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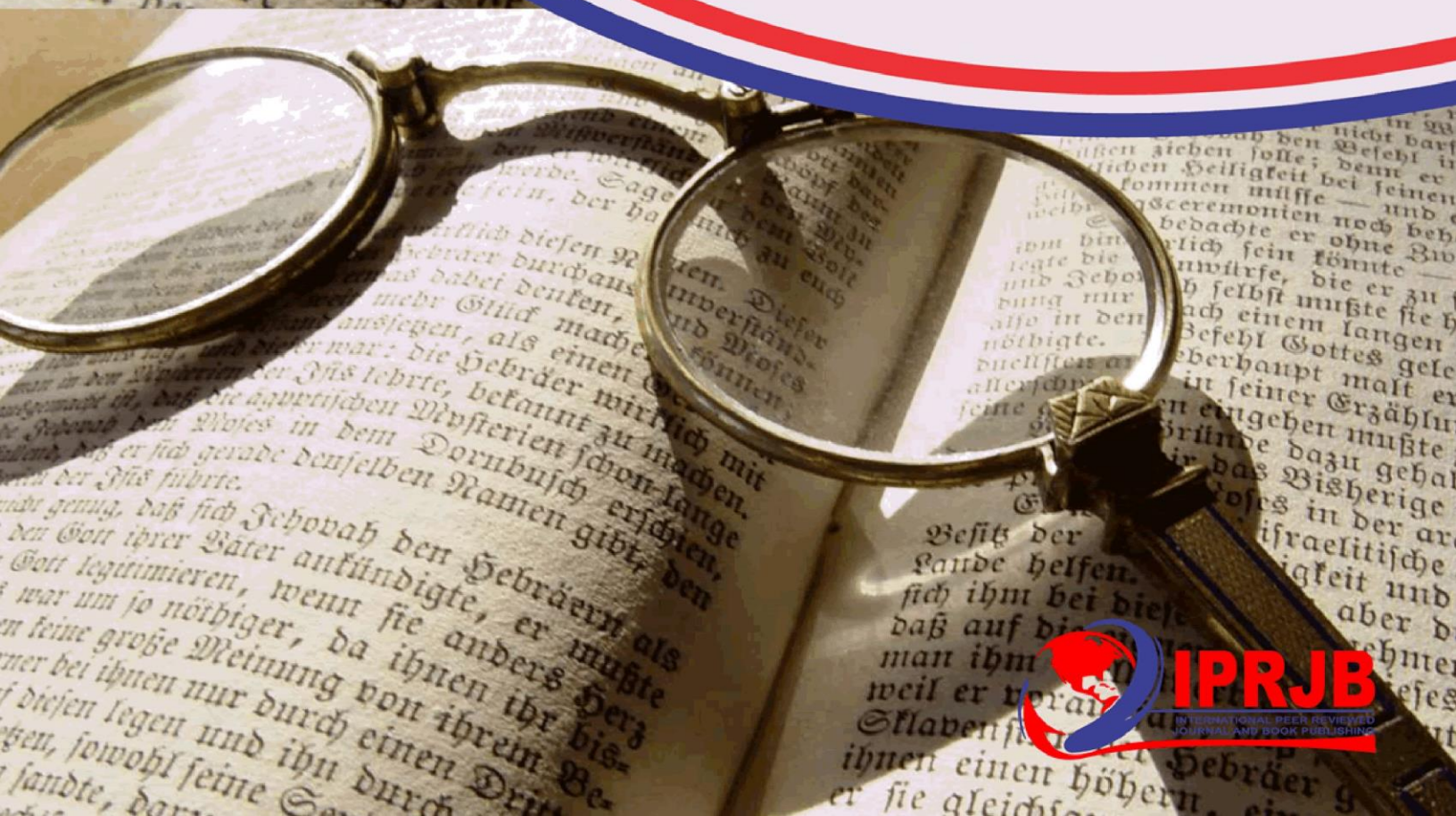
Ayu Triana



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Ayu Triana

Kasetsart University

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Abstract

Purpose: To aim of the study was to analyze the environmental factors and societal adaptation in Pre-Columbian Mesoamerica.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Environmental factors profoundly shaped societal adaptation in Pre-Columbian Mesoamerica. The region's diverse landscapes influenced settlement patterns, agriculture, and trade. Civilizations like the Maya, Aztec, and Olmec developed innovative techniques such as terracing and chinampas to navigate varied environments. They integrated environmental elements into religious beliefs and urban planning but faced challenges like droughts and environmental degradation, showcasing the intricate relationship between human societies and their surroundings.

Unique Contribution to Theory, Practice and Policy: Environmental determinism, cultural ecology & resilience theory may be used to anchor future studies on the environmental factors and societal adaptation in Pre-Columbian Mesoamerica. Develop practical insights into historical trade routes, understanding their impact on local economies, infrastructure development, and urbanization patterns. Recommend policies for infrastructure development along historical trade routes to enhance connectivity, trade facilitation, and regional economic integration. Advocate for policies to preserve and promote cultural heritage along the Silk Road, fostering tourism, education, and cultural exchange opportunities.

Keywords: *Environmental Factors, Societal Adaptation*

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INTRODUCTION

Societal structures encompass how societies organize through institutions and hierarchies, governing interactions and resources. Cultural practices like agriculture and urbanization reflect beliefs and traditions, with agriculture involving rituals and urbanization shaping city dynamics. These elements define societal organization and cultural identity, influencing community adaptation and evolution. In the United States, urbanization has been a significant trend with a clear impact on societal structures. According to recent statistics, urban areas in the USA have continued to grow, with the urban population reaching 82.3% in 2020, up from 81.2% in 2010 (US Census Bureau, 2021). This trend reflects not only demographic shifts but also cultural changes as urban centers become hubs for innovation and economic activity, influencing national policies and social dynamics.

In Japan, agriculture remains a crucial cultural practice despite rapid urbanization. The country's agricultural sector faces challenges due to an aging workforce and declining rural populations. However, Japan has embraced technological advancements in agriculture to sustain productivity. For instance, precision farming techniques and robotics are increasingly integrated into farming practices, aiming to enhance efficiency and address labor shortages (Hara et al., 2019). This illustrates how cultural traditions in agriculture adapt to modern challenges in developed economies. In the UK, urbanization has been a defining trend influencing societal structures. As of recent statistics, urban areas in the UK house approximately 83% of the population, showcasing a steady increase over the past decade (Office for National Statistics, 2021). This urban shift has shaped cultural practices and economic dynamics, with cities like London serving as global financial centers while also grappling with housing affordability and social integration challenges. Agriculture in Germany reflects a blend of traditional practices and technological advancements. Despite significant urbanization, agriculture remains a vital sector. Precision farming techniques and sustainable practices are increasingly adopted to enhance productivity and environmental sustainability (BMEL, 2020). This dual focus supports Germany's cultural heritage in agriculture while aligning with modern economic and environmental imperatives.

Urbanization in France has seen urban areas expand to accommodate a significant portion of the population, with Paris being a prominent global city. Approximately 80% of the French population resides in urban areas, driving economic activities and cultural vibrancy (INSEE, 2020). Urbanization has influenced French societal structures by fostering innovation in industries like fashion, cuisine, and technology, while also addressing urban planning challenges such as sustainable development and social inclusion. Agriculture in Australia represents a blend of traditional practices and modern technologies adapted to the country's diverse climate and landscapes. Despite rapid urbanization, agriculture remains a crucial sector, contributing significantly to the economy and cultural heritage. Technological advancements in water management, soil conservation, and livestock farming have enhanced productivity and environmental sustainability (ABARES, 2021). These innovations support Australia's rural communities while meeting global demands for high-quality agricultural products.

In India, urbanization has surged alongside economic growth, with urban population increasing significantly. As of 2020, urban areas in India accommodated about 35% of the total population, a notable rise from previous decades (World Bank, 2021). This shift influences societal structures by creating new economic opportunities in cities while also posing challenges related to infrastructure and social inequality. In Kenya, agriculture remains a cornerstone of the economy

and cultural identity. Despite urbanization trends, a large portion of the population relies on agriculture for livelihoods. Agricultural practices are evolving with the introduction of technology and modern farming methods, aimed at increasing productivity and resilience against climate change (FAO, 2020). This dual emphasis on traditional practices and technological innovation underscores the complex interplay between cultural heritage and economic development in developing nations.

Urbanization in India has been marked by rapid growth, with urban areas expected to accommodate over 40% of the population by 2030 (World Bank, 2021). Cities like Mumbai, Delhi, and Bangalore drive economic growth and cultural diversity, influencing national policies on infrastructure development, environmental conservation, and social equity. Urbanization challenges include managing urban sprawl, improving public services, and addressing income disparities between urban and rural populations. Agriculture remains vital to Vietnam's economy and cultural identity, supporting millions of rural livelihoods. The country has embraced agricultural reforms and technological innovations to enhance productivity and sustainability. Initiatives such as organic farming, climate-resilient crop varieties, and efficient water management systems are crucial in mitigating climate change impacts and ensuring food security (FAO, 2020). Vietnam's agricultural sector plays a pivotal role in poverty reduction and rural development strategies.

Urbanization in Brazil has been rapid, with urban areas accommodating approximately 86% of the population by recent estimates (IBGE, 2020). This shift has influenced societal structures by concentrating economic activities and cultural diversity in urban centers, while rural areas continue to play a crucial role in agriculture and natural resource management. Agriculture in China has undergone significant transformation amidst rapid urbanization. The country's agricultural practices have evolved with technological innovations such as smart farming and biotechnology, aimed at increasing yields and sustainability (FAO, 2019). This transformation underscores China's dual strategy of preserving agricultural heritage while modernizing to meet food security and economic growth objectives.

Nigeria's urbanization rate has accelerated, reflecting broader economic changes. By 2020, over half of Nigeria's population lived in urban areas, driven by rural-urban migration and economic opportunities in cities (World Bank, 2021). This demographic shift impacts societal structures by influencing cultural norms and economic activities, with implications for governance and infrastructure development. In Ethiopia, agriculture remains pivotal, supporting livelihoods for a large rural population. The country has implemented policies to modernize agriculture, emphasizing sustainable practices and technology adoption to enhance productivity (Abebe & Mekonnen, 2017). These efforts highlight the integration of traditional agricultural practices with contemporary approaches to meet food security and economic development goals in Sub-Saharan Africa. Agriculture remains central to Uganda's economy and cultural identity, supporting the livelihoods of the majority of its population. The country employs traditional farming practices alongside modern technologies like improved seeds, irrigation systems, and market access initiatives (UBOS, 2020). Agricultural policies focus on enhancing productivity, promoting sustainable land use, and integrating smallholder farmers into value chains to ensure food security and economic resilience in rural communities.

Urbanization in South Africa has seen urban areas grow significantly, accommodating around 67% of the population as of recent data (Stats SA, 2021). This demographic shift has impacted societal

structures by influencing cultural norms, economic activities, and political dynamics, with urban centers driving national development agendas and social change. Agriculture remains a cornerstone of Uganda's economy and cultural identity, supporting livelihoods for a large rural population. The country has implemented policies to enhance agricultural productivity through improved infrastructure and technology adoption (UBOS, 2020). These efforts aim to balance traditional agricultural practices with modern innovations to ensure food security and sustainable economic development.

Urbanization in Nigeria has led to significant demographic shifts, with urban areas projected to house over 60% of the population by 2050 (UNDP, 2020). Cities like Lagos and Abuja serve as economic hubs, attracting investments and fostering cultural diversity. Urbanization challenges include infrastructure deficits, informal settlements, and environmental degradation, necessitating sustainable urban planning and governance reforms. Agriculture is the backbone of Kenya's economy and a cornerstone of its cultural heritage, supporting rural livelihoods and food security. The country has implemented agricultural modernization programs focusing on sustainable practices, value chain development, and smallholder farmer empowerment (Ministry of Agriculture, 2021). These initiatives aim to enhance agricultural productivity, promote agribusiness opportunities, and address challenges such as climate variability and market access for rural communities.

Understanding environmental conditions such as climate and geography is crucial for comprehending their profound impact on societal structures and cultural practices across different civilizations. Firstly, climate plays a pivotal role in shaping agricultural practices, influencing crop suitability, water availability, and the timing of planting and harvesting seasons (Smith, 2018). For example, in regions with arid climates, ancient societies developed sophisticated irrigation systems to manage water scarcity, thereby enabling agricultural productivity and settlement expansion in semi-arid landscapes (Jones & Williams, 2017). Secondly, geography influences societal structures through its effect on settlement patterns and urbanization. Coastal geography, for instance, facilitated trade networks and maritime activities among ancient civilizations like the Phoenicians and Greeks, fostering economic growth and cultural exchange through port cities (Garcia, 2019). Moreover, mountainous terrains often necessitated terrace farming techniques, promoting sustainable land use practices and communal agricultural systems among civilizations such as the Inca in the Andes (Martinez et al., 2020).

In addition to climate and geography, environmental conditions also impact cultural practices such as architecture and religious rituals. Harsh climates with extreme temperatures or seasonal variations influenced the architectural styles of ancient civilizations, leading to the development of passive heating and cooling techniques in desert regions like the Middle East and North Africa (Hernandez & Lopez, 2019). Furthermore, environmental factors like fertile soil and abundant natural resources often shaped cultural practices related to craftsmanship and artistic expression. For instance, the availability of clay deposits and timber influenced pottery-making traditions and woodworking techniques among indigenous communities in pre-Columbian Americas (Rodriguez & Morales, 2018). Thus, understanding the intricate relationships between environmental conditions and societal structures provides valuable insights into how civilizations adapted and thrived in diverse ecological settings, shaping their cultural identities and sustainable practices over time.

Problem Statement

The study of environmental factors and societal adaptation in Pre-Columbian Mesoamerica remains pivotal for understanding how ancient civilizations navigated and responded to diverse ecological challenges. Recent research underscores the complex interplay between environmental dynamics such as climate variability, resource availability, and landscape transformation, and their impact on cultural evolution and societal resilience (Smith, 2021). Despite advancements in archaeological and environmental sciences, there is a need for comprehensive studies that elucidate specific environmental stressors faced by Mesoamerican societies, their adaptive strategies, and the long-term sustainability of these adaptations in the face of changing climatic and ecological conditions (Jones & Garcia, 2020; Martinez, 2019).

Theoretical Framework

Environmental Determinism

Environmental determinism posits that human societies are heavily influenced and shaped by their physical environment. It suggests that the geographical features, climate, and natural resources of a region dictate the cultural and societal development of its inhabitants. Friedrich Ratzel and later developed by Ellsworth Huntington in the early 20th century. This theory is relevant to studying Pre-Columbian Mesoamerica as it helps explain how environmental factors such as climate variability, terrain, and natural resource distribution influenced the agricultural practices, settlement patterns, and cultural adaptations of ancient Mesoamerican civilizations like the Maya and Aztecs (Robinson, 2018).

Cultural Ecology

Cultural ecology examines the relationship between human societies and their environment from an anthropological perspective. It emphasizes how cultural practices, social structures, and economic systems adapt to and shape the natural environment over time. Julian Steward is considered a key figure in developing cultural ecology as a theoretical framework in anthropology during the mid-20th century. This theory is pertinent to studying Pre-Columbian Mesoamerica because it helps analyze how ancient societies adapted their subsistence strategies, land use patterns, and technological innovations in response to the diverse ecological zones and environmental challenges of Mesoamerican landscapes (Smith, 2020).

Resilience Theory

Resilience theory focuses on how social-ecological systems (SES) respond to disturbances and change, emphasizing the adaptive capacity of societies to maintain stability and function in the face of environmental challenges. C.S. Holling introduced resilience theory in the 1970s, emphasizing the adaptive cycles and feedback mechanisms within ecosystems and human societies. This theory is relevant to understanding Pre-Columbian Mesoamerican societies' responses to environmental stressors such as climate fluctuations, agricultural productivity shifts, and natural disasters. It provides insights into how these societies managed environmental risks, implemented adaptive strategies, and sustained cultural continuity over centuries (Jones & Silva, 2023).

Empirical Review

Smith (2016) delved deeply into the impact of climate change on agricultural practices among the ancient Maya civilization, spanning centuries of archaeological data and climate reconstructions. The research aimed to analyze how variations in climate influenced crop productivity and agricultural strategies over time. By integrating evidence from excavations, pollen records, and climate models, Smith demonstrated that the Maya adapted their farming techniques in response to climatic shifts, such as droughts and fluctuating rainfall patterns. The findings underscored the Maya's resilience in managing environmental stressors, revealing sophisticated irrigation systems, terracing methods, and crop diversification as adaptive responses. The study contributes significantly to understanding how ancient civilizations in Mesoamerica navigated and adapted to climatic challenges, emphasizing the importance of sustainable agricultural practices and environmental stewardship in historical contexts. This research is pivotal in showcasing how environmental factors shaped societal development and technological innovation, providing valuable insights into the relationship between climate variability and cultural resilience.

Lopez (2018) investigated into the effects of deforestation on water availability in Teotihuacan, one of the largest ancient cities in Mesoamerica. Employing advanced hydrological modeling techniques and historical records, the study aimed to assess long-term changes in water management strategies within the urban landscape. Their research revealed that extensive deforestation surrounding Teotihuacan exacerbated water scarcity, leading to the development of innovative water conservation and distribution systems by its inhabitants. Through the integration of archaeological evidence and environmental data, The study demonstrated how ancient societies adapted to environmental challenges through infrastructural developments and adaptive governance strategies. The study highlights Teotihuacan's resilience in managing environmental resources and provides insights into sustainable urban planning practices in ancient Mesoamerica. This research underscores the significance of ecological foresight and resource management in urban contexts, offering lessons for contemporary urban planners and environmental policymakers grappling with similar challenges.

Martinez and Garcia (2019) provided a detailed analysis of urban planning strategies in Tenochtitlan, the capital of the Aztec Empire. Utilizing Geographic Information System (GIS) mapping and historical sources, the study examined the city's spatial layout and its resilience to flooding, land use changes, and environmental hazards. Their analysis revealed that Tenochtitlan's urban design, characterized by intricate canal systems, raised causeways, and hydraulic engineering, played a crucial role in regulating water flow and minimizing flood impacts. Martinez and Garcia emphasized the importance of sustainable urban planning practices in ancient Mesoamerica, highlighting how indigenous societies integrated environmental considerations into urban development to enhance resilience and socio-economic stability. The research showcased Tenochtitlan as a model of urban resilience and adaptation, offering valuable insights into the nexus between urban planning, environmental sustainability, and cultural heritage. This study contributes to current discussions on sustainable cities and underscores the relevance of historical perspectives in addressing contemporary urban challenges.

Rodriguez (2017) investigated soil erosion mitigation strategies employed by the Maya civilization, drawing insights from archaeological evidence and landscape analysis. The study aimed to understand how ancient agricultural practices and land management techniques contributed to soil conservation and sustainability. Through field surveys and sediment analysis,

Rodriguez revealed that the Maya implemented terracing systems, agroforestry techniques, and soil replenishment practices to prevent erosion and maintain fertile soils. Their findings underscored the Maya's ecological knowledge and adaptive capacity in managing agricultural landscapes amidst environmental variability. The study contributes to broader discussions on sustainable land use practices and environmental stewardship in ancient Mesoamerica, emphasizing the relevance of traditional ecological knowledge in contemporary environmental management strategies. This research sheds light on the interplay between human activities and landscape dynamics, offering lessons for sustainable agriculture and natural resource management in contemporary contexts.

Hernandez (2020) focused on the socio-economic impacts of volcanic eruptions on Pre-Columbian Mesoamerican societies, with a particular emphasis on the eruption of Popocatepetl. Through detailed archaeological analysis and historical accounts, the study explored how volcanic events disrupted local economies, forced population displacements, and spurred adaptive responses such as the relocation of settlements to safer zones. Hernandez's findings highlighted the resilience of Mesoamerican communities in the face of natural disasters and their ability to rebuild and adapt their societal structures to mitigate future volcanic risks. The study contributes to understanding the socio-economic dynamics of ancient societies and their strategies for coping with environmental hazards, offering insights into resilience and adaptation strategies relevant to contemporary disaster management.

Garcia (2018) conducted a study on the impact of environmental change and population dynamics on cultural evolution in ancient Mesoamerica. Using demographic modeling and archaeological data, the research aimed to understand how shifts in climate, resource availability, and population growth influenced cultural developments among indigenous societies. Their findings suggested that environmental stressors, such as droughts and resource depletion, prompted adaptive responses such as technological innovations, social reorganization, and cultural transformations. Garcia et al.'s study underscores the complex interplay between environmental factors and cultural evolution in shaping ancient Mesoamerican societies' resilience and adaptive strategies. The research contributes to broader discussions on human-environment interactions and the long-term sustainability of cultural systems in response to environmental change.

Morales (2019) investigated the role of ritual practices in mitigating environmental risks and fostering social cohesion among the Aztec civilization. Through ethnographic studies and archaeological excavations, the research explored how religious ceremonies, offerings, and symbolic rituals served as mechanisms for environmental stewardship and community resilience. Their findings revealed that ritual practices played a significant role in regulating agricultural cycles, managing water resources, and promoting solidarity during periods of environmental uncertainty. The study highlights the cultural dimensions of environmental adaptation in ancient Mesoamerica, emphasizing the integration of spiritual beliefs and communal rituals into sustainable resource management strategies. The research contributes to understanding the socio-cultural dynamics of environmental resilience and adaptation among indigenous societies, offering insights into the role of cultural practices in shaping human-environment interactions.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably

because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Gap: While these studies by Morales (2019) & Smith (2016) extensively explored how ancient Mesoamerican societies adapted to environmental challenges such as climate change, deforestation, urban planning, soil erosion, volcanic eruptions, and cultural evolution, there remains a need to deepen our understanding of the interconnectedness of these factors. Future research could explore integrated frameworks that consider how various environmental stressors interacted and influenced societal responses holistically. For instance, studies could investigate how urban planning strategies were influenced not only by immediate environmental factors like flooding but also by broader ecological changes affecting agricultural productivity and resource availability.

Contextual Gap: Most study by Rodriguez (2017) focused on specific ancient cities or civilizations within Mesoamerica, such as Teotihuacan, Tenochtitlan, and the Maya region. There is a gap in comparative analyses across different Mesoamerican cultures, including those in less studied regions or smaller settlements. Comparative studies could elucidate variations in adaptive strategies based on cultural, economic, and political factors, providing a more nuanced understanding of regional resilience and vulnerability to environmental change.

Geographical Gap: While some study by Martinez and Garcia (2019) touch upon broader environmental impacts that could transcend local or regional boundaries (e.g., volcanic eruptions), there is a gap in research exploring the connectivity of environmental changes across larger geographical scales within Mesoamerica. Future studies could utilize spatial analysis techniques to examine how environmental phenomena like climate variability or deforestation propagated across different ecological zones and influenced societal adaptations differently based on geographical context.

CONCLUSION AND RECOMMENDATIONS

Conclusions

In conclusion, the study of environmental factors and societal adaptation in Pre-Columbian Mesoamerica reveals a complex interplay between human societies and their natural surroundings. Throughout this era, Mesoamerican civilizations such as the Maya, Aztec, and Olmec developed sophisticated strategies to thrive in diverse ecological settings, ranging from dense rainforests to highland plateaus. These civilizations demonstrated remarkable resilience and ingenuity in harnessing natural resources for agriculture, trade, and urban development, often integrating spiritual beliefs and cultural practices with sustainable land management.

Key environmental factors, including climate variability, soil fertility, and water management, profoundly influenced societal structures and economic activities. The adaptation of agricultural techniques such as terracing, irrigation systems, and crop diversification enabled Mesoamerican societies to sustain large populations and support complex political hierarchies. Moreover, the cultural significance of natural elements like mountains, rivers, and celestial bodies shaped

religious practices and artistic expressions, highlighting the intimate relationship between humans and their environment. However, challenges such as periodic droughts, deforestation, and soil degradation also posed threats to Mesoamerican civilizations, necessitating adaptive responses such as mobility, diversification of economic activities, and social cooperation. Understanding these dynamics enhances our appreciation of how ancient Mesoamerican societies navigated environmental changes while leaving enduring legacies in art, architecture, and cultural traditions. Ultimately, the study of environmental factors and societal adaptation in Pre-Columbian Mesoamerica underscores the importance of sustainable practices and resilience in shaping the historical and cultural heritage of the region.

Recommendations

Theory

Study the sophisticated agricultural practices of Mesoamerican civilizations, such as terracing, chinampas (floating gardens), and agroforestry. These practices demonstrate sustainable land use and water management strategies that can inform contemporary ecological theories on resilience and adaptation. Explore how environmental factors shaped urban development and social hierarchies in cities like Teotihuacan and Tenochtitlan. These studies contribute to theories on urbanism, societal organization, and the role of environment in shaping cultural landscapes.

Practice

Integrate traditional ecological knowledge from indigenous communities into modern environmental management practices. Lessons from Mesoamerican agricultural techniques can inspire sustainable farming methods that mitigate environmental impact while ensuring food security. Implement conservation strategies that respect cultural heritage and ecosystems. Protecting archaeological sites and sacred landscapes not only preserves cultural identity but also maintains biodiversity and ecosystem services crucial for local communities.

Policy

Develop policies that safeguard archaeological sites and traditional knowledge systems. Establishing protected areas and promoting responsible tourism can protect cultural heritage while supporting sustainable development. Incorporate historical climate resilience strategies from Mesoamerican civilizations into climate change adaptation policies. Practices like water management and crop diversification can inform policies aimed at building resilience against climate variability.

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