.972	1.040	0.753
electric	1.650	5.207	***	5.181	5.234	0.000	1.692	5.432		0.207	142.313	0.310
water	-0.560	0.571	***	0.570	0.572	0.000	-0.959	0.383		0.093	1.575	0.184
tenure	-0.578	0.561	***	0.559	0.563	0.000	-1.103	0.332		0.021	5.192	0.432
gov	-0.012	0.988	***	0.988	0.988	0.000	-0.019	0.981	***	0.967	0.995	0.007
(Intercept)	11.348	84800.540	***	82973.447	86667.859	0.000	-0.481	0.618		0.000	279797.317	0.951
Log-Likelihood (LL)		(31,614,128.000)						-3830.298				
Akaike Information Criterion (AIC)		63,228,290.000						7,696.600				
Bayesian Information Criterion (BIC)		63,228,357.000						7,767.802				
Deviance/df		171,340.800						1.319				

*Note: *** 0.01 significance level, ** 0.05, * 0.1*