

Examining the Interdependencies among Livelihood Capitals and their Role in Shaping Adaptive Capacity to Climate Change in Vulnerable Communities: A Systematic Literature Review

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Abstract

Sustainable livelihood in vulnerable communities is increasingly threatened by factors such as climate change, poverty, and inequitable access to livelihood resources. The Sustainable Livelihood Framework (SLF) identifies natural, financial, human, social and physical capital as elements for examining how households build resilience and sustain livelihood under such conditions. However, despite extensive application of the SLF across geographic and socio-economic contexts, critical gaps remain in understanding how the interdependencies among these capitals collectively shape adaptive capacity to climate change, especially in vulnerable countries. A systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was used to identify the nature, patterns and implications of livelihood capital interdependencies in the context of climate resilience using peer-reviewed literature through a rigorous search and screening procedure across major academic databases. Results reveal that livelihood capitals are not independent of each other but rather constitute an interdependent system, in which the effectiveness of any single capital depends on the presence and quality of the others. Social capital is identified as the most interconnected capital, with human capital being the most transformative across capitals. Financial capital is highly versatile and functions effectively as a catalyst for other capitals, while Natural capital is the most vulnerable to climate variability and human exploitation, yet it supports all other capitals. Physical capital requires mostly social, human, and financial investment to generate sustainable outcomes. In conclusion, integrated asset-based policy frameworks are required to simultaneously strengthen multiple capitals, advance context-specific implementation strategies, and foster multi-sectoral collaboration to achieve durable livelihood sustainability and climate resilience.

Keywords: Sustainable Livelihood, Livelihood Capital, Climate Resilience, Climate change adaptation, Vulnerable Communities.

Introduction

Climate change represents one of the threats to sustainable development, affecting the livelihood of the poor and marginalized communities, especially in developing countries, which has called for urgent action on its impacts through Sustainable Development Goal (SDG) 13(climate action) (UN, 2015). Funk et al., (2020) and Piya et al., (2019) observe that

flooding, prolonged droughts, heatwaves, and ecosystem degradation limit the capacity for both rural and urban households to sustain their livelihood, making them vulnerable. This vulnerability is compounded by socio-economic factors such as limited access to financial services, inadequate infrastructure, weak institutional support systems and declining natural resource bases, which limit the capacity of households and communities to adapt, recover, and build long-term resilience to climate change (Ellis, 2001; Gasper et al., 2011; Ngoma et al., 2024; Scoones, 1998).

The concept of sustainable livelihood has gained importance in the development agenda. Livelihood refers to the ability to obtain the basic needs, comprising all the activities, income, and assets, including material and social resources, such as food, shelter, water, energy, and clothing, among others, as a means of living (Chambers & Conway, 1992; Ellis, 2001; Piya et al., 2019). While Sustainability is defined as the development of strategies that meet present needs without compromising the ability of future generations to meet their own needs. It emphasizes the integration of environmental, social and economic well-being (De La Cruz López et al., 2021). In most vulnerable communities of developing countries, these basic needs, and their delivery by government, are limited, which results in rural and urban populations turning to natural systems for basic survival, or emigrating from rural to urban areas (Ellis, 2001; Igben, 2021; Selvaraju et al., 2006). Igben, (2021) and Scoones, (1998) argue that livelihood is a way of harnessing the environment to fulfil living both short and long-term needs, while sustainable livelihood is explained as sustaining the current resource needs while meeting the long-term needs of a population (Chambers & Conway, 1992; Scoones, 1998).

Therefore, Serrat (2017), describes sustainable livelihood as the ability to absorb external shocks or stress and to recover from such through maintaining or improving one's livelihood. A sustainable livelihood can mitigate risks, recover from climate change, maintain or enhance capabilities, and provide net livelihood benefits in the short and long term (Etana et al., 2021; Nelson et al., 2014), thus coping and recovering from unprecedented stresses and shocks now and in the future to reduce Climate Change vulnerability (Matovu et al., 2024). It also tries to improve the living conditions for the present and future by maintaining and enhancing the assets and capabilities without compromising the natural resources base (Matovu et al., 2024; Scoones, 1998), thus climate change is a threat to achieving the goal of sustainable livelihood (Funk et al., 2020; Selvaraju et al., 2006). In other words, a livelihood is sustainable when it can cope with and recover from stress and shocks, maintain and enhance its assets, and provide sustainable livelihood opportunities for the next generation.

The Sustainable Livelihood Framework and other studies have demonstrated that livelihood capital (natural, physical, social, human, and financial) is a resource that households, especially those in vulnerable communities, use to build resilience and improve and sustain their livelihood (Chambers & Conway, 1992; Morse, 2025; Morse & McNamara, 2013; Natarajan et al., 2022; Pal et al., 2024; Scoones, 1998). Natural capital comprises land,

forests, and water. Physical capital includes infrastructure and equipment. Financial capital relates to income, access to credit, and savings. Human capital refers to education, skills, and health. Social capital encompasses networks, relationships, and institutional associations (Habib et al., 2023; Ma et al., 2024; Scoones, 1998).

Despite the widespread application of the SLF in research and policy planning, literature has mainly examined each capital type independently, with limited understanding of interdependencies among them, which presents a critical gap in understanding that the effectiveness of any single capital may be dependent on the availability and quality of the others (Beltrán-Tolosa et al., 2022; Prayitno et al., 2025; Scoones, 1998). This paper aims to examine evidence on the interdependencies among livelihood capitals within the SLF and how interactions shape adaptive capacity to climate change in vulnerable communities and enhance sustainable livelihood. It is also anchored on question, "how do interdependencies among livelihood capitals shape the adaptive capacity of vulnerable communities to climate change?"

Methodology

Study Design

A systematic literature review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. It was preferred for its ability and capacity to provide rigorous, transparent and replicable results while minimising selection bias and ensuring rigour (Alharbi et al., 2024). The design to capture which patterns, gaps, and conclusions from peer-reviewed literature across sustainable livelihood theory, climate change adaptation, and capital interdependencies using the following flow.

Identification, Eligibility and Screening of Literature

A systematic search of the academic literature was conducted in major electronic databases such as Scopus, PubMed, Web of Science and Google Scholar as the most used (Rethlefsen & Page, 2021). The search strategy employed a structured process across titles, abstracts, main text, and keywords such as ("sustainable livelihood" OR "livelihood capital" OR "livelihood assets") AND ("climate change" OR "climate resilience" OR "climate adaptation") AND ("social capital" OR "human capital" OR "natural capital" OR "financial capital" OR "physical capital") AND ("vulnerable communities" OR "rural households" OR "urban households" OR "poverty"). With keywords like "Sustainable Livelihood Framework," "five capitals," "adaptive capacity," and "livelihood interdependencies" used to supplement searches.

The initial database searches yielded 4,836 records, to which an additional 47 records were added through manual citation tracking from reference lists and after removing 1,203 duplicates, a total of 3,680 records were subjected to title and abstract screening which excluded 2,914 records due to insufficient or irrelevant literature to the study's thematic focus. The remaining 766 studies were fully assessed in text with 621 being excluded due to insufficient focus on livelihood capital interdependencies, unavailability of full text or/and

weak methodology. Among the 145 studies that remained, about 89 were published between 2015 and 2025, forming the primary evidence base of the review.

Inclusion and Exclusion Criteria

Studies were deemed eligible for inclusion if (i) they published in a peer-reviewed journal or institutional reports from the World Bank, or the United Nations agencies (ii) they published in English (iii) they focused son one or more dimensions of livelihood capital within the SLF (iv) they addressed themes of climate change, resilience, vulnerability or poverty reduction in relation to livelihood capitals and (v) employed clearly articulated and reproducible methodologies. Studies were excluded if, (i) focused on macro-economic capital theories without reference to household-level or community-level livelihood, (ii) did not have a linkage to a broader livelihood framework, (iii) were opinion pieces, editorials or conference abstracts without empirical or theoretical content or (iv) were not accessible in full-text format.

Full-text methodological quality was assessed using a standardised appraisal checklist appropriate to study design. Empirical studies criteria included clarity of research objectives, appropriateness of data collection methods, transparency of analytical procedures and reliability of findings while theoretical or conceptual works assessment focused on coherence of argumentation, grounding in established frameworks and engagement with the broader literature. Studies were rated as strong, moderate, or weak, with weak-rated studies excluded unless they provided unique theoretical contributions not available in other studies.

Data Extraction

Data extraction was conducted using citation details, geographic context, methodological approach, livelihood capital examined, findings related to capital interdependencies and implications for climate resilience and sustainable livelihood. Thematic analysis was guided by the five capital categories of the SLF as primary organising themes with patterns identifying complementarities, substitutions and capital vulnerability.

2.5 Summary of PRISMA Methodology

Main Process Box	Excluded Records	Included Studies	Stage Label
IDENTIFICATION	Database Search (Scopus, PubMed, Web of Science, Google Scholar) Records identified: n = 4,836		
	↓		

Main Process Box	Excluded Records	Included Studies	Stage Label
	Additional Records via Manual Citation Tracking Additional records: n = 47 ↓		
	Records After Duplicate Removal Duplicates removed: n = 1,203 Records remaining: n = 3,680	Duplicates Removed n = 1,203	
SCREENING	Title & Abstract Screening Records screened: n = 3,680 ↓	→	Records Excluded (Insufficient/Irrelevant to Thematic Focus) n = 2,914
	Studies Forwarded for Full-Text Assessment n = 766		
ELIGIBILITY	Full-Text Articles Assessed for Eligibility n = 766 ↓	→	Full-Texts Excluded • Insufficient focus on capital interdependencies • Full text unavailable • Weak methodology n = 621
	Studies Meeting Eligibility Criteria n = 145		
INCLUSION	Total Studies Included in Review n = 145 ↓		
	Primary Evidence Base (2015–2025) n = 89		

Figure 1: PRIMA Flow Diagram

Results and Discussion

Literature Review/Synthesis

Assets and Sustainable Livelihood

Assets and asset-building are at the core of any poverty and vulnerability reduction strategy in times of stress and shock. As Scoones, (1998a) notes, that these assets function as a stock of resources that can be stored, exchanged, or allocated to activities to generate sustainable livelihood. Sustainable livelihood is a concept that seeks to gain an accurate and realistic understanding of people's strengths in having assets or capital and how they endeavour to translate them into positive livelihood outcomes. It highlights that no single category of assets is sufficient to transform livelihood but rather, a diverse or/and combined assets are required to ensure survival and resilience for vulnerable communities with limited access (Kim & Sumberg, 2015; Scoones, 1998), although different communities vary in terms of livelihood capital vulnerability (C. Zhang & Fang, 2020).

The Department for International Development (DFID) (1999), argues that the combination of assets in various ways can generate positive livelihood outcomes in two ways, that is sequencing and substitution. Sequencing suggests that, to escape poverty, it is necessary to start acquiring a particular combination of assets. It challenges the notion that access to one type of capital alone is sufficient and necessary to escape from poverty and becomes an important guide to provide a starting point for where livelihood support should be strengthened. On the contrary, substitution argues that one type of capital or asset can compensate for others. For example, increased natural capital, such as land, can compensate for limited financial capital to which support can be extended. In this case, assets are not merely instrumental means with which they make a living but also shape the structures and conditions under which livelihood are pursued. Additionally, Prayitno et al. (2025), highlight that, when combined, assets are resources that people use to build livelihood by giving households the capacity to adapt to stress like climate change and eradicate poverty. They are also a basis to challenge, reproduce, or even change rules that govern the control, use and transformation of resources (Bebbington, 1999). Therefore, the Sustainable Livelihood Framework operationalizes this concept by identifying the five assets (social, human, natural, physical, and financial capital) that households draw upon for a sustainable Livelihood (Li et al., 2017; Mobeen et al., 2023).

Interrelations among Assets

Social Capital Versus other Capitals

Social capital is resources upon which people draw in pursuit of their livelihood outcomes developed through networks and cooperations that increase people's trust and ability to work together in communities, especially in times of distress (Woolcock, 1998; H. Zhang et al., 2024). It creates trust and reciprocity, in the community which lowers the costs of working together and enhances the effectiveness of infrastructural and financial interventions. It improves the efficiency of economic relations that can help increase

people's ability to make decisions, resource mobilization and management, generate incomes and make savings through cooperatives and savings groups (financial capital)(Prayitno et al., 2025; Straub et al., 2024; Y. Zhang & Zhao, 2024), which in this case may lead to a wealthier community. Additionally, social capital can help in the effective improvement and management of common natural resources (natural capital), living conditions(human capital), employment opportunities(financial capital), and the maintenance of shared infrastructure (physical capital) through cooperation, mutual understanding and a sense of ownership of these resources within communities(Department for International Development (DFID), 1999; H. Zhang et al., 2024). Kamsi et al., (2025) amplify that communities often rely on social networks when financial and physical resources are limited. Simply put, social capital can help build other capitals. Rahmawati et al. (2024) and Zhang & Zhao, (2024) further highlight that social networks facilitate innovation through the development and sharing of knowledge, linking a close relationship between social and human capital.

Social capital may also be valued as self-sufficient, as it makes particularly important contribution to people's sense of well-being through identity and belonging and among the five livelihood assets, it is the most connected to Transforming Structures that can be used as a product and processes to transformation (World Bank, 2024). For example, in Zambia, the government and NGOs are implementing cash transfer programs (cash for work) illustrate how social protection systems foster human, environmental, financial, social, and physical capital simultaneously to mitigate the effects of shocks to reduce poverty, vulnerability, and inequality and build resilience for sustainable livelihood (GRZ, 2024; Pruce, 2025; Schubert, 2005; World Bank, 2024). Despite the importance of social capital Zhang & Zhao, (2024) observe that its effectiveness diminishes with widening income inequalities among vulnerable households. This means that as households begin to build income, they often lose motivation or capacity to invest in relationships, which erodes social capital. Additionally, climate-related displacement and migration can both disrupt existing social networks and create opportunities for new forms of social capital, presenting complex challenges for maintaining social unity during livelihood transitions(Ma et al., 2024). Thus, while social capital is foundational to building other capitals, it remains vulnerable to broader socio-economic and environmental shocks and should be understood dynamic process rather than a guaranteed safety.

Natural Capital Versus other Capitals

Natural capital, a term used for the natural resources such as land, biodiversity and trees, among others, is recognized as one of the most important determinants of sustainable livelihood (Du et al., 2025). The relationship between natural capital and the vulnerability context is significant because many of the shocks that devastate livelihood are themselves natural processes that destroy natural capital. For example, fires destroy forests, while floods and earthquakes damage agricultural land (Department for International Development (DFID), 1999). Natural capital is important for both rural and urban

communities that derive all or part of their livelihood from resource-based activities such as farming, fishing, gathering in forests and mineral extraction. Therefore, areas with well-developed natural capital often rely less on financial capital (Kamsi et al., 2025). Suggesting that natural resources can serve as a foundation upon which other capitals are generated.

Natural capital fosters job and skills creation(human capital), income generation through tourism and enhances food security(financial capital) (Auliah et al., 2025; Kovalyshyn & Monastyrskyy, 2023; World Bank, 2025). However, it is argued that human life is dependent on key environmental services and food produced from natural resources or capital. For instance human capital such as health and labour will tend to suffer in areas where air quality is poor as a result of industrial activities or natural disasters such as forest fires (He et al., 2020; Paudel, 2023; Zhao et al., 2020), which in the long run may affect social and human capital by reduced social interaction and health when a pandemic or outbreak occurs resulting in reduced financial capital through economic activities(Liu et al., 2021; Pitas & Ehmer, 2020; Samutachak et al., 2023). Evidence also shows that natural capital (tree cutting) may also be disrupted at the expense of physical capital For example, putting up a solar power plant to provide clean energy. Similarly, financial capital in rural areas is raised through ecologically damaging activities such as charcoal burning, bark harvesting, worm collection, and land clearing, which drive deforestation(natural capital), to buy solar energy(physical capital) (Chanda et al., 2025; Manning, 2023).

While natural capital supports the generation of other capitals, human capital (skills, health), financial capital (income from farming, tourism, or resource use), and physical capital (infrastructure like energy systems), as well as fostering social networks, it is highly vulnerable to both climate change and human exploitation. Therefore, strategies for resilience must prioritize protecting and regenerating natural capital, as it is not easily replaceable by other capitals.

Physical Capital Versus other Capitals

Physical capital is basic infrastructure that supports communities to meet their basic needs, these include affordable transport, shelter and buildings, improved water supply and sanitation, clean and affordable energy, and access to information (Xu et al., 2023). Like other relations among capitals Amir-ud-Din et al., (2019) state that physical capital and human capital are closely associated. For instance Hakayuwa et al., (2025), Tutu et al., (2019); Wahed et al. (2013) observe that diseases such as cholera are more prevalent in poor and illiterate communities. When physical capital, such as water supply, sanitation and affordable energy are inadequate, human health (human capital) and economic activities are affected, causing disease and reduced income levels in communities (Mackebach, 2020; Naidoo, 2023; Trépanier et al., 2025; Umar & Kunda-Wamuwi, 2019).

Additionally, Uddin et al. (2025), highlight that infrastructure such as roads and markets also plays a critical role in strengthening market linkages which enhances trade and income.

Similarly, physical capital, such as infrastructure and equipment, enables production efficiency of human capital, such as education, training, and workforce health, enhances productivity and innovation (financial capital) (Novegya Ratih Primandari, 2025; Sairmaly, 2023; Srinivasu & Rao, 2013). Likewise poor infrastructure can hamper education, access to health services and access to markets and income generation activities all associated with other capitals (Ezeudu & Fadeyi, 2024; Srinivasu & Rao, 2013). For example, For example, without proper transport infrastructure, essential farming inputs such as fertilizer cannot be distributed effectively, leading to low agricultural yields and limited market supply, which in turn increases the cost of living. Planas-Carbonell et al. (2023), note that projects like green infrastructure, which enhance natural and physical capital to mitigate and adapt to heat and floods create social benefits and economic opportunities. However, such projects can disrupt social capital when equity is not accounted for. For instance, green adaptation infrastructure, while providing environmental and economic benefits, may lead to the displacement or exclusion of marginalized populations. On the contrary, Investments in climate interventions such as resilient housing, drainage systems, and public transport (physical capital) and by creating jobs and skills (financial and human capital). It also creates strong community networks (social capital) that come together in disseminating warnings and coordinating responses to the maintenance of public infrastructure (Planas-Carbonell et al., 2023; Prayitno et al., 2025).

Physical capital creates a foundation upon which other forms of capital are built and sustained and does not operate in isolation for its effectiveness. Human capital thrives when supported by infrastructure that enables education and workforce health, financial capital expands through productivity and trade facilitated by infrastructure, and social capital is strengthened when projects are inclusive and equitable. Similarly, climate-smart infrastructure can enhance natural capital while simultaneously generating social and economic benefits. However, a lack of physical capital can also exacerbate vulnerabilities, leading to poor health outcomes, reduced income, and weakened social cohesion.

Human Capital Versus other Capitals

Human capital is one of the essential elements for household use in order to attain a sustainable livelihood, which comprises the basic human skills, knowledge, ability to labour and good health (Gallegos, 2025; Pasban & Nojodeh, 2016). Its amount and quality depend on household size and leadership, skill level and health status, among others. Human capital affects community livelihood and access to other assets with even slight changes (Makupa et al., 2023). Human capital such as health status, training or education, is directly related to productivity and food security. Good health and knowledge will enable people to use their skills for income generation thereby increasing their earning capacity, as well as financial literacy that allows households to make informed decisions in financial markets, contributing to profits and stability (Saroj et al., 2024; Woodhall, 1987). Jie & Lan, (2024) add that the expansion of the financial sector is significantly impacted by human and natural capital. Likewise Mobeen et al., (2026) highlight that, better knowledge enables effective

generation and use of financial capital, more climate-resilient farming and better maintenance of physical capital such as infrastructure, such as drainages and bridges as well as better community social relations (Mobeen et al., 2026)

Radulescu et al., (2025), Shi & Xu, (2023) and Zhang, (2024), further note that, human capital will also lead to preservation and creation of natural capital through sustainable resource use and conservation through education, environmental awareness and stewardship and technical capacity to manage forests, water, soil and biodiversity. In addition, human capital provides the skills and health to sustain social capital, such as cooperatives and communal labor which are the very foundations of trust and shared networks (Olabiyi et al., 2025; Puskarova, 2022). Human capital accelerates the growth of physical capital by making infrastructure, equipment and technology (physical capital). A skilled workforce is needed to build roads, maintain machinery and operate new technologies (Osei, 2024; Radulescu et al., 2025; Thach, 2025).

Human capital is key to sustainable livelihood and the effective utilization of other capital. The skills, knowledge, health, and labor capacity of individuals determine not only household resilience but also the ability for communities to access, maintain, and expand physical, financial, social, and natural capital. Good health and education enhance productivity, financial literacy, and income generation, while technical knowledge supports the preservation of natural resources and the maintenance of physical infrastructure. Moreover, it can also foster cooperation, trust, and collective action within communities which enhances social capital. Therefore, because human capital is dynamic, as its quality and quantity can shift rapidly with changes in health, education, it stands out to be the most integrative and transformative asset for the growth, sustainability, and resilience of all other capitals.

Financial Capital Versus other Capitals

Financial capital is arguably the most versatile of the five types of capital and is regarded as the primary source of capital for adaptive investments (Azad & Pritchard, 2022; Habib et al., 2023; Li et al., 2017; Mumuni & Oladele, 2016). It cannot alone solve all the problems of Poverty (Prayitno et al., 2025). However, it can easily be converted into other types of capital and can directly achieve livelihood outcomes (Hakayuwa et al., 2025; Hinfelaar, 2025; Silengo, 2022; Tiwari et al., 2016). For instance, the purchase of food or relief items to reduce food insecurity or recover from disasters.

Financial capital which includes access to credit and income, creates human capital through payment for services such as education and health services (Habib et al., 2023). Financial inclusion programs promoted by institutions such as banks and cooperatives formalize economic interactions that reinforce social capital between households and formal institutions, by expanding trust and facilitating collective resource access (Huang et al., 2024). Access to lending networks such as village banking enables investment such as solar kits, irrigation systems, houses, transport and farming inputs (physical capital) that

enhances livelihood productivity (Azad & Pritchard, 2022; Habib et al., 2023). Additionally, roads, markets, and access to energy (physical capital) are drawn from financial assets enabling better market participation and higher returns on other assets. On the other hand Dammak et al., (2025) notes that the linkage between financial capital and natural capital is more complex, when financial capital is available, households can adopt environmentally sustainable technologies and practices such as soil conservation and water harvesting, and invest in the restoration or protection of natural resources, which effectively conserve natural capital. Availability of financial capital also promotes livelihood diversification which eventually reduces pressure on over-exploiting natural resources in times of stress, preserving natural capital (Bwalya, 2023; Habib et al., 2023; Ho et al., 2024; Yego et al., 2025).

Therefore, financial Capital supports human capital through education and health but also reinforces social capital through trust and collective resource-sharing. Similarly, financial capital facilitates the development of physical capital by enabling investments in housing, transport, energy, and farming inputs, while also supporting the preservation of natural capital through sustainable technologies and livelihood diversification. The effectiveness of financial capital is however, dependent upon the presence of complementary assets such as skills and community trust. Thus, financial capital is best understood as a catalyst rather than a standalone solution because in climate resilience is seen by integrating with human, physical, social, and natural capital to foster sustainability.

Evidence of Livelihood Capital in Enhancing Sustainable Livelihood

Livelihood capital (human, natural, financial, social and physical) are widely regarded as the foundation upon which poor households can eradicate poverty and achieve sustainable development (Scoones, 1998; Wang et al., 2021). Therefore the ability of a household to attain sustainable livelihood depends on access to these assets (Asmamaw et al., 2019; Chepkoech et al., 2020; Hlahla & Hill, 2018) and also their absence reflects a lack of resilience to climate change in vulnerable rural and urban communities thereby making livelihood unsustainable (Ngoma et al., 2024; Pandey et al., 2017). Therefore, it is important that governments and development agencies develop targeted poverty alleviation policies and programs that aim to build livelihood capital and achieve sustainable poverty reduction especially in poor households (Zhao & Lan, 2023), as wealth households generally have better and wider access to capital to invest as compared to poor households with limited access to assets and livelihood opportunities (Asmamaw et al., 2019). Therefore, a deliberate policy framework that achieves poverty reduction and climate resilience (Shepherd et al., 2025) and integrates sustainable livelihood approaches (SLA) with an assessment to advance assets development is one way to develop adaptive capacity to climate change (Clay, 2018). Further, Beltrán-Tolosa et al., (2022) argue that adaptation action to reduce vulnerability to climate change requires implementing policies encompassing the five capitals of livelihood (natural, financial, physical, human, and social), although most institutions have weak implementation strategies and do not target

different assets enhancements for adaptation strategies(Eshun & Denton, 2022; Opoku Mensah et al., 2026; Tweneboah-Koduah, 2025). It then becomes important for collaborative efforts between the public and private sectors, together with urban and rural communities, to build livelihood capital and attain sustainable livelihood and resilience(Eshun & Denton, 2022; Nyathi et al., 2025; Twinomuhangi et al., 2021).

Studies across diverse contexts(Europe, South America, Asia, and Africa) such as (Azad & Pritchard, 2022; Azhari et al., 2025; Cinner et al., 2018; Kuang et al., 2019; Muyambo et al., 2024)(Ma et al., 2024) have demonstrated through various methodologies indicator techniques, household surveys, key informants and observation with different study populations (rural and urban) to assess community resilience via the five livelihood capitals, have generally shown that human, natural, social, financial, and physical capital have a significant positive effect on adaptation capacity to climate change and livelihood sustainability in vulnerable communities. In Zambia, although not much studies have been explored to assess the extent of influence of the five livelihood capitals, (Ngoma et al., 2024) found some evidence suggesting that assets and education reduce vulnerability and increase resilience among smallholder farmers while Melore & Nel, (2020); Sakapaji, (2021; Siatwiinda et al., (2025) adding that indigenous knowledge(human capital) has been used to interpret climate signals as this informs seasonal planning and risk management in improving resilience.

Further, in other instances Awazi et al., (2022) observes that the use physical capital (ownership of farm equipment and use of irrigation systems) and human capital(indigenous knowledge) are the most important assets affecting climate change resilience for farmers. Despite the focus on strengthening policy for human and physical assets, it is important to complement these with financial, natural, and social assets to improve resilience among farmers. Findings also support this by noting that financial and social capital play a key part in coping with and adapting to heat stress(Sultana et al., 2025), livelihood risks and adapting to climate change(Sargani et al., 2023). According to Prayitno et al., (2025) financial capital by itself does not significantly increase resilience, but human, natural, physical, and social capital together have a major, beneficial impact on adaptive ability even though Sujakhu et al., (2019) and Azad & Pritchard, (2022) argues that an improved financial capital alone is the base that shapes and strengthens household adaptive capabilities to climate change. These contrasting findings highlight gaps about the importance of financial capital in resilience building.

Conclusion and Implication

This study highlights the complex interdependencies among livelihood capitals and their collective role in shaping the adaptive capacity of vulnerable communities to climate change. The study concludes that no single capital is sufficient for resilience, a combination of assets is essential. Social capital is the most interconnected capital supporting cooperative resource management, institutional trust and the capacity of other capitals to

generate livelihood outcomes. Human capital is the most transformative and integrative asset. Natural capital is the most vulnerable to both exploitation and climate variability and its depletion cascades across the capital portfolio. Physical capital provides support upon which other capitals function and its transformative potential is realised when accompanied by human skills, social cohesion and financial investment. Financial capital functions most effectively as a catalyst for multi-capital investment rather than as a separate mechanism for poverty reduction and climate resilience.

Social capital fosters trust and cooperation, natural capital provides resources, physical capital supports infrastructure, human capital enables skill development, and financial capital facilitates investments.

Livelihood capitals are interdependent assets that collectively determine household resilience, poverty reduction, and sustainable livelihood, as no single capital is sufficient on its own, they are dynamic in nature and are influenced by socio-economic and environmental factors. For example, income inequality can erode social capital, while climate change can deplete natural capital. Effective access to these capitals enhances adaptive capacity to climate change, while their absence prolongs vulnerability in vulnerable communities. Likewise, each capital is dynamic across time, region, and socio-economic contexts.

While there is a distinction between the complementarity and substitution of capitals both mechanisms as relevant to livelihood strategy however from the evidence we can conclude that substitution (one capital compensates for deficiencies in another) may provide short-term coping mechanism that may not generate durable resilience while Complementarity may represent higher-order integration of capitals that is associated with sustained adaptive capacity and this distinction carries significant implications about how interventions should be designed and evaluated.

Despite the proven importance of livelihood capitals, many institutions lack integrated strategies to enhance them, limiting their effectiveness in building resilience. These findings contribute to the growing body of evidence supporting the Sustainable Livelihood Framework as a tool for resilience-building and highlight the need for targeted and integrated policies.

Recommendations

Governments and development agencies should adopt integrated policies that address all five livelihood capitals. Climate change adaptation interventions must adopt context-specific, asset-based approaches that map vulnerabilities and prioritize the “complementarity” of capitals, also without overlooking “substitution” among capitals, which also plays a role in resilience building by allowing households to offset deficiencies in one capital with the strength of another. For example, physical infrastructure is more effective when reinforced by social networks and human skills, whereas financial capital is more impactful when aligned with the protection of natural resources and cooperation.

Policies should leverage local knowledge and social networks to enhance social and human capital. For example, indigenous knowledge can inform climate adaptation strategies. As well as Investments in climate-resilient infrastructure such as green energy and water systems, should prioritize inclusivity to avoid disrupting social cohesion.

Strategies to protect and regenerate natural resources should be prioritized, as natural capital is not easily replaceable. For example, reforestation programs can enhance biodiversity and support livelihoods. Institutions should also establish robust monitoring and evaluation systems to assess the impact of livelihood capital interventions and adapt strategies as needed.

Civil Society Organisations, governments, NGOs and other development agencies must collaborate and prioritize project implementation interventions that simultaneously and deliberately strengthen multiple and complementary capitals to build sustainable livelihood and resilience in vulnerable rural and urban communities.

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Disclosure of Conflict of Interest

The authors declare that they are not aware of any competing financial interests or personal relationships that may have influenced the work described in this document.

Statement of Ethical Approval

This study is a review of published literature and did not involve human or animal subjects. Therefore, ethical approval was not required.

Statement of Informed Consent

Due to the nature of this work (secondary analysis of peer-reviewed published data), informed consent is not applicable.

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