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Hamma Lakhdar University of El-Oued

Faculty of Arts and Languages

Department of Arts and English Language

The Environmental Factors in the Collapse of the Maya Civilization (The Involvement of Foreign Companies)

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Supervised by :

Hizia BOUREDHA

Nadjoua OMANE

Supervised by :

Dr. TAMMA Soumia

Board of Examiners:

Dr. Mennai Chaima	**President**	University of El Oued
Dr. TAMMA Soumia	**Supervisor**	University of El Oued
Dr. Toumi Nour El Houda	**Examiner**	University of El Oued

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Dedication

This work is dedicated to the cherished memory of my grandmother and aunt, whose love and sacrifices have profoundly shaped my journey. I extend my heartfelt gratitude to my beloved parents, who gave everything to see me reach this stage. To my dear husband, your unwavering encouragement and care have been my strength throughout this endeavor. I also dedicate this to my brothers and sisters—Abla, Hayat, Mohammed, Brahim, Khaled, Sadek, Yousef, and especially my sweet Hadil—whose support has been invaluable. A special dedication to my dearest friend, Dr. Beggat Hanane, whose gratitude and care I deeply cherish. Finally, to everyone who has known and supported me during the realization of this work, thank you.

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This dissertation is dedicated to the memory of my parents whose Souls continue to guide me. It is dedicated to to my elder nephew whose interest and encouragement inspired me to continue. I dedicated the work to all my family members; friends and the beloved ones whose support and beliefs prompt me ahead. Lastly, I dedicate the work to all the ones who are fascinated by exploring ancient civilizations

Omane Nadjoua

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Abstract

This research investigates the interplay of environmental stressors and Spanish colonial intervention within the collapse of Maya civilization throughout the Low lands since 900 CE to the Spanish arrival. It emphasizes the colonial affects often overshadowed by using climatic theories. This study employs a mixed-method approach. It blends quantitative secondary data analysis with qualitative descriptive and thematic techniques to explore the multi-causal factors of the Maya collapse. It is drawn on colonial records, description of archaeological patterns from Tikal and Calakmul, and analysis of paleoclimatic lake sediment cores. All were with a deep respect for the human story behind the data. This was to have a look at drought, deforestation, and land erosion. Findings display those prolonged droughts and deforestation eroded agricultural resilience in that: 40–50% less rain, 60% forest loss and 30% sediment increase. The Spanish arrival with violence, smallpox epidemics (90% population loss), and encomienda labor structures disrupted meals manufacturing (50% maize taken), ending Maya autonomy with Tayasal's fall in 1697. Despite scarce proof due to colonial destruction of codices, this research illuminates how environmental pressures and inner political fragmentation with colonial policies led to societal collapse. These insights underscore the complexity of the Maya decline and offer lessons for present day environmental and cultural resilience via adaptive useful resource management and network-based governance. By bridging paleoclimatic, archaeological, and historic views, this observation contributes to ongoing debates about societal vulnerability, drawing parallels to modern challenges in sustainable development.

Keywords: Autonomy, Collapse, Environmental Factors, Maya civilization, Spanish intervention.

List of Abbreviations and Acronyms

BCE	Before Common Era
CE	Common Era
IPCC	Intergovernmental Panel on Climate Change
LiDAR	Light Detection and Ranging
UNCTAD	United Nations Conference on Trade and Development

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General Introduction

General Introduction

1.1. Background of the Study

The Maya civilization flourished from approximately 2000 BCE to 1500 CE across regions now comprising southeastern Mexico, Guatemala, Belize, Honduras, and El Salvador. They built lively urban centers, crafted striking monuments, and even developed their own hieroglyphic writing alongside clever systems for math and astronomy. Generally speaking, during what's known as the Classic Period (around 250–900CE), major hubs like Tikal, Calakmul, and Palenque emerged as centers where politics, trade, and spirituality mixed in unexpected ways (Martin & Grube, 2008). Then, in the Terminal Classic Period (roughly 800–950CE), many southern lowland cities were suddenly abandoned—the building of new monuments halted and written records quietly started to fade away (Turner & Sabloff, 2012).

Interestingly, not all Maya settlements experienced collapse in the same way or at the same time. While many southern lowland cities were abandoned during the Terminal Classic Period, several northern centers—most notably Chichén Itzá and Mayapán—continued to thrive well in to the Postclassic Period (900–1521CE). These cities managed to sustain political organization, trade networks, and cultural activity beyond the decline of their southern counterparts (Restall, 1998).

However, this resilience was eventually disrupted with the arrival of the Spanish in the early 16th century. The onset of colonial rule triggered a secondary collapse, marked by the introduction of devastating diseases, the imposition of forced labor through systems like the encomienda, and the suppression of indigenous cultural and religious practices. These colonial pressures significantly accelerated the erosion of remaining Maya sociopolitical structures and cultural continuity (Restall, 1998).

The literature identifies several contributing factors to the Maya collapse; however, prolonged droughts emerge as a primary environmental stressor (for example, from paleoclimatic records from lake sediment cores and speleothems (Gill, 2000; Haug et al., 2003). Deforestation (both by

intensive agricultural practices and urbanization) increased soil erosion, reduced soil water retention, and made drought effects more severe (Lentz et al.,2014; Turner&Sabloff,2012). Moreover, it led to soil degradation that was characterized by decreased agricultural productivity and shortage of food in areas where the population was concentrated (Islebe et al., 1996). These environmental challenges were paralleled with sociopolitical factors.

This included also the internal warfare between city-states, maladministration by elites, and peasant revolt. Those situations fragmented the Maya society which was harmfully affected by shocks such as the epidemic of malaria, too (Demarest, 2004; Hamblin & Pitcher, 1980; Martin & Grube, 2008). The use of foreign commercial goods during the pre-colonial period (such as Olmec trade, Teotihuacán trade and Toltec trade) also introduced vulnerabilities to Maya economies as they increased competition between city-states and elites due to their reliance on foreign goods such as obsidian and jade (Kepecs, 2003; Sabloff & Rathje, 1975). The spans of Spanish colonialism further alienated these pressures by applying the system of encomienda that exploited people, agriculture lands, forests, and water resources. These mechanisms made environmental degradation and social collapse increasingly likely (Clendinnen, 1987; Jones, 1989).

The research considers the relationship of environmental factors: drought, deforestation and soil degradation, and the sociopolitical factors and foreign interventions (pre-colonial and colonial), in the collapse of the Mayan civilization. The study is designed to draw parallels with the situation today concerning environmental degradation and external exploitation and can thus provide a perspective to consider sustainability of human societies.

1.2. Problem Statement

Although large research has examined the collapse of the Maya civilization, debates continue over the relative weight of environmental, sociopolitical, and external factors. Environmental determinism has often focused on drought and deforestation, but these alone do not provide a comprehensive explanation (Webster, 2002; Demarest, 2004). Increasingly, scholars highlight internal dynamics such as warfare, elite mismanagement, and peasant unrest as critical

contributors. Pre-colonial for intranet works (e.g., Teotihuacán and Toltec) have received some attention, yet Spanish colonial interventions remain large absenting multi-causal models. Moreover, limited research addresses how environmental degradation interacted with internal instability and foreign exploitation.

This study aims to discover these gaps by adopting a holistic approach to understanding the Maya collapse. It will explore how environmental strains and geopolitical stressors combined to undermine societal resilience, with implications for how contemporary societies confront similar challenges today. Besides, this study seeks to offer a more integrated analysis. Furthermore, it examines how combined stressors contributed to societal fragment action and decline. This study provides insights into both historical collapse and contemporary environmental-social challenges.

1.3. Research Questions

The study will seek to answer the following research questions:

1. What were the major environmental challenges faced by the Maya civilization during the Terminal Classic Period and to what extent did they contribute to the collapse of Maya political and social systems?
2. How did environmental stressors affect city-states' relations, internal stability and eventually the Maya collapse?
3. Was precolonial foreign commercial intervention (elites' mismanagement and destruction of trade) a source of economic and environmental vulnerability for the Maya civilization?
4. In what ways did Spanish colonial policies, such as the encomienda system and resource exploitation, contribute to Maya secondary phase of collapse?

1.4. Aims of the Study

This research aims to investigate the collapse of the Maya civilization through an integrated framework that examines environmental, sociopolitical, and external influences. The specific aims are as follows:

1. To identify and evaluate the primary environmental factors—such as prolonged drought, deforestation, and soil degradation—that contributed to the collapse of the Maya civilization during the Terminal Classic Period (800–950 CE).
2. To assess the role of sociopolitical dynamics, including internal warfare, elite mis management, and peasant unrest, in exacerbating environmental pressures and leading to societal fragmentation.
3. To explore the impact of pre-colonial foreign commercial interventions (e.g., Teotihuacán and Toltec trade) on the economic and environmental vulnerabilities of Maya society.
4. To analyze the consequences of Spanish colonial interventions, particularly the encomienda system, on the decline and secondary collapse of Maya civilization.

1.5. Significance of the Study

This study is significant for several reasons:

First, it adds the knowledge in Maya collapse research by proposing a multi-causal framework that considers the complex interplay between environmental factors (such as drought, deforestation, and soil degradation), sociopolitical dynamics (including elite mismanagement, warfare, and peasant unrest),and external influences (notably pre-colonial trade and Spanish colonial interventions). While earlier studies often focused on isolated causes, this research seeks to produce a more integrated and holistic understanding of the collapse process.

Second, the study offers a methodological contribution by combining various types of data archaeological, paleoclimatic, epigraphic, and historical—through an interdisciplinary approach. This not only enhances analytical depth but also provides a model for studying other cases of societal collapse in different historical and cultural contexts.

Third, the research carries practical insights in today's world. The historical patterns of environmental degradation, political fragmentation, and foreign exploitation observed in the Maya context mirror current global challenges such as climate change, resourced repletion, socioeconomic

inequality, and external economic dependency. By examining how these factors contributed to the weakening of Maya resilience, the study provides insights that can inform sustainability strategies and policy development in the present.

Finally, the study emphasizes the enduring resilience of the Maya people, whose descendants— now numbering over seven million—continue to maintain cultural identity and adapt to modern realities. Recognizing this continuity not only challenges simplistic collapse narratives but also underscores the value of indigenous knowledge systems and the importance of incorporating them into both academic discourse and practical planning.

1.6. Research Methodology

1.6.1. Research Design

This study is based on a qualitative and quantitative design that relies on descriptive and analytical approaches to investigate the multi-causal factors: environmental, sociopolitical, and external, that contributed to the collapse of the Maya civilization. They allow to interpret past patterns since direct observation is impossible and definite resources are not available. So, the qualitative components rely on describing and analyzing archaeological, epigraphic, paleoclimatic, and historical data to construct a coherent and evidence- based narrative. This design allows for the examination of complex interactions across time and space, supporting a comprehensive understanding of systemic collapse in ancient societies.

1.6.2. Data Sources

The research relies on a mix of primary and secondary sources to explore the collapse of ancient Maya civilization. Archaeological evidence from key sites like Tikal, Calakmul, and Chichén Itzá, including settlement patterns, pollen records, and artifacts, will be studied and described. We aim to understand environmental issues like deforestation and soil erosion, as well as sociopolitical factors such as warfare and elite infrastructure (Lentz et al., 2014; Martin & Grube, 2008). Spanish colonial records, such as tribute lists and conquest accounts, will also be reviewed to

assess the impact of colonial exploitation and administrative systems (Clendinnen, 1987; Restall, 1998). Additionally, recent academic studies will provide context and support a comprehensive analysis of the primary data.

1.6.3. Data Analysis

To analyze the information, this study uses both descriptive and analytical methods to address the research questions. Descriptive analysis will summarize environmental factors, like drought duration and deforestation levels. Also, it will analyze sociopolitical indicators, such as the frequency of conflicts and signs of unrest, and foreign influences, like trade disruptions and colonial policies. This is to highlight patterns which led to the collapse. The analytical approach will study previous paleoclimatic and archaeological findings gathered from some Maya sites, and epigraphic records, like warfare motifs, to identify causal connections between environmental pressures, political instability, and the eventual collapse of the Maya civilization.

1.7. Structure of the Study

The structure of this study is organized into two main chapters, each contributing to a holistic and interdisciplinary examination of the Maya collapse. Chapter One provides a critical synthesis of existing scholarship on the Maya collapse. It explores the major schools of thought, including environmental determinism, sociopolitical fragmentation, and external influences such as trade and colonialism. It also identifies theoretical gaps and supports the need for a multi-causal, integrative approach. Chapter Two describes the research design, data collection methods, and analytical strategies used in the study. It explains the qualitative and quantitative approaches , the interdisciplinary nature of the sources, and the ethical considerations involved. The chapter also presents the key findings thematically, interprets the data in relation to the research questions, and synthesizes insights across environmental, political, and external dimensions of the Maya collapse.

CHAPTER ONE

Literature Review: Maya Civilization Collapse

Chapter One:Literature Review

Maya Civilization Collapse

Introduction

This section provides a comprehensive review of literature on environmental factors and foreign interventions causing the Maya civilization's decline. The Maya flourished in Mesoamerica from about 2000 BC to the Spanish arrival in the 16th century. They were a remarkable civilization in East Columbian America, covering western Honduras, El Salvador, eastern Mexico, Belize, and Guatemala.

Figure 1. 1

A Map of the Maya civilization showing key cities and geographical extent

Note. From Martin, S., & Grube, N. (2008). Chronicle of the Maya Kings and Queens: Deciphering the Dynasties of the Ancient Maya (2nd ed.). Thames & Hudson.

The Classic Maya reached their zenith between 250 and 900 CE. They made progress in

mathematics, astronomy, architecture, and art. They established huge city-states such as Tikal, Calakmul, and Palenque each had its own leader and independent governing system. These became centers for political, spiritual, and economic events. Their society was structured around city-states. Cities often-made alliances, traded, and went to war with nearby ones. (Demarest (2004) and others)

Religion was fundamental to life. They had a rich selection of gods and complex ceremonies designed to promote cosmic balance and agricultural fertility. They developed the idea of zero. And they were known for their distinctive hieroglyphic writing system, complex calendar system that they used to track astronomical movements. The Maya produced beautiful objects, ceramics, and textiles. These reflected their ideals, experiences, and environment. And They built remarkable architectural performance, from palaces and pyramids to observatories.

1.1. The Time Periods of the Maya

Their history can be divided into three main eras, each characterized by unique social, political and cultural changes:

Table1.2

The Time Periods of the Maya

	Key Characteristics	Developments	Challenges	Citations
Preclassic (2000 BCE – 250 CE)	Transition from hunter-gatherer to agriculture (corn, beans, squash); early social stratification.	Permanent settlements; monumental centers (e.g., El Mirador, Danta Pyramid); extensive trade (obsidian, jade,	Population pressure on scarce resources; early social stress.	Hammond (1991); Coe (2011).

		ceramics).		
Classic (250 – 900 CE)	Peak of Maya culture; large city-states (Tikal, Calakmul, Palenque); advanced writing and architecture.	Pyramids, ballcourts, palaces; Milpa agriculture, terracing, raised fields; trade and warfare networks.	Deforestation, soil depletion; environmental strain; collapse of southern lowland centers.	Martin & Grube (2008); Schele & Freidel (1990); Turner (1990).
Postclassic (900 – 1521 CE)	Shift to northern lowlands (Chichén Itzá, Mayapán); increased militarization; Toltec influence.	Maritime trade routes (salt, cotton, honey); Toltec-style architecture (e.g., Temple of Warriors).	Spanish conquest; secondary collapse; internal conflicts and militarization.	Sabloff & Rathje (1975); Kepecs (2003); Restall (1998).

After the decline in the southern lowlands, the post -classic era saw a cultural and political change in the northern lowlands, where large centers such as Chichen Itza and Mayapan were born. The images, which depicted the strong cities and wars, had examples of enlarged militarization marked the era (Sabloff & Rathje, 1975). The architectural style of Chichen Itza, which included buildings such as the Temple of Warriors, similar to the Tula`s Toltec architecture, clearly reflected the effect of external cultures, especially from Midst -Mexico to Toltec. Post classic Maya set up huge marine trade routes throughout the Yucatan Peninsula, exchange of goods such as salt, cotton and honey along with other Mesoamerican cultures (Kpec, 2003). The introduction of new issues on the arrival of the Spanish conquistadors at the beginning of the 1500s unheard of the Maya Civilization and indicated the beginning of a secondary collapse (Restall, 1998).

1.2. Geographical Scope of the Maya Civilization

Maya's widespread and varied areas had major impacts on their environmental, social,

political, and economic development. Also, this variety influenced resource management and finally the decline. The area was usually divided into three separate areas, each with its own environmental, social and economical issues and symptoms:

1.2.1. The Southern Lowlands

The center of the classic Maya civilization was in the southern lowlands, including the Usumacinta River region and the Petén Basin in Guatemala. The region has had tropical rainforests, the seasonal wetlands and limestone bedrock that limited the availability of surface water, forcing Maya to depend on human reservoirs (aguadas) and seasonal rain (Dunning et al., 2012). The southern lowlands maintained dense populations through the use of intensive agricultural methods, which maximized cultivable land in marshy areas, such as terracing and raised fields. However, the region's environmental fragility, especially regular rainfall and its thin, nutritional shortages earth, made it extremely weak for climate change. Paleoclimatic records suggest that long -term drought probably made the lack of resources worse, causing larger cities abandonment such as Tikal and Copan in the ninth century CE (Hodell et al., 1995).

1.2.2. The Northern Lowlands

The northern lowlands on the Yucatan Peninsula have had a dryer climate, flattery topography and a carst landscape with some surface rivers. Instead, Maya used Cenotes - natural sinkholes that provided access to groundwater - as their main water source. During the post-classic period, cities such as Chichen Itza and UxMal in the region adapted to the environment by creating reservoirs and water storage systems like chultuns (underground cisterns) (Sharer & Traxler, 2006). And due to better access to groundwater and less reliance on rain-fed agriculture, they may contribute to long-term Maya culture compared to the south. In addition, the proximity to the coastal area promoted maritime trade, which became a major economic strength during the post-classic period (Kepecs, 2003).

1.2.3. The Highlands

Highlands, which included modern Guatemala and Chiapas, parts of Mexico, were

characterized by volcanic scenes, rich soil and milder temperature. Different agricultural practices in the region included excessive demanding activities for commodities such as cocoa and avocado. The Highland Maya population, such as Kaminaljuyú, was crucial to the regional exchange network, offered the hubs of lowland with the paw, a volcanic glass used for equipment and weapons, as well as other materials (Braswell, 2003). Various areas of the highlands offered a natural defense against external attacks, making it a shelter for Maya people at the time of low -way disturbance. However, volcanic activity and earthquakes sometimes threatened the region, affecting its settlement patterns and cultural practices (Sheets, 2002).

Figure 1. 2

Northern, Central and Southern Maya areas / Maya Lowlands and Highlands

Note. From de la Cova, A. R. (n.d.). Maya maps. LatinAmericanStudies.org. *https://www.latinamericanstudies.org/maya-maps.htm*

1.3 Socioeconomic and Cultural Features

The ancient Maya civilization had a complex socio-economic and cultural landscape. It

featured social hierarchies, economic systems, and cultural traditions (Oglesby et al., 2010). The Maya excelled in artistic expressions and intellectual achievements. These reflected their social structure and ideals. Lidar technology highlighted urban planning. Structures like pyramids and ballcourts showed elite power (Garrison et al., 2019).

City states became the center of political power. The Mayans were a reigning elite made by priests, kings and nobles at the top of society. Then farmers, traders and craftsmen, and then workers or slaves followed. Divine Kings (ajaw), whose rights were legalized through rituals and ancestry (Martin & Grub, 2008). Elites including priests and nobles, monitored resources, managed trade networks and ordered architecture. Epigraphic evidence, such as Tikal's stelae, revealed rulers like Jasaw Chan K'awiil in the orchestrating Alliance and War (Martin & Grub, 2008). Ordinary people, farmers and workers maintained the economy by offering agricultural and construction work. Lidar surveys indicated densely rural population. (Canuto et al., 2018). Male dominance was widespread in public areas. Gender dynamics were complex. Women were caregivers, weavers, and sometimes rulers like Lady Six Sky of Naranjo (Joyce, 2000).

Figure 1. 3

Maya Kings' Stelas

Note. Adapted Wikipedia contributors. (2025, May 16). Yaxchilan. Wikipedia. https://en.wikipedia.org/wiki/Yaxchilan

Religion was fundamental to Maya society. Every king claimed the divine authority. This legalized through architecture and rituals (Martin and Grub, 2008). Religion was associated natural elements. They worshiped gods like rain (Chaac) and Maize (Yum Kaax) ones. Sacred places like caves and cenotes hosted rituals. These included bloodshed and human sacrifice like the Sacred

Cenote of Chichen Itza. (Schele & Freidel, 1990). Establishment myths in Popol Vuh described cyclical times (Tedlock, 1996). These activities were done to please the gods and guarantee cosmic orders and agricultural fertility (Schele & Freidel, 1990).

Agriculture formed the backbone of the economy. Intensive agriculture supported high population densities. They slash-and-burn (Milpa), terracing and raised fields (Chinampas). Long - distance trade routes paired Maya with other Mesoamerican civilizations (Sabbloff & Rathje, 1975). Markets in larger cities such as Tikal and Calakmul used cacao as currency (Mason and Freidel, 2012).This facilitated the exchange of goods such as feathers and textiles.

Figure 1. 4

Maya Monuments

Note. From Lunghofer, K. (2024, September 19). The 8 best Maya ruins to visit in Mexico. Trip Savvy. https://www.tripsavvy.com/amazing-maya-ruins-in-mexico-4800186

Along with agriculture, handmade goods were vital for the Maya economy. Pottery, jade pieces and obsidian tools were made by talented craftsmen. Evidence from workshops in places like Copan suggested a centralized production process that was mostly devoted for elites (Aoyama,

1999). Another important factor was the work organizations, as corvée Labor. It was used to create monumental structures such as palaces and pyramids. Shelf systems also confiscated goods from low classes. This strengthened elites' control over resources (Demarest, 2004).

Artistic works included Stelae, murals and ceramics. They depicted rulers, gods and warfare with polychrome pottery as valuable objects (Reents-Budet, 1994). In addition, post -classic art, like frescoes in Mayapán, emphasized the flexibility. The Maya recorded history, astronomy, and ceremonies on scripts, stelae and codices. Madrid and Dresden codices are remarkable pictures.

Figure1.5

Maya Hieroglyph

Note. Cartwright, M. (2014, October 15). Maya writing. World History Encyclopedia. https://www.worldhistory.org/article/655/maya-writing

Figure 1.6

Maya survived Codices

Note. Minster, C. (2019, August 27).Overview of the Maya books. ThoughtCo.

https://www.thoughtco.com/maya-books-overview-2136169

Maya was known for its monumental architecture, artistic expressions and intellectual achievements, all of which reflected their complex social structure and cultural ideals. These cultural and socio-economic aspects emphasized the intensity of the Maya civilization. They also

revealed weaknesses such as agriculture and dependence on untreated social hierarchy.

Figure 1. 7

Maya cities in Classic era and Maya cities in Post Classic era

Note. Maya Empire Project. (n.d.). Maps. https://mayaempireproject.weebly.com/maps.html

1.4 Environmental Factors behind Maya Collapse

Environmental tension is generally considered important for the collapse of Maya, especially in the classic time. There were generally limited in: climate change, drought, deforestation and soil degradation. As discussed below, there are different views on these stresses from scholars.

1.4.1. Drought and Climate Instability

Prolonged droughts were driven by climate change. They played a critical role in the collapse of city-states. Paleoclimatic data indicate severe droughts between 250-900 CE. These disrupted agriculture, maize production, and water supplies. Hodell et al. (1995) identified drought events in sediment cores. They suggested these accorded with the Terminal Classic collapse. Major southern lowland cities were abandoned. Hodell used oxygen isotope data from Lake Chichancanab. The period between 800 and 1000 CE was the driest.

Gill (2000) argued that droughts caused crop failures. They led to food shortages and social instability. The Maya relied on rain-fed agriculture and reservoirs. Medina-Elizalde and Rohling (2012) emphasized precipitation reductions. A 25–40% drop could destabilize agriculture. Kennett

et al. (2022) argued two major drought waves occurred. The second in the 11th century prevented recovery. Populations faced famine and unrest. Turner and Sabloff (2012) noted human-induced stress. This created a "perfect storm" for collapse.

Some scholars argue drought alone cannot explain the collapse. Webster (2002) critiqued the overemphasis on climate. Northern Yucatán thrived post-drought. Access to water sources like cenotes mitigated impacts.

While drought was a well-documented factor, some scholars argue it alone cannot explain the collapse. Webster (2002) critiques the overemphasis on climate. He notes that some Maya regions like northern Yucatán mitigated drought via cenotes. Also, Aimers (2007) noted not all regions collapsed simultaneously. Northern cities thrived despite similar conditions. This suggests variability in water management. Critics highlight earlier droughts were survived. Socio-political factors like elite mismanagement were critical (Demarest et al., 2004).

1.4.2. Deforestation and Soil Degradation

The Maya reached their peak in the Classic period. They saw a rise in population. The need for agriculture and construction was urgent. They cut trees, causing deforestation. This was a key factor in the collapse. Oglesby et al. (2010) and Cook et al. (2012) argued forest clearing reduced rainfall. The reduction was 5–15%. This led to worse drought conditions. Diamond (2005) popularized the idea. Deforestation for agriculture and lime plaster led to soil degradation. It created a climate change feedback circle. In his book "Handbook to Life in the Ancient Maya World" Foster (2002) argues that:

"Overpopulation may have undermined support for the reigning dynasties and put tremendous strain on the area's environmental resources. The circumstance would have worsened by drought, sabotaging any attempts by monarchs to feed their people." (Lynn V. Foster ,2002)

Turner and Sabloff (2012) emphasized that deforestation disrupted ecosystems. It reduced biodiversity and agricultural resilience. Faust (2012) noted that deforestation was a long-term process which effects weakened the Maya’s ability to adapt to climatic changes.

Anselmetti et al. (2007) challenged the deforestation hypothesis at sites like Copan, where pollen data suggested forest cover persisted into the Late Classic. The data implied less severe deforestation than claimed. They argued that Diamond's narrative oversimplified the Maya's environmental management. And they ignored evidence of sustainable practices like agroforestry (McNeil, 2012). The link between deforestation and rainfall reduction is debated, as climate models vary in their predictions of local impacts.

Deforestation and intensive agriculture, on the other side, led to land erosion and degraded soil fertility. They undermined the Maya's agricultural base. Beach et al. (2009) documented significant soil loss in the Maya Lowlands with sediment runoff that indicated upland erosion . Anselmetti et al. (2007) quantified erosion rates and linked them to deforestation and population pressure. Turner and Sabloff (2012) argued that soil depletion, combined with drought, led to crop failures, famine, and social unrest. The Maya's reliance on slash-and-burn agriculture (Milpa) and lack of centralized soil conservation exacerbated these issues (Faust, 2012).

Some scholars, like Webster (1990), argued that erosion's impact is exaggerated, as certain Maya regions-maintained agriculture despite degradation. They managed to adapt strategies like terracing. Erosion varied regionally. And some areas with resilient soils or water access had less impacts (McNeil, 2012). The contributing link between erosion and collapse is also questioned. Socio-political factors like warfare may have driven abandonment (Demarest et al., 2004).

1.4.3. Elites Mismanagement and Internal conflicts

The collapse of the Maya civilization resulted from a complex interplay of environmental and socio-political factors. Droughts disrupted agriculture, while deforestation and erosion compounded resource scarcity. They created hard situations such as famine and societal unrest. Dr. Arlen Chase's work, linked warfare to environmental stress (cited in *Mexico Historico*). Competition among city-state elites for fertile lands and water increased. This ledto violent conflicts. It destabilized Maya society more.

Lucero (2002) argued Maya rulers tied legitimacy to water control. Droughts damaged their

ability to provide resources. The public lost trust in their divine rulers who were seen as faultless. This led to rebellions, rivalry and conflicts. (Simon Martin and Nikolai Grube,2000/ 2008). Also, the shift from land-based to sea-borne trade further weakened inland elite power. The period witnessed a huge political fragmentation. (Lucero, 2002)

Demarest (2004) suggested that excessive monumental construction and warfare drained resources. Elite competition for diverse reasons and trade loss exhausted the peasantry. Webster (2002) pointed to the elites' focus on prestige. Deforestation for jade production (*jade is precious minerals carved into jewelry*), degraded the environment. (Damarest,2004; Webster, 2002)

The elite mismanagement theory is criticized. It focuses heavily on top-down failures. It underestimates the resilience of Maya society. Aimers (2007) argues that the collapse was not a uniform across all city-states. As some regions adapted successfully. Additionally, blaming elites may overlook the activity of non-elite populations. They could have mitigated crises through local agricultural innovations or migration. The emphasis on elite-driven collapse also risks ignoring external factors, such as trade disruptions. Internal migration was a response to the collapse. Turner and Sabloff (2012) noted populations abandoned southern cities. Declines reached up to 90%.They migrated to northern regions like the Yucatán Peninsula. Coastal areas had better water and trade access. Middleton (2017) suggested stressors prompted relocation. Areas like Chichén Itzá flourished during the Terminal Classic. Dunning et al. (2012) argued migration destabilized urban centers. It reduced labor and tax bases. Demarest et al stated:

F"both the land and river routes collapsed into chaos and then fell from significant use between 743 and 810 CE, leaving the more efficient sea route, shown with a blue line, as the dominant channel of commerce from the ninth century CE until the Spanish Conquest" (Demarest, et al.).

Figure 1.8.

Trade Routes in the Classic Maya

Note. From de la Cova, A. R. (n.d.). Maya maps. LatinAmericanStudies.org. https://www.latinamericanstudies.org/maya-maps.htm

The migration hypothesis lacks archaeological evidence of large-scale population movements. Aimers (2007) noted northern cities' rise may reflect local growth. The assumption that migration destabilized southern cities oversimplifies the process. As some lowland areas retained small populations post-collapse. Critics also argue that migration was a successful adaptation. (Aimers, 2007)

Revolts and social unrest were outcomes of environmental and political stressors. Hamblin and Pitcher (1980) proposed peasant revolts against abused elites. Famine and drought exacerbated this. They contributed to urban centers collapse. Demarest (2004) suggested unrest arose from the resource shortages. This led to rebellion or passive resistance such as refusing to pay taxes or labor for monumental projects. Kennett et al. (2022) linked food shortages to the increased civil conflict at Mayapan. This suggested similar dynamics in the Classic period.

The revolt hypothesis relies on speculative reconstructions. Direct evidence of rebellions is scarce. Aimers (2007) argued that social unrest may have been localized rather than a civilization-wide phenomenon. Some cities collapsed without clear signs of conflict. In addition, connecting

collapse to revolts generalizes other factors, such as environmental degradation or trade disruptions. Critics also note that Maya society was decentralized. So, coordinated revolts across city-states were unlikely.

The Maya civilization collapse was due to a complex interplay of environmental factors. Climate instability, repeated mega droughts waves deforestation and strained agricultural systems. The thing that resulted in trade network loss and led to famine and sociopolitical instability and tensions. Populations shifted to more resilient areas. Revolts reflected all those issues. However, each explanation has limitations, as regional variability and the Maya's prior resilience challenge single-factor models.

A multidisciplinary approach is essential for understanding the Maya collapse. Combining archaeology, paleoclimatology, and anthropology, is essential. Other internal and external factors contributed to worsen the existed fragmented state of the Maya. Trade network shifted from overland paths to coastal routes. These created shifts in Maya life. Due to agricultural destruction, they sought other resilience sources. They strengthened trade with the neighboring elites like the Toltec and Teotihuacan.

1.5. Foreign Commercial Intervention

1.5.1. Local Foreign Commercial Intervention

Local foreign intervention shaped Maya economies across pre-colonial and colonial periods. Pre-colonial trade with Teotihuacán, Toltecs, Taínos, Anasazi, and Aztecs brought wealth. They accessed scarce goods like obsidian, cacao, jade, and salt (Smith & Berdan, 2003; Kowalski & Kristan-Graham, 2011). These interactions were reciprocal. Trade also strengthened. It created dependence on fragile trade routes (Sabloff & Rathje, 1975; Kepecs, 2003).

Archaeological evidence, like Tikal's green obsidian, highlights deep integration with Mesoamerican networks (Braswell, 2003). Environmental stressors like drought and deforestation reduced agricultural surpluses (Oglesby et al., 2010). This disrupted trade. Also, the shift in regional power and the shift of trade roads to the coastal areas, likely exacerbated economic instability. And

competition, bloody warfare and foreign alliances were introduced. (Kepecs, 2003)

Some various Maya city-states managed to survive via adaptive practices. These included the milpa and other agricultural strategies (Oglesby et al., 2010). So, clarifying the foreign commercial interventions within the area is a key to understand the colonial context and its role in the decline .

1.5.2. The Colonial Impact (as a Secondary Collapse)

1.5.2.1. The Spanish First contacts and their intervention in the Maya

Early meetings between the Spanish and Maya began in the early 16th century. This marked the start of European intervention. It affected economic, social, and political systems. Contacts were driven by Spanish ambitions for wealth. They set the stage for the colonial exploitation that reshaped the Maya world· This section examines the key events, factors, and outcomes of these early interactions and highlights their role in Maya collapse.

1.5.2.2. The Spanish Policies and their Impacts on the Mayan Decline

The Spanish aimed to colonize the Maya. They integrated it into a colonial economic framework. Though They faced lots of challenges since the Mayans were not centralized and they had diverse polities. The Mayan resisted the Spanish integration who applied diverse laws to subdue the people to their governance. They tried to convert the people to Christianity via evangelization campaigns and use them as means to exchange goods versus protection and guidance. As, they used the religions' teachings to abolish the Mayan culture, traditions, customs and rituals. So, the Spanish burned the Maya's manuscripts and codices. They destroyed religious sites. They aimed to eradicate cosmology and culture to marginalize the Maya elites' control. (Clendinnen, 1987)

1.5.2.3. Reducción and Haciendas

The Spanish imposed the reducción policies which forcibly relocated the Mayans into centralized settlements. This action was to manage easy control, tributes and Christianization. Consequently, the agricultural cycles were disrupted and the economy faced strains. Besides, the Spanish haciendas that developed tremendously. They were key mechanisms to control 60% of arable lands that were producing cash crops for export. (Farriss 1984)

The arrival of Spanish conquistadors deepened pressure on land resources. These were already compromised by centuries of environmental stress and sociopolitical mismanagement. The initial conquest was detailed by Clendinnen (1987). The encomienda system was outlined by Jones (1989). The Spanish systematically extracted resources. This included agricultural produce, timber, water, and soil fertility. Exploitation not only disrupted traditional Mayan land-use practices but also accelerated ecological degradation. It undermined capacity to sustain in the Postclassic and Conquest periods.

1.5.2.4. Agricultural Exploitation and the Encomienda System

The Spanish imposed an administration of intensive agricultural exploitation. They used the encomienda system. Jones (1989) described it as a cornerstone of colonial extraction in the Yucatán. Encomenderos demanded heavy tribute in the form of cash crops such as cacao, cotton, indigo, honey and maize. Maize was the Mayans chief food that was essential in their economy. They redirected Mayan agricultural efforts from survival to colonial profit. Jones (1989) noted archival evidence of tribute lists requiring communities to deliver hundreds of pounds of maize annually. That came at the expense of local food security.

The shift disrupted traditional milpa (slash-and-burn) farming which was a sustainable practice that replaced plans to preserve soil fertility (Sharer & Traxler, 2006). Instead, the Spanish enforced continuous cultivation on fixed lands, accelerating soil exhaustion. This process already happened from pre-conquest deforestation, as Turner and Sabloff (2012) documented. Clendinnen (1987) added that encomenderos frequently seized fertile lands near water sources. They displaced Maya farmers to marginal soils and further strained productivity . They exacerbated famine in a region still recovering from Classic period droughts (Gill, 2000).

1.5.2.5. Deforestation and Resource Extraction

Beyond agriculture, the Spanish exploited the Mayan forests for timber and other resources. They intensified ecological damage. Clendinnen (1987) described how the construction of colonial settlements such as Mérida, built atop the Mayan city of Tihó, required vast quantities of wood for

buildings and lime production (for cement). Shipbuilding increased as Spain expanded its Caribbean presence and trade. This deforestation repeated the earlier Mayan elite strains (Webster, 2002).

On a larger scale, Spanish demand outstripped local regeneration rates. Jones (1989) highlighted the Itza region, where logging for export goods like dyewood (logwood) depleted hardwood forests. And it disrupted watersheds that fed Mayan reservoirs. This loss of tree cover, combined with intensified farming, increased soil erosion and sedimentation in water systems. It reduced their capacity to support agriculture. It was a critical shock in a region disposed to drought (Haug et al., 2003).

1.5.2.6. Water Resource Mismanagement

The Spanish exploitation extended to water resources, a corn stone of Mayan survival. They destabilized the ecological balance. Gill (2000) argued that Mayan elites had historically managed water through reservoirs (Aguadas), natural sinkholes or cenotes, dams and canals, a system that weakened during Terminal Classic droughts. But it persisted in reduced form into the Postclassic. The Spanish, however, repurposed these resources for colonial needs.

Clendinnen (1987) noted that conquistadors and settlers diverted water from Mayan cenotes and reservoirs to irrigate encomienda farms. And water was used to supply new towns, neglecting maintenance of these systems. Jones (1989) cited examples in the Petén, where Spanish overused water for cattle ranching. This mismanagement, coupled with deforestation, filled water infrastructure with mud. Itled it to be less effective. And that deepened exposure to seasonal dry periods.

1.5.2.7. Ecological and Social Consequences

Spanish colonization devastated Maya communities. Ecological, economic, and demographic impacts intertwined. The encomienda system enslaved Maya for labor in mines and plantations. This prompted many to flee to remote mountains abandoning their lands (Farriss, 1984). Resource

exploitation, including deforestation and mining, accelerated ecological ruin. They exacerbated social collapse (Dunning et al., 1998). The introduction of African slaves supplemented labor demands but did not mitigate Maya suffering (Restall, 2003). European diseases, such as smallpox and measles decimated indigenous populations lacking immunity. Some regions lost up to 90% of their people (Lovell & Lutz, 1995). These impacts revealed the catastrophic toll of Spanish policies.

Turner and Sabloff (2012) linked Spanish practices to environmental degradation. They were built on pre-conquest stressors like soil depletion. Scarcity of food and water fueled malnutrition. Population declined, worsened by epidemics (Jones, 1989). Restall (1998) estimated 90% losses in some communities. Loss of land control stripped traditional roles. Farmers became laborers. Chiefs lost authority to encomenderos (Clendinnen, 1987). Resistance was fierce but useless against Spanish military and economic dominance. This left the Maya marginalized (Jones, 1989). Oland and Palka (2016) noted some adaptations. Chainwheel's Maya sustained a salt trade despite restrictions (Kepecs, 2005). In Aguacatepeque, Maya acquired Euro-American pottery (Pezzarossi, 2014). These were undermined by forced labor and tribute (Farriss, 1984; Restall, 2003).

Though,some scholars considered the Spanish existence in Maya as beneficial for the land and its people as it was with Oland and Palka (2016). They highlighted Maya sustained a competitive salt trade, rivaling European markets despite colonial restrictions (Kepecs, 2005, as cited in Oland & Palka, 2016). In Aguacatepeque, Maya adapted to colonial markets by acquiring Euro-American pottery through traditional exchange practices. This was shaped by forced colonial structures (Pezzarossi, 2014, as cited in Oland & Palka, 2016). Yet, these adaptations were undermined by Spanish exploitation. They included forced labor and tribute, which impoverished communities and eroded autonomy (Farriss, 1984; Restall, 2003).

1.5.2.8. Interplay with Environmental Factors and Spanish Intervention

These sociopolitical complications did not operate in isolation but interacted dynamically with environmental stressors. Droughts reduced crop yields (Haug et al., 2003). This intensified elite demands. It sparked conflicts over arable land. Deforestation diminished resources for trade (Turner

& Sabloff, 2012). Postclassic Mayan societies were vulnerable. Restall (1998) noted fragmented polities offered little resistance to conquistadors. Clendinnen (1987) detailed how campaigns exploited divisions. Jones (1989) highlighted Spanish systems. Reducción, encomienda, and haciendas disrupted traditional situations. This accelerated the decline of the civilization.

So, the collapse of the Maya civilization is a complex and multifaceted phenomenon that has been extensively studied by scholars. While the exact causes remain debated, environmental factors and foreign interventions are often cited as significant contributors. This response explores these factors, drawing on insights from various research papers to provide a comprehensive analysis. Scholars like Hodell et al. (1995), Haug et al. (2003), and Gill (2000) argue that prolonged droughts, evidenced by paleoclimatic data (e.g., sediment cores, speleothems), were the decisive factor. They posit that severe rainfall reductions (e.g., 41–54% per Evans et al) crippled maize agriculture, triggering famine, depopulation, and societal collapse. This view emphasizes environmental determinism, suggesting the Maya couldn't adapt to climatic extremes.

While Webster (2002), Demarest (2004), Martin and Grube (2008), and Hamblin and Pitcher (1980) challenge this. They assert that sociopolitical dynamics such as elite mismanagements, warfare, and peasant unrest aliened commoners and destabilized society. (Turner & Sabloff, 2012) They were equally or more critical. They argue that drought alone doesn't explain why earlier dry periods survived. They pointed to evidence like fortified sites (e.g., Aguateca) and epigraphic records of conflict (Martin & Grube, 2008). The conflict lies in whether environmental stress was a trigger amplified by human failure or a secondary factor to internal discord.

Hamblin and Pitcher (1980) and others propose that peasant rebellions or migration, fueled by resentment over elite demands during crises (e.g., drought, per Haug et al., 2003), drove the collapse. Burned elite structures (e.g., Aguateca) support this bottom-up agency. Sabloff and Rathje (1975) and Sharer and Traxler (2006) argue that the collapse of trade networks (e.g., with Teotihuacán) undermined economic stability. And it isolated city-states and weakenedelites reliance on prestige goods (e.g., obsidian).

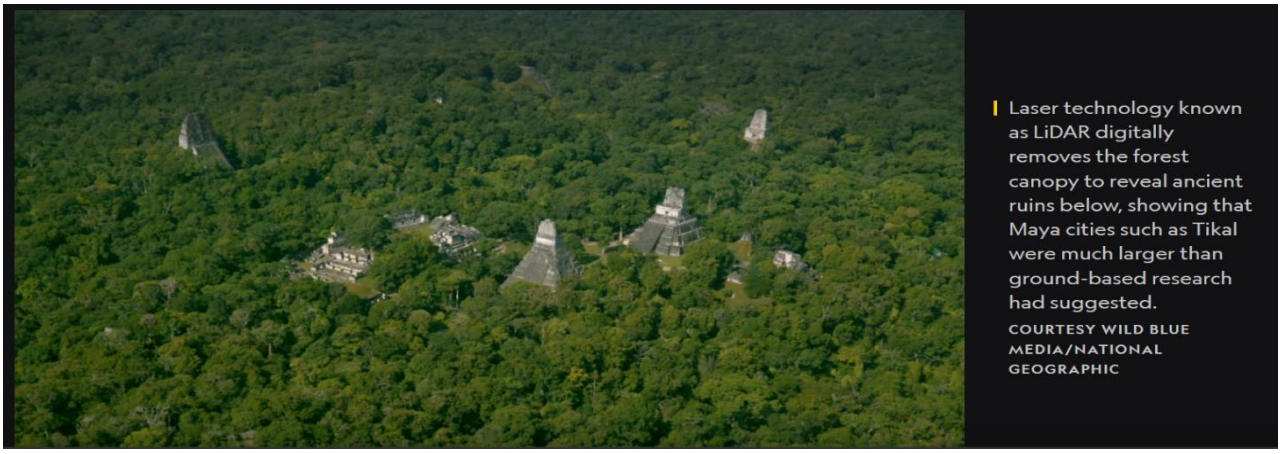
The traditional views (e.g., Diamond, 2005; Turner & Sabloff, 2012) frame the abandonment of southern lowland cities (e.g., Tikal, Calakmul) as a catastrophic collapse. It was driven by overpopulation, deforestation, and drought. This suggests a near-total societal breakdown, with urban centers deserted and elites vanishing.

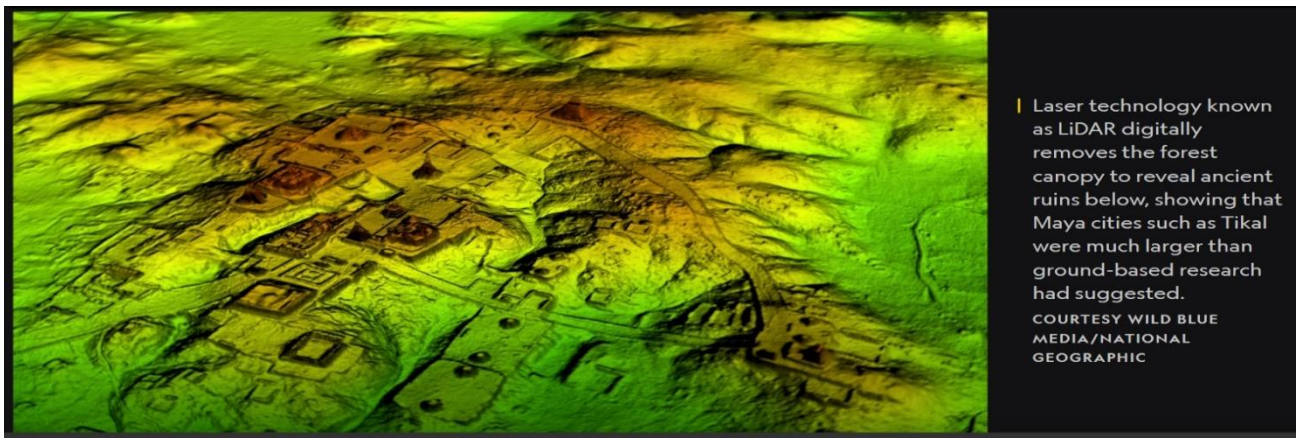
Recent scholarship and critics like Golden (Brandeis NOW, 2021) use lidar data to show rural communities thrived agriculturally (e.g., in the Western Lowlands). He suggested local self-sufficiency mitigated trade loss. This challenges the idea of economic collapse as universal. The advanced technologies, and interdisciplinary methods, have refined older theories and introduced new perspectives. Kennett et al. (2022) argue that drought escalated civil conflict. They used Mayapán (13th–14th centuries) as a case study. Paleoclimate data and archaeological evidence (e.g., fortifications) show conflict peaked during dry periods (1400–1450 CE). They suggested climate stress fueled factionalism. Applied to the Classic period, this posits drought as a catalyst for warfare, not just famine.

Lately, Lucero (Live Science, 2021) argues it was a political transition, not a civilization-wide collapse. They highlight continuity in rural areas and the rise of Postclassic cities (e.g., Mayapán, Chichén Itzá). He supported by lidar evidence of persistent rural settlement. Over 7 million modern Maya descendants reinforce this view.

Figure 1. 9

Tikal from above





Note. From National Geographic. (2025, May 8). Maya laser LiDAR Guatemala Pacunam. https://www.nationalgeographic.com/history/article/maya-laser-lidar-guatemala-pacunam

1.6. Conclusion

The collapse of Maya civilization is a complicated phenomenon. A mix of external, sociopolitical, and environmental forces influence it. Due to unsustainable conditions such as drought and deforestation, vital cities in the southern lowlands were abandoned during the Classic period. Sociopolitical disintegration, which was exacerbated by elite conflicts, mismanagement and destruction severely weakened Maya resilience. Additionally, pre-colonial commercial connections with other Mesoamerican communities brought both opportunities and difficulties. The legacy of such situations accelerated the decline and influenced the civilization's vulnerability to Spanish intervention. Traditional Maya systems were destroyed by diseases, forced labor, and cultural repression after the colonist's arrival in the 16th century. Nonetheless, there is still disagreement in the literature regarding the relative importance of environmental versus sociopolitical causes, and little is known about the resilience of northern lowlands during the Postclassic era. Additionally, metropolitan areas are the primary focus of exploration and still under it, the rural areas are being neglected, besides to many other factors. This chapter has demonstrated the dynamic interaction of internal and external pressures in the collapse of one of Mesoamerica's most sophisticated civilizations by looking at these aspects through a multi-causal lens

CHAPTER TWO

Methodology, Analysis, and Interpretation of Maya Collapse Factors

Chapter Two: Methodology, Analysis, and Interpretation of Maya Collapse Factors

2.1 Introduction

This chapter dives into our study of the Maya collapse, laying out how we approached the research and what we found. We start with our mixed-method research design, blending quantitative and qualitative analysis, followed by the key questions and objectives guiding our work. Then, we explain our data collection methods, using both primary sources like archaeological clues and secondary sources like academic studies, alongside a sampling strategy that covers different time periods and regions.

We also touch on ethical considerations to respect modern Maya communities. Next, we break down our analysis, including a thematic approach to understand the collapse's causes, and share our results through tables, maps, and graphs. Finally, we wrap up with a conclusion, highlighting key findings, limitations, and recommendations for future research.

2.2 Research Methodology

We chose a mixed research approach that fits the descriptive and analytical focus of this work. Well, this lets us piece together the past by pulling from different kinds of information: Quantitative Analysis, like secondary data analysis (Tables, Percentages… (, and qualitative Analysis: use of thematic analysis.

Our study explores the Maya collapse with specific questions and goals to understand how nature and people interacted. We asked -What were the major environmental challenges faced by the Maya civilization during the Terminal Classic Period and to what extent did these environmental factors contribute to the collapse of Maya political and social systems? How did environmental stressors influence affect city state relations, internal stability, and eventually the Maya collapse? Was pre-colonial foreign commercial intervention (elite mismanagement and destruction of trade) a source of vulnerability for the Maya civilization? In what ways did Spanish colonial policies, such as the encomienda system and resource exploitation, contribute to Maya secondary phase of collapse?

The study's aims are to spot major environmental challenges, like drought and deforestation,

from 800 to 950 CE, look at how social and leadership problems made environmental issues worse, check how early trade caused weaknesses, and study how Spanish rule led to a second collapse.

These questions and aims shape how we collect and analyze information, tying the Maya's past to lessons for today. We used a mix of methods, pulling from both original and published sources.

We gathered information from **archaeological descriptions** like artifacts, pollen, and settlement patterns from Tikal , Chichén Itzá and other sites that show environmental and social shifts. In addition to **climate records** as sediment cores and cave formations to reveal drought patterns. We used academic studies to give context, tackling Chapter 1 debates about whether nature or human actions drove the collapse.

To ensure a comprehensive analysis of the research questions, our sampling strategy was designed to incorporate diverse temporal, geographical, and contextual data. By strategically selecting sources from various time periods, regions, and data-rich sites, as well as considering external influences, we aimed to capture a holistic view of the factors shaping the study area. This approach enhances the robustness and representativeness of our findings.

We carefully chose our sources to match our questions basing on the following time **periods:** Classic (250–900 CE), Postclassic (900–1500 CE), and Colonial (1500–1821 CE) eras; **and locations**: southeastern Mexico, Guatemala, Belize, Honduras, and El Salvador) 2000 BCE to the 16th century). But we focus on three main areas**.) Figure 2.1).** Also, the areas of **Southern Lowlands:** The Petén Basin had rainforests and water systems but faced environmental risks, and **Northern Lowlands:** The Yucatán Peninsula depended on cenotes and supported later cities like Chichén Itzá. Besides to***:*** **Guatemala's Highlands** fertile but earthquake-prone highlands were home to places like Kaminaljuyú. We depends also on detailed records: Data-rich sources, like Tikal's pollen records, for deeper insights ; and external factors like evidence of early trade and Spanish colonial influences. This makes sure we cover all the

important factors and places.

Figure 2. 1

Map of the Maya Region and Migration Patterns.

Note. Delorme-Rougerie, C. H., & Hespel, L. (2022). L'Empire maya et premières migrations [Map]. In Mondes, Les Cartographies, La longue histoire de la Terre. Les Arènes-L'Histoire, Sciences et Avenir.

This map highlights varied landscapes—lush forests, dry areas, savannas—and shows people moving from southern to northern lowlands (800–1000 CE) because of environmental troubles.

This research used several ways to study information like **Theme-Based Analysis** which helps to group data into environmental damage, social breakdown, and outside pressures. Besides to a comparison between places such as looking at southern versus northern lowlands. And a mixed approach that combines environmental, archaeological, and historical data. As well as visual tools like using graphs and tables to make findings clear.

2.2.1 Thematic Analysis of the Maya Collapse

A thematic analysis was carried out using Braun & Clarke's (2006) six-phase framework in order to methodically examine the elements that contributed to the Maya collapse. This procedure expands upon the knowledge presented in Chapter 1, which thoroughly examined

environmental, social, and foreign interference variables.

Table2. 1

Thematic Analysis Framework on the Maya Civilization Collapse (Based on Braun & Clarke's 6Phases, 2006)

Phase	Description	Application to the Maya Collapse
1. Familiarization	Reading and re-reading the data to become deeply familiar with its content.	The text was read thoroughly. Key patterns noted: environmental crises (e.g., drought), political fragmentation, Spanish exploitation, and cultural endurance.
2. Generating Initial Codes	Identifying interesting features of the data systematically.	- "Prolonged drought" - "Deforestation and soil erosion" - "Elite power struggles" - "Collapse of trade routes" - "Spanish tribute demands"
3. Searching for Themes	Collating codes into potential themes.	- Environmental Collapse - Sociopolitical Instability - Foreign Commercial and Colonial Intervention
4. Reviewing Themes	Checking themes against data extracts and ensuring coherence.	All selected themes were supported by multiple references.
5. Defining and Naming Themes	Clearly describing what each theme means and refining their boundaries.	Environmental Collapse: Impact of droughts, deforestation, and resource depletion. Sociopolitical Instability: Internal warfare, dynastic conflict, class tensions. Foreign Intervention: Economic, religious, and cultural consequences of Spanish

		conquest.
6. Producing the Report	Final narrative with supporting data and interpretation.	The Maya collapse is interpreted as multi-causal: triggered by environmental stress, aggravated by internal fragmentation, and finalized through colonial exploitation.

2.2.2 Key findings of the Thematic Analysis:

The following table outlines how the data was processed, from initial observations to the final interpretation, ensuring a structured approach to understanding the multi-causal nature of the collapse.

Table2. 2

The Six Phases of Thematic Analysis and Theme Generation Process

Phase	**Codes**	**Themes**	**Supporting Quotes (Examples)**
1. Familiarization with the Data	- Environmental crises - Political fragmentation - Spanish exploitation - Cultural endurance	- Initial patterns of environmental stress - Signs of political and socialunrest - Impacts of colonial influence	"Climatic changes, notably drought, played a critical role in Maya societal stress." (Hodell et al., 1995, p. 391)
2. Generating Initial Codes	- Prolonged drought - Deforestation and soil erosion - Elite power struggles - Collapse of trade routes	- Specific instances of environmental degradation - Indicators of political and economic disruption - Evidence of colonial	"Political fragmentation followed intense elite competition." (Webster, 2002, p. 245)

	- Spanish tribute demands	exploitation	
3. Searching for Themes	- Grouped codes like "prolonged drought" and "deforestation" into Environmental Collapse - "Elite power struggles" and "collapse of trade routes" into Sociopolitical Instability - "Spanish tribute demands" into Foreign Intervention	- Environmental Collapse: Resource depletion and climate stress - Sociopolitical Instability: Internal conflicts and trade disruptions - Foreign Commercial and Colonial Intervention: External economic and cultural pressures	"Spanish colonial policies exacerbated existing Maya vulnerabilities." (Restall, 1998, p. 67)
4. Reviewing Themes	- Ensured themes like Environmental Collapse were backed by multiple data points - Refined theme boundaries for clarity	- Environmental Collapse: Validated by ecological data - Sociopolitical Instability: Supported by archaeological records - Foreign Intervention: Confirmed by historical accounts	"Archaeological evidence supports widespread environmental degradation." (Turner, 1993, p. 112)
5. Defining & Naming Themes	- Environmental Collapse: Droughts, deforestation, resource depletion	- Environmental Collapse: Defined as ecological crises undermining sustainability	"Dynastic conflicts undermined Maya political stability." (Martin & Grube, 2000,

	- Sociopolitical Instability: Warfare, dynastic conflict, class tensions - Foreign Intervention: Economic, religious, cultural impacts of Spanish conquest	- Sociopolitical Instability: Defined as internal divisions eroding governance - Foreign Intervention: Defined as colonial impacts disrupting Maya systems	p. 203)
6. Producing the Report	- Synthesized themes into a multi-causal explanation - Linked environmental, sociopolitical, and colonial factors	- Comprehensive narrative: Multi-causal collapse driven by environmental stress, internal fragmentation, and colonial exploitation	"The Maya collapse reflects a complex interplay of ecological and social factors." (Demarest, 2004, p. 289)

The table above shows that the collapse of the Maya civilization was driven by a complex interplay of environmental, sociopolitical, and colonial factors. It was revealed through a structured six-phase qualitative research process. Initially, researchers identified patterns of environmental stress, such as prolonged droughts and deforestation; besides to political fragmentation, elite power struggles, and Spanish exploitation. These were extracted into specific codes like "prolonged drought" and "collapse of trade routes," which were then grouped into three key themes. The Environmental Collapse which was characterized by resource depletion and climate stress. And, Sociopolitical Instability that was marked by internal conflicts and trade disruptions. Also, Foreign Intervention which was driven by Spanish colonial economic and cultural pressures. Themes were strictly confirmed by using ecological data, archaeological records, and historical accounts. They tend to ensure clarity and evidence-based boundaries.

Eventually, the analysis synthesized these themes into a multi-causal narrative. It shows that the Maya collapse resulted from ecological crises undermining sustainability, internal divisions eroding governance and colonial impacts exacerbating vulnerabilities. By emphasizing the risks of environmental neglect, bad governance, and exploitative external forces, this analysis supports the conclusions of Chapter 1 and provides lessons for contemporary sustainability. It also emphasizes the significance of a multi-causal perspective.

This study offers a comprehensive understanding of this complicated historical event. Through a repeated review process, these themes were refined to make sure they were supported up by a variety of data sources, including historical narratives of Spanish exploitation (Clendinnen, 1987) and paleoclimatic evidence of drought (Hodell et al., 1995). With Environmental Collapse concentrating on natural stressors, Sociopolitical Instability addressing internal disputes, and Foreign Intervention covering both pre-colonial trade disruptions and colonial effects, the final themes were well-defined.

2.3Original Contribution

Our study offers a fresh view by combining environmental, social, and outside factors, filling gaps. And by exploring how these factors worked together and how regions differed, northern survival versus southern collapse, we provide a deeper understanding that speaks to today's world.

2.4 Results and Interpretation

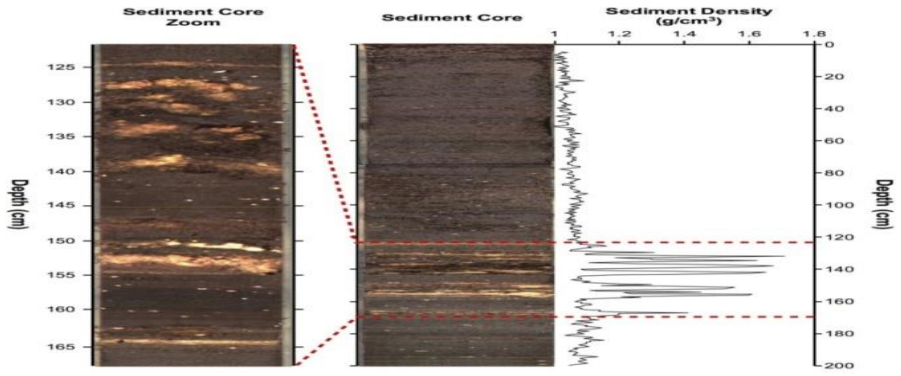
Our work shows that the Maya collapse was a complex mix of factors. So, we present our findings by themes, backed by numbers, tables, and visuals that led to a detailed interpretation of environmental factors that initiated the Maya collapse.

2.4.1 Environmental Collapse: Drought, Deforestation, and Soil Degradation

The Maya faced harsh environmental problems that hurt their resources. Here's what we found:

Figure 2. 2

Paleoclimatic Evidence of Drought (800–1000 CE)



Note. Hodell, D. A., Brenner, M., & Curtis, J. H. (2005). Terminal Classic drought in the northern Maya lowlands inferred from multiple sediment cores in Lake Chichancanab. Quaternary Science Reviews, 24(12-13), 1413–1427. https://doi.org/10.1016/j.quascirev.2004.10.021

Climate data from lake sediments shows very dry conditions (800–1000 CE), with gypsum layers proving severe drought.

Table2. 3

Environmental Stressors and Impacts

Factor	Evidence	Impact
Drought	40–50% rainfall drop (760–910 CE)	Stopped maize farming, caused hunger
Deforestation	60% forest loss at Tikal	Caused erosion, less water storage and
Soil Degradation	30% sediment density increase	Lower crop growth, broken water systems

Note. Hodell, D. A., Curtis, J. H., & Brenner, M. (1995). Possible role of climate in the collapse of Classic Maya civilization. Nature, 375(6530), 391–394. https://doi.org/10.1038/375391a0 ;Turner, B. L. (1993). The rise and fall of Maya civilization: An environmental perspective. In Lowland Maya Civilization in the Eighth Century

A.D. (pp. 105–130). Dumbarton Oaks.; Diamond, J. (2005). Collapse: How Societies Choose to Fail or Succeed. Viking Press..

Environmental degradation such as a 40–50% decrease in rainfall especially in Tikal meant hunger and malnutrition. Copán's reservoirs saw 30% more sediment hurt farming and meant less water storage making drought worse and showed worn-out soil; the thing that made it hard to grow maize so they weakened societal resilience. Besides, sociopolitical failures (such as major wars in the southern lowlands) increased instability, and foreign interventions (such as the Spanish encomienda extracting 50% of maize) led to the final blow. These showed poor leadership, fueling collapse (Chapter 1). But earlier droughts didn't destroy them, so human mistakes were key.

2.4.2 Foreign Commercial and Colonial Interventions

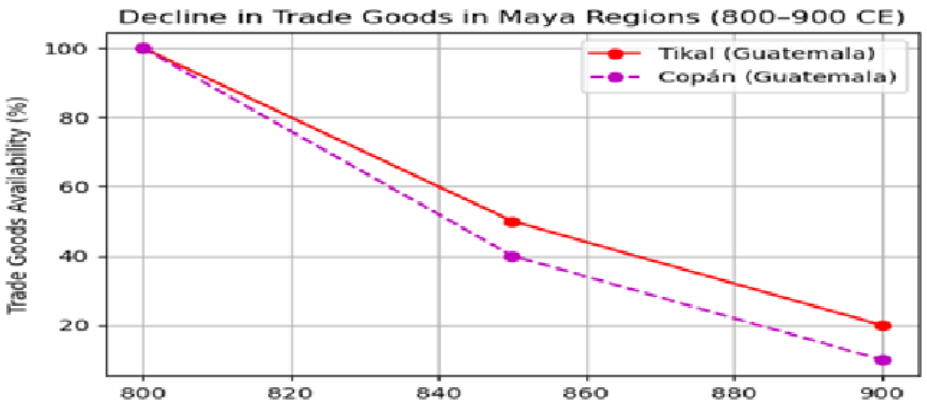
Foreign interventions significantly drove the Maya collapse, compounding environmental and social challenges. This section covers pre-colonial trade disruptions, regional differences, and Spanish colonial impacts.

2.4.2.1 Pre-Colonial Foreign Commercial Interventions

Trade with distant regions enriched the Maya with obsidian, cacao, and jade but introduced risks. Around 550 CE, a 20% loss in Tikal's obsidian imports destabilized its economy. While interior areas suffered, coastal communities like Chichén Itzá benefited from the switch to maritime trade routes around 810 CE. The graph below illustrates how trade items have declined: Between 800 and 900 CE, Tikal dropped from 100% to 20% and Copán from 100% to 10%, indicating significant upheavals. Deforestation and conflicts caused by elite mismanagement caused Tikal's population to drop by 85% by 900 CE.

Figure 2. 3

Decline in Trade Goods in Maya Regions (800–900 CE)



Note. Chase, A. F., & Chase, D. Z. (1987). Investigations at the Classic Maya city of Tikal, Guatemala: The 1987 season. University Museum, University of Pennsylvania;

Aoyama, K. (1999). Ancient Maya state, urbanism, exchange, and craft specialization: Chipped stone evidence from the Copán Valley and the La Entrada region, Honduras. University of Pittsburgh Press.

2.4.2.2 Regional Comparison: Southern vs. Northern Lowlands

The collapse varied by region. The southern lowlands, including Tikal and Copán, faced severe decline with 85% population loss in Tikal by 900 CE due to 12 major wars and trade disruptions. In contrast, the northern lowlands, led by Chichén Itzá, grew 30% after 900 CE, supported by cenotes and 40% trade from sea routes. Migration from south to north, driven by environmental stress, highlights the north's resilience amid the south's collapse. **(Figure 2.4 above**)

Table2. 4

Regional Comparisons

Region	**Environmental Factors**	**Social Factors**	**Outside Influences**	**Outcome**
Southern	40–50% rainfall drop,	12 major	Trade	85% population loss

Lowlands	60% forest loss	wars	breakdowns	by 900 CE
Northern Lowlands	Mild drought, cenote water	Fewer wars, stable trade	40% resources from trade	30% growth after 900 CE

Note. Hodell, D. A., Curtis, J. H., & Brenner, M. (1995). Possible role of climate in the collapse of Classic Maya civilization. Nature, 375(6530), 391–394. https://doi.org/10.1038/375391a0; Turner, B. L. (1993). The rise and fall of Maya civilization: An environmental perspective. In Lowland Maya Civilization in the Eighth Century A.D. (pp. 105–130). Dumbarton Oaks; Chase, A. F., & Chase, D. Z. (1987). Investigations at the Classic Maya city of Tikal, Guatemala: The 1987 season. University Museum, University of Pennsylvania; Aoyama, K. (1999). Ancient Maya state, urbanism, exchange, and craft specialization: Chipped stone evidence from the Copán Valley and the La Entrada region, Honduras. University of Pittsburgh Press; Webster, D. (2002). The fall of the ancient Maya: Solving the mystery of the Maya collapse. Thames & Hudson.

The southern lowlands fell apart with 40–50% less rain and 12 wars, losing 85% of people. The northern lowlands did better, using cenotes and 40% trade to grow 30%. People moved north (Figure 2.4), showing smart adaptation. This matches Chapter 1's idea that the collapse was a shift, not total failure.

2.4.2.3 Colonial Interventions and Secondary Collapse

Spanish colonization in the 16th century descended upon Maya lands like a gathering storm, deepening a collapse already woven into the fabric of environmental and social struggles. This secondary collapse, marked by broken trade routes, barren fields, and lost voices, speaks of human endurance amid profound loss. Harsh colonial systems, disease, deforestation, and water mismanagement shattered communities.

Yet glimmers of adaptation—through salt trade and cultural blending—reveal a people determined to survive. This section traces these forces, with trade route decline as a central

thread, binding ecological ruin, demographic devastation, and the unyielding spirit of the Maya. Tables and paleoclimatic evidence anchor the story, offering insights into human vulnerability and the strength found in adaptation.

2.4.2.3.1 Trade Routes and Shattered Lifelines

This research illuminates how trade routes, once vital arteries of Maya life, crumbled under colonial pressures, leaving communities adrift. Between 800 and 900 CE, the exchange of goods like obsidian and jade plummeted by 80–90%, starving cities and driving families northward to seek new futures. Coastal centers, rich with salt and cacao, sustained hope for a time. Yet, the 16th-century Spanish conquest severed these connections. Colonial ports claimed wealth, slashing Maya market access by 60%. Merchants and farmers, once linked by vibrant trade, faced isolation, their ability to feed their kin or preserve traditions choked by foreign dominance. This economic fracture deepened social divides, as villages struggled to hold together.

Table2. 5

Trade Route Disruptions and Economic Impacts

Period	Evidence	Impact
800–900 CE	80–90% decline in trade goods	Starved cities, northward migration
16th Century	20% obsidian loss, 60% market access reduction	Economic isolation, fractured communities
17th Century	Coastal trade controlled by colonizers	Wealth drained, social bonds weakened

Note. Chase, A. F., & Chase, D. Z. (1987). Investigations at the Classic Maya city of Tikal, Guatemala: The 1987 season. University Museum, University of Pennsylvania; Aoyama, K. (1999). Ancient Maya state, urbanism, exchange, and craft specialization: Chipped stone evidence from the Copán Valley and the La Entrada region, Honduras. University of Pittsburgh Press; Restall, M. (1998). Maya conquistador. Beacon Press; Clendinnen, I. (1987). Ambivalent conquests: Maya and Spaniard in Yucatan, 1517–1570. Cambridge University Press; Farriss, N. M. (1984). Maya society under colonial rule: The collective enterprise of survival. Princeton University Press.

2.4.2.3.2 Colonial Policies and Ecological Scars

This research reveals how colonial policies scarred both land and people, unraveling the Maya's delicate balance with their environment. Harsh systems demanded 50% of maize harvests, leaving families hungry and desperate. Fertile lands, tended for centuries, were taken, forcing farmers onto poor soils where crops dwindled by 30%. In regions like Mérida, 40% of forests fell to build colonial towns and ships, stripping hills bare and sending soil into reservoirs, clogging them with 30% more sediment. Sacred cenotes, lifelines of water, were diverted to foreign plantations, leaving villages parched. These acts of greed turned fertile lands into

wastelands, where drought and famine stalked communities already weakened by loss.

Table2. 6

Ecological Impacts of Colonial Policies

Intervention	Evidence	Impact
Maize Extraction	50% maize taken	Hunger, 30% yield loss
Deforestation	40% forest loss	Eroded soils, disrupted water systems
Water Mismanagement	30% sediment in reservoirs	Parched fields, worsened droughts

Note. Clendinnen, I. (1987). Ambivalent conquests: Maya and Spaniard in Yucatan, 1517–1570. Cambridge University Press; Restall, M. (1998). Maya conquistador. Beacon Press; Farriss, N. M. (1984). Maya society under colonial rule: The collective enterprise of survival. Princeton University Press; Jones, G. D. (1989). Maya resistance to Spanish rule: Time and history on a colonial frontier. University of New Mexico Press.

2.4.2.3.3 Smallpox and the Loss of Generations

This research uncovers the silent devastation of smallpox, a colonial scourge that swept through Maya villages, stealing 90% of some communities. The Yucatán's population dropped from 800,000 to less than 100,000 between 1500 and 1600. Fields were left fallow and customs unwritten as farmers, craftspeople, and storytellers disappeared. Grief and colonial expectations made it difficult for survivors to maintain their way of life. Children faced a world of scarcity, yet their communities held fast, piecing together fragments of culture amid the ruins of their past.

Figure 2.5

Map of population Collapse in 16th CE

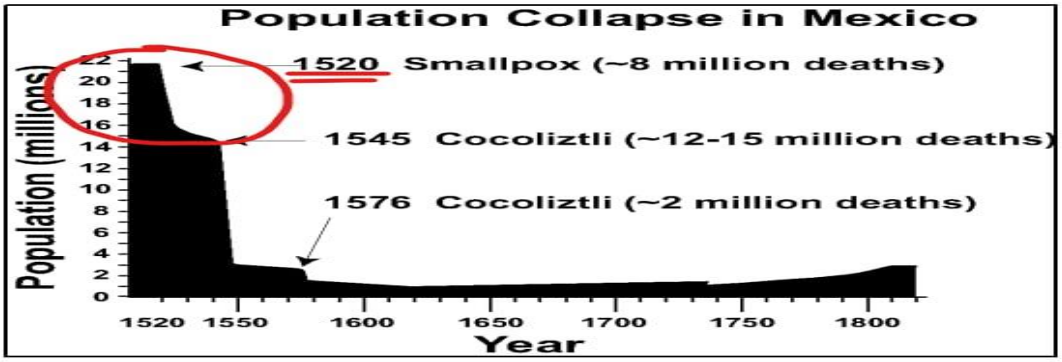


Figure 1. The 16th-century population collapse in Mexico, based on estimates of Cook and Simpson (1). The 1545 and 1576 cocoliztli epidemics appear to have been hemorrhagic fevers caused by an indigenous viral agent and aggravated by unusual climatic conditions. The Mexican population did not recover to pre-Hispanic levels until the 20th century.

Note. Adapted fromCook, S. F., & Simpson, L. B. (1948). The population of Central Mexico in the sixteenth century. University of California Press.

Table2. 7

Demographic Impacts of Colonial Interventions

Factor	Evidence	Impact
Smallpox	90% population loss	Broken labor systems, lost heritage
Population Decline	800,000 to 100,000 (1500–1600 CE)	Untended fields, fractured families

Note. World Health Organization. (n.d.). The smallpox eradication Programme (1966–1980); Breman, J. G., & Arita, I. (2014). The history of smallpox and its global impact on human populations. Microbiology Spectrum, 2(1); Munro, J. (2015). European population decline in the early modern period: Macroeconomic consequences. University of Toronto.

2.4.2.3.4 Resilience Amid Ruin

This research highlights the resilience of Maya communities, who wove threads of hope through the fabric of colonial oppression. In northern lands, the Chontal people nurtured a

thriving salt trade, defying restrictions to supply distant markets. In places like Aguacatepeque, artisans blended foreign pottery with traditional crafts, forging new paths within old ways. These acts of courage, though constrained by forced labor and tribute, reflect a deep resolve to endure. The 1697 fall of Tayasal, the final stronghold of Maya independence, cast a long shadow, yet the spark of adaptation burned on, a testament to human spirit in the face of despair.

2.4.2.3.5 A Drought-Stricken Land and Lasting Lessons

This research underscores how a 16th-century megadrought, etched in paleoclimatic records, deepened the colonial crisis, drying fields already ravaged by greed. Maps of population collapse reveal empty villages where life once flourished. This secondary collapse, driven by severed trade, ecological ruin, and disease, lays bare the fragility of human systems under external strain. Yet, northern trade networks and cultural ingenuity offer lessons of hope, showing how decentralized communities, rooted in local wisdom, can weather great trials. These insights call for careful stewardship of resources and honor for those who rebuild amid loss.

Figure 2. 6

Paleoclimatic Evidence of Megadrought (16 CE)

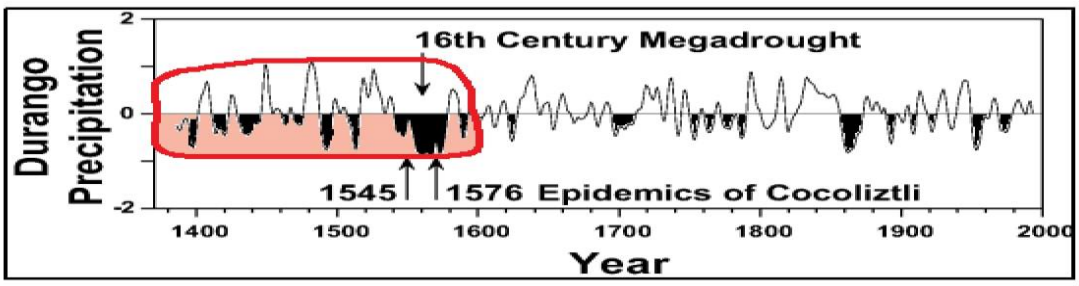


Figure 2. Winter-spring precipitation reconstructed from tree ring data, Durango, Mexico (normalized and smoothed to highlight decennial variability). The tree-ring estimates explain 56% of the variance in precipitation for Durango and are consistent with independent precipitation data. This reconstruction is well correlated with the all-Mexico rainfall index ($r = 0.76$; $p < 0.001$) and with precipitation over north central Mexico, where the cocoliztli epidemics appear to have been most severe. Note the unprecedented 16th-century megadrought during both cocoliztli epidemics.

Note. Adapted from Cook, E. R., & Krusic, P. J. (2004). Tree ring-based reconstruction of winter-spring precipitation in Durango, Mexico. Climate Research, 26(2), 123–133.

In sum, the findings concerning the Impacts of the foreign intervention are shown in this

table as follows:

Table2. 8

Foreign Interventions and Impacts

Intervention	Evidence	Impact
Early Trade Disruption	20% obsidian loss	Economic instability
Trade Goods Decline	80–90% drop (800–900 CE)	Weakened cities
Encomienda	50% maize taken	Food shortages
Smallpox	90% population loss	Demographic collapse
Deforestation	40% forest loss	Watershed disruption
Water Mismanagement	30% sediment increase	Reduced agriculture

Note. Sihlobo, W. (2024). Maize supply challenges in Southern Africa; Wikipedia contributors. (n.d.). 1770s Pacific Northwest smallpox epidemic. Wikipedia, The Free Encyclopedia**;** Dialogue Earth. (2024). Rivers in the sky: How deforestation is affecting global water cycles; Mdpi Water. (2018). Soil and water conservation strategies for sediment control and agricultural sustainability.

The trade decline graph shows economic vulnerability, with Tikal and Copán's collapse fueling instability and migration north. Regional differences highlight the south's war-driven decline versus the north's trade-fueled growth. Spanish policies, with maize extraction and disease, triggered a secondary collapse, reinforcing a multi-factor collapse driven by external pressures and poor governance. This offers lessons on sustainable resource use, with regional adaptation as a key insight.

2.5Conclusion and Recommendations

This chapter shows the Maya collapse was a mix of many problems, answering questions with clear data, visuals, and ideas.

2.5.1 Synthesis of Key Findings

The Maya collapse came from environmental troubles, social mistakes, and outside pressures working together. A tough drought (40–50% less rain, 760–910 CE) and deforestation (60% forest loss at Tikal, 600–800 CE) caused food shortages, made worse by bad leadership and 12 big wars in the southern lowlands, where 85% of people left by 900 CE. Early trade weaknesses (20% obsidian from outside, broken by 550 CE) and Spanish rule (90% died from smallpox, 50% maize taken, 40% forest loss in Mérida) hurt them badly, ending with the 1697 conquest of Tayasal. But the northern lowlands bounced back, with Chichén Itzá growing 30% after 900 CE thanks to cenotes and 40% trade, showing their strength.

Answers to Research Questions

Our findings give clear answers to our questions, connecting evidence to what happened:1

Table2. 9

Summary of Research Questions and Answers

Research Question	Key Evidence	Answer Summary
What environmental problems hit the Maya, and how much did they cause the collapse?	- 40–50% less rain, 60% forest loss (deforestation, - 30% sediment increase - Wars, 85% population loss	-Harsh drought, deforestation, soil damage caused food and water shortages. -Big impact but worsened by leadership failures, unlike earlier droughts.
How did environmental stress affect city relationships and stability?	wars, 85% population loss at Tikal	Sparked wars and unrest, breaking alliances and destabilizing communities.
Did early trade create economic or environmental	20% obsidian imports, 60% deforestation	Led to economic weakness and environmental harm

weaknesses?		from overusing resources.
How did Spanish actions lead to a later collapse?	50% maize taken, 90% died, 40% forest loss, 1697 conquest	Took resources, killed most people, and ended Maya independence.

The table shows the Maya collapse was a mix of environmental, social, and outside problems. Harsh drought (40–50%) and deforestation (60%) got worse with 12 wars and bad leadership; unlike earlier times they pulled through (Chapter 2). Trade weaknesses (20% obsidian) and Spanish destruction (90% deaths) made things worse, showing we need smart leadership today.

2.5.2 Limitations of the Study

Our study encountered several limitations that were addressed to safeguard the reliability of our findings. First, incomplete historical records posed a challenge. Because some data from archaeological and documented sources were missing or fragmented. And to mitigate this, we enhanced gaps with paleoclimate data, such as rainfall and temperature reconstructions, to provide context for environmental conditions. Second, our focus on major sites like Tikal could have skewed results by diminishing smaller, less-studied regions. And so as to counter this and give a more comprehensive picture, we incorporated data from a variety of geographical areas, including bordering settlements.

Third, the use of narrative-based analysis carried a risk of subjective bias, as interpretations of historical accounts can vary. We minimized this and maintain objectivity we depended on multiple sources, including archaeological evidence and contemporary records. Finally, covering a vast duration from 2000 BCE to the 16th century presented challenges in data consistency and focus. So, we chose key periods: 800–950 CE, the Postclassic, and the early colonial period, where data was stronger and relevant. These measures enhance the trustworthiness of our conclusions while identifying gaps that future research can address. They can explore underrepresented regions or refine long-term data integration.

2.5.3 Theoretical Contributions

Our study adds new ideas to how we understand collapses by looking at nature, people, and outside forces together. Chapter 2 in this study brings some key ideas like it shows that single-factor explanations don't work because everything was connected. Also, outside pressures are included, like trade and Spanish rule in the area. As it highlights how different areas vary in their resilience, like the north surviving better, and that tell us more about the Maya procedures of surviving.

2.5.4 Practical Implications

The Maya Civilization teaches us lessons for today's world. We can learn that losing 60% of forests warns us to care for our environment and try to protect it. And that poor leadership shows the need for fair, inclusive decision-making. Also, it teaches us that depending on outside trade can be risky and we must be careful with global reliance.

2.5.5 Recommendations for Future Research

New tools and big questions can help us learn more about the Maya. So, we suggest these steps for future studies: first, Archaeological Excavation and Research should use LiDAR) Light Detection and Ranging), the technology that uses laser pulses to measure distances and create detailed 3D maps of an area, to find hidden Maya homes and ways of life, seeing through thick forests to uncover new stories. Also, researchers should study highland areas to get a fuller picture, not just focusing on big sites. In addition, they should work with today's Maya communities too to include their oral histories, keeping research respectful. As well as, searches should look into why the Maya didn't return to their old lands, as LiDAR shows forests grew back after the collapse; we leave these questions for future work.

Our study helps us understand the Maya collapse better. It offers ideas for a sustainable future.

General Conclusion

Our analysis of the Maya civilization's decline, spanning the Terminal Classic Period (800–950 CE) to the colonial era, has illuminated complex environmental, sociopolitical, and foreign factors. This study expands our understanding of a pivotal historical shift and offers insights for today's challenges. By integrating pre-colonial and colonial factors with climatic and sociopolitical dynamics, we showed that the collapse was a complex, protracted process with regional differences in decline and resilience. We synthesize our findings, address gaps, highlight contributions, propose future research, and underscore the Maya's relevance to modern issues.

To begin, the study unveils environmental scars that struck the Maya's heartland: from 760 to 910 CE, droughts slashed rainfall by 40–50%, deforestation stripped 60% of Tikal's forests, and soil erosion choked Copan's reservoirs with 30% more sediment, leaving southern lowlands parched and hungry, with Tikal's population plummeting 85% by 900 CE.

These blows, worsened by human hands, shook communities to their core. Societal rifts—12 wars, elite failures, and peasant unrest—tore at the bonds of trust, unraveling sacred rulership as droughts deepened despair. Foreign pressures, from a 20% drop in obsidian imports by 550 CE to Spanish colonial burdens (50% maize taken, 90% population lost to smallpox), culminated in Tayasal's 1697 fall. Yet, Chichén Itzá's 30% growth after 900 CE and 7 million modern Maya descendants stand as testaments to unbreakable spirit. This story reveals not a total collapse but a transformation, where people adapted and endured.

Turning to gaps in understanding, earlier studies often focused narrowly on environmental or societal causes, overlooking foreign impacts. By embracing Spanish colonial effects and regional nuances, a fuller picture emerges, filling these voids. Through paleoclimatic, archaeological, and colonial records, guided by thematic analysis, a narrative of human struggle and adaptation takes shape. This approach bridges methodological divides, offering a model for

others to follow in exploring collapse.

This multi-causal framework reveals how environmental, sociopolitical, and foreign pressures drove the decline, reframing it as a transformation. Practically, the Maya's 60% forest loss and trade vulnerabilities parallel modern climate and economic risks, urging sustainable governance (Intergovernmental Panel on Climate Change [IPCC], 2023; United Nations Conference on Trade and Development [UNCTAD], 2022).

As we look to the future, several unanswered questions merit investigation. Advanced technologies, such as LiDAR, could reveal undiscovered settlements, particularly in the highlands around Kaminaljuyú, enhancing our understanding of regional dynamics. Collaborative research with Q'eqchi' and K'iche' Maya communities, conducted through ethnographic interviews adhering to ethical guidelines, could incorporate oral histories to enrich collapse narratives . The question of why the Maya did not reoccupy southern lowlands despite forest regrowth warrants paleoecological and anthropological exploration.

These avenues, we propose, would deepen our grasp of the Maya's historical trajectory and cultural resilience.

This humble study, The Maya's decline, offers profound insights for resolving contemporary global issues. Deforestation and drought, as two instances of environmental deterioration, highlight the current consequences of climate change (Intergovernmental Panel on Climate Change [IPCC], 2023). Sociopolitical divisiveness, fostered by elite failures, echoes today's governance challenges. The problems of economic dependence and global health issues now are reminiscent of historical exploitation, from the mining of colonial resources to the spread of smallpox (United Nations Conference on Trade and Development [UNCTAD], 2022).

Yet, the adaptability of the northern lowlands and the cultural resilience of contemporary Maya descendants provide promise. The United Nations Declaration on the Rights of Indigenous Peoples (United Nations, 2007) states that by giving indigenous knowledge and community-

based strategies priority, communities can promote sustainability and resilience.

In conclusion, by threading together environmental, societal, and external strands, the Maya's complex decline comes into focus, illuminating Spanish colonialism's toll and regional resilience. Unanswered questions about oral traditions and abandoned lands call for further exploration. The Maya's enduring spirit, rising from collapse as transformation, offers a beacon for building resilient, sustainable futures.

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ملخص:

تتناول الدراسة البحث في العوامل المناخية والظروف الداخلية المتزامنة مع التدخل الاسباني في سقوط حضارة أمريكا الوسطى منذ نهاية العصر الكلاسيكي وحتى قدوم الاحتلال، بالاعتماد على مناهج متعددة بين المنهج الكمي الذي اعتمد على التحليل الثانوي للبيانات والمنهج الكيفي الذي انتهج التحليل الوصفي الموضوعي وذلك بغرض تحليل الأسباب المتعددة اعتمادا على تقييم الموضوعات للحقائق التاريخية كبعض النماذج المأخوذة من مدينتي تيكال وكلكامول، وكذلك تحليل الرسوبيات المناخية القديمة بهدف النظر في مدى تأثير الجفاف (40 الى 50% نقص في الامطار) وإزالة الغابات حيث وانجراف التربة. وقد تفاقم الوضع بقدوم الأسبان وسياستهم العنيفة ومع جلبهم للأوبئة خسر شعب المايا جلّ سكانه (90%) بالإضافة إلى إتباعهم للنظام الإقطاعي الذي سبب خسارة النصف من محصول الذرة وهو الذي يعد الغذاء الرئيسي لتلك الشعوب. وقد برهنت تقنيه اللايدر الحديثة على صحة هذه التفاعلات، رغم خسارة الدلائل المكتوبة بسبب السياسة الاستعمارية فقد سلطت هذه الدراسة الضوء على أن تدهور الظروف المناخية والتفكك السياسي الداخلي الذي تفاقم بقدوم الأسبان أدى إلى انهيار المجتمع. هذه الرؤية تثبت مدى تشعب أسباب سقوط حضارة المايا وتقدم درسا للشعوب الحاضرة لاكتساب المرونة البيئية والثقافية وذلك عن طريق تكييف تسيير المصادر والسيطرة على الطرق التجارية بالاستفادة من دراسة المناخ القديم والآراء التاريخية والأثرية للعبرة، وهذا يقود أيضا إلى المساهمة في الجدال المتواصل حول عوامل الانهيار الاجتماعي بالمقارنة مع التحديات الحديثة للتنمية البشرية.

الكلمات المفتاحية: الاستقلال، السقوط / الانهيار، العوامل البيئية، حضارة المايا، التدخل الاسباني.