A Historical Seismology of Luzon Earthquakes in the 20th Century: The Dynamics of State Responses on Four Earthquake Disasters

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Abstract

This paper presents a historical study of four earthquake disasters that occurred in Luzon, Philippines, namely: (1) the 20 August 1937 Luzon Earthquake, (2) the 02 August 1968 Manila-Casiguran Earthquake, (3) the 17 August 1983 Ilocos Norte Earthquake, and (4) the 16 July 1990 North Luzon Earthquake. This research work uses historical seismology as a primary framework. The study adheres to its emphasis on the historical analysis of human experiences and societal conditions in the context of earthquake disasters. Using newspaper articles, government reports, and seismological studies, this study argues that the four subject earthquakes set specific and time-bound institutional responses and scientific output that formatively contribute to the history of the country's responses to calamities and continuing policy formulations as a component of post-disaster rehabilitation. This paper discusses the following: (1) a brief survey of the scholarly works in the field of historical seismology; (2) the scales and impacts of the four subject earthquakes; and (3) an extensive discussion of the state's crisis management of the post-disaster situation, with a focus on the roles of the military in the rescue operations, and the dynamics of institutional scientific knowledge production and policy formulations concerning earthquakes and public infrastructures.

Keywords: *Earthquakes, Luzon island, historical seismology, state responses, military, scientific institutions*

Introduction

Earthquakes are part of the geographic and geological reality of the Philippine archipelago. The country's location in the Pacific region and tectonic foundations reinforce the existence and prevalence of this hazardous natural environmental process. Earthquakes torment human communities; they are a hazard that shows a society's weakness and exposes the population's disaster response capabilities under the context of various social conditions.

The history of earthquakes, or natural hazards in general, falls into the discipline of environmental history. The study of the natural environments includes the method of analyzing how communities and societies altered physical landscapes, as well as how the structure of the earth dictated the form, nature, and flow of human settlements. At what vantage point, can we consider physical events involving nature as "historical"? Natural events, such as natural hazards turn out to be historical if considered disasters; environmental events that caused havoc to human groups and settlements. With this, disasters, as dictated by a definite hazard, occur because of the chance recurrences of natural threats, modified in detail but fortuitously by human circumstances (Hewitt, 1983, p. 5) Thus, considering what Hewitt (1983) calls the "dominant view," disasters are by-products of hazards and are attributed to nature (p. 6). Moreover, Endfield, et. al (2009) argues that disasters are "social texts" are they are interpreted and conceptualized socially, thus hazards, and disasters are socially constructed and defined (p. 305). Furthermore, anthropologists argue that disasters spring from the "nexus" where natures, societies, and technologies meet, a point where place, people, and human constructions intersect, and an amalgam of a potentially destructive agent from the natural and technological sphere and a population in a socially produced condition of vulnerability (Hoffman and Oliver-Smith, 2020, pp. 1 and 4).

This paper presents a historical study of four earthquake disasters that occurred in Luzon, Philippines, namely (1) the 20 August 1937 Luzon Earthquake, (2) the 02 August 1968 Manila-Casiguran Earthquake, (3) the 17 August 1983 Ilocos Norte Earthquake, and (4) the 16 July 1990 North Luzon Earthquake. It provides an analysis of how notable earthquake disasters caused devastations in national scopes throughout the twentieth century and how these events reveal various levels and developments in institutional responses of the state. The study considers the subject earthquakes as historical turning points: natural environmental processes that change and challenge the physical and social landscapes of human communities, and as representative of the social conditions of the era in terms of disaster response and rehabilitation. The study also limits the geographic scope of earthquakes that occurred on the island of Luzon. These earthquakes have substantial historical documentation and the scales of their societal impacts have considerable historical weight and implications.

This work uses historical seismology as a primary framework. Guidoboni and Ebel (2009) define historical seismology as the documentation, enumeration, and cataloguing of earthquakes and identifying their location in a certain period in the past, and taking into consideration the accounting of the effects of earthquakes on the physical environment and human infrastructures, and the value of such documentation in the study of those societies (pp. 6-7). Highlighting the experience in Japan, Ishibashi (2004) defines historical seismology as "seismological observation and analysis not by seismograms but by historical materials," and "is an integration of historiography and earthquake science." (p. 350). This research work adheres to historical seismology's emphasis on the historical analysis of human experiences and societal conditions in the context of earthquake disasters. Using newspaper articles, government reports, and seismological studies about these earthquakes, this study argues that the four subject earthquakes set specific and time-bound institutional responses and scientific output that formatively contribute to the history of the country's responses to calamities and continuing policy formulations as a component of post-disaster rehabilitation. Moreover, to serve as an intellectual guidepost, the French Annales School's intellectual tradition of the history of long duration (*longue durée*) and serial history (*histoire serielle*) are used as these approaches identify the "continuities and discontinuities within a series of relatively homogenous state," (Burke, 1990, p. 111) by identifying and analyzing recurring patterns of environmental processes, which must be examined and interpreted more qualitatively. (Forster, 1978, p. 69).

This paper has the following parts: (1) a brief survey of the scholarly works in the field of historical seismology; (2) the scales and impacts of the four subject earthquakes; and (3) an extensive discussion of the state's crisis management of the post-disaster situation, with a focus on the roles of the military in the rescue and recovery operations, and the dynamics of institutional scientific knowledge production and policy formulations concerning earthquakes and public infrastructures. The story of these earthquake disasters and the responses to them essentially illustrate how evolutions and continuities occurred in the country's disaster response mechanisms.

Historical Seismology: Earthquake Disasters as Focus of Historical Scholarship

The field of historical seismology has been present in natural and social science research endeavors for quite a time. Although it was not labeled as is, pioneer scientists and engineers who advanced this field as a proactive branch of seismology and engineering factored in the importance of relating the earthquake as a geological phenomenon to the broader societal dynamics, its relationship to people and communities, and how the latter in return understand and appreciate earthquake as an environmental phenomenon. Works on historical seismology are different from seismological studies where the quantitative character is studied, and instrumental and observational approaches are used.

Since the end of the 19th century, this field had a slow yet thriving development. John Milne's pioneering work on earthquakes and its effects in public construction, *Earthquake and other Earth Movements* (1886)[i] tackles the origin, nature, and science of earthquake, and its effects on land and public edifices. In the 1980s and 1990s, the works of Francophone historians gave a renewed appreciation of historical seismology as a discipline. The works of French seismologist and historian Jean Vogt (1929-2005) deal with the theoretical, quantitative, and qualitative aspects of historical earthquakes, and historical seismology (Fréchet and Albini, 2008, pp. 3-16).[ii] The Belgian scholar Pierre Alexander of the Belgian Royal Observatory made valuable historical catalogs/studies about earthquakes in Belgium during the ancient and modern ages, which banked on the importance of critical appraisal of seismological data to establish the historical value of earthquake events and experiences, Alexandre worked on developing the field of historical seismology focusing on the events in Belgium and Western Europe.[iii] The last two decades saw a the surge of considerable scholarly works on historical seismology. In many countries, the tradition of historical seismology has been grounded on their own social experience and the need to further understand earthquakes and their effects in their respective societies, geared with the need to distinguish it from the rigors of historical mentality. To mention some, the works of Coen (2003), Quenet (2005), Fréchet, Meghraoui, and Stucchi (2008), Guidoboni and Ebel (2009), Clancey (2006, 2013), Ishibashi (1999, 2011), Reid (2015), and Matsu'ura (2017), are studies that are event and location-specific, thus projecting a case study-based and localized understanding of historical seismology as a field of research in Portugal, United States, France, Italy, United Kingdom, Japan, and Indonesia.

In the case of the Philippines, historical seismology took shape as a field in various forms of historical studies and approaches. Catalogues and listing of notable/historical earthquakes are one group of published materials, mostly written by seismologists and earthquake experts. Some of these are the works of Jesuit scientists, such as Miguel Saderra Masó's *La Seismologia en Filipinas* (1895) was the pioneering work, followed by an expanded one written in English, titled *Catalogue of Violent and Destructive Earthquakes in the Philippines, 1599-1909* (1910), and *Volcanoes and Seismic Centers of the Philippine Archipelago* (1904); William Repetti's *Catalogue of Philippine Earthquakes, 1589-1899* (1946), and R.G. Valenzuela and L.C. Garcia's *Studies on Philippine Earthquakes* (1988), which contains quantitative analyses of historical earthquakes in the archipelago, primarily based on Repetti's work. The late-19th century Spanish colonial engineers also made studies on notable earthquakes of the era. To name some: Antonio del García Canto's *Los Terremotos de Manila* (1863), Enrique Abella y Casariego's *Terremotos de Nueva Vizcaya (Filipinas) en 1881* (1884) and *Terremotos experimentados en la Isla de Luzón durante los meses de Marzo y Abril de 1892* (1893), and José Centeno's *Memoria sobre los temblores de tierra ocurridos en julio de 1880 en la isla de Luzón* (1881). Aitor Anduaga's works, namely "Earthquake Building Overseas: Military Engineers, Cyclonic-Seismic Affinity and the Spanish Dominion in the Philippines, 1860-1898" (2013) and *Cyclones and Earthquakes: the Jesuits, Prediction, Trade, & Spanish Dominion in Cuba & the Philippines, 1850-1898* (2017), are comprehensive studies of earthquake spearheaded by Jesuit scientists and Spanish colonial engineers of the 19th century in the Philippines, and how the scientific knowledge they produced were transformed as core concepts in the Spanish colonial state's policies on urban construction. The British historian Greg Bankoff, has brought into the table pioneering ideas in Philippine environmental history such as "cultures of disasters," (2003) disasters as "frequent life experience," (2009) and "hazardousness of a place," (2016) also introduced a reading of the colonial transformations of Manila as an urban space, from the point of view of earthquakes, in his work *Fire and Quake in the Construction of Old Manila* (2007) adds up to the growing literature on the field. The same approach, with focus on the policies implemented by the Madrid government, can be found in Susana Ramírez Martín's work, *El Terremoto de Manila de 1863: Medidas políticas y económicas* (2006).

Earthquake-specific historical studies written by Filipino scholars offer varying interpretations about notable earthquakes, most of which occurred during the Spanish colonial era, and highlight the necessity to critically examine archival materials, whether religious, scientific, or bureaucratic in nature, to reconstruct the experiences of the local people in times of calamities. One of the earliest made is *Moro Gulf Tsunami of 17 August 1976* (1978) by Victor Badillo, S.J. and Zinnia Astilla, a study of the destructive 1976 earthquake and Tsunami in Weatern Mindanao. This is followed by Raymund Abejo's "Mga Kalamidad at ang Rebelyong Dios-Dios sa Samar noong Dantaon 19" (2005), Alvin Camba's (2012) "Religion, Disaster and Colonial Power in the Spanish Philippines in the Sixteenth and Seventeenth Centuries," (2012), Francis Gealogo's "Historical Seismology and the Documentation of Postdisaster Conditions: The 1863-1880 Luzon Earthquakes" (2016), and Kerby Alvarez's "The June 1863 and the July 1880 Earthquakes in Luzon, Philippines: Interpretations and Disasters" (2020), which tackle the meanings and responses to earthquakes during the Spanish colonial period in the Philippines.

Banking on these scholarly outputs, this present work aims to further contribute to the literature of historical seismology by tackling and analyzing select notable earthquakes in Luzon through the course of the long 20th century.

Four Luzon Earthquakes in the 20th Century: Scale sand Impacts

The four subject earthquakes were notably devastating, not only because of the sheer scale of their ground movements but also of how they severely devastated and altered the physical features and urban landscapes the towns and cities where they occurred. (See Table No. 1) In fact, as a form of popular reference, most of the subject earthquakes have been referred to the town or city which was severely hit or destructed: the 1968 Manila earthquake, the 1983 Laoag earthquake, and the 1990 Baguio earthquake. Meanwhile, the 1937 earthquake, although not referred to as "Manila earthquake," most of the recorded devastations occurred in the capital city. But despite the apparent focus on the devastated landscape, the media and government reporting of the subject earthquakes were comprehensive to include almost all the recorded destructions outside the most severely affected areas. Moreover, another commonality of the four subject earthquakes was that the massive ground movements occurred in a busy, inopportune time of the day – late afternoon, early and late evening, and early morning. The unfavorable conditions at the time the earthquakes struck rendered the people helpless and had an inadequate response to escape and bring themselves to immediate safety.

Table No. 1
The subject earthquake disasters and their scale and impacts (1937[i], 1968[ii], 1983[iii], and 1990[iv])

Earthquake Disaster	Date	Day and Estimated Time of the Day of Occurrence	Intensity/ Magnitude	Epicenter	Severely Devastated Areas	Death and Injuries
1937 Luzon Earthquake	20 August 1937	Friday, early evening	Intensity 6/7 Magnitude 7.5 in the Richter Scale	Alabat Island/ Casiguran Bay	Manila	Est. 35 injured
1968 Manila -Casuguran Earthquake	02 August 1968	Friday, early morning	Intensity 6 in Rossi-Forel Scale Magnitude 7.5 in Richter Scale	Casiguran-Singalan Bay, Aurora	Manila, Casiguran, and Southern Luzon	280 deaths 286 injuries

1983 Ilocos Norte Earthquake	17 August 1983	Saturday, evening	Intensity 7 in Rossi-Forel Scale Magnitude 5.3 in Richter Scale	Laoag, Ilocos Norte	Northern Luzon - Ilocos Provinces	19 deaths 190 injuries
1990 North Luzon Earthquake	16 July 1990	Monday, late afternoon	Intensity 8 in Rossi-Forel Scale Magnitude 7.7-7.8 in Richter Scale	Nueva Ecija	Northern Luzon, especially Baguio, Cabanatuan, and Pangasinan	Est. 1650 deaths 3300 injuries Unaccounted missing individuals

i Manila Observatory, 1937b; Magsaysay and Feliciano, 1937; Sales, 1937; "Worst Quake since 1880 Shakes Manila, Provinces."; Repetti, 1937; "Towers knocked off churches; Big Buildings Sway"; "Earthquake Damage in Provinces Mounts; "Major magnitude 7.5 earthquake."

ii Flores, n.d.; Oca, 1968; Kintanar, 1968; Omote, et. al., 1969; Buan, Jr., 1968; "Quakes rock all Luzon."; Castro, 1968; Zumel and Panuncialman, 1968; "The Big Quake,"

iii Valenzuela and Garcia, 1983; Santiago and Rillon, 1983; "Quake kills 21 in Ilocos; "North Luzon hit by strong quake."; "Earthquake."; "North Luzon hit by strong quake."; "Quake kills 18 in Ilocos"; "20 still trapped in rubble,"; "13 dead as quake hits Ilocos."; "The 1983 Laoag Earthquake" Philippine."

iv Rantucci, 1994; "Earthquake!"; *The July 16, 1990 Luzon Earthquake*; *The July 16, 1990 Philippines Earthquake*; Booth, at. al., 1991; Tadao, 1992; Nakata, et. al. 1996; Viñaviles, 1990; Batnag, 1990.

20 August 1937 Luzon Earthquake

On the night of 20 August 1937, a Friday, a magnitude 7.5 (Richter Scale), Intensity 6/7 (Rossi-Forel Scale) earthquake was experienced in Manila and the nearby provinces of Laguna and Tayabas. A large section of the Luzon felt the quake, crossing the Dagupan to Batangas landmass corridor ("Observatory Instruments Destroyed."). The first tremor lasted for almost three minutes and was followed by two aftershocks (Repetti, 1937; Towers knocked off churches,"). An eyewitness described the event as a "national disaster" as confusion and terror hounded the capital ("Worst Quake since 1880 Shakes Manila, Provinces."). The first combined report of injuries states there was one death, and 62 injuries (ibid.). The Escolta business district suffered massive damage, worst in the vicinity was the Heacock Building, which was twisted and broken. ("Towers knocked off churches; Big Buildings Sway."). Two days after the quake, the Manila City Engineering Department declared the building condemned and in danger of collapsing (ibid.). Water and electricity facilities in Manila were damaged and caused problems in the delivery of services in the city. The water supply in Manila was severely affected after the city's water line was damaged by the tremor: the 36-inch water main pipeline on Calle Suter in Sta. Ana district, which was supplying the northern districts of Manila, and two more mains in the Ayala Bridge and Piers 3 and 5 areas, causing water sprouts and flooding ("City Water Mains Broken,"). The Metropolitan Water District immediately acted on the engineering and repair needs of the city, and alternative water sources were identified and rerouted to meet the water needs of the Metro Manila area ("Earthquake Damage in Provinces Mounts,"). The Manila Electric Company (Meralco) reported that their lines and wires suffered slight damage throughout the city (ibid.). On the night of the earthquake, President Manuel L. Quezon was supposed to attend a big banquet at the Rizal Memorial Stadium dedicated in his honor. ("Quake delays appearance of Quezon at Fete.").

02 August 1968 Manila Earth-Casiguran Earthquake

In the early morning of 02 August 1968, an Intensity VI (Rossi-Forrel Scale) earthquake hit the island of Luzon, affecting the capital city, and some coastal towns in the province of Quezon (Flores, n.d., p. 483). A report from an ad hoc committee of the Geological Society of the Philippines described the earthquake as "the most powerful of a series to shock the country in at least two decades," that hir northern Luzon and the districts of Manila. (Oca, 1968, p. 171). The epicenter was identified to be the area 45 kilometers from Casiguran, Quezon (not yet part of present-day Aurora province), near a master fault at Singalan Bay (ibid.). The first major ground movement was felt at 4:21 am, in Intensity VI, and lasted for one minute, and was followed by an aftershock of the third intensity, at 4:46 am (Buan, Jr., 1968). One broadsheet described the early morning tremors as: "The first and more violent, rolled in like a steamroller, tumbling home appurtenances, knocking down old and new buildings alike, driving cracks on concrete edifices and roads and public constructions," (Castro, 1968). Initial reports published in newspapers reveal various earthquake intensities in different cities in Metro Manila and the provinces. In Manila, it was Intensity 4, and in Quezon City the first shock was Intensity V, and the second was Intensity 3; in the provinces, Baguio and Ambuklao (Benguet), Intensity 6, Baler (Quezon, now Aurora), Intensity VI, Aparri and Tuguegarao (Cagayan), Intensity VI, Lucena (Quezon) and Camalig (Albay), Intensity V, and Vigan (Ilocos Sur), Intensity V (Buan, Jr., 1968; "Hundreds Die in Quakes!"). The First and Second Philippine Constabulary Zones also made initial assessments of the situation in the provinces, such as in Bulacan, Benguet, Cagayan, Ifugao, , Ilocos Norte, Isabela, Ilocos Sur, Mt. Province, Nueva Ecija, Nueva Vizcaya, Tarlac, and Zambales, and reported minimal or no damage at all (Zumel and Panuncialman, 1968). The earthquake took 322 lives, 300 people got injured, and major structures in Manila were severely damaged (Flores, n.d., p. 483). Several dozens of buildings, both public and private, suffered from massive damage. most of which were in Intramuros, Escolta, and Manila Post Office areas ("The Big Quake,"). The most devastated was Ruby Tower Apartments Building, a 6-story commercial apartment, located in Sta. Cruz, Manila (Buan, Jr., 1968). The three-year-old condominium building, which had 95 apartments, collapsed like a "multi-layered cake after the quake." ("Ruby Death Toll Now 143,"). Almost 80 families were trapped inside the building and almost 200 people died inside the collapsed structure (Castro, 1968).

17 August 1983 Ilocos Norte Earthquake

On the evening of 17 August 1983, a magnitude 5.7 (Richter Scale), Intensity VII (Rossi-Forel Scale) earthquake hit the province of Ilocos Norte (Quake kills 21 in Ilocos,"; North Luzon hit by strong quake,"). It was felt exactly at 8:18 pm, and the epicenter was located to be 430 kilometers north of Manila, approximately around Laoag City, the capital of Ilocos Norte ("Quake kills 21 in Ilocos,). Cities in Luzon felt the tremor and recorded varying intensities: Vigan, Ilocos Sur (Intensity VI), Aparri, Cagayan (Intensity V), Baguio, Benguet (Intensity IV), Dagupan, Pangasinan (Intensity III), Metro Manila (Intensity III), and Puerto Galera, Occidental Mindoro (Intensity I). ("North Luzon hit by strong quake,"). Several days before the said earthquake, two other earthquakes were registered in the Ilocos region: one on 11 August, an Intensity V, and one on 13 August, an Intensity II (ibid.). The Ministry of National Defense (MND), through the National Disaster Coordinating Council (NDCC), reported that 11 towns in the province were identified to have suffered from the earthquake (De Vera, 1983). In another survey of the Defense Ministry done three days after the earthquake, they identified 87 major structures destroyed by the quake, and 212 others were partially damaged (Contractors of collapsed buildings face probe.”). Initial damage estimates announced by Vice Governor Roque Ablan, Jr. were approximated at 50 million pesos[iv] (“Quake kills 21 in Ilocos,”). In contrast to earlier assessments on the ground, the Public Works Ministry said that the damage to Ilocos Norte was only minimal and that only a small number of commercial, residential, and government buildings were damaged (ibid.). According to the report by the Office of Civil Defense (OCD), Laoag City registered the greatest number of collapsed and severely damaged infrastructures, which include commercial buildings, municipal and school buildings, libraries, museums, and private houses (“13 dead as quake hits Ilocos,”). The towns of San Nicolas, Bacarra, Currimao, Batac, Vincar, and Sarrat, President Marcos’ hometown (“Quake kills 21 in Ilocos,”).

16 July 1990 North Luzon Earthquake

On 16 July 1990 a 7.7-magnitude (Richter Scale), Intensity VII (Rossi-Forel) earthquake rocked central and northern Luzon. The epicenter was identified to be 10 kilometers southeast of Cabanatuan City in Nueva Ecija (“68 killed in Luzon quake,”; Castro, 1990). The first shock happened at exactly 4:26 pm on 16 July; Metro Manila, Cabanatuan City, and Baguio City strongly felt the tremor, but the extent of the quake reached northern Luzon and the Bicol region, and caused a tidal wave in the Agoo town, along the coastline of La Union (Castro, 1990). Officials described it as “an earthquake with a strength of 3 atomic bombs,” and the “strongest quake to hit the country in 22 years,” referring to the earthquake in August 1968. (“68 killed in Luzon quake,”). Major landscape devastations include a 120-kilometers long rupture between Gabaldon (Nueva Ecija), Dingalan Bay area (Quezon), and Kayapa (Nueva Vizcaya) thirty kilometers east of Baguio City, and massive liquefactions in the Pangasinan and Tarlac, 70 kilometers long and 20 kilometers wide, which affected main roads in the two provinces (Rantucci, 1993, p. 40-41, 59). Primary bridges in Central Luzon collapsed, and long stretches of concrete highways were severely damaged, making them impassable and cutting off many municipalities from commercial travel (“Earthquake!”). River facilities, parapets, and protective structures, in general, suffered widespread damage due to ground shaking or lateral spreading induced by liquefaction; sewerage networks were almost entirely disrupted in cities affected by this liquefaction (Rantucci, 1993, p 59). Dams such as the Ambuklao and Binga in Benguet, and Masiway and Pantabangan in Nueva Ecija were also damaged (ibid.). Of the public utilities, the electricity network was the most badly hit. Numerous poles were tilted, and the electricity supply was interrupted for days and even weeks in some of the remotest areas (ibid.). The National Power Corporation (NAPOCOR) announced that power was cut off in many areas, as damages were seen in Binga Hydroelectric Plant which resulted in the cut of power supply in Northern Luzon for hours a day, while other plants such as Calaca in Batangas and Sucat 2 and 3 in Muntinlupa were also affected (Rodriguez, et. al., 1990). The earthquake gravely hit the cities of Baguio in Benguet and Cabanatuan in Nueva Ecija. Doomsday sceneries as people were in a severe panic, with major buildings collapsing and authorities were clueless about where to act and respond first.

Crisis Management of Earthquake Disasters

In discussing the crisis management of the four subject earthquake disasters, two key areas are common: the military played a key role in the initial responses – mostly rescue and recovery operations, treating it as a form of civil defense and scientific agencies, post-disaster engineering studies, and policy reform initiatives always took place

Table No. 2
The subject earthquake disasters and institutions, key individuals, and vital events pertaining to disaster response and management (1937[i], 1968[ii], 1983[iii], and 1990[iv])

Earthquake Disaster	Key Institutions Involved in the Overall Government Response[v]	Key Individuals	Key Events Related to the in the Disaster and Post-disaster Response
1937 Luzon Earthquake	PWB, Bureau of Posts, PC	Manuel L. Quezon, President of the Commonwealth of the Philippines Miguel Selga, Weather Bureau Director	.kl • Severe damage in the Heacock Building • Creation of the Earthquake Board • Active role of the National Research Council of the Philippines (NRCP) in earthquake research
1968 Manila -Casuguran Earthquake	PWB, AFP, PC, Manila Police District (MPD), Manila City Government, CDA, House of Representatives, Senate of the Philippines, NRCP, UNESCO,	Ferdinand E. Marcos, President Imelda Marcos, First Lady Rafael Salas, Executive Secretary Antonio J. Villegas, Manila City Mayor	• Collapse of the Ruby Tower Apartments • Creation of the Villegas Citizen's Committee • Passage of the National Building Code (in 1972)

1983 Ilocos Norte Earthquake	Ilocos Norte Provincial Government, PC [provincial and regional], AFP, PNRC, PAGASA, Bureau of Mines and Geo-Sciences, PHIVOLC, DSW	Ferdinand "Bongbong" Marcos, Jr, Ilocos Norte Governor Fabian Ver, AFP Chief-of-Staff	• Dozens of damaged buildings in Laoag City, Ilocos Norte • Collapse of the Kaunlaran Building in San Nicolas, Ilocos Norte
1990 North Luzon Earthquake	AFP, NDCC, OCD, DPWH, DSWD, PHIVOLCS,	Corazon Aquino, President Fidel Ramos, Defense Secretary Renato de Villa, AFP Chief of Staff Fiorello Estuar, DPWH Secretary Raymundo Punongbayan, PHIVOLCS Chief	• Collapse of Hyatt Terraces Hotel • Collapse of Central Colleges of the Philippines • Controversy involving Secretary Estuar and the collapse of the Hyatt Terraces Hotel

i Manila Observatory, 1937b; Magsaysay and Feliciano, 1937; Sales, 1937; "Worst Quake since 1880 Shakes Manila, Provinces."; Repetti, 1937; "Towers knocked off churches; Big Buildings Sway"; "Earthquake Damage in Provinces Mounts; "Major magnitude 7.5 earthquake."

ii Flores, n.d.; Oca, 1968; Kintanar, 1968; Omote, et. al., 1969; Buan, Jr., 1968; "Quakes rock all Luzon."; Castro, 1968; Zumel and Panuncialman, 1968; "The Big Quake,".

iii Valenzuela and Garcia, 1983; Santiago and Rillon, 1983; "Quake kills 21 in Ilocos; "North Luzon hit by strong quake."; "Earthquake."; "North Luzon hit by strong quake."; "Quake kills 18 in Ilocos"; "20 still trapped in rubble,"; "13 dead as quake hits Ilocos."; "The 1983 Laoag Earthquake" Philippine.".

iv Rantucci, 1994; "Earthquake!"; *The July 16, 1990 Luzon Earthquake; The July 16, 1990 Philippines Earthquake*; Booth, at. al., 1991; Tadao, 1992; Nakata, et. al. 1996; Viñaviles, 1990; Batnag, 1990.

v Legend: PWB: Philippine Weather Bureau; PC: Philippine Constabulary; AFP: Armed Forces of the Philippines; CDA: Civil Defense Administration; PNRC: Philippine National Red Cross; DPWH: Department of Public Works and Highways; NDCC: National Disaster Coordinating Council; OCD: office of Civil Defense; DSW: Department of Social Work; DSWD: Department of Social Work and Development; NRCP: National Research Council of the Philippines; PAGASA: Philippine Atmospheric, Geophysical, and Astronomical Services Administration; Comvol: Commission on Volcanology; PHIVOLC: Philippine Institute of Volcanology; PHILVOLCS: Philippine Institute of Volcanology and Seismology;

for post-disaster rehabilitation programs and infrastructural reforms. Analyzing these aspects reveals the character of the state's perspectives and mechanisms on disaster management and how they evolved.

The role of the military in the state's post-disaster operations

The military institution has always been an essential force of the Philippine government in operationalizing its rescue and recovery mechanisms in times of calamities. In the four subject earthquakes studies, the military played roles in the immediate response operations of the government, the most common being the vital force that conducted and supervise rescue and recovery operations.

The PC and local police maintained order in panic-stricken Manila as the situation precipitated after the tremors. Many people got injured due to fallen debris, posts, and commotion in prime hotels, theaters, movie houses, and main thoroughfares in the city's business and commercial areas, where the public was gathered the thickest. People gathered in open streets and brought out their pillows, blankets, and clothes, and many started crowding drugstores for first aid medicine ("Worst Quake since 1880,"). Fearing a possible big aftershock, thousands camped out in large fields such as in Luneta, the Sunken Gardens, in front of San Agustin Church, Manila Cathedral, and Plaza Santo Tomas, and in Plaza Sampaloc and Plaza McKinley ("Thousands Spend Night Outdoors,"). Philippine Bar candidates were preparing for the bar examinations studied by candlelight placed on boxes used as improvised tables (Ibid.). The uniformed personnel placed trucks in front of houses and did not allow people to return to their homes, as safety is not yet secured (Ibid.). Aside from the residents of Manila and nearby provinces, the 20 August 1937 earthquake also had unlikely "victims". The said earthquake welcomed the 435 refugees, many were American families, professionals, and missionaries, from war-torn Shanghai, that arrived in Manila to escape the Japanese bombing of the said city in China ("435 refugees in new panic as quake strikes,"; "Arrivals caught at Pier by shocks fear fresh bombardment," "Bring Sad Tales,"; "Pathetic Stories of Flight from War-Torn City are Recounted,"). The fear of bombings and food shortage pushed the refugees to leave Shanghai eventually, and upon their disembarkation from S.S. President Jefferson docked in Manila, they thought that the sudden tremor was Japanese planes following them and bombing Manila (ibid.). After the major tremor, some of the refugees went towards open areas such as Luneta, the Sunken Garden, and Intramuros ("Thousands Spend Night Outdoors,").

In the early morning of 02 August 1968, hours after the earthquake struck, Executive Secretary Rafael Salas arrived at the disaster area and assembled the first-order response team for the rescue operations.

(Buan, Jr., 1968). Tagged as "Operation Ruby," the official rescue force was composed of military and civilian personnel – firemen, members of the Armed Forces of the Philippines (AFP), the Manila Police District (MPD), Manila City employees, and national government officers. PC Major General Gaudencio Tobias and Brigadier General Emilio Zerrudo, zone commander of the PC in Manila headed the rescue force. (Zumel and Panuncialman, 1968; "Hundreds Die in Quakes!"). During the second day of the rescue operation, almost 2000 personnel were working on the disaster site (Zumel and Panuncialman, 1968). Using cranes and bulldozers, the rescuers relentlessly worked to recover dead bodies and salvage survivors pinned down by the collapsed Ruby Tower. The disaster ground zero was a "picture of [a] feverish site," as jarring sounds of moving large trucks and equipment harrowed the area (Ibid.). The Department of Social Work (DSW), together with the Philippine National Red Cross (PNRC), managed the release and distribution of relief goods for the victims and the rescuers. The DSW allocated 130,750 pesos[v] for relief and rehabilitation efforts, and 10,000[vi] pesos as financial support for the victims of Ruby Tower, in response to the immediate order from President Ferdinand E. Marcos on the use of the national calamity fund (Zumel and Panuncialman, 1968; "Hundreds Die in Quakes!"). The Arellano High School served as the operations center: classrooms were used as temporary medical rooms for rescue survivors and food and shelter stations were set up (Zumel and Panuncialman, 1968). Per the initiative of Manila Mayor Antonio J. Villegas, the Manila Health Department acted as the primary first-aid and treatment group stationed in Arellano High School ("Ruby Death Toll Now 143,"). On his first visit to the disaster site, President Marcos commended all the personnel and volunteers and that "act[s] of kindness and generosity prevailed." (ibid.). Indeed, government agencies and the private sector worked together and mobilized their resources to rescue as many survivors as possible from the collapsed Ruby Tower. But the operations did not go steadily. "Operation Ruby" faced a profusion of challenges, deficiencies, and predicaments during the weeklong operations. One report from the ground summarized the situation:

> "And there was chaos. No proper equipment were around on the first day; only a flurry of contradictory suggestions on how to best save the victims. 'Dig from the ground,' said one. 'Start from the top,' said another. 'Search horizontally, floor by floor,' cried someone else. 'I know the buildings, let me tell you where you start digging,' insisted another. Too many were eager to help, and only succeeded in getting in help's way." (Abesamis, 1968a)

The compounded problems of equipment shortage, heat, rain, and the presence of bystanders in the area hindered the rescue operations. Rescuers suffered from dehydration and bruises and cuts. ("Ruby Death Toll Now 143,").

One government agency specially designed to respond to social needs in times of disasters, the Civil Defense Administration (CDA), was apparently out of sight during the Ruby Tower rescue operations. The CDA was established to prepare the populace for emergencies like natural disasters and wars but has failed to accomplish its mission through the years – an ample supply of trained rescuers is needed (ibid.). Leaders from the House of Representatives, such as Speaker Jose Laurel, Jr., and House Assistant Majority Floor Leader Joaquin Roces, urged President Marcos to reactivate the CDA, with particular emphasis on training and rescue workers (Ibid.). It was observed by many that the biggest handicap of the rescue work was the lack of trained rescuers; for example, a survivor with a broken rib developed another complication because of mishandling by some rescuers (ibid.). "Operation Ruby" was not only a nightmare of pulling out possible survivors from the collapsed Ruby Tower, but also a dilemma for hospital facilities, and post-disaster recording and documentation.

In the case of the 18 August 1983 earthquake, a more attentive and structured military presence was seen at the disaster's ground zero. The *Philippine Daily Express* reported on 19 August 1983 that the President mobilized the entire government machinery to assist victims, and that the relief and rescue operations are in full swing under the supervision of his son, Governor Ferdinand Marcos, Jr., assisted by Public Works Minister Jesus Hipolito and other officials ("Quake kills 21 in Ilocos,"). The young Marcos, visited the disaster-stricken sites, Laoag City, and seven other towns, and on the same day, personally supervised the food distribution, and medical relief operations ("Relief stepped up,"). In a report sent to his father, Governor Marcos, Jr. said that the situation is under control, and that priority in rescue and relief operations in the recovery of victims at the collapsed Kaunlaran Building in San Nicolas town (ibid.; "Death toll now 16 in Ilocos quake."; "Quake death toll now 24"; "Ilocos situation under control,"). The Ilocos Norte governor created an emergency task force named "Paglingap," which was composed of members from the provincial and city, and town governments, the AFP, the PC, the Ministry of Social Services and Development (MSSD). Full government authorities were tapped and performed their functions as needed. On 20 August 1983, on the fourth day of the province-wide rescue work, there was a need to step up the rescue operations. The head of the military initiated a separate mobilization. General Ver launched the Task Force "Damayan," and appointed Brigadier General Victoriano Asada, PC Region 1 Commander, as the overall in-charge (De Vera, 1983). The task force was composed of the military and the police forces: The Ilocos Norte PC, the Integrated National Police (INP), the AFP Corps of Engineers, the regional civil relations services, the Public Works Ministry, and other vital government services (ibid.). The President had earlier tasked the AFP to make its military transportation and other facilities available for disaster operations ("Quake kills 18 in Ilocos,"). The Ministry of Defense, through the NDCC, kept a close watch on the situation as well (De Vera, 1983). Together with another agency that is supposed to be designated to act in times of calamities, the OCD, the Defense Ministry, and the NDCC coordinate with agencies for information low to the media. These agencies, together with the Philippine National Red Cross (PNRC), released updated information about casualties and injuries and news about the rescue and relief operations ("North Luzon hit by strong quake,"; Quake kills 18 in Ilocos"; 20 still trapped in rubble?"; "13 dead as quake hits Ilocos,").

The regime of Ferdinand E. Marcos (1972-1986), politically and historically, has been characterized as a government of total control. It was known to have used the power of the executive and bureaucracy, the military, and local warlords to immediately implement its draconian programs and policies. Headed by Marcos, and the triumvirate of First Lady Imelda Marcos, General Ver, and Defense Minister Juan Ponce Enrile, "produced new strategies and techniques of social control, through the development of their vice-like regulation and management of disaster relief." (Warren, 2013, p. 14). Provincial loyalties and localized patronage were central in the operationalization of full governmental response and relief efforts for the people of Ilocos Norte after the killer earthquake. But looking thoroughly at the reports published in government-controlled newspapers, two things come to light: (1) there is an evident competition and distribution of work amongst "power groups" that led various rescue operations, and (2) there is an apparent attempt to hide the non-presence of Ferdinand and Imelda Marcos in the scenes, a contrast to the default template of hands-on father-mother tandem in times of disasters.

In general, the rescue, recovery, and rehabilitation operations of the government on the 16 July 1990 earthquake were, literally and figuratively, a political tremor and a fiscal earthquake. The former, the government, particularly the military establishment, was still recovering from the almost-successful coup-de-etat in December 1989. The latter, as the state had to exhaust all available fiscal crunching measures to gather funds for the rehabilitation of affected provinces (Aquino, 1990; Rodriguez, 1990; "Aquino to ask Congress help."; "DOTC, DPWH funds to be tapped,"; "Savings to boost quake fund."; Villa, 1990).

The scale of destruction of a large region of northern Luzon, particularly the cities of Baguio and Cabanatuan after the 16 July 1990 earthquake posed a major challenge to the military as front liners in the rescue operations. Together with the support of the local private sector and foreign military support teams, particularly from the United State (US), the Philippine military-led and managed the extremely difficult rescue and retrieval activities. Rescue operations were immediately started, sans direct national government instructions. Local governments and regional agencies of national departments acted relative to the available resources. The earthquake disaster isolated Baguio from the rest of the Benguet province for several days; cranes, tractors, and other heavy equipment can't reach the city because of landslides ("Severe food, water, power shortages hit Baguio city.") Cadets from the Philippine Military Academy (PMA) conducted rescue operation using a few equipment and bare hands along the structures in Session Road, especially at the Baguio Park Hotel. (Viñaviles, 1990). Foreign teams augmented the low number of local rescue teams; groups from Japan, the US, and England arrived, but they came a little late, as rescuers gave up in their search for survivors in Nevada Hotel and Hyatt Terraces Hotel ("Severe food, water, power shortages hit Baguio city."). Two days after the earthquake, helicopters from PAF and Subic Naval base airlifted relief goods and equipment; some people tried to ride the choppers (Ibid.). In Cabanatuan, the same problems that hounded Baguio were also observed. Instantaneously, the city government formed a rescue team, but the lack of heavy equipment hampered their work (Masaganda and Sagmit, 1190). The collapsed Christian Colleges of the Philippines (CCP) Building in the city was a huge task, and it needed not only an additional workforce, but big machines to move the pillars and walls of the collapsed structure. Nueva Ecija Governor Narciso Nario sought the help of Olongapo Mayor Richard Gordon, who immediately formed a rescue team and had direct access to the facilities at the US Naval Base in Subic (Solano, 1990). The US Navy Seabees from Subic Naval Base arrived to help in the retrieval operations (Fabian, 1990). As of the following night after the earthquake, 167 were pulled out alive, and five died in the rubble (Ibid.). After the third day of rescue operations in Cabanatuan on 18 July, rescuers composed of the joined forces of the AFP and the US military groups from Subic and Clark military bases recovered 64 casualties ("Ecija teams find 64 bodies.") At the national level, the military also managed the prolonged rescue operations that run for weeks. President Corazon Aquino formed an overall committee to coordinate all forms of assistance: headed by Defense Secretary Fidel Ramos as Chairman of NDCC, Transportation and Communications Secretary Jose de

Jesus as coordinator in Baguio, Health Secretary Alfredo Bengzon as coordinator in Pangasinan, and Brigadier General Ernesto Calupig, Division Commander of the Army 7th Infantry Division, to take in charge of the rescue operations in the CCP Building in Cabanatuan City (Rodriguez, Castro, and Yamzon, 1990). An Earthquake Assistance Center at the Bahay Ugnayan near Malacañang was set up under the Office of the President; will serve as a link up to the different agencies working on disaster relief operations (Ibid.). The AFP also served as the primary courier of the distribution of immediate relief goods collected and prepared by the Department of Social Welfare and Development (Rodriguez, 1990; Lobo, 1990; Rodriguez, Castro, and Yamzon, 1990). Though the whole military was mobilized and used the available resources for rescue operations, the government had a lot of lapses and mismanaged many aspects of the overall scheme of crisis management. The NDCC and the OCD, which were both led by high-ranking military officials, received a multitude of criticisms. The performance of the two agencies "revealed the government's and society's unpreparedness for a state of calamity or emergency…" and the lack of proper structure in assembling government personnel for the immediate actions needed (Balthazar, 1990). By their mandate, the two agencies were to be the prime coordinating force in times of disaster. The NDCC and OCD, as supposedly the agencies that were way ahead in disaster preparedness and management, were the ones struggling to get things done during the early days of the rescue and relief operations in disaster-hit areas. They earned the ire of journalists critical of the government and were labeled ineffective and incompetent government agencies. One made sarcastic remarks that sum up their performance: "NDCC living true to its name. It's a disaster," (Guevara, 1990a) and "[The] Office of Civil Defense issues precautionary measures to take during and after quake, Now it tells us." (Guevara, 1990b). Another one described the OCD as an outdated World War II idea and was a "dumping ground for political protégées." (Rama, 1990). Experts suggested that "a rescue agency run by professionals" must be established, wherein "a permanent, professionalized disaster relief agency, composed of specialists in rescue procedures and preparedness, nobody will be in charge of any disaster control operations." (Ibid.) The government was aware of these criticisms and to a certain extent self-reflexive about their inadequacies. AFP Chief of Staff General Renato de Villa said in a statement, "Our capability for relief operations appears to be adequate, but that of rescue and recovery is not good enough." (Yamzon, 1990).

Scientific agencies, earthquake studies, and policy reforms

Another vital component of the state's disaster response is the intertwined institutional responses such as the work of administrative and scientific agencies, the seismological and engineering research they initiated, and the policy reforms and formulations they spearheaded to concretize the rehabilitation and streamline the risk reduction programs of the government. In this approach, the government attempted to scientifically answer the problem of infrastructural recovery and proactively lay down mitigation plans for future urban destruction due to earthquakes. The state treated the earthquake disasters as social and economic problems that required institutional solutions – from the immediate and extensive research on the nature and character of earthquakes to the reorganization of agencies and implementation of new and revised policies on urban infrastructures.

Government scientific institutions on earthquakes have a long history that dates back to the second half of the 19th century. Two groups of professionals advanced the scientific research and studies about earthquakes: first were the Jesuits of the Observatorio Meteórologico de Manila, and the second was the Spanish colonial military, civil, and mining engineers. On the one hand, the Jesuit scientists contributed to this scientific scheme by presenting up-to-date scientific studies on the nature of terrestrial movements, giving light to some issues regarding earthquakes and volcanic eruptions (Saderra Masó, 1895). On the other hand, the joint efforts of the military, mining, and civil engineers reconstituted the nature of their field and synergized seismology with public-urban reconstruction strategies and policies (Anduaga, 2014; Anduaga 2017). The Jesuits of the observatory obtained various instruments from Europe through the help of merchants in Manila and their fellow scientists in Europe (Repetti, n.d.)[vii]. During the American colonial period, the reorganized observatory, the Philippine Weather Bureau (PWB), which was under the Department of Interior, had a Seismic Department that conducted monitoring and studies on earthquakes (Alvarez, 2016). In the 1950s, the goal of national modernization led to the expansion of the PWB's work on seismology and the Geophysical Division remained a vital part of the agency's work (*Weather Bureau Centennial, 1865-1965*, p. 11). In line with the government's thrust to create institutions for the promotion of national welfare, this division of the PWB assumed major tasks (Ibid, p. 22):

> (1) preparation and dissemination of technical advice to the public on geophysical matters and phenomena, such as tsunamis and seismic sea waves;
>
> (2) supervision of the operation and maintenance of geophysical observatory and seismic observation network;
>
> (3) formulation, coordination, and development of geophysical studies on Philippine seismicity and utilization of the same in earthquake engineering;

and (4) utilization of geophysical data with related scientific and technical agencies.

This work of the PWB on seismology continued until it was mandated by a new act, which created a revitalized weather institution in the Philippines in 1972, the Philippine Astronomical and Geophysical Services Administration (PAGASA), as a component of the Ministry of National Defense (MND) (*Vital Documents in the New Society,* pp. 57-59.).

Measuring and monitoring earthquakes has also undergone evolution during this period of institutional transformation. Documentary sources reveal that intensity[viii] appeared first as the measurement scale, and magnitude[ix] appeared several decades after. In Miguel Saderra Masó's *La Seismológia en Filipinas* (1895), a six-level scale on earthquake intensity was used as a measurement: (I) *Perceptible* (Discernable), (II) *Ligero* (Light) (III) *Regular* (Regular), (IV) *Fuerte* (Strong), (V) *Violento* (Violent), and (VI) *Destructor (Destructive)* (pp. 55, 58, 59, 63, 65, 67).[x] Interestingly, José Algué, in his *Atlas de Filipinas* (1899), presents a five-level distribution scale: *Muy Raros* (Very Rare), *Raros* (Rare), *Algo Frecuentes* (Somewhat Frequent), *Frecuentes* (Frequent) *and Muy Frecuentes.* (Very Frequent) (Map. No. 6). In his *Catalogue* (1910), he used the (De) Rossi-Forel Scale (1-X) in characterizing the intensities of documented Philippines earthquakes from 1599-1910 (pp. 4-5). Since then the Philippines followed the Rossi-Forel Scale in measuring intensity, until 1991, a year after the July 1990 North Luzon Earthquake, the Philippine Institute of Volcanology and Seismology (PHIVOLCS) devised a new intensity scale, and since 1996, uses its intensity measurement, the PHIVOLCS Earthquake Intensity Scale (PEIS) (Corsino, 2010).[xi] In terms of earthquake measurement scales, the Philippines follows the international standard. The problem, that perennially appears throughout the 20th century, was the lack of the number of stations and personnel to cover the whole archipelago. And this appears as a commentary from seismological chiefs in various instances, as will be discussed below.

Disaster occurrences are a solid and unique backdrop to produce new and updated knowledge about the workings of the physical environment. The knowledge production scheme on the four subject earthquakes was spearheaded by government scientific enterprise, and in some instances, foreign institutions were actively involved (in the August 1968 and July 1990 earthquakes). The scholarly outputs by seismologists, geologists, and engineers are technical reports and provide raw data, seismological and geological interpretation of the earthquake, as well as policy recommendations for the government. How did scientific agencies involved in each earthquake disaster and the studies they produced factor in the state's policies on the rehabilitation of disaster-affected communities? The scientific studies conducted to determine the nature of the 1937 and 1968 earthquakes provided the baseline research for the adoption of a new building construction policy in the capital city and the country in the 20th century (Repetti, 1937; Magsaysay and Feliciano, 1937; Sales, 1937; Oca, 1968; Kintanar, 1968; Omote, et. al. 1969, Flores, n.d.) These studies illustrate how the science of seismology in the country was at the center of disaster rehabilitation programs, and how the state engaged the scientists, specifically

Table No. 3
Matrix of information on the Studies made about the subject earthquakes

Earthquake Disaster	Period of Production After the Disaster	Number of Published Studies	Nature of Production (Local, International, Collaboration)	Institutions Involved
1937 Luzon Earthquake	1937 4 months	3[i]	Local (government)	• National Research Council of the Philippine Islands
1968 Manila -Casuguran Earthquake	1968-1969 1 month-1 year	3[ii]	Local (journals) and International	• The Philippine Geologist • Philippine Economy and Industrial Journal • United Nations Educational, Scientific, and Cultural Organization (UNESCO)
1983 Ilocos Norte Earthquake	1983 2-4 months	2[iii]	Local (government)	• Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) • Bureau of Mines and Geo-sciences

1990 North Luzon Earthquake	1990-1996 6 months-5 years	6[iv]	Local and International	• Philippine Institutte of Volcanology and Seismology (PHIVOLCS) • EQE Engineering, Inc. • Earthquake Engineering Field Investigation Team (EEFIT) • Inter-Agency Committee for Documenting and Establishing Database on the July 1990 Earthquake • Architectural Institute of Japan • Presidenza del Consiglio del Ministri-Italy • Hiroshima University Research Center for Regional Geography

i Repetti, 1937; Magsaysay and Feliciano, 1937; Sales, 1937.
ii Oca, 1968; Kintanar, 1968); Omote, et. al., 1969.
iii Valenzuela and Garcia, 1983; Santiago and Rillon, 1983.
iv Rantucci, 1994; "Earthquake!"; *The July 16, 1990 Luzon Earthquake; The July 16, 1990 Philippines Earthquake*; Booth, at. al., 1991; Tadao, 1992; Nakata, et. al. 1996.

seismologists, geologists, and engineers, in framing the country's national infrastructure code and strengthening the national institutions on science that deal with hazards and calamities. This law was tested and reviewed eventually, after the 1983 and 1990 earthquakes.

Two institutions led the Philippine Commonwealth Government's initiatives to study the nature and effects of the 1937 Luzon earthquake. The National Research Council of the Philippines (NRCP)[xii], and the PWB pursued collaborative research ventures to assess the destruction of the earthquake using seismological approaches and to formulate recommendations to the government on the reforms needed, particularly in civil construction. The NRC acting based on its mandate as a support think-tank of the government for various social and economic programs, published on December 1937 in their scientific bulletin a compilation of studies made by scientists about the 20 August 1937 earthquake. Three studies were made the seismologists and engineers, detailing the nature of the earthquake, its impact on public strictures, and recommendations for the enhancement of structural engineering practices in public infrastructures. The studies included in the journal the geological and seismological assessment of the said earthquake, with particular recommendations on how to deal with the devastation, specifically on building earthquake-proof edifices and the enhancement of structural engineering practices in public infrastructures. (See Table No. 3). Father William Repetti, a seismologist at the PWB, who also served as the head of the Seismological Section of the NRCP, made a brief study to determine the epicenter of the earthquake and the extent of its tremors by focusing on the P-waves and S-waves of the movements (Repetti, 1937, p. 56-58). Despite the losses of instruments at their central station in Manila ("Observatory Instruments Destroyed"), the PWB was able to provide an ample amount of information necessary to assess the situation and inform the government and stakeholders about the seismic details of the disaster. He used the reports gathered in their stations in Manila, Baguio, and Butuan, as well as reports from foreign seismological stations, in Hong Kong, Phu-lien, Zikawei in Shanghai, and Sydney, to validate their initial finding on the intensity of the earthquake, as well as the location of the tremor's epicenter (Ibid.). Despite the existence of scientific literature produced by the PWB in the past years, such as Saderra Masó's *Volcanoes and Seismic Centers of the Philippine Archipelago* (1904), wherein he identified at least 18 important and active seismic, volcanic spots in the archipelago (pp. 24-78), these stations did not have their seismological stations at the time of the 1937 earthquake. Father Repetti relied heavily on scientific data from abroad. He lamented that the scarcity of information was due to the lack of a working network of seismological stations in the archipelago:

"If we have a network of seismic stations covering the Islands, as there is in Japan, we would probably be able to learn something definite about the mechanism of the earthquake from the first motions. In the present case, with only two observations we can only suggest what possibly took place." (Ibid., p. 59).

But despite this, the PWB was able to tap the Bureau of Posts to mobilize their staff and their telegraphic stations across the archipelago to gather pertinent information about the extent of the earthquake's damage (Manila Observatory, 1937a).

The two other studies in the journal feature the experts' identification of the problems in public edifice construction and their recommendations for improving them. On the one hand, Magsaysay and Feliciano (1937) argue that the geographic nature of the archipelago and the nature of the August 1937 earthquake revealed some inconsistencies in public edifice construction, as some areas are observed to have more destruction than others, despite being in the same geographic zone. They argue that the government can follow knowledge set up by old structures in the archipelago, such as the "empirical rule" followed in building the church of Paoay in Ilocos Norte, where the popular large buttresses can be found (ibid., p. 11). This is in contrast to the "common sense rule" that was followed in the buildings in Manila, thus, the instability of it, or destruction, in times of strong tremors. is an inevitable scenario (ibid.). The authors ended their study by arguing for a new building code is needed not only for Manila but also for the whole country (ibid.). They also appealed to the government that seismology, geophysics, and structural engineering must be given more attention as scientific disciplines (ibid.). On the other hand, Sales (1937) presents a comprehensive report on the guidelines for earthquake-proof design and construction and points out three core principles to be considered to attain earthquake-proof edifices: (1) rigidity, (2) rational distribution, and (3) making the natural period of elastic oscillation of the building smaller than the probable period of vibration of an earthquake of destructive intensity (p. 61). Using the ideas used in earthquake-resistant structures in Japan and the United States, Salas listed down twelve important parameters to be looked closely upon to attain the resilience of a structure in times of tremors: location of the building, acceptable method of building design, the orientation of a structure, ground plan shape of the building, height of the edifice, the building's foundation, general and superstructure characteristics, the strength of structures wherein acceleration, forces, and working stresses are calculated precisely, use of materials, and precautionary measures in their uses (ibid., pp. 62-82). Moreover, he also recommended that the government must revise some policies on the building code, and certain urban policies to be more dynamic in terms of preparing for calamities: on the one hand, the building code must indicate that it gives architects and engineers the exclusive right to design buildings and other engineering architectures, and must require owners, engineers, and contractors to provide specific documents and do certain tasks to endure the safety of buildings and constructions, and, on the other hand, the government must revise the archiving and data management scheme to bring about efficient reference systems in case of calamities (ibid.).

President Quezon, to implement a long-term response to the huge damage brought by the earthquake, issued an order creating the Earthquake Board, which was headed by PWB Director Father Miguel Selga (Repetti, 1948, P. 29). This board was a revival of the Earthquake Committee created in 1924 by then American Governor-General Leonard Wood and was headed by Father Selga's predecessor in the PWB, Father José Algué.[xiii] The Earthquake Board was tasked to study the earthquake situation in the country, recommend solutions, and draft policies on public safety and infrastructures (Repetti, 1948, pp. 29-30). Unfortunately, the 1924 Earthquake Committee turned out to be a non-functioning body and was deemed as fly-by-night. Scientists urged the government to make the 1937 board a permanent agency and suggested that it be integrated as a section of the NRCP, as the "Earthquake Research Board," to receive a necessary appropriation for earthquake research, like what most earthquake-prone countries do (Sales, 1937, pp. 85-86).

A similar scenario of scientists being at the frontline of research on public construction after an earthquake disaster happened in 1968. The bulk of research initiatives centered on the dire need to revisit the building practices in Manila, as well as in many urban towns and cities in the country after the peculiar collapse of the whole Ruby Tower Apartments building. The 17 August 1968 earthquake disaster prompted the approval of the National Building Code (Flores, n.d., p. 483). Two agencies conducted studies about the earthquake and its effects on the buildings in the city. First, a local committee was mandated to investigate the problems in the city's building policies, and another one, was a team from the United Nations Education, Scientific, and Cultural Organization (UNESCO), which was requested by the Office of the President.

Manila Mayor Villegas initiated a series of inquiries regarding the cause of the collapse of the Ruby Tower Apartments and ordered the creation of a Citizen's Committee composed of experts in the field of civil engineering and architecture, such as Cesar Concio who acted as Chairperson, and members Fiorello Estuar, Cesar Caliwara, Napoleon Campomanes, and Petronilo Parungao (Gervasio, 1966, pp. 51-57). The committee found out several problems: (1) that general the collapse was caused by the failure to meet the standards of a high-rise building, (2) the inadequacy of design, lack of ductility in the columns and beams, poor quality of materials, the improper placing of reinforcement bars, poor workmanship, and lack of supervision, all of which were responsibilities of the contractor of the building, and (3) that the building instantaneously collapsed after the shock and that no soil exploration test was conducted at the site before its construction." (Flores, n.d., p. 483; Oca, 1968, p. 175). Moreover, they also discovered that most of the buildings which are moderately to severely damaged are located along the north bank of Pasig River in the Escolta district, apparently, in the loose and poorly consolidated sediments, the seismic energy released by the earthquake is amplified and its full force in transmitted on to the building structures (Oca, 1968, p. 176). Structural failures due to substandard materials and execution of an ineffective construction plan were identified and these passed through the procedural engineering auditing offices, from the city to the national level. Ineffective screening of the plans and issuance of building permits occurred due to bureaucratic corruption in certain offices. A newspaper commentary labels the Ruby Tower incident as a "Pandora's Box of Anomalies," as discussions on the supposed anomalies in the approval of the construction emerged (Azurin, 1990). The findings of the Mayor Villegas' committee were quite similar to the UNESCO Team report in 1969, wherein they identified that the "disastrous failure of this building during the earthquake was doubtless due to a combination of several factors", such as unbalanced stiffness of the structure, lack of capacity to absorb shocks, unsuitable components to carry the towers' overloaded capacity, the use of low-strength concrete and hollow concrete blocks (Omote, et. al., 1968, p. 38). Sunitiro Omote, acting director of the Tokyo International Institute of Seismology, served as head of the team. The aim of the team centered on two objectives: (1) to make a preliminary study of the seismological and engineering aspects of the earthquake, and (2) to identify actions that should be taken to improve knowledge of the seismic conditions of the country and the means of protection against earthquake (Ibid., p. 3). The committee identified various reasons for the collapse and severe destruction of buildings, most of which were due to shortsightedness in architectural and engineering planning and execution and outdated and improper structural components that are not fit for earthquake-prone countries. At the end of their report, the UNESCO team made several recommendations, particularly, on matters related to scientific approaches in dealing with earthquakes and earthquake-resistant construction. They recommended that the Citizen's Committee of the Manila City Government finalized their documentation of data related to the earthquake, as well as separate documentation of the city's subsoil condition, through intensive geological research (ibid., pp. 51-52).

They also made specific recommendations in the city's building code, on the establishment of additional seismological stations around the country, and investing in education, training, and research for experts, particularly on maximizing the potential for study opportunities abroad.

The Ruby Tower controversy originally prompted the passage of the National Building Code (NBC) on 26 August 1972, spearheaded by Senate President Gil Puyat and Senator Helen Benitez (Flores, n.d., p. 489). The NBC, known officially as Republic Act No. 6541 (An Act to Ordain and Institute a National Building Code of the Philippines), was aimed at declaring as a state policy "to safeguard the life, health, property, and public welfare consistent with the principles of environmental management and control," thus it must be a responsibility of the government to "provide a framework of minimum standards and requirements by guiding, regulating, and controlling…" the location, siting, design, quality of materials, construction, use, occupancy, and maintenance of buildings and structures (Republic Act 6541). Five years later, on 19 February 1977, RA 6541 was revised through a presidential decree (Presidential Decree 1096). The passage of the NBC in 1972 was a product of years of political lobbying and scientific research on the most suitable way of institutionalizing practices and codifying rules and regulations on public construction. In their recommendations on how to improve Manila's urban landscape, the UNESCO Team emphasized the much-needed revisions in the city's building code. The team's recommendations encompassed aspects not only of the construction quality and design but also of the foundation and proper identification of area through extensive zoning based upon known seismicity not only in urban areas but also in the whole country (Omote, et. al., 1969, pp. 51-52).

Structural experts, geologists, and seismologists, in the post-disaster assessment of the scientific causes of the tragedy, unanimously pointed out the need for proper and appropriate soil zoning for the public. In the years before the passage of the NBC, there was an evident clamor for local sub-soil zoning maps for metropolitan areas to show the dynamic soil structure to earthquake motions (Flores, n.d., p. 489). PWB Chief Geophysicist Wellington Minoza suggested the institution of building codes for designing earthquake-proof structures and also the organization of research on the behavior of the ground when the earth vibrates (Abesamis, 1968). Furthermore, experts also suggested that the institutionalization of rules and policies be applied to research agencies and documentation practices. A proposal for the establishment of a Building Research Institute, similar to that in Japan, was necessary to take care of the above recommendations and prosecute relevant studies, and maintain collaborations with local research organizations and allied institutions in other countries (Flores, n.d., pp. 489-490). Moreover, some scientists also urged the practitioners in the field to adopt an International Scale for Magnitude and Intensity of Earthquakes, and Metric System for measurements to achieve better coordination of all scientific research and technological development (ibid.). The codification of mechanisms and regulations in constructing buildings and infrastructure was made possible due to the extremity of the Ruby Tower Tragedy, making it a turning point, and an event that surfaced the malpractices and outdated style and designs in public constructions, not merely or less of earthquake-resistant buildings. One journalist observed that days after the earthquake, "the earth's every movement became the concern not only of lonely geophysicists and seismologists in their run-down buildings but also of the ordinary layman, stilled and silenced by the awful sounds beneath his feet." (Abesamis, 1968).

With the NBC passed into law, the succeeding earthquakes tested the means the government was implementing the law, and at the same time, challenged the scientific agencies in strengthening and improving the scientific foundations of the country's mitigation policies on structural devastations.

Another layer of institutional enhancement to meet the need for a more scientific intervention in disasters took place in 1982. On 17 March 1982, President Marcos issued Executive Order No. 784 reorganizing the NSDB and its agencies into a National Science and Technology Authority (NSTA) (*Philippine Presidential Decrees*, 2004, pp. 89-102). The establishment of NSTA was founded on the imperative that scientific and technological efforts are geared to meet the demands of economic and social development and that the results of such endeavors be appropriately applied and utilized for the benefit of the Filipino people (Ibid., p. 89). One agency that undergo restructuring was the Commission on Volcanology (Comvol), a scientific agency that was established in 1952 (Laws and Regulations,). With a redefined platform of functionality and services, not only focusing on volcanic activities but also on other geological phenomena such as earthquakes, the Comvol was transformed into the Philippine Institute of Volcanology (PHIVOLC) (*Annual Report of the Philippine Institute of Volcanology*. 1982, p. 4). One of their tasks was to supplement the work of the PAGASA, and "to investigate and conduct studies of all active Philippine volcanoes and other volcanic terrains, volcanism, and other related phenomena." (ibid.). Appointed as director of PHIVOLC was Raymundo Punongbayan, a US-trained geologist-volcanologist and UP professor, while then Comvol Acting Director Olimpio Peña was designated as Deputy Director (Ibid.). In 1984, PAGASA underwent reorganization and one of its divisions, the National Geophysical and Astronomical Office (NGAO), was merged with PHIVOLC, adding seismology as one of its scientific turf (Executive Order No. 984). The order thus provided for the centralization of seismological studies and research in the institute; the agency was then known as the PHIVOLCS. (*Annual Report of the Philippine Institute of Volcanology and Seismology*, 1985, p. 1). To sum up, a reorganized agency specifically mandated to enhance studies on earthquakes was born from 1982 to 1984, with a bureaucratic vision of centralizing scientific work and expanding the benefits of science to the larger society.

Given these institutional shuffling and institutionalization of scientific micromanagement, one can infer that the government can directly act on the scientific needs in times of disasters, through proper monitoring of environmental hazards that control it. But this reorganization that took place from 1982 to 1984, sandwiched the August 1983 Ilocos Norte earthquake. And it implies the way the said earthquake was scientifically studied: it did not receive appropriate scientific enthusiasm compared to the previous earthquakes. Tthe documentary sources about the earthquake did not expound on the role of scientific institutions in the post-disaster programs of the government. The available materials concerning this earthquake, from newspapers to published government reports, have limited information about the extent of the earthquake. The *Bulletin Today* published the first newspaper report about the quake, which barely included extensive information about the earthquake, indicating only its extent, and some preliminary data gathered by the PAGASA. ("Earthquake."). Other local reports indicate that the earthquake was also felt in other provinces in Luzon, such as Nueva Ecija, Tarlac, Pampanga, and Southern Luzon provinces ("North Luzon hit by strong quake."). The earthquake was characterized as tectonic and caused by massive adjustments along the fault line crossing the Ilocos region ("Ilocos towns prone to quakes."). It was compared to be the same as the earthquake that jolted Southern Mindanao in April 1976 ("Quake kills 21 in Ilocos,"). PAGASA Chief Roman Kintanar emphasized that Laoag and the surrounding Ilocos Norte regions are earthquake-prone areas, as they sit on the path of a major fault line, along with the western coast of Luzon ("Ilocos towns prone to quakes."). But the PAGASA, and the Bureau of Mines and Geo-Sciences, produced the two available scientific reports of the August 1983 earthquake.[xiv] This apparent dearth in terms of research was partly a product of the institutional revamps in the national scientific agencies mentioned. The under-transition agencies were not able to maximize their work, and the lack of extensive scientific appreciation of the August 1983 earthquake hastened the aforementioned centralization of seismologic work as seen in the transfer of the work from the Defense Ministry (where PAGASA was placed in 1972) to the NSTA, towards the creation of PHIVOLCS in 1984.

Six years after it crystallized to its contemporary form, the PHIVOLCS, under the leadership of Punongbayan, gained recognition as the legally mandated scientific institution on earthquakes due to its commendable work in the aftermath of the July 1990 earthquake in northern Luzon, from locally conducted preliminary research work and later on, especially, collaborations with foreign experts and agencies in expanding the produced scientific outputs about the said earthquake. The July 1990 earthquake was a scientific phenomenon that became the center of international attention. Foreign scientific institutions funded the available comprehensive geological and seismological studies about the July 1990 earthquake. From 1990 to 1996, scientific teams from the United States, Japan, United Kingdom, and Italy went to the Philippines and corroborated with Philippine scientific institutions to make their respective studies about the nature and effects of the July 1990 earthquake not only in the Philippines but also in the field of geology and seismology. A month after the earthquake, a "quick look report" by an engineering firm from California was made and published (*The July 16, 1990 Philippines Earthquake, 1990*). The study was a survey of the extent and source of damage, and the direct impacts of the earthquake in various urban sectors of the affected communities. The report concludes that "…the major lessons from it include the relationship of soft soils to building design practices, the vulnerability of multinational corporations to uncontrollable events across the globe, and the need for appropriate engineering and quality control in seismic areas." (ibid., p. 46). The second study made about the earthquake was by the Earthquake Engineering Field Investigation Team from London, and contains a more detailed study of the nature of the earthquake and provides a more detailed discussion of the economic losses caused by the earthquake to provinces in Luzon (Booth, et. al., 1991). Other studies were made possible through a collaboration of Filipino and Japanese seismologists containing a detailed, technical geological and seismological analysis of the July 1990 earthquake (Nakata, et. al, 1996). Two years after the earthquake, an inter/agency committee composed almost of scientists from PHILVOCS and other academic institutions came up with their report. It was aimed at documenting and establishing a transparent database of studies made about the earthquake, not only from the point of view of geology and seismology, but also included studies made by sociologists, psychologists, social workers, and urban planners about the said earthquake (*The July 16, 1990 Philippines Earthquake, 1990*). And lastly, a study funded by the Italian government attempts to correlate the two large-scale geological phenomena that Luzon experienced in 1990 and 1991, as it discusses not only the July 1990 earthquake but also the infamous June 1991 Mt. Pinatubo Eruption (Rantucci, 1994). But ironically, the apparent reliance of local scientists for collaborations rested on the need for, no doubt, research funding, and additional technical support. PHIVOLCS chief Punongbayan directly, and indirectly lamented the lack of government interest in further seismological studies, especially after the San Francisco earthquake of 1989 ("Phivolcs assesses quake effects."). He added that the PHIVOLCS before the earthquake only has 12 seismic stations, from a minimum ideal of 60; and only 1 percent of the 150 million (sic billion) national budget for 1990 was allotted to the said agency (ibid.).

In the local scene, the public's interest in the work of PHILVOLCS gained momentum. On the one hand, tapping the unnoticed and underfunded studies of PHIVOLCS and the University of the Philippines (UP) on earthquake engineering was pointed out to be a good start for a long-term scientific initiative in popularizing earthquake-resistant buildings and structures (Sayson, 1990). The government was urged to emulate the practice and system followed by Makati City business district buildings, as well as the Main Building of the University of Santo Tomas (UST) in their respective edifices regarding earthquake resistance of their structures, strength technologies, and international building code compliance (Ilagan, 1990). On the other hand, the interaction of PHIVOLCS and the media brought a greater appreciation of the importance of popularizing fundamental knowledge on earthquakes. The media helped in the appreciation of earthquakes through their short reports and information dissemination initiatives and made the complicated field of seismology a matter of public literacy. Discussions or re-introduction of the "basics", such as plate tectonic theory, a short history of earthquake occurrences in the Philippines, and even the scales used (such as Rossi-Forel Scale, Richter Scale, and Modified Mercalli Scale) are some of the information made available through print media (Miranda, 1990; "Editorial: Earthquakes and its magnitude measure."). Constructive and informed opinions from journalists also made sense, particularly on the issue of scientific communication. Some suggested that the government must improve domestic communication; as the recent earthquake tragedy proved to be: "In the national interest, it may be wise for the government to create a favorable climate for the introduction of modern technology into domestic communications industry." ("Editorial: Earthquakes and its magnitude measure."; Flores, 1990). But there was also an incidence of panicked brought about by the improper handling of scientific information. Several days after the 16 July 1990 tremor, a rumor caused panic in the Makati Central Business District (CBD) as thousands of employees in Metro Manila poured out into the streets after hearing a TV news report broadcasted in several news stations that another strong earthquake will hit the area ("Quake jitters hit Metro."). The PHILVOLCS scientist immediately clarified the matter; Punongbayan clarified that the big earthquake rumor, which originated from a misunderstood statement of a Japanese seismologist on possible aftershocks, is improbable as no one could precisely predict earthquakes (Ibid.).

With institutional reorganizations and continuous disaster-scientific research with the visionary goal of concrete operationalization of the use of new and updated knowledge on earthquakes, controversial problems still rose in evident instances of major structural collapses. The case of the Kaunlaran Building in San Nicolas, Ilocos Norte that was destroyed by the August 1983 earthquake, and the Hyatt Hotel in Baguio City in July 1990, proved that the problems from the Ruby Tower tragedy, which prompted the passage of the NBC, still haunted the government. The essential aims of the scientific works from the August 1937 and August 1968 were not achieved fully.

Built in 1981, the Kaunlaran Building in San Nicolas town in Ilocos Norte became the face of a provincial-wide dilemma concerning NBC. The building, a display center for cars and lodging houses of students and sales associates, collapsed due to the August 1983 earthquake (De Vera, 1983; "13 dead as quake hits Ilocos,"). An inter-agency committee composed of the Ilocos Norte Provincial Government, San Nicolas Municipal Government, and the Ministry of Public Works, which was patterned after the 1968 Ruby Tower committee, assessed the Kaunlaran Building and concluded that the structure was made out of substandard and inferior-quality materials ("Contractors of collapsed buildings face probe."). Local officials acted in unison on the report of the committee. On the one hand, San Nicolas town mayor Benjamin Madamda said that he would file criminal charges against the designers and contractors; while on the other hand, Vice Governor Roquito Ablan ordered the province-wide inspection of structures to determine their integrity after the quake and initiated a separate investigation on the contractors of ten other buildings in the province that were severely damaged (Ibid.).

In the case of the July 1990 earthquake, despite the proactive scientific initiatives and renewed public discussion on the importance of seismic-proof structures, one controversy erupted and questioned the effectiveness and precision of the implementation of the existing national building code. During the crucial period of the rescue and retrieval operations in the devastated, the Public Works Chief, Secretary Fiorello Estuar, got involved in a controversy concerning the collapsed Hyatt Terraces in Baguio City. His involvement with the engineering firm that built the said structure (Patiño, 1990). Constructed in 1984, the Hyatt Terraces' structural integrity was tested early by an earthquake the following year. A structural engineer, Octavio Kalalo recalled that he was commissioned to assess the building and he recommended that Hyatt Terraces should not have been repaired and reconstructed due to major defects ("Engineer recalls Hyatt report in '85.") Kalalo further revealed that they sent a report to the Commission on Appointments in December 1988, which by then was conducting confirmation hearing on the appointment of Estuar, to show that the latter mishandled the reconstruction of the Hyatt Terraces (Ibid.). The media was quick to dig deeper into the issue and discovered details that further implicated Estuar. One journalist described the issue as "another Joecon Affair" in the President's cabinet (Patiño, 1990).[xv] The media also found out that he once declared that no earthquake could put the Hyatt Terraces down (Beltran, 1990). The media also discovered that no available copy of the design calculation of the hotel from Estuar's engineering firm and the Baguio City Engineer's Office ("Engineer recalls Hyatt report in '85."). Moreover, it was later discovered that many huge buildings in Baguio City, such as the Hyatt Terraces, were not insured ("Baguio buildings found not insured."). Lastly, Estuar's credibility was further questioned as his participation in the Citizen's Committee that studied the Ruby Tower Apartments' collapse, which was one of the events that led to the passage of the NBC, was deemed ironical to the irregularities he was accused of, and scathing damage to his decades of work as a civil engineer. (Bigornia, 1990).[xvi] On his part, Estuar denied the accusations against him, but out of delicadeza, he submitted his resignation to President Aquino so as not to delay the government efforts on the rehabilitation of affected areas (Parazo, 1990). The President did not accept Estuar's resignation from his post, arguing that times were crucial and that the cabinet must stay intact approaching the gigantic task of rehabilitating devastated communities (Patiño, 1990; Catapusan, 1990).

Indeed, the Hyatt Terraces issue involving Estuar was another Pandora's Box of anomalies, this time, under the existence of a national code regulating public construction. The matter was not about one government official implicated in controversy, but the tip of the iceberg of the larger bureaucratic dilemma such as conflict of interest, government neglect, and to a certain extent, irregularities and corruption in the engineering sector. It touched the public engineering sector in a sensitive yet opportune time, as calls to reexamine the 1972 NBC were initiated within the sector and the public. ("Editorial: Another killer earthquake calls for closer supervision.") The issue of expanding accountability from the engineering sector and government officials, as well as strengthening the implementation of the country's building code through corruption prevention, were proposed (Caruncho, 1990; "Probe urged on building violations.").

Conclusion: Making a Case for Earthquakes in Philippines History

Philippine environmental history could be both a topic of inquiry and a methodological approach to the reconstruction of local and national histories. As a component, the history of hazards and disasters provides a scholarly understanding of conventionally scientific norms and phenomena. This study of select earthquakes presents a treatment of hazards as historical events and turning points and were important transitional and triggering events in the social and political structure of each period when they occurred. They are also opportunities and reinvigoration of specific scientific and bureaucratic schemes manifested in the way sectors responded and acted after such earthquakes.

As mentioned in the introductory part, historical seismology is a valuable field not only to study the scientific aspect of earthquakes but their historical dimensions across time, particularly in durations of long periods. Embracing the Annales School of prolonged and protracted views of historical change, the narrative of earthquake disasters presented in this work offers a grasp of the Philippine earthquake experience in the long 20th century. It shows us the repetitive cycle of failures and openings for proactive development; a Möbius strip of disaster and recovery, scientific engagement, and policy improvements. The cycle of rescue operations, immediate and ill-equipped in terms of capacity coincides and moves to bureaucratic responses such as fiscal and budgetary decisions, institutional scientific intervention, and public infrastructure policy and regulation review. There is an apparent repetition of shortcomings, responses, and post-disaster programs implemented. Local and foreign scientific engagements and interventions composed the body of scholarly output on earthquakes and they contributed significantly to the academic framing of earthquakes as environmental phenomena that need institutional understanding. Surveying our country's journey and travails in disaster response, seismological knowledge production, and policy formulations and revisions is an important fundamental step in our aspiration to have a truly proactive disaster response mechanism. By looking at our seismological past, we could examine and appraise our gains and failures in disaster crisis management, and reexamine the bureaucratic and administrative mandates and obligations of government institutions, such as the military and scientific agencies. As a strategic proposition, a sunset review of the existing Philippine Disaster Risk Reduction Management Act using historical perspectives is an essential step in fulfilling our national yearning for a disaster-proof society.

From this conjunction, how can we have a bird's eye view of the trajectory of Philippine disaster history writing? Making a case for earthquakes not only as geological processes of the physical environment but as hazards that perennially stimulate constant geographical and social alterations to human communities could be a core concept in historical scholarship. This present work that attempts to illustrate the prevailing discourses on geological calamities using select notable disasters provides an erudite opportunity to reconstruct the Philippine past from the lens of hazards and disasters.

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Endnotes

i John Milne was one of the pillars of the Imperial College of Engineering in Japan (later composed what is now The University of Tokyo) and the Seismological Society of Japan. He is considered as the "Father of Japanese Seismology." See the National Museum of Nature and Science of Japan <https://www.kahaku.go.jp/english/event/2013/06johnMilne/>.

ii Some of the works of Jean Vogt are the following: "Révision de deux séismes majeurs de la région d'Aix-la-Chapelle - Verviers - Liège ressentis en France 1504, 1692" (1983), "Probl`emes m´ethodologiques de la sismicit´e historique, base des discussions de risque sismique." (1986); "L'imbroglio des catalogues de sismicit´e historique. A propos d'une crise sismique ressentie `a la fin du XVIIIe si`ecle dans la plaine rh´enane et en Souabe." (1994), and "Bref historique des enqu^etes macrosismiques en France, dans leur contexte, avec quelques exemples de pays voisins." (2003).

iii Some of the works of Pierre Alexandre are the following: "Catalogue des séismes survenus au Moyen Age en Belgique et dans les régions voisines." (1985), "La séismicité historique du Hainaut, de la Flandre et de l'Artois de 700 à 1800". (1990); "Les Séismes en Europe occidentale de 394 à 1259. Nouveau catalogue critique." (1990), and "The seismic cataclysm of 29 March 1000: genesis of a mistake." (1991).

iv Using the "Inflation Calculator for the Philippines," it is estimated to be 741,509,052.97 Philippine Pesos (PhP), <https://www.worlddata.info/asia/philippines/inflation-rates.php>.

v Using the "Inflation Calculator for the Philippines", it is estimated to be 11,322,800.08 Philippine pesos <https://www.worlddata.info/asia/philippines/inflation-rates.php>.

vi Using the "Inflation Calculator for the Philippines", it is estimated to be 865,988.53 Philippine pesos <https://www.worlddata.info/asia/philippines/inflation-rates.php>.

vii The observatory obtained instruments such as the Bertelli tromometer (1881), a Secchi seismograph and seismoscope (1881), a pendulum and two geophones (1886), a duplex-pendulum seismoscope (1888) obtained from renowned seismologist John Milne, a Secchi microseismograph (1888), and a Gray-Milne three-component seismograph (1888). See Repetti, n.d.

viii Intensity refers to the degree of tremor and shaking in a given area or distance from the earthquake's epicenter (DOST-PHILVOLCS; British Geological Survey Website).

ix Magnitude is defined as the measurement of the earthquake energy released at a given focus or epicenter. It is measured and calculated instrumentally using a seismograph. The Philippines follows the 1935 Richter Scale from the United States of America. (DOST-PHILVOLCS; British Geological Survey Website).

x Saderra Masó also explained the scales used by the observatory in relation to the widely used Rossi-Forel Scale in earthquake research: I (*Percetibl*e, II and III), II (*Ligero*, IV), III (*Regular*, V), IV (*Fuerte*, VI and VII), V (*Violente*, VIII), and V (*Destructor*, IX and X). (Repetti, n.d.)

xi The PEIS has 10 intensity measurements: (I) Scarcely Perceptible, (II) Slightly Felt, (III) Weak, (IV) Moderately Strong, (V) Strong, (VI) Very Strong, (VII) Destructive, (VIII) Very Destructive, (IX) Devastating, (X) Completely Devastating.

xii The National Research Council (NRC) of the Philippine Islands was created on 08 December 1933 by the Philippine Legislature under Act. No. 4120, and was organized with the cooperation of the Department of Agriculture and Commerce. *National Research Council of the Philippine Islands, Bulletin No. 14* (Dec 1937).

xiii The Earthquake Committee was created "for the purpose of making a scientific study of the conditions existing in the Philippine Islands…and to recommend practicable means of preparedness or precautionary measures, giving particular attention to constructions, water system (including canalization and sewage), natural drainage, gas and electric plants and system, the location of the cable lines, and such other features as the board may deem necessary, especially in the regions believed to be the most exposed danger." Leonard Wood, Executive Order No. 9, "The Study of Earthquakes in the Philippines", *Science*, Vol. 59, No. 1526, INS S1.1 067, Institutional Records, Manila Observatory Archives.

xiv R.G. Valenzuela and L. C. Garcia, *Laoag Earthquake of 17 August 1983 Summary Report* (PAGASA, 10 October 1983); N.G. Santiago and E.A Rillon, *Assessment on the effects of the August 17, 1983 Earthquake in Laoag City* (Bureau of Mines and Geo-sciences, December 1983). Unfortunately, no available copies of these works were found. Only a summary of their findings is available at the PHIVOLCS website <https://www.phivolcs.dost.gov.ph/>.

xv President Aquino's Department of Trade and Industry Secretary, Jose "Joe" Concepcion, Jr., was accused of benefitting from government contracts to favor his company, the Republic Flour Mills (RFM). See Greg Ogle, "Profile: Jose Concepcion." *Asian Left Review* (August 1990), p. 7. <https://bit.ly/2DIfgNr>, Date accessed>, 31 October 2018.

xvi The University of the Philippines Alumni Engineers (UPAE), the alumni organization of the University of the Philippines College Engineering, recognized Estuar as the Most Distinguished Alumnus in 1990, for his expertise in engineering repair and structural engineering. See <www.upae.org/upae-awardees/>.

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