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Assessing the Nexus between Climate Change and Public Health in Nepal: A Comprehensive Exploration of Impacts, Vulnerabilities, and Adaptive Strategies

Uddhav Sigdel, PhD*
Associate Professor
Central Department of Population Studies
Tribhuvan University, Kathmandu Nepal
uddhav.sigdel@rrlc.tu.edu.np
https://orcid.org/0009-0003-1970-645X
Corresponding*

Sudhir Kumar Rimal
Baneshwor Multiple Campus, Shantinagar, Kathmandu**,** Nepal
rimalsudhir@gmail.com

Ramita Subedi
Baneshwor Multiple Campus, Shantinagar, Kathmandu**,** Nepal
ramitasubedidhakal@gmail.com

Shiva Prasad Bhattarai
Baneshwor Multiple Campus, Shantinagar, Kathmandu**,** Nepal
shivakbhattrai@gmail.com

Harka Bahadur Dhungel
Baneshwor Multiple Campus, Shantinagar, Kathmandu**,** Nepal
hemrajdhungel98@gmail.com

Shailaja Pokharel
Baneshwor Multiple Campus, Shantinagar, Kathmandu**,** Nepal
pokhrelshailaja@gmail.com

Laxmi Adhikari
Baneshwor Multiple Campus, Shantinagar, Kathmandu**,** Nepal
manju36adhi@gmail.com

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Abstract

Climate change and variability exert a global influence, affecting individuals and regions across the world. However, its impact is particularly pronounced in specific geographical areas and their inhabitants. Nepal, a globally recognized mountainous country, encompasses 18 percent of the world's mountainous terrain and spans 4.3 million km^2 across eight Asian countries: Nepal, Bhutan, Afghanistan, Bangladesh, China, India, Myanmar, and Pakistan. These Asian regions are experiencing a warming trend that surpasses the global average, accompanied by a significant increase in precipitation over the past six decades, leading to heightened frequency and intensity of specific extreme events. The alterations in temperature and precipitation have already impacted and are expected to continue affecting various climate-dependent sectors such as hydrology, agriculture, biodiversity, and human health. This paper aims to document the historical and anticipated impacts of climate change on the health and well-being of Nepal's population, providing adaptation and mitigation strategies to alleviate these effects. Additionally, the study assesses the indirect impact of agriculture and other human-related issues on human health and well-being. Utilizing narrative review processes, the research concludes the outlined issues. In Nepal, climate change contributes to complex challenges, resulting in the proliferation of infectious diseases, non-communicable diseases (NCDs), malnutrition, and injuries, as evident from this review. Consequently, the prompt implementation of climate change adaptation and mitigation measures is imperative to protect the vulnerable populations residing in the country.

Keywords: climate change, health, impact, NCDs, vulnerable populations

Introduction

For the past six decades, Nepal is undergoing experiencing various influences of climate change, affecting areas such as agricultural production, socio-cultural aspects, and the health of its population. According to World Health Organizations (WHO), environment changes attributed to human activities over the last thirty years have resulted in an annual loss of more than 150,000 lives (Patz et al., 1996). These changes contribute to a range of common human illnesses, including increased mortality in cardiovascular and respiratory diseases during heatwaves, alterations in the spread of infectious syndromes/diseases and malnutrition result of crop failures.

The inter-government forum for climate change known as IPCC (inter-governmental Panel on Climate Change) relies on the widely accepted logical consensus, indicating that the growing concentration of greenhouse gases from human activities will lead to surface warming and other climatic changes on Earth. Drawing on data from prominent modelling groups globally, the IPCC predicts a potential increase in the world's average temperature within the range of $1.4\text{-}5.8^0$ C by the year 2100 (Cambridge University Press, 2001).

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Examining the existence, potential future occurrence and magnitude of health repercussions resulting from climate change represents a noteworthy contribution to both international and national policy dialogues. Recognizing the extensive health risks should broaden these discussions beyond the already vital considerations of economic disruption, threats to infrastructure, loss of amenities, and the endangerment of species. The evidence and foresight regarding adverse health consequences will help pinpoint priorities for strategic adaptive measures. Crucially, this will strengthen the case for proactive policies, providing a more profound comprehension of the genuine meaning of sustainability (McMichael et al., 2006).

Since the 1970s, Nepal has witnessed a notable increase in its average annual temperature, with a recorded rise of 0.06^0C per year (Shrestha et al., 1999; Sharma & Tsering, 2009). This temperature elevation is more pronounced during winter compared to summer, especially in mountain and middle hills of the country (Xu et al., 2009). The impact of environmental change and unpredictability in the mountainous regions is evident through irregular rainfall patterns, variability onset of the rainfall seasons, and occurrences of dry atmosphere (Gentle & Maraseni, 2012). These alterations adversely affect agriculture, food production, livelihoods, and water security (Kohler et al., 2010; Macchi, 2011; Gentle & Maraseni, 2012).

It is argued that farmers' responses to changes are predominantly influenced by socioeconomic factors and, to some extent, climatic conditions (Sujakhu et al., 2016). Current coping strategies are largely tied to non-calamities factors- resources, government policies, labour availability, market conditions, and ownership of property. Consequently, those factors must be recognized in adaption and intervention planning. The communities of farmers have acknowledged the needs of the farmers for production and management in response to the climate change impacts. With enhanced support and strategic planning, the measures could be refined to address further climate and environment-related challenges in upland development. It is well understood that climatic change has multifaceted challenges on agricultural production in the mountainous and other regions of Nepal, and it also affects the health of the population in the country.

Situating Knowledge on Climate Change and Health Outcomes

Climate change has far-reaching implications for individuals globally, particularly affecting the health aspect on a worldwide scale. The results of environmental change are often associated with with alterations in outcomes of climate change garnering significant attention due to their profound effects on people's well-being across the planet. Notably, there has been insufficient emphasis on the secondary outcomes linked to ecological disruptions, including crop failures, shifts in disease vector patterns, and an increase in the incidence of diarrheal diseases (Smith et al., 2014). Current forecasts indicate that the ongoing impact of climate change will notably worsen the prevalence of diarrheal diseases (Kovats & Lloyd, 2014), which

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play a significant role in child health and deaths in developing countries including the Nepalese context (Carlton et al., 2016).

The IPCC publication highlights that South Asian countries are confronted with increased vulnerability to the effects of climate change (IPCC, 2022). Existing evidence indicates a more rapid rise in maximum temperatures (0.05^0C/year) compared to minimum temperatures (0.03^0C/year) in Nepal (Practical Action, 2009). The warming trends show notable variation, the mountain regions experienced more warming than plain land due to the impact of climate change (Karki et al., 1970). Simultaneously, the middle hills regions are contending with scarcity of water due to long-term droughts along with the lessening of spring sources (DoHS, 2015).

It is also identified that changes in sleet conditions are known and leading factors those causes in high rainfall regions and droughts. in high-rainfall regions and droughts, coupled with water scarcity, in areas with lower rainfall (PAN, 2010). The impacts of climate change are already observable across multiple sectors, including public health. According to the government report, higher temperatures contribute to higher levels of food and water-related diseases (DoHS, 2015). This aligns with other research indicating a correlation between meteorological factors like relative humidity (Aik et al., 2020), temperature (Wangdi & Clements, 2017), and precipitation (Horn et al., 2018), and incidences of diarrheal diseases. Considering that diarrheal diseases are among the leading causes of death in Nepal, there is a substantial likelihood that their impact will intensify the upcoming situations of diseases and viral infections (IHME, 2016). The significant outcomes of climate change mirror various health effects on human health and other dimensions of human activities.

The well-being of both present and upcoming generations is at risk due to diverse environmental alterations, with climate fluctuations being a significant factor (Dhimal et al., 2021). These alterations not only pose a threat to the health advancements made in recent years but also add to the potential disease burden in the future. The primary catalyst behind these global environmental changes is human activity, leading to the deterioration of Earth's natural systems. These systems play a crucial role in supplying necessities such as food, clean water, and fresh air, and in maintaining global temperatures within ranges conducive to human well-being (Haines et al., 2017).

Human health is significantly impacted by both direct and indirect environmental changes, resulting in a substantial disease burden. The repercussions of these alterations amplify health risks and contribute to the prevalence of diseases that are particularly sensitive to environmental and climatic conditions. In 2012, about 23 percent of global mortality, around to 12.6 million, would be attributed to risk factors associated the environment (Prüss-Ustün, 2017). These factors encompass all external physical, chemical, and biological elements, along

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with related behaviors, excluding natural environments beyond reasonable modification. Notably, the rates of death and disease burden linked to the environment are higher in low and middle-income countries, presenting challenges to achieve the sustainable development goals set by the United Nations for the nations closely intertwined to determinants of environment health (UN, 2017; Dhimal et al., 2017).

The climatical changes emerge as a significant challenges to human being and humanity and overall wellbeing, mainly affecting socio-environmental factors that determine human health, accessibility of clean air, safe water, food security and decent standard of living (Hayes, 2018). Predictions suggest that climate change will exert substantial adverse effects on future illness and death rates. For example, the World Health Organization (WHO) anticipates that heat-related fatalities will exceed 100,000 annually by the 2050s, with higher mortality rates expected developing nations, particularly in Indian sub-continent (WHO, 2014). The previously mentioned description prompts consideration of the extent to which the climatic change effects on human health and well-being is fully comprehended.

The globe is presently undergoing widespread environmental transformations, including climate variations that have substantial effects on the health and well-being of people. Nevertheless, the exact measurement of these influences on human health remains uncertain (Dhimal et al., 2021). Scientific understanding on a global scale is still in the process of exploring the evolving dynamics of climate and its related factors across diverse climatic conditions. In this context, this narrative review aims to identify the primary concerns regarding changing scenario of climate and human health in Nepal.

Methods and Materials

Selection of the Publication for the Review

The narrative review methods recommend the collection of data from various scientific publication databases. Narrative review is approach of the secondary analysis which is universally acknowledged, largely referenced, and accepted in leading research publications. The appropriate criteria is developed for inclusion and exclusion of the papers during the review processes It is conducted a searching high quality research papers published in the refereed journals and established scientific online database including PubMed, Science Direct, Google Scholar, and JSTOR focusing on the theme of the study such as climate change and impacts of human health
including various dimensions within a 5 year specific timeframe (from January 2019 to December 2023).

To be eligible for inclusion in this review work, keywords of selected papers had to incorporate the term "Climate Change and Human Health in Nepal, Climate Change and its Impact, and Impact of climate Change" and at least one of the following eleven words and phrases: climate

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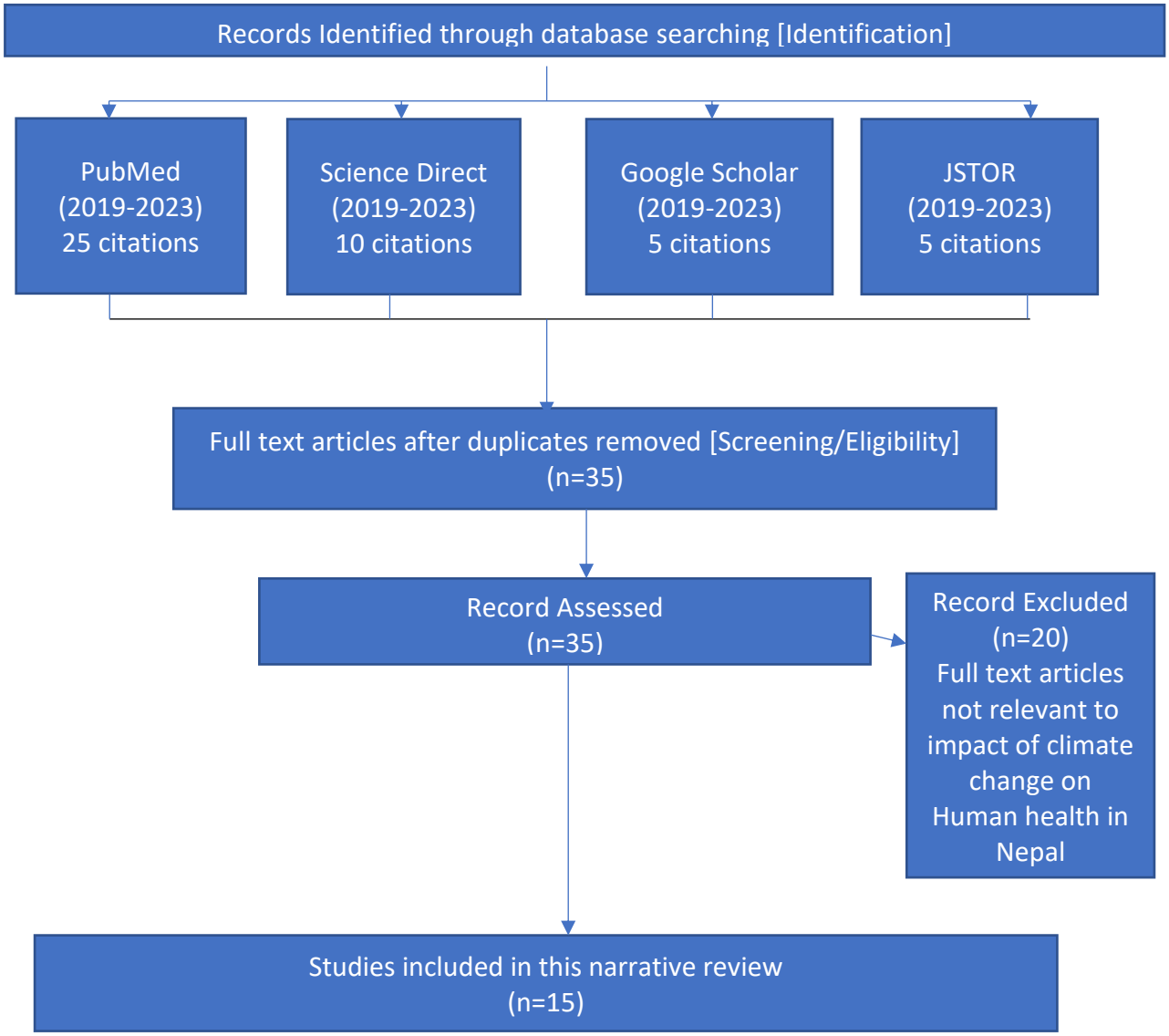
change and its impact on human health, predicting, assessment, mitigatin, flood, climate change, agricultural production, farmers or farming and health outcomes. These criteria were initially identified by researchers in an introductory survey of the literature on Impact of Climate on Human Health in Nepal.

This review incorporates extensive findings from PubMed, Science Direct, and Google Scholar. Notably, JSTOR yielded a significant number of searching outcomes, with the initial some of the pages each relevant terms. Additionally, specific criteria were applied to filter out non-reviewed and non-scientific and very old literatures, with a focus on selecting journals published in the English language. This exclusion is motivated by the absence of a narrative review approach to assess grey literature and the lack of reliable methods to verify its scientific reliability.

Table 1: Process of database search



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The search across scientific databases such as Science Direct (5), PubMed (25) , Google Scholar (5), and JSTOR (5) yielded a considerable number of research papers. Following the elimination of duplicates, 35 articles were retained retained. As appropriateness of the papers, it is narrowed down to 15 articles after a thorough review, which involved excluding irrelevant ones. The study specifically omitted papers not related to the Nepal context or those published prior to 2019 and after December 2023.

Variability Identification

Following the meticulous selection process, the comprehensive examination encompassed a total of 20 acquired publications. To enhance the analytical depth, the papers underwent a meticulous coding process based on overarching categories, and subsequently, they were systematically organized according to the design and narratives of interest. To ensure methodological rigor and accuracy, the selected narratives underwent a thorough validation process. This validation was accomplished through consensus among the co-authors actively involved in the study, thereby effectively eliminating any potential inconsistencies and bolstering the reliability of the analytical framework.

Issues of Narrative Review

Our endeavor involved a comprehensive assessment aimed at discerning the nature of health impact and well-being within the Nepal and identifying its underlying issues. The scope of our inquiry extended to qualifying the impact on both indirect issues of human health such as agriculture and other issues to related to human health and concurrently documenting any pertinent application that that hold the potential to alleviate these problems.

Findings

The findings of the narrative review from the 20 articles are presented in a broad based agricultural production which indirectly impact of human health whereas health outcomes also assessed. Beside these, the remaining factors are assessed from the another one heading. Each papers' narratives are presenting including design of the study as well.

Climate Change and Impact on Agriculture Sector

A study by the authors on climate change determining variations in environmental changes to extent of crop losses by Poudel and other in 2021. Elevation gradients facilitate a surrogate to replicate the effect and overall climatic change. In Nepal, a field study was conducted to elevation gradient to investigate how abiotic conditions influence populations of agriculturally

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significant insect herbivores as well as waste of vegetable production and its damages. Temperature fluctuations corresponding to elevation had an impact on insect capture numbers and the level of plant damage caused by herbivory. In the context of climate warming, our findings underscore that the interactive influence of elevation and climatic factors, such as temperature, will play a pivotal role in determining variations in insect pest populations and the extent of crop losses (Poudel et al., 2021).

In fact, global farmers are confronted with escalating climate variability and extreme weather conditions. A study explores the social and economic repercussions of extreme weather events (EWE) on farmers in Nepal, examining how they cope with and adapt to heatwaves and cold spells spanning from 2012 to 2017. The survey study conducted in Banke and Bardiya with 350 farmers. The farmers were specifically queried about the impacts of extreme temperatures, their influence on labor productivity and collective farmer health, and the preventive measures they had implemented. In the study it was presented that about 84 percent of the farmers self-reported experiencing moderate or severe heat stress in the last five years, and around 85 percent reported moderate or severe cold stress. The study revealed that farmers were comparatively less prepared for the potential threats of cold spells than heatwaves, making them less inclined to adopt coping strategies, given their recent emergence (Budhathoki & Zander, 2019). It is also need to understand the locally product fertilizer and pesticides to protect the outcomes of climate change. The participatory on-farm field trials were conducted in the Kavre district in 2017-2018 for *jholmal* and straw mulching.

The applicability of liquid fertilizer such as *jholmal* demonstrated a strong link with the gourd yield at both sites (foothill and hilltop) compared to the farmers' used to practices (with a respective yield increase of 30.5% and 31.1% in foothills in 2017 and 2018, and 26.6% and 28.7% in hilltops). Additionally, jholmal-treated plots exhibited a notable reduction in fruit infestation. Similarly, the use of straw mulch resulted in an increased tomato yield compared to non-mulched trials (with a respective yield increase of 16.5% and 20.3% in 2017 and 2018). These findings emphasize the scientific basis of traditionally used practices and highlight their potential as a climate friendly approaches to enhance agro-ecosystem health (Bhsal et al., 2022). Moreover, they support smallholder farmers in adapting to the adverse impacts of climate change and building socio-ecological resilience. In addition, animal pollination support and agricultural production is also areas of climate change study and impact of human health. Animal pollination is essential for sustaining agricultural output, ensuring the growth of nutritious foods like fruits, vegetables, nuts, and legumes that play a crucial role in providing essential nutrients and guarding against noncommunicable diseases. However, the majority of crops currently experience less-than-ideal pollination due to a shortage of diverse and abundant pollinating insects. Animal pollinators are presently facing various anthropogenic challenges, including but not limited to, changes in land use, intensive farming methods, the use of harmful pesticides and pollinators was determined based on existing research. Subsequently, it is

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simulated the closure of "pollinator yield gaps" by eliminating the portion of total yield gaps associated with inadequate pollination.

Globally, it is estimated that inadequate pollination results in the loss of 3 to 5 percent of fruit an vegetable related production of fruit, vegetable, and nut production. This leads to approximately 427,000 excess deaths annually (with a 95% uncertainty interval of 86,000 to 691,000) due to the reduced consumption of healthy foods and related diseases (Smith et al., 2022). The modeled impacts are not uniform, with concentrated food production losses in lower-income countries. In contrast, the effects consumption of food and deaths attributed to inadequate pollination are more pronounced in middle and developed nations having high rates of noncommunicable diseases. The cases studies explore that the economic cost of crop production is 12 to 31 percent lower than it would be with abundant pollinators, primarily due to losses in fruit and vegetable production ranging from 3 to 19 percent. The aforementioned facts indicate that inadequate pollination contributed to the loss of vegetable, fruits and nut production. This is also connected with the livelihood of the farmers.

As understand the climate chage effect on farmers lives, survey was conducted with 747 households across four physiographic regions Koshi River Basin (KRB). Additionally, the climate data of 1980 to 2018 also were were used to calculate trends, analyzed using the Mann–Kendall trend test and Sen's slope for inter-annual climatic trends. The survey revealed increasing temperatures, climate-induced crop diseases, heightened pest frequency, droughts, floods, and reduced rainfall due to climate change is strong indicator for the measurement. There were significant change and adverse effect on crop production, human health, livestock and vegetation. Changing trends of climate across all physiographic regions confirmed rising temperatures and diminishing rainfall, with varying rates of change in each area, aligning with farmers' local knowledge. The hill region experienced the highest temperature increase at 0.0975^0C/a ($p = 0.0002$), while the mountain region saw the sharpest rainfall decrease at −10.424 mm/a ($p = 0.016$) between 1980 and 2018. It is suggested that implementing region-specific adaptation strategy can be alivate the impact of climate change (Paudel et al., 2021). Proposed strategies include developing irrigation infrastructure, creating drought-tolerant crop seeds, enhancing pest and other issues of farmers are crucial

Climate Change and Impact on Human Health

The paper by Newnham et al. (2020) addresses results of climate change on mental health and emphasizes the importance of addressing both psychological and structural problems in responding to mental illness challenges following disasters and pandemics. The authors highlight the establishment of the Asia Pacific Disaster Mental Health Network in June 2020, supported by the World Health Organization DRM (disaster risk management) This network aims to advance research, practice, and policy in disaster-oriented mental health across the

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region, bringing together in disaster psychiatry, psychologists and public health experts. The ultimate goal is to enhance community readiness and response to disasters, pandemics, and mass trauma through elevated policy frameworks, research efforts, and evidence-based applications.

The inaugural meetings led to the setting agendas of regional disaster mental health and its five prioritized issues. These priorities include strengthening community engagement in mental health planning, supporting and assessing mental health system capacity for disaster response, utilizing emerging technologies in mental healthcare, addressing the mental health impacts of climate change, and prioritizing mental health support for high-risk groups. The integration of those priority issues/areas into further knowledge generating, practice and policy prescriptions efforts aims to enhance psychosocial initiatives for populations affected by climate change outcomes, including Nepal (Newnham et al., 2020).

In 2023, two review papers shed light on the impact of climate change on health in Nepal. The first, published in peer reviewed journal of Travel Medicine, focuses on the rising incidence of dengue in the country. The paper emphasizes the link between increasing temperatures due to climate change and the expanded habitat for Aedes mosquitoes, leading to a surge in dengue cases. The authors stress the importance of implementing strategies to prevent future outbreaks ((Bijukchhe et al., 2023).The second review paper explores broader influence of climate change on health in Nepal, dating back to the 1970s. It particularly examine the connection between climate change and both communicable diseases like dengue and non-communicable diseases (NCDs). The paper reviews eight different study designs to examine the causal and correlational relationships between the environment and NCDs. The findings suggest a global rise in NCD prevalence, with environmental risk factors, including climate change, playing a significant role. It is indicate that the increasing temperatures would likely to exacerbate the public health impact of NCDs (Dhimal et al., 2023)..

Dhimal and other researchers investigated the connection between diarrhea prevalence in Nepal and climate change. Diarrhea, a significant health concern in low-income countries like Nepal, is believed to be influenced by temperature changes, suggesting a potential association with climate change. The study explored the impact of increasing mean temperatures and variability in temperature and precipitation, which are linked to climate change, on the rise of water and food-borne diseases. The research conducted a national-level ecological study, analyzing monthly data on diarrheal disease counts and meteorological information across 15 eco-development regions in Nepal from 2002 to 2014.

The study found a significant increase in diarrheal disease incidence in Nepal associated with a 1°C rise in mean temperature (4.4%) and a 1cm increment in rainfall (0.28%). Seasonal variations were observed, with an 11.63 percent raised in cases during the summer and a 14.5

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percent decrease in the spring compared to winter. The impact of temperature and rainfall was most pronounced in the mountain region compared to other eco-regions of Nepal. The results emphasize a clear link between weather factors and the burden of diarrheal disease in the country. The study concludes that ongoing climate change may further escalate diarrheal disease incidence, particularly in mountainous regions, highlighting the need for resource allocation and prevention and control base mechnicms. Additionally, the paragraph mentions vector-borne diseases as another concern arising from climate change (Dhimal et al., 2022).

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The increase in vector-borne diseases globally is expected to worsen due to human-induced climate change. Regions with limited resources are particularly affected, as existing surveillance programs are insufficient to cope with the growing potential of vector species. There is an urgent need for affordable and easily applicable methods, especially in resource-limited areas and field conditions, to serve as pre-informed systems for vector-borne disease outbreaks. In this context, the goal was to improve entomological capabilities in Nepal, a country grappling with endemic vector-borne diseases and frequent dengue fever outbreaks. It was conducted an online workshop to facilitate the transfer of knowledge to scientific experts in Nepal across diverse disciplines. The study's findings confirm the validation of a barcoding pipeline for adult mosquitoes and eggs, along with various sample types such as homogenized samples, dried specimens, those stored in ethanol, and frozen tissue. Positive feedback from participants indicates successful knowledge transfer, with a desire to implement the method. The study emphasizes the urgency of cost-effective strategies for assessing disease outbreak likelihood. Field sequencing is highlighted as an economical and easily implementable solution. Additionally, the paragraph notes the understanding that climate change impacts malaria prevalence in the country (Hartke et al., 2022).

The study in Nepal investigated the impact of climate and its variations on the spatial issues and timing of malaria risk. Using global climate models, the research evaluated season lengths and spatial scopes for malaria transmission suitability based on different combinations of malaria vectors. The assessments were compared with observed estimates of malaria risk. Thermal thresholds for malaria transmission suitability were provided by the models during the baseline period (1960–1990) and under future climate scenarios (RCP 4.5 and RCP 8.5 in 2030 and 2050). The study used Warren's I metric to compare season lengths and spatial extents of suitability for different malaria types between baseline and future climate scenarios. The study found that the spatial areas of suitability to transmission is expected to change in the future (Bhattarai et al., 2022). Notably, some of these areas do not align with the government's current risk designations, potentially impacting vector control interventions. The study suggests that public health officials could use this information to guide targeted interventions for malaria elimination and prevention of resurgence in Nepal.

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Climate Change and Impact on Other Human Related Issues

The study led by Adeleye and colleagues explores the implications of energy usage on climate change within sustainable development goal 13, which emphasizes the urgency of combatting climate change. Focusing on nonrenewable energy and globalization's impact on carbon emissions, the study systematically reexamines these dynamics in relation to the Kuznets hypothesis. The research utilizes unbalanced panel data spanning seven South Asian countries (Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka) from 1980 to 2019. The study highlights that South Asian countries, especially those in early development stages, are grappling with hazardous substances adversely affecting human health. The negative value of the non-linear square term in the nonrenewable energy-emissions relationship supports the inverted U-shaped Environmental Kuznets Curve (EKC) theory. In summary, the research suggests that the impact of energy and globalization on carbon emissions varies, with intense globalization making countries more susceptible to environmental degradation. The concluding note mentions the influence of climatic change on Medicinal and Aromatic plants in Nepal (Adeleye et al., 2022).

The study emphasizes the significant contributions of Medicinal and Aromatic Plants (MAPs) to the well-being of humanity, providing both cost and health benefits. In Nepal, which has documented 2,331 MAP species, approximately 300 are actively traded. However, the wild harvesting of MAPs in the country faces increasing pressures due to overexploitation for trade, climate change, and development impacts. Despite localized studies on climate change and MAPs, there is a lack of consolidated understanding of how major traded MAP species' distribution will be affected in the future. The study employs ensemble modelling and a hotspot approach to predict the potential distribution of 29 MAP species in Nepal under current and future climate conditions. The findings indicate that future climate change is likely to reduce suitable areas for two-thirds of the studied species, leading to a decline in climatically suitable hotspots across various factors (Shrestha et al., 2022). The study underscores the importance of considering the potential threats posed by future climate change when formulating strategies for protected areas, environmental conservation, and climate adaptation policies related to MAPs.

The study addresses the limited information on household-level expenses associated with prevalent health problems and possible financial burdens of climate adaptation in Nepal. The study, based on survey data from 420 households, aims to quantify these costs and explore their connections. An ingredients-based approach is employed to estimate both health and adaptation costs, with a multivariate regression analysis The direct cost constitutes the highest component among health-related expenses for households, making up 2/3rd of the total cost of health care. On average, households allocate 15.90 percent of their income to cover direct healthcare costs. The study identifies considerable climate hazard costs among affected households. The

communicable diseases as well as participation in climate awareness programs, drought occurrences, family members in terms of size, and per capita income loss, are identified as contributors to increased climate adaptation costs. Conversely, the occurrence of gastritis, prevalence of diarrhea, and exposure to cold waves are less likely to impact these costs (Paudel & Pant, 2020).

The comprehensive systematic review by Sultan and colleagues focuses on assessing climate change vulnerability in the Himalayas, including Nepal. The Himalayan region, characterized by its fragile high mountain landscape, poses acute vulnerability due to interconnected environment, and socio-economic factors linked to the rule of nature. The study aims to address the lack of geographical understanding of these vulnerable exposures by reviewing existing social, economic and spatial vulnerabilities research in the region and proposing mitigation interventions. Employing the PRISMA criteria, the researchers conducted a thorough search across four databases, resulting in 59 vulnerability research papers for analysis, covering all Himalayan countries. The majority of vulnerability studies were concentrated in the central Himalayan region, followed by the western Himalayas, with fewer studies in the eastern Himalayas (Sultan et al., 2022). Key drivers of change included climate change, land use/land cover, and glacial lake formation. While social science methods were predominantly used in vulnerability assessments, natural science methods were less frequently employed. Despite infrequent coverage in vulnerability studies, the analysis identified fourteen recommendations, focusing primarily on policy, livelihood and measures. The study underscores the necessity for cross-sectoral interventions to achieve sustainable development, effectively handling the available resources and their utilization, and address pressing vulnerable situations in the Himalayan context.

Conclusion

This review paper emphasizes that the impacts of climate change extend beyond the natural environment to affect the human body. It outlines various effects, including the exacerbation of existing communicable and non-communicable diseases and the emergence of new infections in individuals previously unaffected. The warming climate alters the antigens encountered by our bodies, potentially overwhelming the immune system and challenging its ability to maintain tolerance. Human practices, such as increased antimicrobial use and reduced exposure to diverse natural environments, influence the microbiome, agriculture, and contribute to various health issues. Dysbiosis, or microbial imbalance, is linked to inflammatory, autoimmune, and neurological diseases. The review stresses that climate change is not just a concern for future generations; it is impacting people currently. Immediate action is necessary to mitigate climate change, not only to preserve the planet but also to safeguard human health, as our bodies' adaptive capabilities occur over generations. The findings of the review paper highlight the wide-ranging impacts of climate change on agriculture production, farmers' livelihoods, herbs, medicinal plants, disasters, and various other human-related issues.

It suggests that existing studies are insufficient in addressing the comprehensive impact of climate change on human health. The review emphasizes the need for comprehensive research policies to tackle these global challenges and secure the future of the Earth and humanity.

The narrative review underscores the growing but underdeveloped field of research at the intersectionality of climate change and human health, including mental health, particularly in the context of Nepal. The focus has primarily been on assessing broad health risks associated with climate change, with limited attention given to practical interventions and policies to protect mental health. Most existing research is quantitative, cross-sectional, and conducted in high-income countries, potentially limiting its interpretability and generalizability to Nepal. Despite these limitations, consistent evidence suggests a negative association between climate change and mental health. Additionally, there is a call for exploring interventions, policies, and decision-making mechanisms to mitigate problems, considering it a critical focus in mental health research due to the significant global threat climate change poses in the 21st century.

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