Navigating the Climate Crisis

Analyca Policy Institute
SARA Hamrani

The changing climate patterns and agriculture: The effects of climate change on agriculture encompass local, regional, and global dimensions, as highlighted by the Intergovernmental Panel on Climate Change in 2001. The extent of these effects hinges on the rate and magnitude of climate shifts, as well as the responses of both natural and human systems. The adaptive capacity of agricultural systems is influenced not only by climatic factors but also by socio-economic conditions, technological advancements, and agricultural markets. To comprehensively evaluate the impact of climate change policies on agriculture, it is valuable to establish a set of metrics that enable the analysis of the scale and timing of these impacts. These metrics should allow for both monetary and non-monetary assessments, aiding in the assessment of benefits.

Collaboration with agricultural stakeholders and decision-makers is essential to identify these metrics. Doing so would facilitate the development of strategies for adaptation and mitigation in response to climate change, spanning various scales from local to global. The establishment of a cohesive set of metrics for climate change's effects on agriculture also aids in defining vulnerability thresholds for agroecosystems. These thresholds delineate the point beyond which adaptation becomes ineffective.

Climate change introduces several challenges to agriculture, including heightened temperatures, altered precipitation patterns, increased water demands, and more frequent extreme events like droughts and floods. Notably, elevated CO2 levels can have positive impacts on crops. However, the amalgamation of these factors is anticipated to gradually diminish crop yields and amplify production risks across multiple regions in the coming decades. The effects differ based on geographic context: moderate warming may initially benefit crop yields in temperate zones but prove detrimental in semi-arid and tropical areas. Continued warming, projected for the latter part of the 21st century, is anticipated to negatively affect crop yields universally.

Farm-level adaptations might mitigate the effects of warming by a limited extent, akin to ‘buying time’. However, comprehensive projections of food supply must encompass not only climate-related aspects at the field level but also the entire production chain and market dynamics. Socio-economic factors play a crucial role. Presently, global climate impacts on food production are believed to be relatively small, albeit with substantial regional disparities. Developing nations are more susceptible due to warmer

baseline climates, stressed production environments, heightened exposure to extreme events, and limited resources for adaptation. As a result, climate change might expose an additional 5–170 million people to the risk of hunger by 2100, contingent upon socio-economic scenarios.

Among developing countries, sub-Saharan Africa might experience the most adverse effects due to dwindling land and water resources and an escalating number of individuals at risk of hunger. Mediterranean countries are likely to grapple with severe droughts leading to agricultural land abandonment and desertification. It is noteworthy that the augmented frequency of extreme events, such as droughts and floods, could disproportionately affect food supply beyond the impacts projected solely from mean climate changes. The extent of these impacts might be considerably larger and manifest sooner than current projections indicate. Moreover, climate change could exacerbate irrigation needs beyond existing models, particularly in North Africa and southeast Asia.

Analysing the policy implications of agricultural impacts, Hitz and Smith (2004) introduced a preliminary set of impact metrics, encompassing crop yield, cultivated land area, and the number of people vulnerable to hunger. These metrics were correlated with global mean temperature changes, serving as a proxy for the trajectory of climate change over the century. Insights from these analyses, coupled with prior summaries such as the IPCC TAR (2001), suggest that agricultural production on a global scale might encounter minimal or even favourable effects from climate impacts in the next few decades, up to approximately 2.5°C of global warming. The positive effects of elevated CO2 could potentially outweigh negative temperature signals during this phase. However, beyond this temperature threshold, negative global impacts are projected across all regions as temperatures continue to rise.

The changing climate patterns and food security: Food security pertains to ensuring sufficient access to food, achievable through both trade and production. The self-sufficiency of production is not a prerequisite for food security, whether at the household or national level. Even individuals with high food security predominantly purchase their food rather than cultivate it, and even economically prosperous nations import essential consumer goods. However, if the regions and countries most vulnerable to food production losses due to climate change are also those heavily reliant on agriculture with limited alternative income sources, diminishing harvests will unquestionably erode household and national food security.

Numerous impoverished countries already face substantial deficits in cereal production annually, leading to significant portions of their populations suffering from undernourishment. To comprehensively grasp the array of climate change effects on food security, it is imperative to comprehend the repercussions for prices, incomes, trade, as well as production. For

instance, a decline in domestic food production would trigger an increase in food prices, thereby jeopardising the accessibility of food for individuals dependent on markets to meet their dietary needs. However, delving deeper into such intricate matters proves to be more challenging.

The consequences of climate change will exhibit marked variations across continents, nations, and livelihood systems, contingent on local resource allocations, agricultural practices (mechanised or traditional, irrigated or rain-fed, commercial or subsistence-oriented), urbanization rates, economic diversification (agricultural versus industrial and service sectors), and a multitude of other environmental and socio-economic variables.

The changing climate patterns and water resources: To begin with, it is crucial to recognise the inherent dynamism within freshwater systems. These systems exhibit a state of constant change, even when not influenced by the impacts of climatic shifts. Seasonal variations, a routine occurrence, are typically factored into relevant regulatory frameworks and management strategies. Against this backdrop, identifying and highlighting specific climate change-induced impacts can sometimes prove challenging. According to the Intergovernmental Panel on Climate Change (IPCC), the risks associated with climate change in freshwater contexts escalate notably as greenhouse gas concentrations rise. Forecasts indicate that climate change will notably diminish renewable surface water and groundwater resources in most arid subtropical regions. Conversely, regions with snowfall have already witnessed alterations in observed streamflow patterns due to climate change. Furthermore, by the close of the 21st century, climate change is projected to escalate the occurrence of meteorological droughts (reduced rainfall) and agricultural droughts (diminished soil moisture) in currently arid regions. Climate change is also exerting influence on the seasonal fluctuations of water flows, groundwater levels, and nutrient movements. Scientific understanding has provided a foundational grasp of how the global and regional hydrological cycles will transform, underscoring the profound impacts of climate change on water systems. However, it is also probable that unforeseen changes and circumstances will arise concerning freshwater systems, challenging their management frameworks. Resilience and adaptive capacity will emerge as pivotal attributes in navigating this process, while security's pertinence will concurrently heighten. Arguments have been put forth that when the pace of change in a water system surpasses its adaptability, the intricate ties to overall security and stability become glaringly evident. Evidentially climate change's effects will not uniformly manifest across every freshwater basin worldwide. Even within individual basins, the effects of climate change will differ based on location. Broadly, the repercussions of climate change on freshwater resources hinge on a multitude of factors, encompassing geographical

elements, human water demand and utilization, existing management mechanisms, governance structures and institutions, and ecosystem resilience (including vulnerability and adaptive capacity). The inherent variability of climate change's impact on freshwater resources is predisposed to amplify uncertainties and strain, potentially rendering a water management framework susceptible to conflicts among users. Worth noting is that water management systems in many parts of the world are already strained due to escalating freshwater demands, with climate change poised to compound these challenges.

In essence, climate change accentuates the established fact that freshwater resources are inherently characterised by uneven and irregular distribution. Additionally, climate change ushers in escalated uncertainties, stressors, and potential conflict triggers within water management. Globally, the likelihood of water security risks – spanning floods, droughts, pollution, and even acts of terrorism – escalating is high. These risks, predominantly stemming from climate change, are amplified by the concomitant uncertainties. Climate change inevitably reshapes the sources of water-related conflicts: issues concerning water quantity and quality; disputes amid water users; and the consequences of water-linked extreme events (which will amplify in frequency and intensity due to climate change). Pollution, floods, scarcity of water, or challenges in fulfilling diverse water resource uses due to climate shifts might sow tensions and ignite conflicts between nations or other stakeholders, even when direct culpability isn't apparent. Clearly, environmental shifts are poised to exacerbate existing conflicts and trigger fresh social and political disputes revolving around water. This is particularly pronounced given the current context of water's augmented political and economic value, further compounded by climate-induced water scarcity casting doubt on many prevailing water utilisation practices.

Climate change and human security example Nigeria : The subtle progression of climate change can mask its significance as a substantial threat to human security. A wealth of evidence showcases the adverse impact of climate change on peaceful human existence across numerous global regions. The United Nations defines human security as a people-centric concept that integrates diverse determinants of well-being, including economic, food, health, environmental, personal, communal, and political security. The Human Security Network (1999) asserts that building human security is imperative for creating a humane world where people can lead lives marked

by security, dignity, and liberation from poverty, despair, and need.

The United Nations classifies human security into acute risks arising from abrupt disruptions like natural disasters, and chronic threats such as disease, hunger, and conflict. Accordingly, achieving conventional notions of national and international security is incomplete without acknowledging the underpinning importance of human security. Just as national security complements international security, human security is equally complementary to both, constituting a fundamental aspect of security discourse. The United Nations' General Assembly Resolution 66/290 underscores human security as an approach to help member states tackle overarching challenges to their people's survival, livelihoods, and dignity. This approach necessitates people-focused, comprehensive, context-tailored, and prevention-oriented responses that enhance the protection and empowerment of all individuals.

To assess the ramifications of climate change on national and international security comprehensively, adopting a human security perspective proves more effective. Climate change presents an emerging threat to human security in Nigeria, evident through its varied manifestations that have incited violent conflicts, destabilising public safety and overall stability. The fluctuating climatic conditions driven by climate change have diminished agricultural potential and triggered increased aridity of northern Nigeria's pasture areas, pushing pastoralists southward and into competition with local farmers for limited resources. Barnett and Adge (2007) note that ‘climate change is eroding human security by curtailing access to vital natural resources and undermining states' capacity to promote human security’. Instances of floods, droughts, and desertification have led to population displacement and reduced agricultural output, fuelling conflicts and insurgency in various Nigerian regions.

Multiple scholars, including Odo (2012), Folami (2013), Oladele (2010), and Adishi and Oluka (2018), have established a clear link between climate change and conflicts between farmers and herders in Nigeria. Ongoing environmental degradation in parts of Northern Nigeria, resulting in the loss of grazing lands, has triggered a southward migration of pastoralists, leading to violent clashes with host communities' farmers. This pattern of conflict has disrupted agricultural activities, resulted in substantial loss of human lives, and devastated farming settlements and communities, intensifying armed trafficking across national boundaries. Some herders, armed due to these conflicts, have turned to criminal activities like kidnapping, armed robbery, and sexual assault, exacerbating the country's security situation.

In Nigeria, rainfall significantly governs agricultural endeavours. The Sahel and Sudan savannah belts encompass extensive grazing areas alongside localized cultivation of cereals and vegetables in

Fadamas. The Guinea savannah is the primary food-producing region, cultivating root crops, tuber crops, cereals, and vegetables in abundance. These regions have all been adversely impacted by climate change in varying ways. Persistent drought in the Sudan and Sahel savannahs has forced pastoralists toward the guinea savannah and rainforest areas, intensifying pressure on these lands. Pastoralists, in their quest for water and grazing fields, have often encroached on farmlands, inciting conflict with local farmers. Consequently, conflicts between farmers and herders have become recurrent in Nigeria's middle belt and parts of the south.

Climate change and access to resources:

The effects of climate change intersect with a complex social landscape that is already populated by diverse groups with varying levels of resource access. Resource access, encompassing the ability to utilize both natural and human resources for benefits (Ribot & Peluso, 2003), plays a pivotal role in influencing vulnerability. It can magnify or diminish exposure, sensitivity, and adaptive capacity. These resources encompass both tangible and intangible, private and public assets. Examples include private capital, liquid assets, disaster warning systems, emergency response, alternative housing, insurance, food reserves, migration support, durable infrastructure, transportation, and information networks. However, the mere presence of these resources in a location does not guarantee their accessibility or utilization for reducing vulnerability (Sen, 1984). Access to these resources involves intricate social dynamics and power structures, often posing challenges for marginalized and economically disadvantaged populations to navigate (Watts, 1983).

Disparities in resource access are evident across regions even within prosperous countries, as well as within communities and neighbourhoods within the same urban area. In this context, a hazard like a hurricane or drought escalates into a disaster only when certain groups lack the ability to safeguard themselves. In essence, so-called ‘natural’ disasters are fundamentally human-made disasters. The impact of Superstorm Sandy on New York and New Jersey in 2012 illustrates this. With over 100 fatalities (Kunz et al., 2013), the toll was particularly high among the elderly due in part to limited access to healthcare and transportation (Kunz et al., 2013). Comparatively, Hurricane Katrina claimed about 1,800 lives in the economically disadvantaged coastal areas of Louisiana and Mississippi. Among the victims were predominantly elderly individuals, but in New Orleans, a significant portion were also impoverished and Black, especially in the Lower Ninth Ward near breached levees. The disaster that unfolded with Hurricane Katrina stemmed from deficient infrastructure, prevalent poverty, segregation, and insufficient resources for preparation, evasion, and recovery. A comparison between the aftermath of Hurricane Maria in Puerto Rico and Hurricane Harvey in Texas in 2017 highlights the social aspect

of disasters (Weiss, Lebrón, & Chase, 2018). Puerto Rico suffered prolonged devastation, while Texan communities rebounded more swiftly.

Disparities in adaptive capacity also persist: certain communities recover more rapidly than others from hurricanes or floods. Acknowledging and comprehending these distinctions necessitates deeper insight from scientists and policymakers into the nature of resource access and adaptive capacity. The central tenet in comprehending both is that they underscore an uneven distribution of existing resources, rather than a scarcity (Gaillard, 2010; Ribot, 1995; Sen, 1984).

The inability of certain groups to secure resource access and the ability to adjust to climate-related impacts arises directly from their lack of control over daily life, their restricted choice of residence, and limitations in securing livelihoods. Consequently, climate-related impacts and the resulting distress faced by specific populations signify a failure in development, where vulnerabilities converge with other development-linked crises' origins (Gaillard, 2010, p. 222). These developmental shortfalls emanate from issues tied to various social hierarchies grounded in racial, caste, and gender discrimination, poverty, and power differentials.

1. **Social Categories: Race, Caste, and Gender**

Rather than manifesting as overt acts of explicit racial bias, structural racism operates subtly, generating racial disparities in educational achievements, income levels, and wealth by perpetuating unequal resource access (Bonilla-Silva, 1997; Lopez, 2003). This form of racism, defined as 'the complete web of social relations and practices that uphold white privilege' (Bonilla-Silva, 2013, p. 9), contributes to heightened vulnerability among non-white populations in the United States. Within the U.S., as of 2014, white households earned 65% more income and possessed 13 times the wealth of African American households (Pew Research Center, 2016). The latter were disproportionately impacted by home foreclosures after the 2009 recession (Rugh & Massey, 2010). These disparities can lead to adaptation planning that inadvertently ignores racial factors, further deepening inequalities in accessing resources necessary for climate adaptation (Hardy, Milligan, & Heynen, 2017). For example, on the Chesapeake Bay's Eastern Shore, three African American communities experienced social and political isolation, diminishing their access to resources for adapting to frequent floods and limiting their influence in government decisions (Miller Hesed & Paolisso, 2015). Consequently, strategies to reduce vulnerability should pay attention to the unique challenges faced by populations along lines of race, class, gender, ethnicity, and other facets of social distinction. Similar dynamics, specific to each region, can drive inequitable adaptation planning in contexts outside the United States (Graham, Barnett, Fincher, Mortreux, & Hurlimann, 2015; Sultana, 2017).

In various countries, individuals encounter social discrimination based on endogamous, hereditary, and hierarchical caste systems. While not always officially recognized, these societal divisions can significantly impact exposure to climate-related consequences, along with access to essentials like food, water, land, education, and government support including disaster relief. In India, the concept of caste is now understood as fluid, dynamic, and contested. However, research in Orissa revealed that upper-caste women adapted more effectively to multiple disasters than lower-caste women, who lacked stable housing and local networks to shield them from floods, cyclones, and droughts (Ray-Bennett, 2009). These cases underscore how caste, class, gender, and other social categories intersect to form distinct vulnerabilities, detectable only through such intersectional analysis (Bosher, Penning-Rowsell, & Tapsell, 2007).

Gender significantly shapes vulnerability to climate-related impacts. Factors like inadequate access to resources and limited control over them accentuate women's susceptibility, undermining their capacity to manage the consequences of disasters. A study in coastal Bangladesh examined the immediate and gradual effects of cyclone Aila in 2009, including increased challenges like working in hotter fields, fetching water from salt-contaminated wells, and repairing infrastructure damaged by recurrent tidal floods (Al Nahian, Islam, & Bala, 2013). These situations heightened the difficulty of women's daily resource gathering tasks, leading to increased food insecurity. The study also revealed that due to constrained gender roles, women were unable to attend NGO training or income-generating activities without spousal consent. The most stark illustration of women's vulnerability occurs when cultural and religious norms prevent them from evacuating rising floodwaters without male accompaniment. Therefore, addressing vulnerability mandates a comprehensive grasp of gender dynamics, alongside their interactions with race, caste, and class.

2. Poverty and Vulnerability

Climate-related disasters disproportionately afflict impoverished individuals and nations, yielding the most severe repercussions for them (Roberts & Parks, 2006). The intricate relationship between poverty and vulnerability unfolds through multiple dimensions. Vulnerability hinges on the economic, institutional, and political capabilities of diverse individuals affected by climate-induced impacts (Bohle et al., 1994). When access to resources is constrained by financial limitations, vulnerability emerges from a lack of economic capacity. If certain groups inhabit areas devoid of essential resources, vulnerability springs from an institutional capacity deficit. Furthermore, when resource access is curtailed by exploitation or unjust resource distribution, vulnerability arises from a deficiency in political capacity to attain or retain resources. While all these marginalized groups might be characterized as impoverished, strategies to mitigate or

diminish their vulnerability can significantly vary.

Numerous groups contend with overlapping deficits in economic, institutional, and political capacity. Consider disaster preparedness, encompassing the formulation of disaster plans, resource stockpiling, insurance acquisition, defence establishment, and information seeking. For economically disadvantaged households and communities, climate threat readiness is more arduous due to limited income, time, language proficiency, and awareness regarding resource access (Mileti, 1999). Vulnerability among these communities stems from both their insufficient resources for climate impact preparation and the paucity of institutional capacity to provide these resources in an accessible format.

Another illustration highlights the limitations of standard disaster warnings for impoverished communities. In Bangladesh, successive devastating floods and cyclones prompted the government to shift focus from relief and recovery to early alerts and evacuations, leading to remarkable reductions in associated fatalities (Ribot, 2010). Nonetheless, Bose (2015, p. 5) observes that these benefits often evade informal settlements in Dhaka due in part to 'the inability to notify residents lacking legal property titles or stable residences, and the transient nature of the communities'. These households face vulnerability owing to an institutional capacity shortfall that excludes them from disaster warning initiatives. Furthermore, their inability to claim legal status underscores their lack of political capacity.

A prevalent poverty-vulnerability nexus pertains to the built environment. Impoverished dwellings are often more susceptible to weather and climate impacts, as they are often situated in hazard-prone zones like floodplains and unstable slopes (e.g., Wisner, 2001). Poorly constructed buildings heighten sensitivity to climate effects rendering the impoverished susceptible to climate change itself while magnifying post-disaster recovery challenges. Following Hurricane Andrew, for instance, although the Federal Emergency Management Agency (FEMA) established disaster-assistance canters, those most affected by the storm -largely impoverished- received limited relocation aid due to transportation and childcare barriers, and work-related constraints on claims filing (Dash, Peacock, & Morrow, 1997). For the impoverished, recovering from climate-related disasters often involves securing safe housing and relocating (Fothergill & Peek, 2004), both of which reflect deficiencies in economic, institutional, and political capacity, all interlinked with power dynamics.

3. Dynamics of Power

The dynamics of influencing and coercing various groups -collectively known as social power- originate from and perpetuate the social hierarchies that generate imbalances in resource access, ultimately leading to varying vulnerabilities across communities. Hence, power differentials can be perceived as a fusion of the preceding two issues discussed. Vulnerability emerges not solely from the

marginalization or impoverishment of specific social groups, but also through mechanisms that sustain or exacerbate marginalization, poverty, and even adaptation planning. Groups with greater political influence are better positioned to secure funding for climate impact planning, adaptation, and response. It is plausible that inequalities in adaptive capacity can be intensified by permitting 'influential geographical groups to limit detrimental environmental effects and capture favourable environmental outcomes in specific locations, yielding unjust socio-environmental repercussions' (Collins, 2010, p. 265).

Concerning climate change's coastal impacts, these disparities are compounded financially through unequal allocation of adaptation resources and physically through constructing sea walls or similar coastal defences that essentially transfer the issue elsewhere. In many coastal hazard scenarios, structures like sea walls, dikes, and flood channels -dubbed 'grey infrastructure'-may safeguard targeted populations while redistributing risk to other areas (Atteridge & Remling, 2018). In Southeast Asia, flood risk strategies heavily reliant on structural measures prioritize shielding high-value assets that benefit local elites over preserving ecological services such as productive fisheries, wetlands, and floodplains that primarily support rural farming and fishing communities. In a study spanning eight global cities, two primary pathways were identified where vulnerability reduction efforts could exacerbate inequality (Anguelovski et al., 2016). First, initiatives like infrastructure investments, land-use regulations, or new protected zones disproportionately affected or displaced disadvantaged groups (Anguelovski et al., 2016, p. 334). The second pathway pertained to approaches that favoured economically valuable areas over low-income or minority neighbourhoods, framed adaptation as an individual responsibility rather than a communal good, or omitted the affected communities from the decision-making process. Beyond heterogeneous urban environments, the conventional dichotomy between 'rural' and 'urban' inadequately captures the diversity of relationships between individuals and the landscapes significantly influencing vulnerability. Even in densely populated regions, if most people face similar exposure to local climate impacts, distinct activity spaces—defined as geographic extents traversed in daily routines- can yield divergent effects (Ren, 2016). Notable disparities emerged in the aftermath of the 2005 Maharashtra Floods in Mumbai, India, and Hurricane Sandy.

In sparsely populated areas, the livelihoods of individuals engaged in agriculture, forestry, and fisheries are intimately tied to the environment. Climate impacts imperil not only their well-being but also their economic sustenance (Berkes, 2007; Watts et al., 2015). Access to medical care and disaster response resources may also be more limited compared to higher population density zones. In regions with lower population densities, declining resources

coincide with the privatisation of public services and restricted social-service delivery, albeit with variations. Whether in densely or sparsely populated areas, daily activity spaces impact health, exposure to environmental pollutants, food accessibility, and the capacity for both short- and long-distance travel. Programs aimed at reducing climate change vulnerability should thus be tailored to specific social contexts (as exemplified in cases like the Navajo Nation and Southern Appalachia). Further research is crucial to determine the optimal combination of capacities -those addressing specific climate-related impacts (specific capacities) and those remedying structural deficits (e.g., income, education, and political power disparities; i.e., generic capacity)- that are essential in diverse locations (Lemos, Lo, Nelson, Eakin, & Bedran-Martins, 2016). Elevating these capacities and addressing issues of power, poverty, race, caste, and gender necessitate a transformative shift in climate change governance practices.

4. Governance and Climate Change

The realm of governance -how societies tackle problems through governmental bodies and other organizations- simultaneously shapes and responds to vulnerabilities arising from climate change. The scope of governance transcends formal governmental structures, encompassing 'the interactions between government and society, including the mechanisms through which private actors, markets, and interest-driven networks influence policy choices' (Chaffin et al., 2016, p. 401). Climate change poses both immediate 'pulse' challenges like Cyclone Nargis, which claimed over 130,000 lives in Myanmar in 2008, and gradual 'press' events such as rising sea levels (Collins et al., 2011). The need for distinctly diverse governance styles and institutions for these scenarios cannot be overstated.

At its core, representation emerges as a fundamental concern. Representation refers to the ability of various groups to engage in the political processes that shape procedures and impact outcomes, a vital component for human security amid climate-driven pressures. Building upon Sen's (1984) insights on capabilities and the origins of famine, Watts and Bohle introduce the notion of a 'vulnerability space', where control over resources (like food), class-rooted patterns of social reproduction, and overall rights intersect. They posit that 'reducing vulnerability necessitates the promotion of entitlements', which is fundamentally political (Watts & Bohle, 1993, p. 49). Famine (and similarly, the catastrophic aftermath of climate-induced disasters) disproportionately affects three intersecting groups: those lacking resources, those lacking power, and those exploited. This social mapping of vulnerability types, they contend, also corresponds spatially, with different global regions ranking higher or lower on each variable (Watts & Bohle, 1993, p. 56). This viewpoint illuminates how governance marked by skewed power distribution, perpetuates and perpetuates vulnerability

patterns; addressing governance is pivotal in vulnerability reduction.

Non-Governmental Organizations (NGOs) play a pivotal role in diminishing climate change vulnerability. Advocacy organizations representing vulnerable populations can challenge governmental climate policies' effectiveness in reaching the impoverished, while alliances between governments and local NGOs can significantly amplify the capacity for impactful societal action. The ascension of climate concerns on local governments' agendas encourages novel partnerships spanning sectors. For instance, climate change significantly affects health (Watts et al., 2015), such as heightened asthma incidence. As these causal links become better comprehended, hospitals, universities, and state health departments join forces with social advocacy groups, labour unions, and environmental organizations to design initiatives addressing health and broader environmental well-being (Rudolph, Gould, & Berko, 2015).

To foster scientifically sound and socially resilient approaches to adaptation, community groups must be engaged at every phase: identifying challenges, crafting responses, executing actions, and evaluating outcomes. The Centres for Disease Control and Prevention (CDC) adopt a community-based participatory research model -initially developed for comprehending and addressing health concerns- that could be adapted to build resilience (Simonds, Wallerstein, Duran, & Villegas, 2013). Other institutions have carried out numerous programs using iterative engagement, tackling issues such as disaster management in the Philippines and water and crop management in Ghana (Allen, 2006; Tschakert & Dietrich, 2009). As the cases discussed here exemplify, fostering relationships cultivates accountability among experts and policymakers, surmounting the deficiencies of top-down decision-making.

Vulnerability to climate change is not universally uniform across populations. The roots of vulnerability predominantly lie within the realms of social and economic dynamics, extending beyond variations in exposure to climate-induced hazards and environmental perils.

A pivotal determinant of communities' capacity to strategize and counteract climate change impacts is their access to resources. Mitigating disparities in resource accessibility presents a dual challenge: it demands localised actions aimed at communities or specific projects, coupled with more comprehensive systemic shifts to alleviate poverty and political marginalization. Climate change introduces both immediate and long-term complexities into effective governance strategies.

Conclusion : Developing nations are disproportionately affected by climate change, particularly due to the challenges of urbanisation, escalating water scarcity, and insufficient technological advancements. The transfer of technology and knowledge has yielded limited aid to these countries thus far. Crafting effective adaptation

strategies is imperative to mitigate or prevent the adverse consequences of climate change on food security. Within the food system, adaptation initiatives aim to curtail vulnerability and bolster the system's adaptability to climate shifts. In specific regions, prolonged climatic events are reshaping agroecological zones. Adapting to extreme occurrences seeks to minimise harm, alter hazards, avert detrimental consequences, and apportion losses, culminating in a more resilient system. Beyond existing and projected climate alterations, successful adaptation necessitates both technological solutions such as biotechnologically produced new crop varieties and non-technological approaches like improved land management and market mechanisms.

Evidentially, collaborative approach is indispensable for sufficiently mitigating the impacts of climate change. Despite ongoing extensive efforts, certain regions continue to lag in progress. Nevertheless, the research literature has outlined several clear future trajectories. Anticipate growing populations, increased demands, and shifting dietary habits. Meeting these needs will heavily rely on enhanced productivity, as the potential for agricultural land expansion remains extremely constrained. Cognisant limitations should be placed on meat consumption, particularly red meats like beef, within reasonable bounds. Achieving this is a viable yet complex endeavour, given current consumer hesitance toward meat substitutes and persisting challenges in large-scale production. Elevating product awareness and fostering trust in alternatives should be prioritised. Concurrently, the consumption disparity between developed and developing countries must be ameliorated. Notably, discussions on reduced meat consumption should factor in considerations of marginalized lands and biodiversity. Furthermore, alternative diets with reduced meat intake yield evident health advantages (Tilman & Clark, 2014), warranting due consideration.

References :

1. Anguelovski, I., Shi, L., Chu, E., Gallagher, D., Goh, K., Lamb, Z., … Teicher, H. (2016). Equity impacts of urban land use planning for climate adaptation: Critical perspectives from the global North and South. *Journal of Planning Education and Research*, **36**(3), 333–348.
2. Atteridge, A., & Remling, E. (2018). Is adaptation reducing vulnerability or redistributing it? *WIREs Climate Change*, **9**(1), e500–e516.
3. Al Nahian, M., Islam, G. M. T., & Bala, S. K. (2013). A new approach in gender vulnerability assessment using matrix framework. In *Proceedings of the 4th International Conference on Water & Flood Management* (ICWFM-2013). Dhaka, Bangladesh: Institute of Water and Flood Management
4. Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: Lessons from resilience thinking. *Natural Hazards*, **41**(2), 283–295.

5. Bennett, T. M. B., Maynard, N. G., Cochran, P., Gough, R., Lynn, K., Maldonado, J., … Cozzeo, K. (2014). Indigenous peoples, lands, and resources. Climate change impacts in the United States. In J. M. Melillo, T. C. Richmond, & G. W. Yohe (Eds.), *Third national climate assessment* (pp. 297–317)
6. Chaffin, B. C., Garmestani, A. S., Gunderson, L. H., Benson, M. H., Angeler, D. G., Arnold, C. A., … Allen, C. R. (2016). Transformative environmental governance. *Annual Review of Environment and Resources*, **41**, 399–423.
7. Collins, S. L., Carpenter, S. R., Swinton, S. M., Orenstein, D. E., Childers, D. L., Gragson, T. L., … Whitmer, A. C. (2011). An integrated conceptual framework for long-term social–ecological research. *Frontiers in Ecology and the Environment*, **9**(6), 351–357.
8. Fothergill, A., & Peek, L. A. (2004). Poverty and disasters in the United States: A review of recent sociological findings. *Natural Hazards*, **32**, 89–110.
9. Hitz, Samuel, and Joel B. Smith. 2004. "Esti- mating Global Impacts from Climate Change." Global Environmental Change, 14(3): 201–18.
10. Sen, A. (1984). Rights and capabilities. In A. Sen (Ed.), *Resources, values and development* (pp. 307–204). Oxford, England: Basil Blackwell.
11. Ribot, J. (1995). The causal structure of vulnerability: Its application to climate impact analysis. *GeoJournal*, **35**(2), 119–122.
12. Roberts, J. T., & Parks, B. (2006). *A climate of injustice: Global inequality, north-south politics, and climate policy*.
13. Wisner, B. (2001). Risk and the neoliberal state: Why post-Mitch lessons didn't reduce El Salvador's earthquake losses. *Disasters*, **25**(3), 251–268.
14. Watts, M. J., & Bohle, H. (1993). The space of vulnerability: The causal structure of hunger and famine. *Progress in Human Geography*, **17**(1), 43–68.