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Article

Exploring Social Science Viewpoints on the Factors Influencing and Reactions to Global Climate Change

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Abstract: This article presents an extensive review of contemporary studies in the fields of anthropology, archaeology, geography, and sociology, examining the human activities that contribute to climate change. It specifically emphasizes the factors that lead to carbon emissions, as well as strategies for reducing their impact and adapting to the changing environment. The four disciplines prioritize cultural, economic, geographical, historical, political, and social-structural aspects as significant catalysts and reactions to climate change. Each of these fields offers distinct viewpoints and valuable insights into the factors caused by human activity, but they also operate together and contribute to comprehensive, interdisciplinary frameworks. The article commences by examining research on the temporal aspects of human activities that contribute to carbon emissions. It emphasizes the interplay between long-term and short-term factors that influence these emissions. Subsequently, detailed explanations of how the disciplines have contributed to the comprehension of mitigation as well as adaptation are presented. The article concludes with a concise overview of the main lessons provided by the four disciplines, along with recommendations for further investigation.

Keywords: Climate change; Emissions; Mitigation; Adaptation; Social science; Sustainability

1. Introduction

The causes of climate change are examined in various scientific and climate assessment literature [1]. "Anthropogenic" drivers are human actions that cause climate change and the socioeconomic variables that influence and determine those actions [2]. In a broader sense, human driving factors refer to the various characteristics of societies that significantly impact the global climate [3].

The emissions and atmospheric levels of long-lasting greenhouse gases (GHG), particularly carbon emissions, have experienced a significant surge since the pre-industrial era [4]. The primary cause of this growth can be attributed to human activities related to the use of fossil fuels and agriculture. However, other changes in land use, such as deforestation, also make significant but minor contributions to this increase [5]. The magnitude of these emissions has played a significant role in the classification of a new geological epoch, known as the Anthropocene, where human activity is the main catalyst [6].

This article provides an overview of current anthropological, archaeological, geographical, and sociological viewpoints on human-induced causes of climate change, specifically focusing on factors that contribute to carbon emissions. Focus is also directed towards the various ways in which these social science fields contribute to research on mitigation and adaptation. The four disciplines collectively prioritize cultural, economic, geographic, historical, political, and social-structural elements as significant catalysts and reactions to climate change. Although each of these disciplines offers distinct insights and valuable contributions to our collective comprehension of the human aspects of climate change, they also synergistically complement each other and contribute to comprehensive, interdisciplinary frameworks [7].

Although not a comprehensive analysis, the article discusses significant contributions from various fields that enhance our understanding of the factors and reactions related to climate change. The debate commences by examining the temporal aspects, specifically focusing on the interplay between long-term and near-term factors that contribute to carbon emissions. Subsequently, detailed explanations of how the disciplines have contributed to the comprehension of mitigation and adaptation are presented. The conclusion provides a concise

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overview of the main lessons presented by the four disciplines, along with recommendations for further research.

2. Climate change drivers and their interactions

The long-term and short-term factors that cause climate change constantly influence each other [8]. Anthropology, archeology, geography, and sociology study various human activities that contribute to carbon emissions. These activities include economic systems such as growth, cycles, consumption, and trade; power dynamics, social stratification, and inequality; population growth and demographic changes; technology; infrastructure; and changes in land use and transformation. The definitions of "long" and "near" terms can vary both within and across various fields. The word "long-term" might encompass spans of several decades, one or more centuries, or even greater durations, whereas "near-term" typically refers to a time shorter than a year.

2.1. Social aspects of economic structures

2.1.1. Economic growth

Economic growth is a significant contributor to climate change, as it encompasses both long-term and short-term factors that determine the timing and magnitude of its impact [9]. Sociological research has utilized longitudinal modeling approaches and statistical interactions to evaluate the potentially fluctuating impact of economic development on carbon emissions at the national level [10]. This research examines the possibility of a separation between gross domestic product (GDP) and emissions from a sociological perspective. It primarily focuses on evaluating predictions derived from social theories, including ecological modernization theory and treadmill of production theory [11].

In essence, ecological modernization theory posits that the modernization process leads to increased self-awareness and critical thinking inside the socioeconomic system [12]. Technological advancement and environmental awareness, which are closely linked to economic progress, are considered essential elements of modernization through the adoption of eco-friendly industrial production methods, such as decreased reliance on fossil fuels, and the promotion of sustainable consumption [13]. On the other hand, the treadmill of production theory suggests that in market economies, the pursuit of more profits through growth leads to a continuous increase in energy consumption and pollution, resulting in a decline in overall environmental conditions [14]. Economic development encompasses the expansion of resource use and the generation of waste throughout the many phases of production processes. This includes the heightened consumption of fossil fuels and the subsequent release of carbon emissions [15].

The first sociological study to adopt this technique examines the relationship between GDP per capita and time in longitudinal models of anthropogenic carbon emissions for both developed and developing nations [16]. The analysis focuses on three metrics for national carbon emissions: aggregate emissions, emissions per person, and emissions per unit of gross domestic product (GDP). The findings demonstrate a robust correlation between per capita emissions and GDP per capita in industrialized countries, which is consistent in magnitude across time. In emerging countries, the correlation between emissions and GDP per capita becomes stronger with time, which is contrary to decoupling. However, it still remains less significant than the correlation between per capita emissions and GDP in wealthy countries. The analysis suggests that in wealthy countries, the impact of GDP per capita on total emissions has declined over time, indicating a decoupling trend. On the other hand, in developing countries, the relationship between GDP per capita and total emissions has remained stable during the studied period [17]. The examination of emissions per unit of GDP indicates a small separation for the group of advanced nations, however the results for the group of developing countries remain uncertain. In summary, the research on decoupling offers conflicting evidence for both ecological modernization theory and treadmill of production theory. It indicates that both frameworks would benefit from further examination of how the global organization of production and the structure of international trade impact the connection between carbon emissions and economic development [18].

Studies have utilized modeling techniques that consider the relationship between time and GDP per capita to analyze the impact of economic growth on the "carbon intensity of human well-being" (CIWB). This ratio measures the relationship between per capita carbon emissions and a measure of human well-being. These studies have been conducted on samples of nations from various regions including the Americas, Europe, Oceania, Asia, and Africa [19]. The results indicate that the impact of GDP per capita on CIWB is significant, positive, and consistent over time for countries in North America, Europe, and Oceania. Additionally, the magnitude of this effect has increased over time for countries in other regions [20].

Recent sociological studies on national carbon emissions have also emphasized significant variations over time in the impact of urbanization in different regions, which are closely linked to patterns of economic development [21]. In Asia, the impact of urbanization on emissions, measured as the percentage of the population living in urban areas, has consistently grown over time. In contrast, in Latin America, the impact of urbanization has shown slight fluctuations but remains at a moderate level. The impact of urbanization on emissions is more significant for the wealthier nations in North America, Europe, and Oceania compared to those in other areas. However, this impact steadily declined over the 1980s and 1990s, followed by a small increase in the early 2000s. Previous studies indicate that in developing countries with a higher prevalence of urban slums, the impact of urbanization on carbon emissions is somewhat reduced. This is because households in urban slums face structural disadvantages and tend to consume less fossil fuel energy and other carbon-intensive products. These findings underscore the socioeconomic differences and structural inequities within urban areas [22].

Drivers that have the most pronounced effects over brief timeframes might illustrate how economic cycles impact emissions, either by increasing or decreasing them [23]. Carbon emissions resulting from the combustion of fossil fuels in the United States experienced a decrease from 2007 to 2013 [24]. Geographers' research indicates that the economic slump was a more significant factor than the replacement of coal with natural gas in the electricity sector in explaining the reduction [25]. The relevant causes included a decrease in overall economic activity, alterations in the production of industrial goods due to decreased private sector investment in capital formation, and a little rise in the utilization of renewable energy compared to fossil fuel energy [26]. In the past, advancements in technology have only partially offset the increased emissions resulting from economic growth, both within individual countries and on a global scale [27].

The dissolution of the Soviet Union also resulted in reductions in GHG emissions [28]. In the 1990s, the former Soviet republics underwent a decrease in population and economic activity, as well as a shift away from urban areas. These factors had an impact on the amount of carbon emissions produced. An analysis of these patterns reveals that the reversals resulted in significant decreases in carbon emissions. Additionally, the events in the former Soviet republics serve as a prominent illustration of substantial reductions in carbon emissions. Despite economic downturns, the durable infrastructure in former Soviet republics, such as roads, pipelines, and factories, resulted in higher emissions compared to other low to moderate income nations that had not undergone intensive industrialization [29].

While the economic collapse in former Soviet countries is not an ideal model for reducing emissions, it does demonstrate that once energy-intensive infrastructure is established, it leads to a certain level of energy consumption that is difficult to control [30]. Further sociological research has confirmed a consistent trend observed in various countries: economic decline does not significantly decrease carbon emissions and energy consumption, while economic growth tends to increase them. This finding underscores the challenge of reducing energy demand once a country has established its industrial infrastructure [31].

Furthermore, sociologists have examined variations in the contributions of different components of GDP to emissions [32]. For instance, a collection of cross-sectional and longitudinal studies demonstrates a robust correlation between working hours and carbon emissions. This correlation holds true for developed countries, as well as both developing and developed countries. It is also observed within the United States, across different states [33]. The most robust correlation is known as the "scale effect," which indicates that the number of hours worked is directly linked to the magnitude of total output. Countries that have decreased their average working hours, like those in Northern Europe, tend to have lower levels of emissions, all other factors remaining constant. The second, lesser channel of influence, known as the "composition effect," operates through household decision-making. This effect suggests that, while keeping income constant, households with limited free time tend to engage in purchasing patterns that are more carbon intensive. This postulated impact has not been quantified by direct measurement, but it is observable in comprehensive assessments of the entire economy [34].

2.1.2. Consumption

Given that consumption often constitutes the greatest portion of output, social scientists have extensively examined its impact on GHG emissions [35]. Therefore, the emergence of a consumer society or consumer culture, characterized by a growing adoption of a consumer-centric lifestyle, can be seen as a catalyst for emissions [36]. Expenditure habits and investments are directly influenced by income, infrastructure, social organization, and culture, which in turn have a significant impact on climate change [37]. Increased income and prosperity typically result in elevated levels of energy consumption and carbon emissions [38]. Research in geography has found that the urbanization of populations, especially in low- and moderate-income areas, is linked to the emergence of lifestyles that use a significant amount of resources [39].

The distribution of carbon emissions varies among countries as income levels increase [40]. Geographical research reveals that as nations are arranged in order of income, significant differences in carbon footprints are observed among lower-income countries. Specifically, there is a decrease in the gap between carbon footprints within a country as income levels rise [41]. The discrepancy in carbon footprints decreases when countries experience economic growth, nevertheless, the average carbon footprint rises in tandem with income [42]. Furthermore, it is observed that the carbon footprint of all countries increases as wealth rises, despite a decrease in carbon intensity. This means that when income increases, there is a greater proportion of lower carbon consumption expenditures, such as healthcare or education, included in the overall consumption mix [43].

From an anthropological and sociological perspective, the concept of consumption as a driver of behavior considers the influence of cultural and social factors. This includes analyzing the role of status consumption and status rivalry [44]. Status-seeking exacerbates emissions by prompting individuals to acquire carbon-intensive consumer goods and services, such as spacious residences, oversized vehicles, frequent holidays, and other opulent pleasures, which have traditionally functioned as symbols of social status due to their conspicuousness [45]. Consumption habits might contribute to emission reduction when green products like hybrid autos or solar roof systems are seen as prestigious symbols [46].

Consumer practices hold significant importance. Engaging in energy-intensive activities, such as increased heating and cooling or more frequent showers, typically leads to higher emissions. However, making changes to these behaviors or embracing alternatives, such as opting for public transportation instead of driving, can help decrease emissions [47]. The adoption of green energy options, such as rooftop solar photovoltaic systems, has demonstrated a significant spatial pattern. This suggests that "peer effects" might exert a substantial influence on consumer choices [48]. Adoption frequently takes place among nearby households, regardless of socioeconomic status and political affiliation [49].

The concept of "lifestyle" is equally valuable in examining carbon emissions [50]. The consumption habits of society groups with varied socioeconomic features, such as identity, education, employment, or family status, are a reflection of how people live and consume [51]. Residential accommodations are a crucial component of decisions relating to one's way of living [52]. Residents in suburban areas, particularly in wealthier countries, typically buy spacious homes that have significant heating and cooling needs [53]. Factors such as the distance of commuting, availability of public transportation, proximity to recreational areas, city centers, public services, and stores are additional crucial factors of carbon emissions particular to neighborhoods and connected with lifestyle [54]. Geographers have evaluated drivers for various lifestyle groups at detailed spatial levels using large-scale data [55]. Geo-demographics utilizes a comprehensive collection of geographically specific variables that capture the home environment and its impact on emission patterns [56]. This form of study identifies the key factors that determine lifestyle-related emissions, which can also hinder efforts to bring about change and reduce emissions [57].

An emerging field of environmental social science research on consumption is shifting its focus toward the armed forces of nations. Recent longitudinal analyses in sociology have established a connection between higher levels of national-level energy consumption and carbon emissions and the relative size and capital intensity of a nation's militaries. The size is measured as the military participation rate, while capital intensity is measured as military expenditures as a percentage of GDP and military expenditures per soldier. This finding applies to both developed and developing nations [58]. A global network of military facilities necessitates the utilization of a substantial quantity of resources, such as fossil fuels, for the purposes of staffing, operating, and transporting equipment and troops across various locations [59]. Conventional military equipment, including aircraft, vessels, helicopters, tanks, and vehicles, necessitate substantial energy usage. As an illustration, operating a nonnuclear aircraft carrier for one hour requires 21,300 liters (or 5,621 gallons) of fossil fuel. Similarly, large, advanced military helicopters consume five gallons of fuel for each mile they travel. Fighter planes like the F-15 and F-16 consume between 1,500 and 1,700 gallons of fuel per hour. If the afterburners are activated, a maximum of 14,400 gallons are expelled every hour. This research on the environmental effects of countries' armed forces is also applicable to strategies addressing global disparities and ecologically imbalanced trade.

2.2. Power, social stratification, and inequality

The dynamics of power, social stratification, and inequality at various levels, whether international, regional, national, or subnational, have a significant impact on emissions and climate change. The countries with the biggest greenhouse gas emissions, in addition to the United States, are China, India, and Brazil. Who holds authority in those nations? The question's answer carries significant policy consequences at both national and international levels. It not only impacts global changes but also shapes the way local populations feel and contributes to the increase in carbon emissions and climate change [60].

Social science theoretical views that examine power and inequality encompass political economy and political ecology, along with concepts related to state intervention and individual decision-making and conduct. Studies in geography and sociology have shown that in recent years, there has been a rise in worldwide outsourcing of pollution from wealthier countries to poorer countries, either through manufacturing or extraction [61]. This phenomenon has also been observed within nations, as pollution is being transferred across different regions [62]. Impoverished areas frequently supply resources and workforce for worldwide production networks and serve as sites for energy-intensive production stages that significantly contribute to pollution, such as the release of carbon emissions through the combustion of fossil fuels [63].

The current structure of global supply chains tends to perpetuate international disparities in the world system when considering the benefits and costs involved [64]. More-developed countries typically have a higher proportion of value added compared to pollution, whereas less-developed countries contribute more to environmental destruction and its associated health impacts per unit of value added in global supply chains [65]. Currently, China is facing the most significant adverse impacts, but other countries and areas also have comparable roles [66]. Bangladesh, Cambodia, and India are prominent textile producers, while Laos, Myanmar, and various African nations have numerous instances of "land grabs," which involve the acquisition or leasing of land for export-oriented production under conditions that are disadvantageous to local communities. This practice has significant implications for the environment and climate change, including deforestation [67].

Households can provide an alternative perspective to states when examining global inequities [68]. On a global scale, households belonging to the highest 10% income bracket are accountable for 36% of carbon emissions, whereas homes in the lowest 50% income bracket are responsible for a mere 15% of emissions [69]. The mean annual carbon footprint of the world's affluent individuals is approximately 14 times greater than that of the lowest income bracket. In 2010, the carbon footprints varied from 26.3 tons for the highest global income category to 1.9 tons for the lowest [70].

Recent research in the fields of sociology and geography has examined how domestic inequality contributes to carbon emissions. These studies have found that both income and wealth inequality within a country are positively linked to carbon emissions. Specifically, the concentration of income and wealth among the wealthiest individuals in society plays a significant role in driving carbon emissions [71]. These relationships are evident in both economically developed nations, such as the United States, and developing nations, such as China [72].

Several variables contribute to the favorable correlations between emissions and both income disparity and wealth inequality [73]. Individuals with higher incomes and greater wealth typically consume a larger quantity of goods and services due to their participation in Veblenian status consumption or consumption competition [74]. These dynamics cause households to raise their spending in order to match the conspicuous lifestyles of wealthier households, which in recent years has involved the consumption of energy-intensive luxury like multiple residences and private planes [75]. Furthermore, individuals who own significant money also happen to be the proprietors of companies that contribute to pollution and organizations involved in energy production [76]. In order to safeguard these assets, individuals are inclined to utilize their economic resources to acquire political influence, which they then employ to exert control over the policy landscape [77]. Another factor to consider is that there is a direct correlation between economic disparity and working hours. Recent sociological studies have demonstrated that longer working hours contribute to higher energy consumption and carbon emissions [78].

Ecologically unequal exchange is a significant feature of inequality in relation to emissions. This approach is relevant to various social science fields, including anthropology, geography, and sociology. Unequal international exchange refers to the establishment of power imbalances between developed and less-developed countries. In this process, the more-developed countries obtain disproportionate advantages over the less-developed ones through trade patterns and global production networks [79]. Ecologically unequal trade is the process where energy and other natural resources are taken from less-developed countries, causing environmental damage, while ecologically destructive production and disposal activities are shifted to these countries [80]. Studies within this framework suggest that imbalanced trade interactions and the distinctive features of global production networks play a role in the increase of energy consumption, carbon emissions resulting from production activities, and deforestation in developing countries [81-84]. Research on the environmental effects of militarization [58], as discussed earlier, indicates that countries with larger and more advanced militaries have a greater ability to obtain and control larger quantities of fossil fuels and other natural resources from various parts of the world. This ultimately results in higher carbon emissions.

2.3. Demographic factors

The impact of the human population on the environment, particularly in terms of carbon emissions, is well recognized and supported by empirical evidence from social science research [85]. Nevertheless, the intricate ecological consequences of population growth, in conjunction with other demographic factors, are hardly recorded. Research in geography and sociology indicates that population increase in poor nations, albeit higher than in rich nations, has a lesser impact on global climate stability compared to the consumption practices of affluent nations [86]. This is because the consumption patterns of wealthy nations contribute more significantly to rising energy consumption and emissions.

In addition to population size and growth, additional demographic factors that have significant implications for emissions include the age distribution, number of homes, and average household size within a specific population [87]. When a bigger proportion of the population is of working age, there is typically an increase in energy use and emissions [88]. In industrialized nations, where there are increasing numbers of elderly individuals, low fertility rates contribute to reducing emissions. However, the impact of the changing age distribution on emissions is only moderately limited, particularly in the short term [89]. Within certain situations, the quantity of homes has a greater influence on environmental effects than the quantity of individuals [90]. In prosperous nations, there is a decline in household size, resulting in an increase in both energy consumption and carbon emissions [91]. In addition, there has been a decrease in average household size in quickly growing countries as well [92].

2.4. Land-use transformation

Anthropologists, archeologists, geographers, and sociologists have provided evidence that the alteration of land use is a fundamental factor contributing to human-induced climate change [93]. Support for this finding is based on the extensive and uninterrupted documentation of changes caused by human activity [94]. Land-use transition occurs as a result of both contextual and proximal forces. Contextual causes encompass various global markets and institutional setups. Proximate causes refer to human actions that directly contribute to emissions [95].

Archeologists have proven that these changes have occurred over a significant period of time, starting from the beginning of the Holocene period over 10,000 years ago and continuing until the era of widespread agriculture, particularly around 7,000 years ago [96]. Land-use change and biomass burning are significant factors contributing to climate change in modern times. Specifically, the agriculture, forestry, and other land-use sector accounts for approximately 25% of human-caused emissions, primarily resulting from deforestation, agricultural soil and nutrient management practices, and livestock activities [97-113].

The research conducted in the fields of geography, anthropology, and sociology examines how the interplay between national politics, international treaties, social hierarchy, geographical areas, and different scales of analysis contribute to the changes in land use and land cover at the district or municipal level [114]. Proximate factors are associated with various circumstances inside households, communities, and local infrastructure [115]. Social scientists frequently examine land conversion in rural areas, particularly in tropical regions, where they investigate the social and institutional mechanisms behind deforestation [116]. Their examination of land-use and land-cover change in urban, suburban, and exurban areas is crucial for comprehending the resource consumption patterns and greenhouse gas emissions of urban populations [117].

Changes in the landscape are also linked to significant investments of money, such as the construction of hydroelectric dams, extensive irrigation, and the permanent drainage of wetlands, which alter local ecosystems on a huge scale [118]. An illustration of this is Brazil's historical progression in constructing highways and hydro-electric dams in the Amazon region, which showcases how investments can result in unforeseen and unsustainable surges of population. These booms result in several issues for human wellbeing, such as limited access to services, economic disparities, and loss of livelihood. Additionally, they contribute to ecological challenges like deforestation, which in turn has climate-related effects [119]. National governments frequently engage in development activities that lead to deforestation, whereas local growth coalitions advocate for road construction and development, even in cases when national governments reduce their involvement in deforestation-causing activities [120].

3. Mitigation and adaptation

Human reactions to the dangers and consequences of climate change can be broadly categorized into two groups: mitigation and adaptation [1]. "Mitigation" refers to the deliberate actions taken by humans to decrease the production of carbon and other greenhouse gases, or to increase the absorption of these gases by natural processes [121]. Adaptation refers to the modifications made in natural or human systems as a result of real or anticipated climatic stimuli or their impacts. These modifications serve to reduce damage or take advantage of advantageous chances [122]. Mitigation and adaptation strategies are implemented at different sizes and timeframes, utilizing methods that encompass technological, economic, institutional, regulatory, ecosystem-based, informational, and social variables [123]. Furthermore, the choices made for mitigation and adaptation are influenced by path dependency, which implies that the available options are frequently limited by the consequences of previous actions [124]. Although the causes of rising levels of GHG in the atmosphere are primarily international and global, the impacts of current climate change are felt at the local level [125]. This section examines how strategies for addressing and adjusting to climate change are shaped by enduring and immediate social dynamics, as well as the interactions among different stakeholders.

3.1. Temporal contexts

Archeology reveals that several regions, impacted by distinct local climate change patterns, experienced comparable effects over extended periods of time. An illustration of this is the Long-Term Vulnerability and Transformations Project, which is conducted at Arizona State University in partnership with the North Atlantic Biocultural Organization. The project aims to analyze and evaluate how various societies reacted to abrupt climate changes over the period from the thirteenth to the fifteenth centuries CE. Despite significant variations in the environment and society, instances of successful adaptation shared fundamental structural characteristics. While researchers have acknowledged the existence of painful transitions and complete societal collapse, they have also identified several successful adaptations. These include maintaining a balance between population size and available resources, having a diverse range of food and other options, establishing social networks that minimize risk, implementing storage systems, promoting mobility and migration, ensuring equal access to resources, and reducing barriers to resource availability [126]. Throughout history, there has been a tendency to reject the adoption of technologies and practices from other cultures, as well as a tendency to excessively rely on fixed infrastructure, such as irrigation. These behaviors have frequently resulted in negative path dependency. Societal collapse is typically linked to rigid or misaligned managerial reactions and the erosion of social capital that supports collective actions. According to the research conducted by Chase and Scarborough [127], collapse typically occurs well before all resources are completely depleted. Therefore, it should be seen as a failure in management.

Archaeology not only provides chronological background but also offers insights that can align with the shorter temporal scales often studied in other social sciences. Historical ecological research integrates archeology, history, environmental social sciences, humanities, local and traditional knowledge, paleoecology, and the viewpoints of modern resource managers. This approach provides a comprehensive framework for comprehending long-term perspectives on how humans have responded to and impacted climate change [128].

The Resilience Alliance employs adaptive management practices that utilize insights from archeology to inform long-term perspectives. The Resilience Alliance and other interdisciplinary networks of scientists and practitioners focus on enhancing the ability to respond to sudden and often catastrophic events that exceed critical thresholds. Additionally, they aim to identify early indicators that suggest the approach of these thresholds, enabling the anticipation of tipping points and allowing for timely mitigation and adaptation measures. Threshold crossings typically include a combination of intricate environmental and social factors. Expanding the range of these "red flag" variables might help managers anticipate impending changes. For instance, Streeter et al. [129] employ a combination of social and environmental factors along with a creative utilization of volcanic tephra (ash) horizons in Iceland to indicate the effects of human activities on the Icelandic environment.

An influential factor in this matter is the issue of Shifting Baselines, when subsequent generations of resource managers regard their present circumstances as the norm without acknowledging the longer-term trends and patterns of simplification and degradation. This issue is extensively documented in the field of fisheries and marine resource management, but it also applies to terrestrial circumstances. Engelhard et al. [130] observed in their investigation of 100 years of North Sea cod distribution that both climatic change and fishing pressure had an effect on fish distributions.

3.2. Governance

Multiple social science perspectives have been used to analyze the role and structure of international environmental agreements in the field of governance and policy [131]. World Society Theory, a sociological tradition known as neo-institutionalism, emphasizes the impact of global institutional frameworks on both social development and environmental impacts [132]. World Society Theory posits that nation-states are socially constructed entities that exist inside a transnational system including of structures, agents, and norms. This system serves to legitimize and promote certain acts while discouraging others. An essential participant in world society theory is the International Nongovernmental Organization (INGO). Environmental INGOs are believed to both mirror and propagate the values and ideas of global society to countries and local entities [133]. Research in this field has discovered that connections to the pro-environmental global community (with a greater number of environmental international non-governmental organizations) are linked to small decreases in carbon emissions at the national level [134]. Studies in this field also suggest that the impact of economic expansion on carbon emissions has gradually reduced in strength over time in countries that hold a prominent position in the worldwide network of environmental INGOs. To clarify, the interconnectedness of world society can assist in separating economic development from emissions [135].

Studies in political sociology also demonstrate the significance of governance structure. A recent study utilizes multilevel modeling approaches to examine carbon emissions from fossil-fuel power plants in the 25 post-Soviet transition republics in Central and Eastern Europe and Eurasia. Several plant-level factors contribute to increased emissions, such as the use of coal as the main fuel, the size and age of the plant, the rate at which it operates, and its heat rate [28]. Regarding governance, the findings suggest that plant-level emissions tend to be lower, on average, in the transition states that became part of the European Union (EU). This is because the market reforms and environmental directives implemented by the EU are highly significant in reducing emissions. The correlation between plant-level emissions and EU accession is stronger for the post-Soviet nations who joined the EU earlier compared to those that joined more recently.

In the United States, environmental restrictions also have the potential to cause decreases in carbon emissions from power plants that burn fossil fuels [44]. Grant et al. [136] use multilevel modeling approaches to examine the impact of state policies on emissions from particular power plants, using both plant-level and state-level data. Both direct methods, such as implementing emission caps and targets, and indirect strategies, such as establishing public benefit funds, effectively reduce emissions from plants and can therefore serve as effective components of a federal climate regime. A recent study, which analyzed data over a lengthy period of time from all 50 states in the U.S., suggests that the impact of population and wealth on carbon emissions at the state level is significantly influenced by the pro-environmental voting of congressional representatives [137]. Political and institutional variables have the potential to improve or mitigate the environmental impacts caused by economic and demographic issues [138].

Additional studies in sociology and geography have identified subnational possibilities to address the climate "policy void" in U.S. politics [139]. This study promotes the multi-level governance of climate change, which incorporates many levels of authority and often includes a wider spectrum of policy actors in the decision-making process [140]. This research also examines how networks of influential policymakers are participating in the climate change discourse. The social science literature on polycentric governance also makes similar assertions [141-144], particularly in relation to global climate politics following the signing of the Paris

Agreement in 2015 [145]. Polycentricity is a type of governance characterized by the presence of numerous centers that have the ability to make decisions independently to some extent. Some scholars have suggested that when decision-making centers consider each other in both competitive and cooperative interactions and use conflict resolution processes, they might be seen as a polycentric governance system [146].

Anthropologists have utilized political ecology ideas to assess the efficacy of governing structures and methodologies. This research has examined the role of the state and private property in managing resources and the commons. It specifically investigates situations where individuals in a shared-resource setting are motivated by their own self-interest, leading to tragedy of the commons. This phenomenon is prevalent in civilizations with smaller scales, but it may even be observed in modern nations where local autonomy is integrated into a larger national structure.

Global mitigation policies aimed at decreasing deforestation and enhancing carbon sequestration in global forests encompass the Clean Development Mechanism (CDM), Reducing Emissions from Deforestation in Developing Countries (REDD), and REDD+ [147]. On a global scale, although REDD and REDD+ have improved the management of natural resources and decreased the deterioration of land, deforestation is still on the rise in Indonesia, Malaysia, and certain regions of Africa and South America. Moreover, there are noticeable discrepancies between the policies established at higher levels and the actions carried out at the project or community level, which is evident in the execution of these programs [148]. There are concerns over the fairness and effectiveness of the policies. An assessment of 9 examples in Uganda reveals that there is an asymmetry in the advantages, with local people frequently experiencing "expulsion and marginalization" [149]. Research conducted on the Khasi Hills Project in India suggests that community-based forest management can be an effective strategy for addressing the main causes of deforestation. This approach can be further enhanced by receiving support from internationally recognized and certified carbon projects, such as REDD+ and Afforestation and Reforestation [150]. The notion of REDD+ is undergoing development, and one of the most promising strategies is "Jurisdictional REDD," which encompasses various land-use types across landscapes and involves diverse stakeholders under a subnational jurisdiction [151]. In a broader sense, our research suggests that global-scale projects should establish better connections with local environmental and social situations [152].

CDMs utilize carbon offsets to effectively address human-caused climate change. This is typically achieved by implementing advanced technology or design solutions in the form of large-scale energy generation plants or chemical manufacturing facilities that employ carbon capture technology. CDM projects and policies have been subject to shortcomings as outlined by social science critics. As an example, the movement of capital in the compliance market reflects the unequal distribution of direct foreign investment. Sub-Saharan Africa receives less than 2% of this investment, while China, Brazil, and India, which are the three largest recipients, receive the majority of the investment in the CDM. Furthermore, there are some unachieved objectives, such as the implementation of initiatives that decrease carbon emissions and the promotion of projects that have additional benefits for the creation of more sustainable communities. The social scientific literature on CDMs examines various areas of concern, such as institutional frameworks, including the utilization of markets, as well as unintended incentives and consequences [153].

3.3. Technology

The utilization of energy has undergone significant changes throughout thousands of years [154-157]. However, due to its crucial role in driving economic development, altering the existing reliance on fossil fuels is expected to be challenging within the framework of the modern global economy [158,159]. Technological solutions frequently offer temporary remedies but can sometimes have unforeseen, lasting consequences [160]. Technological improvements are commonly believed to be an effective technique for lowering energy use and the resulting greenhouse gas emissions [161]. This is often achieved via increasing energy efficiency. Efficiency reduces the cost of energy and related services, but it can also lead to an increase in demand for them, resulting in a rise in overall emissions. This concept, known as "rebound effects," was first proposed by William Stanley Jevons in the nineteenth century.

Sociologists employ multilevel modeling tools to examine a comprehensive dataset encompassing almost all fossil fuel power plants worldwide. Their objective is to ascertain if the influence of efficiency on emissions differs based on factors such as the plants' age, size, and placement within global economic and normative systems. Their research suggests that each of these elements has a substantial impact on efficiency and consequently influences the occurrence of ecologically harmful rebound effects. Research shows that a small fraction, specifically the dirtiest 5%, of fossil fuel power plants in various countries globally are responsible for a significant amount of the overall emissions produced by their respective industries. If these facilities maintained their current energy generation levels while achieving certain intensity goals through improved efficiencies or alternative methods, global carbon emissions from electricity could potentially decrease by up to 40% [162].

Studies utilize qualitative comparative analysis (QCA) techniques to analyze the combined impact of global, political, and organizational factors on the carbon emissions of fossil-fueled power plants. The objective is to identify hyper-polluting plants worldwide that contribute significantly to the total emissions of the electricity generation sector. QCA analyzes instances by considering them as combinations of qualities and uses Boolean algebra to construct expressions representing combinations linked to a specific conclusion. This technique is very appropriate for assessing higher-order interactions and identifying the most relevant combination of elements among multiple possibilities for a result. Their research uncovers that hyper-polluters' emission rates are determined by four separate causal patterns, which they categorize as coercive, quiescent, expropriative, and inertial configurations. Furthermore, these same conditions also contribute to higher emission levels in plants. Coercive and quiescent configurations improve plants' capacity to release their carbon emissions by neutralizing and manipulating potential sources of opposition, while expropriative and inertial configurations hinder plants' ability to reduce emissions by subjecting them to opportunistic behavior and forces of resistance.

An illustrative instance of the unforeseen repercussions of technical advancement is the impact of renewable energy [163,164]. It is not guaranteed that incorporating renewable energy sources into the economy without making fundamental modifications will automatically lead to a decrease in the use of fossil fuels [165,166]. According to sociological research, since 1960, the increase in nonfossil fuel sources has had a minimal effect on reducing the use of fossil fuels. This is true even when considering economic growth, population growth, and other factors. In other words, nonfossil energy sources were mostly used in addition to fossil energy sources, rather than replacing them [167]. This discovery, despite its initial appearance of being unexpected, aligns with a well-established body of research in the field of technology studies. This study consistently demonstrates that technologies frequently produce unforeseen outcomes as a result of their interactions with social, economic, and political factors. Additional sociological studies indicate that the relationship between the growing utilization of renewable energy sources and economic development may result in a stronger connection between GDP and carbon emissions. This is because renewable energy is more commonly employed as a substitute for nuclear power rather than fossil fuels, thereby perpetuating the predominance of fossil fuels as the primary source of electricity generation [168].

Nevertheless, a study on U.S. homes and nonbusiness travel suggests that it is possible to make significant and immediate reductions in carbon emissions by implementing and utilizing existing technologies. Research employs data on the most efficient documented treatments to assess the plasticity (which quantifies the ease and speed of change) of 17 different household actions categorized by behavior. These solutions utilized several policy tools and robust social marketing strategies but did not incorporate any new regulatory measures. Experts predict that if implemented across the country within a decade, it may result in a significant decrease of 123 million metric tons of carbon emissions, without negatively impacting the well-being of households.

3.4. Decarbonization

Research on decarbonization has mostly concentrated on assessing the viability, technological routes, and expenses associated with both short-term and long-term strategies for reducing carbon emissions. Many long-term climate stabilization studies employ modeling frameworks that incorporate the global energy economy. In contrast, other scenario modeling research concentrates on specific examples such as the U.S. economy and energy sectors. Geographical research and related studies often analyze sector, area, city, and time periods separately to examine changes in infrastructure, deployment of technology, investment in specific sectors, and the behavioral patterns associated with transitioning to low-carbon practices [169]. Based on scenario-based projections, there are potential opportunities to separate economic growth from carbon emissions on a global and local scale [170,171]. Additionally, research conducted at the municipal and neighborhood levels has identified varying rates of emissions based on different socioeconomic conditions and ecosystem regimes [172,173].

Nevertheless, our understanding of the shift towards a low-carbon economy and extensive decarbonization is constrained by a dearth of empirical data. To date, there are no documented instances where communities or nations have intentionally and methodically achieved significant decarbonization. However, social science literature is increasingly focusing on the circumstances and possibilities of a decarbonization transition that is socially possible. The topics examined encompass governance ability, social, political, and institutional adaptations at various levels, dimensions of well-being, attitudes and behavior, benefits, diffusion of innovation, equity and justice, data circumstances, and limitations and uncertainty of information [174-176]. The study also investigates the additional advantages of climate change mitigation [177], and an increasing body of research explores these applications specifically in metropolitan areas and cities [178,179].

4. Conclusions

This article provides a concise overview of recent research in anthropology, archaeology, geography, and sociology regarding the causes of climate change. It specifically focuses on the human-induced variables that contribute to carbon emissions and the various elements that impact the effectiveness of policies aimed at mitigating and adapting to climate change. The research from various social science disciplines emphasizes that several key human factors that contribute to climate change include economic conditions and development, demographic growth and changes, power dynamics, social stratification and inequality, technology, infrastructure, and land-use change. The near- and long-term dynamic interactions of these factors, taking place across different spatial scales and institutional contexts, determine the possible approaches to reduce the impact and adjust to the situation.

Carbon emissions are mostly caused by economic activity, which leads to increased income and consumption. Power dynamics, social hierarchy, and various types of disparities frequently play a crucial role in influencing outcomes, such as carbon emissions, both at the national and sub-national levels. Examinations conducted at a small scale, such as the family, and within specific locations, such as urban areas, highlight the significance of sociocultural environments in comprehending consumption as a motivating factor. Population expansion plays a significant role in causing climate change, however, not all individuals contribute to carbon emissions in the same way. Furthermore, land use and conversion have a crucial role in driving climate change due to their involvement in intricate interactions across several levels. Key factors encompass international agreements, worldwide and regional economic dynamics, domestic policies and political landscape, urban-rural dynamics, household conduct, and local infrastructure. The social sciences not only delve into this intricate nature but also propose alternate techniques for adaptation and mitigation. These strategies consider the historical ecology and the varying temporal linkages between the natural and social realms.

An analysis of the long-term factors that contribute to climate change and human actions can aid in understanding critical points and potential turning points, as well as in developing strategic planning scenarios. Gaining insight into the present consequences of previous human actions and the enduring evolutionary mechanisms that influence human conduct are crucial not just for comprehending the factors behind climate change, but also for formulating strategies to reduce its effects and adapt to them. For global-scale policies and programs to be effective, they must be aligned with regional and local conditions and social situations. Furthermore, achieving decarbonization necessitates significant transformations in both energy systems and regulations. Examining the impact of policies on the accessibility of low- and noncarbon energy technologies, as well as overall energy production and consumption, can result in more sustainable results. Technologies can have unforeseen and unintended effects as a result of their interactions with social, economic, and political factors. To efficiently decrease carbon emissions, it is imperative to make structural modifications, including diminishing wealth inequality, enhancing sustainable consumption, and adopting efficient regulatory procedures.

This article reviews several fields of social science literature, which indicates numerous opportunities for future data collecting and research. Initially, it is crucial to address the substantial requirement of collecting missing information at the household, society, and other local scales regarding factors that contribute to climate change, as well as measures taken to reduce its impact and adapt to it. Furthermore, it is imperative to enhance our comprehension of consumer wants, preferences, and product utilization. This will enable us to identify specific areas where emissions might be reduced. Furthermore, there is still a requirement to comprehensively include knowledge of social and physical systems. This is necessary for comprehending the pathways associated with drivers and for effectively developing adaptation and mitigation strategies. Another crucial aspect to consider is the establishment of more explicit channels at all levels for transferring historical facts and expertise into practical application. Key factors to examine include the promotion of renewable energy as well as job creation, the provision of incentives for renewable energy consumption in households and industries, the exploration of alternative economic growth models, and the development of strategies to reduce carbon emissions while maintaining ecological sustainability and social equity. Furthermore, there is a pressing requirement for extensive and methodical cross-regional comparisons of situations pertaining to enduring human-environmental dynamics. Such comparisons would greatly facilitate the process of drawing general conclusions about long-term learning. Furthermore, there is a necessity for enhancements in predicting the thresholds and tipping points of both social and natural systems. Enhanced forecasts are necessary to inform society's actions in response to abrupt, frequently disastrous occurrences that surpass critical thresholds, as well as to provide advance notice of their impending arrival, allowing for timely mitigation and preparation for adjustment. Another aspect that should be addressed in the future is rectifying misconceptions regarding changing reference points. Issues arise when subsequent cohorts of resource managers and scholars view present circumstances as a natural reference point for assessing future occurrences, instead of acknowledging historical trends and patterns of simplifying and degradation that may have taken place in previous decades, centuries, or millennia. Furthermore, conventional methods of carbon emissions accounting, such as territorial or production-based approaches, fail to quantify the degree to which environmentally detrimental production is relocated to foreign countries. Consumption-based accounting allows for the tracking of carbon emissions across worldwide and regional supply chains by adjusting the boundaries of the system. It also redistributes these emissions to the end consumer. Therefore, it would be beneficial for research that examines international inequality from viewpoints like ecologically unequal exchange to thoroughly study both consumption-based and production-based indicators of emissions. Ultimately, research inquiries must center more explicitly on the correlation between decarbonization and economic growth. Research is necessary to examine the social, structural, institutional, technological, as well as behavioral factors that would guarantee feasible transitions toward decarbonization. This is particularly important considering the large amount of carbon sequestration needed, as well as the effects on land use and food prices. Additionally, it is crucial to understand how a low-carbon economy would impact individual well-being and social equality.

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