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REVIEW

# A systematic review of current progress in community based vulnerability assessments

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## Abstract

This systematic literature review critically evaluates the extent to which community-based vulnerability assessments are progressing towards less siloed approaches that address spatial and temporal interactions and multiple exposures. The review focuses on studies that apply the most commonly operationalised frameworks in the livelihoods and climate change disciplines between 2014 and 2023, the Sustainable Livelihoods Framework (SLF) (n = 72) and the IPCC AR4 Framework (AR4) (n = 101). This review found that a minimal number of studies are addressing limitations. This was most significant in relation to the inadequate consideration of spatial scale (SLF 1%; AR4 5%), future temporal scale (SLF 4%; AR4 7%), and exposure to multiple shocks and stressors (AR4 7%; SLF 8%) within studies. Progress was seen with respect to overcoming siloed perspectives, which had previously led to the exclusion of external shock and stressor events (SLF) or socioeconomic factors (AR4) within assessments. Despite this progress, AR4 based studies were found to exclude key components of adaptive capacity, particularly in relation to natural (28%), financial (57%) and components of social capital. Additionally, only 47% of SLF based studies measured exposure to shock and stressor events. To overcome limitations scholars must engage with i) less-siloed frameworks that combine perspectives from the livelihoods and climate change disciplines and ii) non-static approaches that assess vulnerability in the context of social-ecological systems or use ethnographic methods (e.g., scenario planning and participatory mapping) to contextualise outputs. By engaging with these limitations, scholars reduce the potential for assessments to produce ineffective, or maladaptive outcomes.

**Keywords** Community-based vulnerability assessments · Vulnerability limitations · IPCC AR4 · Sustainable Livelihoods Framework · Systematic review

## Introduction

The application of community-based vulnerability assessments (CBVAs) as tools to guide positive development outcomes is on the rise in low-income rural environments (Thiault et al. 2021; Windfeld et al. 2019). These studies aim to support local communities in achieving livelihood goals such as poverty reduction, sustainable natural resource use, or adaptation to global change by evaluating their likelihood of being impacted by exposure to shock and stressor events (Adger 2006; Serrat 2017; Smit and Wandel 2006). Assessment outputs are commonly used to inform the design and development of strategic management actions, by providing a basis to better understand the structural factors that drive vulnerability (Füssel and Klein 2006; Johnson et al. 2016; Thiault et al. 2020). Over recent decades CBVAs have increased in popularity and have primarily focused on vulnerability in the context of climate change, or the capacity to meet Sustainable Development Goals (Ford et al. 2018; Zhang et al. 2019). This has led to the implementation of CBVAs which are approached through the lens of climate change adaptation or livelihoods and development (from here on referred to as a livelihoods perspective). Where the

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former aims to support adaptation to physical shock and stressor events (Adger 2006), and the latter aims to alleviate internal socioeconomic conditions such as poverty (Scoones 2009). However, the existence of distinct limitations within CBVAs applied from these lenses has led scholars to question if outputs can adequately capture the complexities of human–environment interactions (McDowell et al. 2016; O'Brien et al. 2007). These limitations include i) failure to integrate the full range of biophysical and socioeconomic factors that drive vulnerability (Ford and Pearce 2012; Ford et al. 2018), ii) the limited consideration of spatial and temporal interactions that drive feedback effects for communities (Fekete et al. 2010; Thiault et al. 2018) and iii) failure to address vulnerability in the context of multiple shock and stressor events (Bennett et al. 2016). By failing to progress beyond these limitations, where CBVA outputs are used to inform management, there is a potential for maladaptive responses to emerge from well-intended actions (Castree et al. 2014; Magnan et al. 2016; Murphy 2011).

The origins and trajectory of the vulnerability concept within the livelihoods and climate change adaptation disciplines have resulted in distinct perspectives and desired outcomes for CBVAs (Adger 2006; Hufschmidt 2011; Janssen and Ostrom 2006). For example, when approached from the livelihood's perspective (Sen 1981), vulnerability is addressed as an internal socioeconomic condition, measured by quantifying a household's access to a list of pre-defined assets considered important in the context of livelihoods (O'Brien et al. 2007). Vulnerable households are identified as those that have limited access to these assets, placing them at risk of impact from undesirable social conditions such as poverty or food insecurity (Scoones 2009). Outcomes of this approach are framed around improving access to assets within a community (e.g., via the development of fair and just livelihood portfolios), and often give specific focus to the Sustainable Development Goals (Morse and McNamara 2013). Limitations of livelihoods based CBVAs relate to failures to consider how the broader context (i.e., external shocks and stressors that exist in a landscape in which a household operates) influences vulnerability (Dilley and Boudreau 2001; Mensah 2011). By exclusively analysing internal socioeconomic conditions, livelihoods based assessments are unable to understand how external events (such as climate change) may impact a community (McLean 2015). Additionally, the static nature of assessments means factors known to influence vulnerability across multiple spatial (e.g., institutional and governance context) and temporal (e.g., changing resource availability) scales are often not evaluated (Natarajan et al 2022).

CBVAs approached from the climate change adaptation perspective explicitly focus on addressing the broader vulnerability context in which a community operates (Burton et al. 1978; O'Brien et al. 2007). These CBVAs tend to assess spatial and temporal variation in the biophysical characteristics of climatic shocks and stressor events, before integrating this with a basic assessment of the socioeconomic conditions that are likely to be impacted by exposure to these events. This enables climate based CBVAs to predict a community's vulnerability to future biophysical conditions and develop adaptive actions (e.g., resilient livelihood portfolios) to reduce the potential socioeconomic impact of climate change (Adger 2006; Füssel and Klein 2006; Kelly and Adger 2000). Limitations of CBVAs approached from this perspective relate to an empirical focus on the biophysical characteristics of shock and stressor events, paired with an incomplete and static picture of internal socioeconomic conditions (Ford and Pearce 2012; Ford et al 2018; McDowell et al. 2016). This focus can lead to maladaptive management actions that fail to identify and account for the full extent of impact climate change will have on a community (Ford et al. 2018). Maladaptive management can also result from the mismatch that occurs when pairing future shock and stressor events with present-day socioeconomic conditions (Jurgilevich et al. 2017). Additionally, a focus on climate as the main driver of global change means CBVA's applied from this perspective often fail to consider the presence of key non-climatic shocks and stressors that exist within the landscape (e.g., resource extraction, land-use change, socioeconomic issues) (Bennett et al. 2016). This siloed focus on climate as the main driver of vulnerability has continued to persist despite an increased awareness of the cumulative impacts that result from multiple interacting global change pressures (Ford et al 2018; Rasanen et al. 2016).

In response to the limitations mentioned previously, vulnerability scholars have promoted a transition towards less siloed approaches to CBVAs that merge perspectives from the livelihoods and climate change adaptation disciplines to address vulnerability more holistically (Ford et al. 2018; Guerrero et al. 2018; Singh et al. 2017; Thiault et al. 2021). Such a transition would result in CBVAs that examine interactions between vulnerability arising from internal socioeconomic conditions (e.g., livelihoods based studies), with vulnerability resulting from exposure to global change pressures that exist within the broader landscape (e.g., climate based studies) (O'Brien et al. 2007). By merging these perspectives, CBVAs can better integrate the range of biophysical and socioeconomic factors that drive vulnerability (McDowell et al. 2016; McLean 2015). Scholars have also called for the development of methods to better address: i) cross-scale spatial and temporal interactions (Jurgilevich et al. 2017), and ii) exposure to multiple interacting shocks and stressors (Orr et al. 2020). In doing so, CBVAs approaches would exhibit increased capacity to capture and understand vulnerability as a characteristic of complex social-ecological systems (Ford et al. 2018).

Over the past decade, numerous vulnerability frameworks and methodological approaches have emerged that apply less siloed perspectives and capture interactions across broader spatial and temporal scales and multiple exposures (e.g., Berrouet et al 2018; Birkmann et al. 2013; Cinner et al. 2013; IPCC 2014; Marshall et al. 2013; Naylor et al 2020; Thiault et al. 2018). However, CBVA critique articles spanning the early 2000's to late 2010's, continue to present the same limitations, suggesting little progress has been made to combat these issues within the majority of studies (Dilley and Boudreau 2001; Ford and Pearce 2012; O'Brien et al. 2007 Fekete et al. 2010; Cameron 2012; Morse and McNamara 2013; Bennett et al. 2016; McDowell et al. 2016; Ford et al. 2018; Thiault et al. 2018). This may be associated to the continued domination of CBVA approaches originating from the livelihoods (i.e., Sustainable Livelihoods Framework (SLF) (Scoones 1998; DFID 1999)), and climate change adaptation (i.e., Intergovernmental Panel on Climate Change AR4 Framework (IPCC AR4) (IPCC 2007)) disciplines, that are subject to previously mentioned limitations. To reiterate, for SLF based studies limitations include i) failure to incorporate the broader vulnerability context (i.e., external shocks and stressors), and ii) failure to consider spatial and temporal scale (Mensah 2011). Whilst for IPCC AR4 studies (from here on referred to as IPCC studies) limitations include i) the development of an incomplete and static snapshot of socioeconomic vulnerability, and ii) a singular focus on exposure to climate change (McDowell et al. 2016; Jurgilevich et al 2017). Despite significant attempts to highlight these limitations (Ford et al. 2018; Thiault et al. 2021) the SLF and IPCC AR4 persist as the most commonly applied CBVA approaches, with restricted perspective on if, and how, authors are attempting to overcome their limitations. This review aims to address this research gap by systematically identifying, analysing, and critically evaluating if scholars are progressing beyond limitations within contemporary CBVAs that apply the SLF and IPCC AR4. The discussion outlines the implications of failing to engage with limitations and presents methodological approaches (including relative strengths of the SLF and IPCC framework) to support scholars in overcoming these issues (Fig. 1). In doing so, the review contributes to a growing body of work that intends to support CBVAs in better facilitating positive development outcomes. Given the exclusive focus on the SLF and IPCC framework, it must be acknowledged that this review does not capture trends across the entirety of the CBVA literature. Examples of additional CBVA approaches that tackle limitations have been provided throughout the discussion to contextualise review outputs in the broader CBVA landscape.

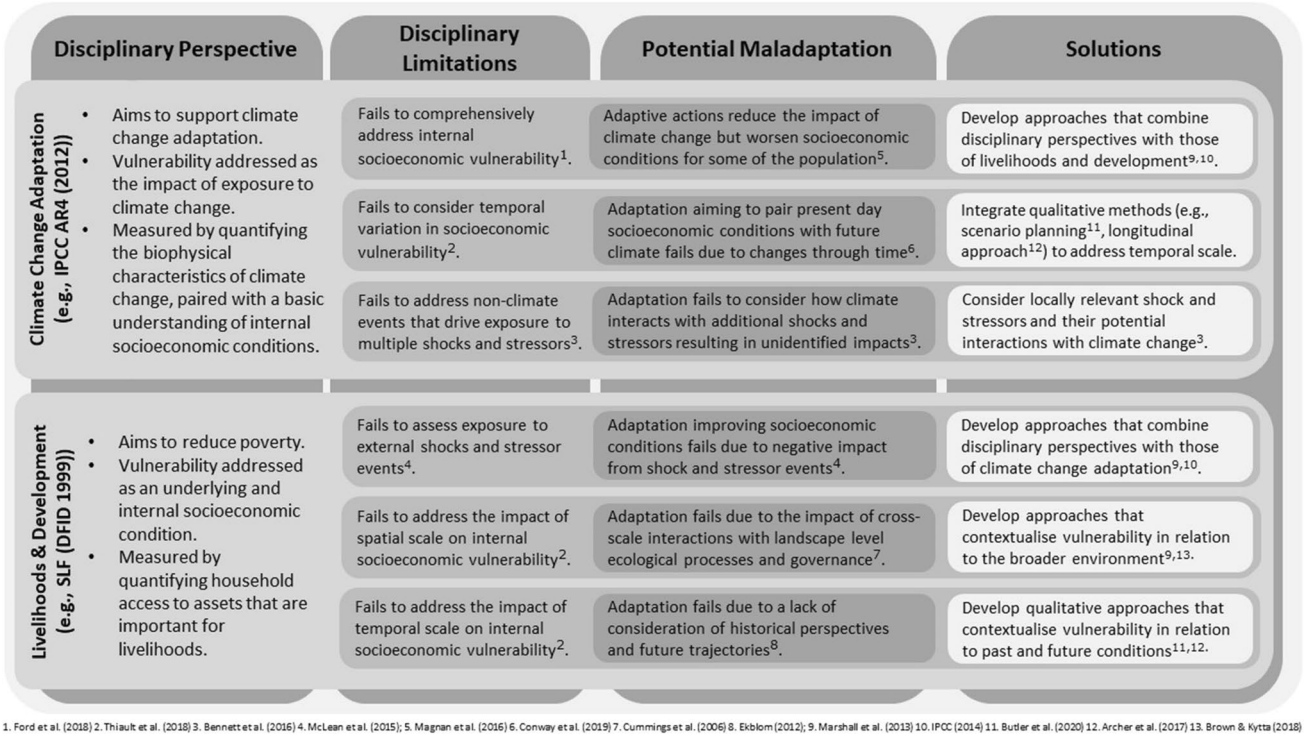


**Fig. 1** Limitations emerging from climate change adaptation (e.g., IPCC AR4) and livelihoods and development (e.g., SLF) community-based vulnerability assessment frameworks, with associated maladaptation potential and suggested methodological solutions

## Materials and methods

A systematic literature review was conducted to identify, examine, and critically evaluate community-based vulnerability assessments (CBVAs) based on the SLF and IPCC AR4 framework conducted in low-income rural environments between 2014 and 2023. The review was conducted in four steps: (1) a scoping exercise to identify the extent and focus of systematic reviews in the topic area, and to confirm that the SLF and IPCC AR4 are the most commonly operationalised frameworks in CBVA research, (2) a systematic literature search for CBVAs using SLF and IPCC AR4 frameworks in the period 2014 to 2023, (3) application of inclusion and exclusion criteria to systematic search results, and (4) data extraction and content analysis to answer key research questions regarding the extent to which contemporary CBVAs tackle limitations surrounding siloed perspectives (resulting in the exclusion of external shock and stressor events (SLF) or socioeconomic factors (IPCC) from assessments) and inadequate consideration of temporal and spatial scale and multiple exposures. Details of each of these steps are provided in the following subsection and an overview of the process is shown in Fig. 2.

### Scoping exercise

A scoping exercise was conducted using the Web of Science (Core Collection) to identify systematic literature reviews assessing CBVAs over the last decade. Of the 22 reviews that were identified (Supplementary Information 1), none focused on identifying, examining, and critically evaluating the extent to which the limitations of CBVA approaches are tackled within widely applied frameworks. The scoping review also guided development of the systematic search strategy, with database selection, timeframe and inclusion criteria informed by past review methodologies. Given the popularity of CBVAs as a tool to support development, study focus was refined to centre around the most popular frameworks applied from the climate change adaptation (i.e., IPCC AR4) and livelihoods and development (i.e., SLF) perspectives. An additional scoping exercise was conducted to contextualise the popularity of these frameworks in comparison to other highly cited CBVA approaches (e.g., Birkmann et al. 2013; Cinner et al 2013; IPCC 2007, 2014; Marshall et al. 2013; Thiault et al. 2018). This exercise was subject to the same systematic search strategy and screening process applied to the full systematic review process described below.

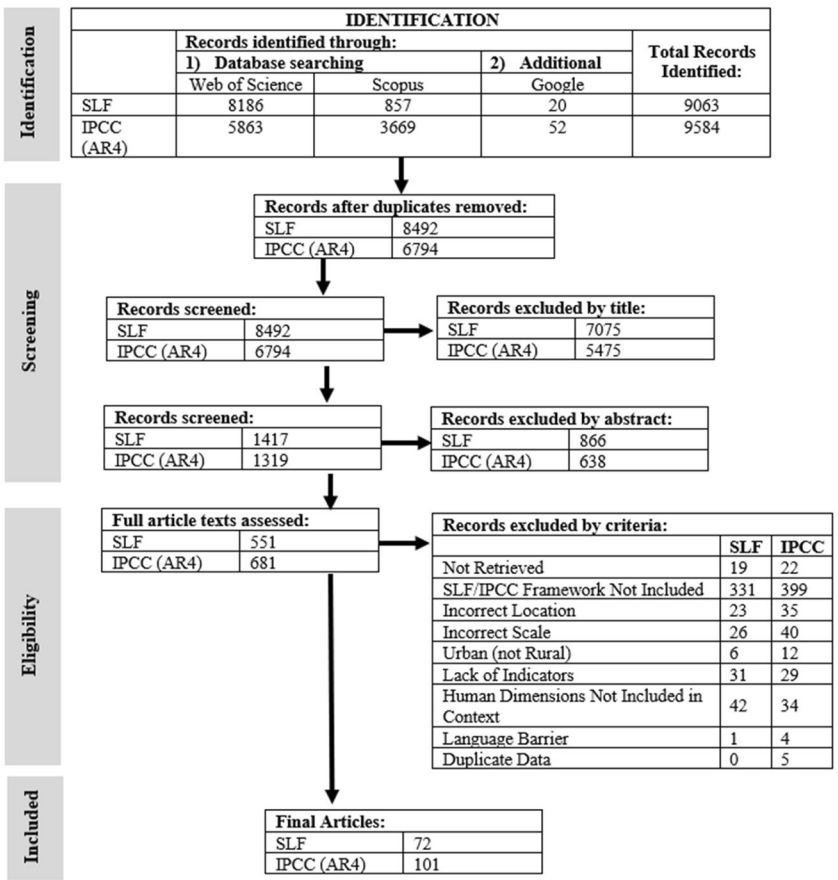


**Fig. 2** The screening process (based on PRISMA (2020) guidelines) used to identify CBVAs applying the Sustainable Livelihoods Framework (Scoones 1998) and IPCC AR4 Framework (IPCC 2007) between 2014–2023

### Systematic search strategy

The Voyant Text Mining tool was used to select relevant keywords for each framework. Search strings were developed and pre-tested within selected databases (Web of Science – Core Collection, Scopus, and Google Search Engine). Additional keywords were included to reflect the focus on CBVAs during framework application. Final search strings are provided in Supplementary Information 2. The literature search was completed in March 2023 and was restricted to journal articles and conference papers published between 2014 and 2023. This date range was chosen to reflect the publication of the IPCC's 2014 AR5 Risk Framework, which marked a seminal transition of this organisation towards a less siloed approach to vulnerability (Sharma and Ravindranath 2019). By focusing on post 2014 literature, this review provides a contemporary analysis of CBVAs during a time of increased focus on the limitations of vulnerability assessments. It is acknowledged that search strings may result in the exclusion of some cross-scalar studies that address community level vulnerability in tandem with other administrative units.

### Screening process

A systematic approach to literature screening was adopted following PRISMA guidelines (Page et al. 2021). Following the removal of duplicate articles, the screening process progressively examined the title, abstract and full text of each CBVA, based on a pre-defined set of inclusion and exclusion criteria. A full list of these criteria is provided in Supplementary Information 2. The screening process resulted in the identification of 173 CBVAs for inclusion within the review (Supplementary Information 3). Of these articles, n = 72 applied the SLF and n = 101 applied the IPCC AR4 framework (Fig. 2).

### Document review & content analysis

A structured approach for extracting, analysing, and critically evaluating qualitative and quantitative data from CBVAs was developed to: i) determine bibliographical and methodological trends across CBVAs that apply the SLF and IPCC frameworks, and ii) examine if, and how contemporary CBVAs are progressing beyond framework limitations. To guide this process, the following thematic questions were applied to data extraction and content analysis:

1. How are CBVAs applying the SLF and IPCC frameworks distributed across time (e.g., year of publication)?
2. Are there any methodological trends in CBVAs applied from the livelihoods and climate change adaptation disciplines?
3. Do SLF based CBVAs tackle limitations surrounding: i) failure to incorporate the broader vulnerability context (i.e., the characteristics of external shock and stressor events) and ii) failure to consider spatial and temporal scale?
4. Do IPCC based CBVAs tackle limitations surrounding: i) failure to adequately address socioeconomic vulnerability and its temporal components and ii) failure to address exposure to multiple drivers of global change.

Data extraction focused on the empirical assessment of vulnerability by analysing the methods and supplementary information of each article. Data were collected using N-Vivo 12 and later exported for analysis into MS Excel. Content analysis was used to compile and group the data, which included the collation of vulnerability assessment indicators into thematic groups related to previously listed disciplinary criticisms. Specifically, the list of indicators applied within CBVAs were extracted and grouped into the major components of the IPCC AR4 (e.g., exposure, sensitivity, and adaptive capacity) and SLF (e.g., natural, physical, financial, social, and human capital) (Table 1). Under these components, indicators were classified into groups that followed similar themes (e.g., age, gender, education, ethnicity, and religion were grouped to represent sociodemographic profile). This allowed the content analysis to reflect if and how: i) SLF based studies incorporated the broader vulnerability context (i.e., included indicators of exposure), and ii) IPCC based studies addressed socioeconomic vulnerability (i.e., included indicators of sensitivity, adaptive capacity, and corresponding capital asset categories). Analysis of exposure-based indicators also identified studies that addressed multiple drivers of global change. Finally, content analysis was used to identify spatial (e.g., landscape interactions and multi-level governance dynamics) and temporal (e.g., historical climate/socioeconomic variability and future climate/socioeconomic projections) indicators. A full list of the framework used for data extraction and content analysis is provided in Supplementary Information 2.

## Results

### Trends in the application of the sustainable livelihoods framework and IPCC AR4 frameworks

Results from the scoping exercise support the assumption that the SLF (38%) and IPCC AR4 framework (53%) are the most popular CBVA approaches adopted in studies applied from the livelihoods and climate change adaptation perspectives. For the IPCC this was particularly evident between 2020 to 2021, where 60% of all studies applied this framework. In contrast, the SLF decreased in popularity by 7%

**Table 1** The components used to structure content analysis based on the IPCC AR4 framework (IPCC 2007) and the capital assets component of the Sustainable Livelihoods Framework (DFID 1999)

| Component | Definition (IPCC 2007) |
|---|---|
| Exposure | The degree to which a system is exposed to shocks and stressors |
| Sensitivity | The degree to which a system is affected by exposure to shocks and stressors |
| Adaptive Capacity | The ability of a system to adjust to exposure to shocks and stressors, moderate potential damage, take advantage of opportunities, or cope with consequences |
| | Sustainable Livelihoods Framework (DFID 1999) |
| Human Capital | The skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives |
| Physical Capital | The basic infrastructure and producer goods needed to support livelihoods |
| Social Capital | The social resources upon which people draw in pursuit of their livelihood objectives |
| Financial Capital | The financial resources that people use to achieve their livelihood objective |
| Natural Capital | The natural resource stocks from which resource flows and services (e.g., nutrient cycling, erosion protection) useful for livelihoods are derived |

during this time period. Notably, whilst the IPCC AR4 and SLF studies experienced a steep decline in 2022, the number of CBVAs applying additional widely cited frameworks grew. This was due to the increased application (n = 5) of Birkmann et al. (2013) Methods for Improvement of Vulnerability Assessment in Europe (a.k.a. MOVE) Framework. Despite the IPCC's transition to use of the AR5 risk framework in 2014, no CBVA studies were identified to apply this approach in the context of this review (Fig. 3).

## Methodological approaches to community-based vulnerability assessments

CBVAs across both frameworks primarily adopted a mixed methods approach to data collection (72%; n = 124), with the most widely applied methods being household surveys (55%; n = 84) and focus group discussions (56%; n = 97). The majority of CBVAs assessed vulnerability based on generic indicator sets that had been applied by prior studies (66%; n = 115). However, additional context specific indicators explicit to the local context were included in some assessments. Where this occurred, indicators were selected using literature reviews (38%; n = 66), local (38%; n = 66) and expert knowledge (37%; n = 64). The majority of SLF based studies presented CBVA outputs as descriptive statistics (63%; n = 45). In contrast, IPCC based assessments developed composite values for vulnerability based on index calculations (100%; n = 101). The most popular index methods were the Livelihood Vulnerability Index (55%; n = 56) (Hahn et al. 2009) and Pandey and Jha's (2012) Climate Vulnerability Index (10%; n = 10).

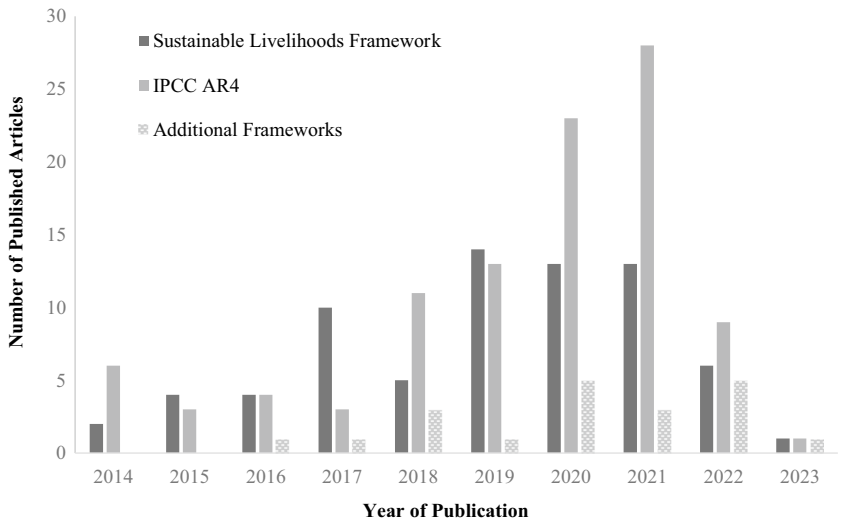


**Fig. 3** Trends in the number of CBVAs published between September 2014 and March 2023 that apply the Sustainable Livelihoods Framework, IPCC AR4 and additional widely cited CBVA Frameworks (i.e., Birkmann et al. 2013; Cinner et al. 2013; IPCC 2014; Marshall et al. 2013 and Thiault et al. 2018)

## Criticism 1: Evidence of siloed perspectives

### Do IPCC based community-based vulnerability assessments evaluate socioeconomic vulnerability?

All IPCC based CBVAs assessed socioeconomic indicators related to adaptive capacity (IPCC 2007). However, SLF based studies tended to conduct a more extensive analysis, with significant variation observed in the number and types of adaptive capacity indicators applied across frameworks. For example, IPCC based CBVAs were less likely to measure financial (FC) (57%; n = 58) and natural (NC) (28%; n = 28) capital, compared to SLF based studies (FC = 94%; n = 68, and NC = 85%; n = 61). Additionally, whilst a comparable percentage of CBVAs addressed social capital (IPCC AR4 = 86%; n = 87, SLF = 89%; n = 64), IPCC based studies lacked key aspects of community cohesion (e.g., capacity building, collective action, and decision-making capacity) (11%; n = 11) and social relationships (e.g., trust, sense of belonging, social networks, and attitudes) (13%; n = 13) (Fig. 4).

The majority of IPCC based studies included socioeconomic measures of sensitivity (90%; n = 91), compared with 67% of SLF based studies. Sensitivity indicators focused on key livelihood objectives that may be impacted by hazard exposure (e.g., food, water, housing, and health security). Food and water security were the most widely assessed objectives within IPCC studies, with associated indicators found in 73% (n = 74) versus only 15% (n = 11) of SLF based CBVAs. There was limited comparability in the type and number of sensitivity indicators applied across frameworks. For example, SLF based studies tended to adopt a singular measure for a given livelihood objective such as food security (e.g., food sufficiency (11%)), versus the use of a broader range of measures within IPCC based CBVAs (e.g., household food production (43%), food accessibility (31%) and seed storage (25%)) (Fig. 5). The application of the Livelihood Vulnerability Index (LVI, Hahn et al. 2009) within 62% (n = 63) of IPCC based CBVAs influenced results. Where CBVAs applied this index, indicators were selected based on LVI methodology, and were analogous across studies. As the LVI pays specific focus to measures of sensitivity, this influenced the number of IPCC based CBVAs assessing this component of vulnerability. For example, water security indicators were included within 96% (n = 97) of IPCC based studies that applied the LVI versus 32% (n = 32) of studies that did not apply this index.

### Do sustainable livelihoods framework based community-based vulnerability assessments incorporate the broader vulnerability context?

All SLF based CBVAs framed vulnerability around exposure to the broader vulnerability context (i.e., exposure to external shocks and stressors). This was commonly related to exposure to natural hazards (e.g., flooding and drought) (57%; 41), resource exploitation (e.g., logging, mining and fishing) (43%; n = 31), or social issues (e.g., crime and conflict) (46%; n = 30). In contrast, IPCC based studies focused primarily on exposure to climate change (89%; n = 90), with social issues and resource extraction addressed within only 7% (n = 7) of CBVAs (Fig. 6).

Despite all SLF-based studies framing vulnerability around exposure to an external hazard, this did not always translate to the inclusion of exposure as an empirical component of CBVAs. Attempts to empirically measure exposure were made in 47% (n = 34) of SLF based studies, and usually related to the frequency of climatic shock events (17%; n = 12). Empirical analysis of social issues and resource extraction occurred in only 10% (n = 7) of SLF based studies. In contrast, exposure was empirically measured in 100% of IPCC based studies. Additionally, IPCC based CBVAs used an average of $3 \pm 2$ indicators to measure the characteristics of a hazard (e.g., natural hazard magnitude, frequency and duration), compared to the application of a single indicator within SLF-based studies.

## Criticism 2: Incorporation of spatial and temporal scale

### Do sustainable livelihoods framework based studies incorporate spatial and temporal scale?

Indicators across multiple spatial and temporal scales were measured within 1% (n = 1) and 19% (n = 14) of SLF based CBVAs respectively. Where temporal interactions were measured, focus was given to understanding past exposure to climate variability or natural hazard events (e.g., floods and droughts), with a singular study (Huq et al. 2015) attempting an analysis of future biophysical and social vulnerability using scenario planning methods. Spatial scale was implicit within exposure based indicators (i.e., indicators identified place-based characteristics of shock and stressor events) however, few studies considered spatial scale in relation to sensitivity and adaptive capacity. Where this type of analysis did occur, it was limited to a measurement of multiscalar governance dynamics (as an indicator of adaptive capacity) within a singular SLF based study. Similar trends were shown in IPCC based CBVAs, where interactions across spatial scales were measured in only 5% (n = 5) of studies.

### Do IPCC based studies address temporal variation in socioeconomic vulnerability?

Although results found a greater number of IPCC based CBVAs to address temporal scale (54%; n = 55) than SLF

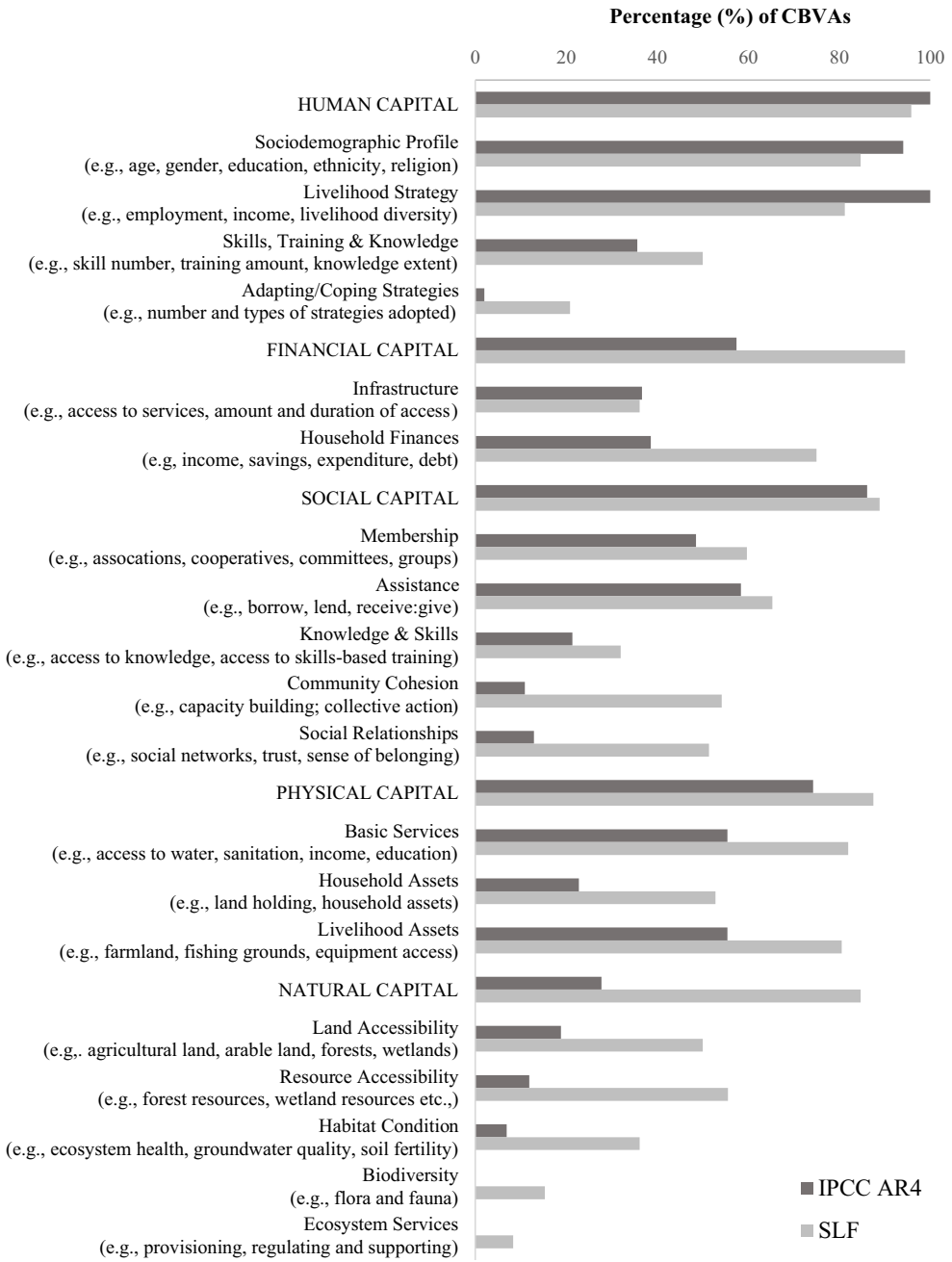


**Fig. 4** The types of adaptive capital indicators applied within IPCC AR4 and SLF based CBVAs, represented as the percentage of studies applying an indicator grouping. Indicators are categorised based on capital asset types found within the SLF (DFID 1999) (i.e., human, financial, social, physical and natural), while sub-headings reflect thematically similar indicators, grouped during content analysis

based studies, these focused exclusively on temporal variation in biophysical exposure. This primarily concerned past climate variability (51%; n = 50), with few studies incorporating future projections of climate change (7%; n = 6). Across IPCC based CBVAs no temporal analysis of socioeconomic factors was observed.

## Criticism 3: Analysis of multiple exposures

### Do IPCC based studies analyse exposure to multiple shocks and stressors?

A limited number of IPCC based CBVAs addressed how exposure to multiple shocks and stressors may impact

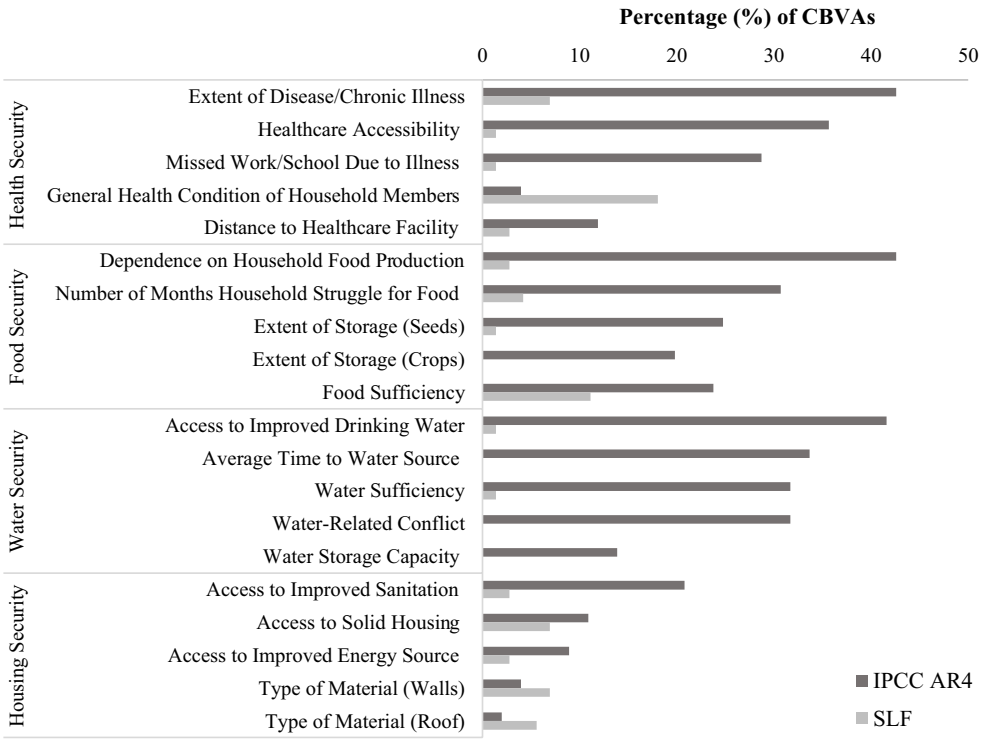


**Fig. 5** The percentage of SLF and IPCC based CBVAs that applied sensitivity indicators relating to health, water, food and housing security

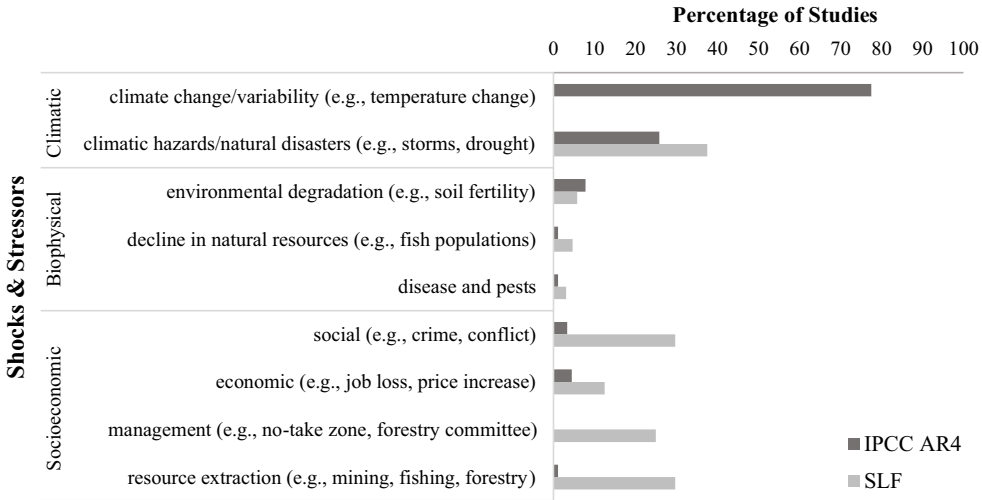


**Fig. 6** The percentage of IPCC and SLF based CBVAs framing vulnerability around exposure to external shocks and stressor types

vulnerability (7%; n = 6). Where this did occur, studies assessed the simultaneous presence of natural hazard events or environmental issues (e.g., pollution) (4%; n = 4) with climate variability (7%; n = 6). A small number of SLF based studies addressed multiple exposures (8%: n = 6), however the focus was given more to natural hazard events, and environmental issues (e.g., pests and disease) than to climate change. Those CBVAs that did assess multiple exposures determined the number of times a community had experienced simultaneous exposure to shocks and stressors over a specified time period. No study attempted to assess interactions and cumulative impacts resulting from multiple exposure events.

## Discussion

The upward trend in the number of CBVAs applying the SLF and IPCC framework highlights continued growth in their popularity. It also emphasises the need to understand if associated CBVAs are progressing beyond the limitations of their respective frameworks. For the AR4 growth

has occurred despite the IPCCs organisational transition to the AR5 framework, which attempts to tackle limitations by moving away from vulnerability to the concept of risk (IPCC 2014; Mach et al. 2016; Sharma and Ravindranath 2019). Ishtiaque et al (2022) and Estoque et al. (2023) have identified three primary explanations for the limited uptake of AR5, including: i) reluctance to abandon the AR4 methodology, ii) a lack of awareness and confusion surrounding AR5 and, iii) a continued requirement for methodological guidelines. These factors should be considered and addressed by authors when developing novel CBVA approaches. Where applied in non-CBVA contexts, AR5 studies have shown limited progress in the inclusion of socioeconomic vulnerability and exposure to multiple drivers of global change (Alam et al. 2022; Bera et al. 2022; Malakar et al. 2021; Mondal et al. 2022; Singha et al. 2023). As such, further work is required to establish if AR5 can help progress the IPCC framework beyond present limitations. This review identified the increasing popularity of the MOVE framework (Birkmann et al. 2013) in recent years. Studies applying MOVE cite the capacity to better integrate spatial analysis and depict internal socioeconomic conditions as the primary rationale for selecting this framework (Hamidi et al. 2022; Van et al 2022; Sultana et al. 2023). This suggests increased awareness of, and progression towards the use of non-siloed and dynamic CBVA frameworks. The recent decline in SLF and IPCC application is likely attributed to the covid-19 pandemic, which prevented on ground data collection in many areas. Confirmation of the rationale for this decline, and evolving trends in framework application will require ongoing bibliographical analysis.

This review shows modest progress has been made in addressing CBVA limitations associated to the Sustainable Livelihoods Framework (SLF) and IPCC AR4 Vulnerability Framework (IPCC). Greatest progress was observed with respect to overcoming siloed framework perspectives. For example, IPCC-based studies moved beyond a perceived focus on biophysical factors to include a well-developed analysis of socioeconomic vulnerability drivers. However, further steps could be made towards comprehensively analysing adaptive capacity. In contrast, approximately half of SLF based studies empirically addressed characteristics of the broader vulnerability context (e.g., external shock and stressor events), but failed to extend this to a comprehensive understanding of socioeconomic sensitivity to hazard exposure. Limitations associated with spatial and temporal scale and multiple exposures transcended disciplinary perspectives and were applicable across frameworks. This included limited incorporation of spatial and temporal analysis associated to both biophysical and socioeconomic vulnerability factors, and a focus on vulnerability in the context of a single type of shock or stressor. The following sections discuss the implications of persistent CBVA limitations within the SLF and IPCC framework and suggests available methodological steps scholars can engage with to progress beyond them.

## Limitation 1: Overcoming siloed perspectives

The tendency for livelihoods and climate change adaptation scholars to overly emphasise either social (i.e., SLF) or biophysical (i.e., IPCC) factors is the most common criticism directed at CBVAs (Ford et al. 2018; Sejersen 2015). However, this review suggests that most scholars are tackling this limitation by incorporating biophysical, environmental, and socioeconomic vulnerability drivers within assessments. This was particularly evident with respect to IPCC based studies which included a diverse analysis of socioeconomic vulnerability drivers. This can largely be attributed to the emergence of the Livelihood Vulnerability Index (LVI), which explicitly focuses on bridging the gap between CBVAs applied from the livelihoods versus climate change adaptation perspective (Hahn et al. 2009). To do so, the LVI incorporates SLF based indicators within the IPCC AR4 framework, providing a less siloed CBVA approach that focuses on both socioeconomic vulnerability and hazard exposure. The LVIs popularity suggests a general understanding of the benefits of adopting less siloed CBVA methods; however, strict adherence to the approach's methodology appears to limit the depth of analysis regarding adaptive capacity. This is a concern, given the importance of key social, financial, and natural capital indicators (excluded within the LVI) which play a foundational role in socioeconomic vulnerability (Azad & Pritchard 2022; Freitag et al. 2014; Pelling & High 2005). Adherence to LVI indicators also prevented authors from using site-specific measures in CBVAs, important in developing a locally contextualised understanding of vulnerability (Hinkel 2011; Nguyen et al. 2016). To overcome these limitations, authors engaging with the LVI (and the overarching IPCC AR4 framework) should focus on extending the types of indicators included within CBVAs. This can be done, for example, by better integrating SLF based capital assets that comprise adaptive capacity within IPCC based studies. By developing a more detailed understanding of adaptive capacity, IPCC based assessments can better support community-led management interventions that recognise and utilise local strengths, whilst acknowledging the extent of impact shocks and stressors may have on capital asset availability (Adger 2005; Currenti et al. 2019; Sidle et al. 2013). Understanding adaptive capacity can also help to overcome top-down externally driven adaptation interventions that do not necessarily reflect local needs (Cameron 2012; Hall and Sanders 2015). By describing CBVA outputs in the context of adaptive capacity, management can additionally be framed in a way that empowers communities (Bene et al. 2016). This can help CBVAs to overcome the passive and negative framing that occurs when management exclusively focuses on the

negative impacts of hazard exposure (Bene et al. 2016; Bennett et al. 2016; Haalboom and Natcher 2012).

By framing vulnerability around exposure to an external shock or stressor, many SLF based CBVAs appear to have acknowledged the broader vulnerability context. This contrasts to original SLF analysis, that focuses on identifying how internal socioeconomic characteristics drive vulnerability to undesirable conditions such as poverty or food insecurity (Macfayden and Corcoran 2002; Morse and McNamara 2013). In expanding the framing of vulnerability, the livelihoods discipline has acknowledged the interconnectivity between global environmental change and socioeconomic conditions, and the need to address these factors together (Natarajan et al. 2022). However, translation of this framing into an empirical measurement of the broader vulnerability context (i.e., exposure indicators) occurred within only half of reviewed SLF studies. Exposure based on a sole measure of hazard frequency also fails to capture the full impact of a hazard on a community. This can render CBVA outputs ineffective in assessing vulnerability to external hazards, leading to ineffective adaptive management (Magnan et al. 2016). This has been demonstrated where resource-based management failed due to the impact of external hazard exposure on the local environment (Morand et al. 2012; Roscher et al. 2021). Exclusion of the broader vulnerability context was correlated to a limited assessment of sensitivity in SLF based studies. This is likely attributed to the intrinsic connection between sensitivity and hazard exposure, with sensitivity representing the status of key socioeconomic factors that are likely to be impacted by external shock and stressor events (IPCC 2007). In the context of development, incorporating sensitivity within CBVAs is vital. This enables scholars to develop a less siloed understanding of vulnerability based on the extent of their resource base (i.e., adaptive capacity), alongside their sensitivity to impact from external shocks and stressors (O'Brien et al. 2007; Scoones 2009). Such integration ensures CBVA approaches can sufficiently support livelihoods development amidst growing community exposure to global change drivers (i.e., climate change, resource extraction etc.,) (Mazibuko 2013; Mensah 2011). This review confirms that despite some progression, persistence remains in the siloed perspectives adopted in livelihoods and climate change adaptation based CBVAs. Scholars engaged in this space must become aware of this limitation and aim to apply less siloed approaches (such as the LVI (Hahn et al. 2009)) that are capable of achieving a holistic understanding of vulnerability.

## Limitation 2: Incorporating spatial and temporal scale

The exclusion of spatial and temporal scale as empirical components of vulnerability was observed across frameworks, with most CBVAs approaching vulnerability as a static concept. This has occurred despite widespread literary acknowledgement of the role spatial and temporal interactions play in driving vulnerability (Fekete et al. 2010; Jurgilevich et al. 2017; Keinberger et al. 2013). Beyond the SLF and IPCC frameworks, numerous CBVA approaches have been developed that explicitly focus on addressing these acknowledgments (e.g., Archer et al. 2017; Butler et al. 2020; Fawcett et al. 2017; Naylor et al. 2020); however, uptake of these approaches has been limited. In terms of spatial scale, cross-scale vulnerability drivers primarily relate to multiscalar governance dynamics (Carina and Keskitalo 2008; Wellstead et al. 2013) and landscape level ecological processes that occur more broadly than community level socioeconomic interactions (Carmenta et al. 2020; Sayer et al. 2013). Multiscalar governance interactions were included in several CBVAs (Baffoe and Matsuda 2018; Busse et al. 2017; Gentle et al. 2014; Maleki et al. 2018) but were limited to basic perception-based questions on the impact of leadership and governance structures on community livelihoods. Given the significant role these dynamics play in shaping local resource access and adaptive capacity, it is argued that a more nuanced understanding of governance is required within CBVAs (Carina and Keskitalo 2008; Keskitalo 2012). Difficulties in pigeon-holing complex and contextually specific governance factors into quantitative indicators is acknowledged (Oulahen et al. 2018). However, scholars can still aim to ground CBVA outputs within the broader governance context. Where achieved, this information has been demonstrated to enhance the translation of CBVA outputs into effective adaptive management by highlighting appropriate and effective pathways to connect community and broader scale governance mechanisms (Ford et al. 2018; Jurgilevich 2021; Wellstead et al. 2013).

Failure to consider landscape level ecological characteristics is also concerning, given that spatial mismatches exist between social and ecological processes (Cumming et al. 2006; Fekete et al. 2010; Sidle et al. 2013). Such mismatches have been implicated in maladaptive management, demonstrated by Diedrich et al. (2016) and Minter et al. (2018) where upstream land use change drove significant socioeconomic impact in downstream environments. By engaging with methods to address landscape level interactions, CBVAs can identify such impacts, and better support decision makers in navigating trade-offs across space (Diedrich et al. 2022). Numerous contemporary CBVA frameworks provide methods to engage with landscape level interactions by mapping vulnerability in the context of social-ecological systems (Cinner et al. 2013; Marshall et al. 2013; Thiault et al. 2018). However, these frameworks are not widely applied. In the CBVA context, limited uptake of landscape approaches may be associated with the complexity of quantifying ecological vulnerability, which requires a detailed

understanding of ecosystem dynamics, species assemblages and biological characteristics (Thiault et al. 2018). An alternative approach, likely more suited to the logistical constraints of many CBVAs, involves the application of ethnographic research methods such as participatory mapping which address vulnerability as a place-based concept (Brown and Kyttä 2018; Cutter et al. 2008). This provides an opportunity to map local knowledge of landscape level interactions, whilst also documenting the spatial location of assets that will be impacted by hazard exposure (Sullivan-Wiley et al. 2019). Applying a place-based approach to vulnerability has increased in popularity in recent years, as scholars acknowledge significant spatial variation in the socioeconomic and biophysical conditions that drive vulnerability (Meenar 2017; Thomas et al. 2018). This has been recognised by the IPCC in their transitional AR5 framework, where exposure is reframed as a spatially explicit concept (IPCC 2014). In doing so, AR5 based studies explicitly address landscape level interactions occurring between the location of hazards and community assets.

Temporal scale was addressed within a greater number of CBVAs than spatial scale. Where included, temporal analysis focused on historical recall of climate variability and natural hazard frequency, indicating possible future event occurrence within an area (Berz et al. 2001). However, no CBVAs included historical recall of sensitivity or adaptive capacity characteristics, which are known to be influenced by long-term social and cultural interactions (Ekblom 2012). While this information does not necessarily require integration within indicator-based assessments, qualitative research methods (e.g., key informant interviews) can be used to ground CBVA outputs in historical socioeconomic conditions (Ford and Goldhar 2012). Such information has considerable value when developing adaptive management, as it ensures future actions align with historical characteristics that may continue to shape the local context (Bussey et al. 2012). In contrast to historical analysis, future projections of vulnerability were included within few CBVAs. For SLF-based studies, this may be attributed to the disciplinary lens of the livelihood's perspective, which classically assesses vulnerability in relation to present-day socioeconomic conditions (Conway et al. 2019). However, many climate change adaptation vulnerability assessments utilise modelled climate projections to interpret potential future impact from hazard exposure (Warren et al. 2018). Such projections were not observed within IPCC based CBVAs. This is likely due to this reviews' focus on community-based studies and associated challenges in down-scaling global climate models to the local scale (Giorgio 2018). Where down-scaled data is not available for a region, the process typically demands significant resources, which often exceed the capacity and scope of CBVAs (Wilby et al. 2004). At the community scale, ethnographic methods provide an alternative approach to integrate futures analysis into CBVAs. A key example includes scenario planning, a participatory approach used to envision what the future may look like within a community, based on a range of possible trajectories (Bennett et al. 2016; Birkmann et al. 2015; Butler et al. 2016). By conceptualising future trends in both biophysical and socioeconomic conditions, the approach enables present day understandings of vulnerability to be paired with qualitative interpretations of the future (Butler et al. 2016; 2020). Scenario planning also provides a mechanism to overcome the lack of socioeconomic projections in CBVA studies (Nicholls et al. 2008). In doing so, the approach supports learning, knowledge co-production and innovation for adaptive management which effectively responds to potential changes in both the human and environmental systems (Totin et al. 2018; Werners et al. 2021; Preston et al. 2011). Given the dynamic nature of vulnerability, the application of longitudinal research approaches, as exemplified in the works of Archer et al. (2017), Fawcett et al. (2017; 2018) should also be considered when conducting CBVAs. By conducting a series of repeated CBVAs through time, longitudinal approaches serve not only as a means of continuous monitoring and evaluation, but also act as a mechanism to ascertain if previous adaptive measures remain suitable and effective in the context of global change (Archer et al. 2017).

### Limitation 3: Addressing multiple exposures

The final limitation in this review concerns a lack of progression in addressing vulnerability to multiple shocks and stressor events. Whilst primarily aimed at IPCC based CBVAs, the issue was demonstrated across both frameworks. Bennett et al. (2016) attribute the inability to address multiple exposures in CBVAs to the people centred approach adopted by many scholars, who use a top-down approach when selecting the hazards that a community is exposed to. From the climate change adaptation perspective, this has resulted in CBVAs that focus singularly on climate change, overlooking locally relevant shocks and stressors (e.g., fishing, logging, mining, water pollution, food insecurity etc.,) that communities prioritise due to their contemporary impact on livelihoods (Aalst et al. 2008; Tiepolo et al. 2019). Given the interactions and cumulative impacts that result from multiple exposures, it is essential to consider local scale issues in tandem with global change drivers (Rasanen et al. 2016). In doing so, CBVA outputs can identify instances where the adaptation process for one issue (e.g., climate change) may be impacted by local threats (e.g., reductions in natural resource availability) (Sherman et al. 2015; Thulstrup 2015). Several approaches have been developed to integrate multiple exposures into CBVAs that consolidate top-down and bottom-up methods for hazard identification (e.g., Bennett et al. 2016; Lede et al. 2021; Lung et al 2013; Simpson et al.

2021). These approaches enable scholars to identify large-scale exogenous issues that are the focus of global adaptation efforts (i.e., climate change), and combine these with locally relevant exposures that operate at different scales and speeds (Kittinger et al. 2013). Lede et al. (2021) demonstrate the value of acknowledging, respecting and integrating local threat perceptions into CBVAs through their work in the western Canadian Arctic. By adopting a multi-exposure approach, the authors identified local societal exposures that impacted Inuit livelihoods and influenced their ability to respond to climate change. This knowledge was able to support long-term adaptation to climate change that addressed potential interactions between exposure events, whilst additionally providing the opportunity to manage local shocks and stressors.

## Moving forward: Overcoming limitations of community based vulnerability assessments

The ability for CBVAs to reveal where, how, and why people are vulnerable, and apply this information to support positive development outcomes has been widely acknowledged (Thiault et al. 2021; Windfeld et al. 2019). This review confirmed an upward trend in the use of the SLF and IPCC AR4 Framework to guide livelihoods development and adaptation to global change. However, the popularity of these frameworks has not corresponded with substantial progress in addressing their limitations, despite many attempts to raise awareness of, and combat these issues (Castree et al. 2014; Ford et al. 2018; Magnan et al 2016; McDowell et al. 2016; Murphy 2011). Across both frameworks, progress was most limited in the inclusion of spatial and temporal scale, and exposure to multiple shocks and stressors. Whilst some progress was made in overcoming siloed perspectives (with IPCC based studies attempting a detailed analysis of socioeconomic vulnerability, although limited in relation to adaptive capacity; and SLF based studies framing and beginning to assess vulnerability in the context of exposure to external shocks and stressors) further work is required to consolidate viewpoints from the livelihoods and climate change adaptation disciplines within CBVAs. Drawing on key strengths from the SLF and IPCC framework may support such consolidation, leading to CBVA approaches that can identify internal socioeconomic characteristics that make a household vulnerable to undesirable conditions (e.g., poverty and food insecurity), whilst additionally understanding how these conditions can be compounded by place-based exposure to external shock and stressor events. Scholars should additionally become aware of and aim to utilise CBVA approaches that already adopt less siloed perspectives (e.g., MOVE (Birkmann et al. 2013), IPCC AR5 (IPCC 2014), and the LVI (Hahn et al. 2009)). Such progression should be paired with attempts to incorporate spatial and temporal scale and multiple exposures within CBVAs allowing assessment outputs to evolve from a static to a dynamic understanding of vulnerability. In doing so, CBVAs can better capture complex interactions across scales and exposure events and illustrate subsequent impacts on community livelihoods and adaptation strategies (Bennett et al. 2016; Jurgilevich et al. 2017). In the context of CBVAs, ethnographic research methods (e.g., participatory mapping (Brown and Kyttä 2018); scenario planning (Butler et al. 2016); and longitudinal approaches (Fawcett et al. 2017;18)) may provide scholars the opportunity to better understand and interpret such complex interactions. We acknowledge that this review does not capture all CBVA literature trends. However, the persistence of limitations in SLF and IPCC based studies highlights the need for scholars to recognise and engage with the issues discussed in this review. Where such progress fails to occur, scholars should acknowledge potential implications when applying CBVA outputs to inform adaptive management. Given the increasing rates, scales, and interconnectivities of global change processes, progressing beyond SLF and IPCC based limitations should be a top priority. By failing to do so, scholars should question whether associated CBVAs can adequately support long-term positive development outcomes.

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## References

Aalst KM, Cannon T, Burton I (2008) Community level adaptation to climate change: The potential role of participatory community risk assessment. Glob Environ Chang 18(1):165–179. https://doi.org/10.1016/j.gloenvcha.2007.06.002

Adger WN (2005) Uncertainty in adaptive capacity. Comptes Rendus Geosci. 337(4):399–410. https://doi.org/10.1016/j.crte.2004.11.004

Adger WN (2006) Vulnerability. Glob Environ Chang-Hum Policy Dimens 16(3):268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006

Alam KM, Dasgupta S, Barua A, Ravindranath (2022) Assessing climate-relevant vulnerability of the Indian Himalayan Region (IHR): A district level analysis. Nat Hazards. 112:1395–1421. https://doi.org/10.1007/s11069-022-05233-x

Archer L, Ford DJ, Pearce T, Kowal S, Gough AW et al (2017) Longitudinal assessment of climate vulnerability: a case study from the Canadian Arctic. Sustain Sci. 12:15–29. https://doi.org/10.1007/s11625-016-0401-5

Azad J, Pritchard B (2022) Financial capital as a shaper of households' adaptive capabilities to flood risk in northern Bangladesh. Ecol Econ. 195:107–112. https://doi.org/10.1016/j.ecolecon.2022.107381

Baffoe G, Matsuda H (2018) An empirical assessment of households' livelihood vulnerability: The case of rural Ghana. Soc Indic Res 140:1225–1257. https://doi.org/10.1007/s11205-017-1796-9

Bene C, Headey D, Haddad L, Von Grebmer K (2016) Is resilience a useful concept in the context of food security and nutritional programmes? Some conceptual and practical considerations. Food Secur 8:123–138. https://doi.org/10.1007/s12571-015-0526-x

Bennett NJ, Blythe J, Tyler S, Ban NC (2016) Communities and change in the Anthropocene: understanding social-ecological vulnerability and planning adaptations to multiple interacting exposures. Reg Environ Change 16:907–926. https://doi.org/10.1007/s10113-015-0839-5

Bera A, Meraj G, Kanga S, Farooq M, Singh KS et al (2022) Vulnerability and risk assessment to climate change in Sagar Island, India. Water. 14:823–845. https://doi.org/10.3390/w14050823

Berrouet LN, Machado J, Villegas-Palacio C (2018) Vulnerability of socio-ecological systems: A conceptual framework. Ecol Indic. 84:632–647. https://doi.org/10.1016/j.ecolind.2017.07.051

Berz G, Kron W, Loster T, Rauch E, Schimetschek J et al (2001) World map of natural hazards – A global view of the distribution and intensity of significant exposures. Nat Hazards. 23:443–46.5. https://doi.org/10.1023/A:1011193724026

Birkmann J, Cardona DO, Carreno LM, Barbat HA, Pelling M et al (2013) Framing vulnerability, risk and societal responses: the MOVE framework. Nat Hazards. 67:193–211. https://doi.org/10.1007/s11069-013-0558-5

Birkmann J, Cutter SL, Rothman DS, Welle T, Garschagen M et al (2015) Scenarios for vulnerability: opportunities and constraints in the context of climate change and disaster risk. Clim Change 133:53–68. https://doi.org/10.1007/s10584-013-0913-2

Brown G, Kyttä M (2018) Key issues and priorities in participatory mapping: Toward integration or increased specialization? Appl Geogr 95:1–8. https://doi.org/10.1016/j.apgeog.2018.04.002

Burton I, Kates RW, White GF (1978) The environment as hazard. Guildford, New York

Busse HA, Jogo W, Fofanah M, Tesfay H, Hadush M et al (2017) Participatory assessment of factors influencing Nutrition and livelihoods in rural Ethiopia: Implications for measuring impacts of multisector Nutrition programs. Food Nutr Bull 38(4):468–484. https://doi.org/10.1177/0379572117703265

Bussey M, Carter WR, Keys N, Carter J, Mangoyana R et al (2012) Futures. 44(4), 385–397. https://doi.org/10.1016/j.futures.2011.12.002

Butler JRA, Bohensky EL, Suadnya W, Yanuartati Y, Handayani T et al (2016) Scenario planning to leap-frog the Sustainable Development Goals: An adaptation pathways approach. Clim Risk Manag 12:83–99. https://doi.org/10.1016/j.crm.2015.11.003

Butler JRA, Bergseng AM, Bohensky E, Pedde S, Aitkenhead M et al (2020) Adapting scenarios for climate adaptation: Practitioners perspectives on a popular planning method. Environ Sci Policy 104:13–19. https://doi.org/10.1016/j.envsci.2019.10.014

Cameron ES (2012) Securing indigenous politics: a critique of the vulnerability and adaptation approach to the human dimensions of climate change in the Canadian Arctic. Glob Environ Chang 22(1):103–114. https://doi.org/10.1016/j.gloenvcha.2011.11.004

Carina E, Keskitalo ECH (2008) Governance in vulnerability assessment: the role of globalising decision-making networks in determining local vulnerability and adaptive capacity. Mitig Adapt Strat Glob Change 14:185–201. https://doi.org/10.1007/s11027-008-9159-0

Carmenta R, Coomes DA, DeClerck FA, Hart AK, Harvey CA et al (2020) Characterising and evaluating integrated landscape initiatives. OneEarth 21(2):174–187. https://doi.org/10.1016/j.oneear.2020.01.009

Castree N, Adams WM, Barry J, Brockington D, Buscher B et al (2014) Changing the intellectual climate. Nat Clim Chang 4(9):763–768. https://doi.org/10.1038/Nclimate2339

Cinner EJ, Huchery C, Darling SE, Humphries TA, Graham JAN et al (2013) Evaluating social and ecological vulnerability of coral reef fisheries to climate change. PLoS ONE. 8(9):743–755. https://doi.org/10.1371/journal.pone.0074321

Conway D, Nicholls RJ, Brown S, Tebboth MG, Adger WN et al (2019) The need for bottom-up assessments of climate risks and adaptation in climate-sensitive regions. Nat Clim Chang 9(7):503–511. https://doi.org/10.1038/s41558-019-0502-0

Cumming GS, Cumming DH, Redman CL (2006) Scale mismatches in social-ecological systems: causes, consequences, and solutions. Ecol Soc 11(1):1–21. https://doi.org/10.5751/ES01569-110114

Currenti R, Pearce T, Salabogi T, Vuli L, Salabogi K et al (2019) Adaptation of climate change in an interior Pacific Island Village: a case study of Nawairuku, Ra, Fiji. Hum Ecol. 47:65–80. https://doi.org/10.1007/s10745-019-0049-8

Cutter LS, Barnes L, Berry M, Burton C, Evans E et al (2008) A place-based model for understanding community resilience to natural disasters. Glob Environ Chang. 18(4):598–606. https://doi.org/10.1016/j.gloenvcha.2008.07.013

DFID (1999) Sustainable Livelihoods Guidance Sheet. Department of International Development, London

Diedrich A, Farr M, Stoeckl N, Larson S, Pandihau L et al (2016) Sustainable management of communities in Papua New Guinea: Report on Western New Britain survey results for the socio-cultural component. ACIAR project report. James Cook University, Townsville

Diedrich A, Duce S, Eriksson H, Govan H, Harohau D et al (2022) An applied research agenda for navigating diverse livelihood challenges in rural coastal communities in the tropics. OneEarth. https://doi.org/10.1016/j.oneear.2022.10.005

Dilley M, Boudreau ET (2001) Coming to terms with vulnerability: a critique of the food security definition. Food Policy. 26:229–247. https://doi.org/10.1016/S0306-9192(00)00046-4

Ekblom A (2012) Livelihood security, vulnerability and resilience: A historical analysis of Chibuene, Southern Mozambique. Ambio. 41:479–489. https://doi.org/10.1007/s13280-012-0286-1

Estoque CR, Ishtiaque A, Parajuli J, Athukorala S, Rabby WY et al (2023) Has the IPCC's revised vulnerability concept been well adopted? Ambio. 52:376–389. https://doi.org/10.1007/s13280-022-01806-z

Fawcett D, Pearce T, Ford DJ, Archer L (2017) Operationalising longitudinal approaches to climate change vulnerability assessment. Glob Environ Chang. 45:79–88. https://doi.org/10.1016/j.gloenvcha.2017.05.002

Fawcett D, Pearce T, Notaina R, Ford DJ, Collings P (2018) Inuit adaptability to changing environmental conditions over an 11 year period in Ulukhaktok, Northwest Territories. Polar Rec. 54(275):119–132. https://doi.org/10.1017/S003224741800027X

Fekete A, Damm M, Birkmann J (2010) Scales as a challenge for vulnerability assessment. Nat Hazards 55:729–747. https://doi.org/10.1007/s11069-009-9445-5

Ford DF, Goldhar C (2012) Cliamte change vulnerability and adaptation in resource dependent communities: a case study from West Greenland. Clim Res. 54:181–196. https://doi.org/10.3354/cr01118

Ford DF, Pearce T (2012) Climate change vulnerability and adaptation research focusing on the Inuit subsistence sector in Canada: Directions for future research. Can Geogr. 56(2):275–287. https://doi.org/10.1111/j.1541-0064.2012.00418.x

Ford DF, Pearce T, McDowell G, Berrang-Ford L, Sayles SJ et al (2018) Vulnerability and its discontents: the past, present, and future of climate change vulnerability research. Clim Change 151:189–203. https://doi.org/10.1007/s10584-018-2304-1

Freitag CR, Abramson BD, Chalana M, Dixon M (2014) Whole community resilience: An asset-based approach to enhancing adaptive capacity before a disruption. J Am Plan Assoc. 80(4):324–335. https://doi.org/10.1080/01944363.2014.9904805

Füssel HM, Klein RJT (2006) Climate change vulnerability assessments: An evolution of conceptual thinking. Clim Change 75(3):301–329. https://doi.org/10.1007/s10584-006-0329-3

Gentle P, Thwaites R, Race D, Alexander K (2014) Differential impacts of climate change on communities in the middle hills region of Nepal. Nat Hazards 74:815–836. https://doi.org/10.1007/s10584-017-2124-8

Giorgio F (2018) Thirty years of regional climate modelling: Where are we and where are we going next? J Geophys Res: Atmos. 124:5606–5723. https://doi.org/10.1029/2018JD030094

Guerrero MA, Bennett JN, Wilson AK, Carter N, Gill D et al (2018) Achieving the promise of integration in social-ecological research: a review and prospectus. Ecol Soc 23(3):38. https://doi.org/10.5751/ES-10232-230338

Haalboom B, Natcher DC (2012) The power and peril of "vulnerability": approaching community labels with caution in climate change research. Arctic 65:319–327. https://doi.org/10.14430/arctic4219

Hahn MB, Riederer AM, Foster SO (2009) The Livelihood Vulnerability Index. A pragmatic approach to assessing risks from climate variability and change – A case study in Mozambique. Glob Environ Chang. 19(1):74–88. https://doi.org/10.1016/j.gloenvcha.2008.11.002

Hall EF, Sanders T (2015) Accountability and the academy: producing knowledge about the human dimensions of climate change. J Roy Anthropol Inst 21(2):438–461. https://doi.org/10.1111/1467-9655.12162

Hamidi RA, Jing L, Shahab M, Azam K, Tariq RM et al (2022) Flood exposure and social vulnerability analysis in rural areas of developing countries: An empirical study of Charsadda District, Pakistan. Water. 14(7):1176–1182. https://doi.org/10.3390/w14071176

Hinkel J (2011) Indicators of vulnerability and adaptive capacity: Towards a clarification of the science-policy interface. Glob Environ Chang-Hum Policy Dimens 21(1):198–208. https://doi.org/10.1016/j.gloenvcha.2010.08.002

Hufschmidt G (2011) A comparative analysis of several vulnerability concepts. Nat Hazards 58(2):621–643. https://doi.org/10.1007/s11069-011-9823-7

Huq N, Huge J, Boon E, Gain KA (2015) Climate change impacts in agricultural communities in rural areas of coastal Bangladesh: A tale of many stories. Sustainability. 7:8437–8460. https://doi.org/10.3390/su7078437

IPCC (2007) In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE. (Eds.) Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge, UK: Cambridge University Press. 976 pp

IPCC (2014) In: Field CB, Barros VR, Dokken D.J, Mach K.J, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (Eds.) Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1039 –1099

Ishtiaque A, Estoque RC, Eakin H, Parajuli J, Rabby YW (2022) IPCC's current conceptualisation of 'vulnerability' needs more clarification for climate change vulnerability assessments. J Environ Manag. 303:114–123. https://doi.org/10.1016/j.jenvman.2021.114246/

Janssen MA, Ostrom E (2006) Resilience, vulnerability, and adaptation: a cross-cutting theme of the International Human Dimensions Programme on Global Environmental Change. Glob Environ Chang 16(3):237–239. https://doi.org/10.1016/j.gloenvcha.2006.04.003

Johnson JE, Welch DJ, Maynard JA, Bell JD, Pecl G et al (2016) Assessing and reducing vulnerability to climate change. Moving from theory to practical decision-support. Mar Policy. 1(74):220–229. https://doi.org/10.1016/j.marpol.2016.09.024

Jurgilevich A (2021) Governance modes and epistemologies of future-oriented vulnerability assessments: Example of a mixed-methods approach. Futures 128:102–127. https://doi.org/10.1016/j.futures.2021.102717

Jurgilevich A, Rasanen A, Groundstroem F, Juhola S (2017) A systematic review of dynamics in climate risk and vulnerability assessments. Environ Res Lett 12(1):013002. https://doi.org/10.1088/1748-9326/aa5508

Keinberger S, Blaschke T, Zaidi ZR (2013) A framework for spatio-temporal scales and concepts from different disciplines: the 'vulnerability cube.' Nat Hazards 68:1343–1369. https://doi.org/10.1007/s11069-012-0513-x

Kelly PM, Adger WN (2000) Theory and practice in assessing vulnerability to climate change and facilitating adaptation. Clim Change 47(4):325–352. https://doi.org/10.1023/A:1005627828199

Keskitalo ECH (2012) Climate change and globalisation in the Arctic. An integrated approach to vulnerability assessment. Routledge, London, p 272. https://doi.org/10.4324/9781849770798

Kittinger NJ (2013) Human dimensions of small-scale and traditional fisheries in the Asia-Pacific region. Pac Sci 67(3):315–325. https://doi.org/10.2984/67.3.1

Lede E, Pearce T, Furgal C, Wolki M, Ashford G et al (2021) The role of multiple stressors in adaptation to climate change in the Canadian Arctic. Reg Environ Chang. 21:50–63. https://doi.org/10.1007/s10113-021-01769-z

Lung T, Lavalle C, Hiederer R, Dosio A, Bouwer ML (2013) A multi-hazard regional level impact assessment for Europe combining indicators of climatic and non-climatic change. Glob Environ Chang. 23(2):522–536. https://doi.org/10.1016/j.gloenvcha.2012.11.009

Macfayden G, Corcoran E (2002) Literature review of studies on poverty in fishing communities and of lessons learned in using the sustainable livelihoods approach in poverty alleviation strategies and projects. FAO Fish Circular. Number 0429. FAO, Rome, p 102

Mach JK, Mastrandrea DM, Bilir ET, Field BC (2016) Understanding and responding to danger from climate change: the role of key risks in the IPCC AR5. Clim Chang. 136:427–444. https://doi.org/10.1007/s10584-016-1645-x

Magnan AK, Schipper ELF, Burkett M, Bharwani S, Burton I et al (2016) Addressing the risk of maladaptation to climate change. Wiley Interdiscip Rev Clim Chang 7(5):646–665. https://doi.org/10.1002/wcc.409

Malakar K, Mishra T, Hari V, Karmakar S (2021) Risk mapping of Indian coastal districts using IPCC-AR5 framework and multi-attribute decision making approach. J Environ Manag. 294:112–126. https://doi.org/10.1016/j.jenvman.2021.112948

Maleki R, Nooripoor M, Azadi H, Lebailly P (2018) Vulnerability assessment of rural households to Urmia Lake drying (the case of Shabestar region). Sustainability 10(6):1862. https://doi.org/10.3390/su10061862

Marshall N, Tobin R, Marshall P, Gooch M, Hobday A (2013) Social vulnerability of marine resource users to extreme weather events. Ecosystems 16(5):797–809. https://doi.org/10.1007/s10021-013-9651-6

Mazibuko S (2013) Understanding underdevelopment through the sustainable livelihoods approach. Community Dev. 44(2):173–187. https://doi.org/10.1080/15575330.2012.683798

McDowell G, Ford J, Jones J (2016) Community-level climate change vulnerability research trends, progress, and future directions. Environ Res Lett 11(3). https://doi.org/10.1088/1748-9326/11/3/033001

McLean JE (2015) Beyond the pentagon prison of sustainable livelihood approaches and towards livelihood trajectory approaches. Asia Pac Viewpoint. 56(3):380–391. https://doi.org/10.1111/apv.12097

McLeod E, Weis MWS, Wongbusarakum S, Gombos M, Daze A et al (2015) Community-based climate vulnerability and their adaptation tools: A review of tools and their applications. Coast Manag 43:439–458. https://doi.org/10.1080/08920753.2015.1046809

Meenar RM (2017) Using participatory and mixed-methods approaches in GIS to develop a place-based food insecurity and vulnerability index. Environ Plan. 49(5):1181–1295. https://doi.org/10.1177/0308518X16686352

Mensah JE (2011) The Sustainable Livelihoods Framework: A Reconstruction. Global Youth Alliance Development Group. Accra, Ghana. pp 1–20

Minter T, Oriana G, Boso D, Van Der Ploeg J (2018) From happy hour to hungry hour: Logging, fisheries and food security in Malaita, Solomon Islands. Penang, Malaysia: WorldFish Program Report. Pp.1–56

Mondal M, Biswas A, Haldar S, Mandal S, Mandal P et al (2022) Rural livelihood risk to hydro-meteorological extreme events: Empircal evidence from Indian Suburban applying IPCC-AR5 and DEMATEL methodology. Int J Disaster Risk Reduction. 77:100–113. https://doi.org/10.1016/j.ijdrr.2022.103100

Morand P, Kodio A, Andrew N, Sinaba F, Lemoalle J et al (2012) Vulnerability and adaptation of African rural populations to hydro-climate change: experience from fishing communities in the Inner Niger Delta (Mali). Clim Change 115:463–483. https://doi.org/10.1007/s10584-012-0492-7

Morse S, McNamara N (2013) Sustainable livelihood approach. A critique of theory and practice. Springer Science & Business Media, New York. https://doi.org/10.1007/978-94-007-6268-8

Murphy BL (2011) From interdisciplinary to inter-epistemological approaches: Confronting the challenges of integrated climate change research. Can Geogr-Geographe Canadien 55(4):490–509. https://doi.org/10.1111/j.1541-0064.2011.00388.x

Natarajan N, Newsham A, Rigg J, Suhardiman D (2022) A sustainable livelihoods framework for the 21st century. World Dev. 155:105–110. https://doi.org/10.1016/j.worlddev.2022.105898

Naylor A, Ford J, Pearce T, Alstine VJ (2020) Conceptualising climate vulnerability in complex adaptive systems. 2(5), 444–454. https://doi.org/10.1016/j.oneear.2020.04.011

Nguyen TXT, Bonetti J, Rogers K, Woodroffe DC (2016) Indicator-based assessment of climate change impacts on coasts: A review of concepts, methodological approaches, and vulnerability indices. Ocean Coast Manag 123:18–43. https://doi.org/10.1016/j.ocecoaman.2015.11.022

Nicholls JR, Wong PP, Burkett V, Woodroffe DC, Hay J (2008) Climate change and coastal vulnerability assessment: scenarios for integrated assessment. Sustain Sci 3:89–102. https://doi.org/10.1007/s11625-008-0050-4

O'Brien K, Eriksen S, Nygaard LP, Schjolden A (2007) Why different interpretations of vulnerability matter in climate change discourses. Clim Policy 7(1):73–88. https://doi.org/10.1080/14693062.2007.9685639

Orr JA, Vinebrooke RD, Jackson MC, Kroeker KJ, Kordas RL et al (2020) Towards a unified study of multiple stressors: divisions and common goals across research disciplines. Proc R Soc B-Biol Sci 287(1926). https://doi.org/10.1098/rspb.2020.0421

Oulahen G, Chang ES, Yip KZJ, Conger T, Mareleira M et al (2018) Contextualising institutional factors in an indicator-based analysis of hazard vulnerability for coastal communities. J Environ Plan Manag. 61(14):2491–2511. https://doi.org/10.1080/09640568.2017.1399109

Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffman TC et al (2021) The PRISMA 2020 Statement: An updated guideline for reporting systematic reviews. Syst Rev 10(1):1–11. https://doi.org/10.1186/s13643-021-01626-4

Pandey R, Jha SK (2012) Climate vulnerability index - measure of climate change vulnerability to communities: a case of rural Lower Himalaya India. Mitig Adapt Strateg Global Change 17(5):487–506. https://doi.org/10.1007/s11027-011-9338-2

Pelling M, High C (2005) Understanding adaptation: What can social capital offer assessments of adaptive capacity? Glob Environ Chang. 15(4):308–319. https://doi.org/10.1016/j.gloenvcha.2005.02.001/

Preston LB, Yuen JE, Westaway MR (2011) Putting vulnerability to climate change on the map: a review of approaches, benefits and risks. Sustain Sci 6:177–202. https://doi.org/10.1007/s11625-011-0129-1

Rasanen A, Juhola S, Nygren A, Kakonen M, Kalliom M et al (2016) Climate change multiple stressors and human vulnerability: a systematic review. Reg Environ Change 16(8):2291–2302. https://doi.org/10.1007/s10113-016-0974-7

Roscher BM, Allison HE, Mills JD, Eriksson H, Hellebrandt D et al (2021) Sustainable development outcomes of livelihood diversification in small-scale fisheries. Fish Fish 23:910–225. https://doi.org/10.1111/faf.12662

Sayer J, Sunderland T, Ghazoul J, Pfund JL, Sheil D et al (2013) Ten principles for a landscape approach to reconciling agriculture, conservation and other competing land uses. Proc Natl Acad Sci 110(21):8349–8356. https://doi.org/10.1073/pnas.1210595110

Scoones I (1998) Sustainable rural livelihoods: a framework for analysis. IDS Working Paper 72. Institute of Development Studies, Brighton

Scoones I (2009) Livelihoods perspectives and rural development. J Peasant Stud 36(1):171–196. https://doi.org/10.1080/03066150902820503

Sejersen F (2015) Rethinking Greenland and the Arctic in the era of climate change. Routledge, New Northern Horizons

Sen A (1981) Ingredients of Famine Analysis - Availability and Entitlements. Quart J Econ 96(3):433–464. https://doi.org/10.2307/1882681

Serrat O (2017) The sustainable livelihoods approach Knowledge Solutions. Springer Open, Singapore, pp 21–26

Sharma J, Ravindranath NH (2019) Applying IPCC 2014 framework for hazard-specific vulnerability assessment under climate

change. Environ Res Commun 1(5). https://doi.org/10.1088/2515-7620/ab24ed
Sherman M, Ford J, Llanos-Cuentas A, Valdivia MJ, Bussalleu A et al (2015) Vulnerability and adaptive capacity of community food systems in the Peruvian Amazon: a case study from Panaillo. Nat Hazards 77:2049–2079. https://doi.org/10.1007/s11069-015-1690-1
Sidle CR, Benson HW, Carrier FJ, Kamail T (2013) Broader perspective on ecosystem sustainability: Consequences for decision making. PNAS. 110(23):9201–9208. https://doi.org/10.1073/pnas.1302328110
Simpson PN, Mach JK, Constable A, Hess J, Hogerth R et al (2021) A framework for complex climate chage risk assessment. One Earth. 4(4):489–501. https://doi.org/10.1016/j.oneear.2021.03.005
Singh C, Deshpande T, Basu R (2017) How do we assess vulnerability to climate change in India? A systematic review of literature. Reg Environ Change 17(2):527–538. https://doi.org/10.1007/s10113-016-1043-y
Singha A, Pramanick N, Acharyya R (2023) Implication of applying IPCC AR4 and AR5 framework for drought-based vulnerability and risk assessment in Bankura and Purulia districts, West Bengal. Geospatial Sci Digit Earth Obs. 1164:2009–2030. https://doi.org/10.1088/1755-1315/1164/1/012009/
Smit B, Wandel J (2006) Adaptation, adaptive capacity and vulnerability. Glob Environ Chang Hum Policy Dimens 16(3):282–292. https://doi.org/10.1016/j.gloenvcha.2006.03.008
Sullivan-Wiley KA, Gianotti AGS, Connors JPC (2019) Mapping vulnerability: Opportunities and limitations of participatory community mapping. Appl Geogr. 105:47–57. https://doi.org/10.1016/j.apgeog.2019.02.008
Sultana R, Irfanullah H, Selim AS, Budrudzaman (2023) Vulnerability and ecosystem-based adaptation in the farming communities of droughtprone Northwest Bangladesh. Environ Challenges. 11:100–117. https://doi.org/10.1016/j.envc.2023.100707
Thiault L, Marshall P, Gelcich S, Collin A, Chlous F et al (2018) Mapping social-ecological vulnerability to inform local decision making. Conserv Biol. 32(2):447–456. https://doi.org/10.1111/cobi.12989
Thiault L, Gelcich S, Marshall N, Marshall P, Chlous F et al (2020) Operationalising vulnerability for social-ecological integration in conservation and natural resource management. Conserv Lett 13(1):12677. https://doi.org/10.1111/conl.12677
Thiault L, Jupiter S, Johnson JE, Cinner JE, Jarvis RM et al (2021) Harnessing the potential of vulnerability assessments for managing social-ecological systems. Ecol Soc 26(2):1–22. https://doi.org/10.5751/ES-12167-260201
Thomas K, Hardy DR, Lazarus H, Mendez M, Orlove B et al (2018) Explaining differential vulnerability to climate change: A social science review. Wiley Clim Chang. 10:1–18. https://doi.org/10.1002/wcc.565
Thulstrup AW (2015) Livelihood resilience and adaptive capacity: Tracing changes in household access to capital in Central Vietnam. World Dev 74:352–362. https://doi.org/10.1016/j.worlddev.2015.05.019
Tiepolo M, Bacci M, Braccio S, Bechis S (2019) Multi-hazard risk assessment at community level integrating local and scientific knowledge in the Hodh Chargui, Mauritania. Sustainability 11:5064–5087. https://doi.org/10.3390/su11185063
Totin E, Butler JR, Sidibe A, Partey S, Thornton KP et al (2018) Can scenario planning catalyse transformational change? Evaluating a climate change policy case study in Mali. Futures. 96:44–56. https://doi.org/10.1016/j.futures.2017.11.005
Van TC, Tuan CN, Son TN, Tri QD, Anh NL et al (2022) Flood vulnerability assessment and mapping: A case of Ben Hai-Thach Han River basin in Vietnam. Int J Disaster Risk Reduction. 75(1):102–114. https://doi.org/10.1016/j.ijdrr.2022.102969
Warren FR, Brown KW, Watkiss P, Betts AR, Murphy MJ et al (2018) Advancing national climate change risk assessment to deliver national adaptation plans. Philos Trans A. 376:201–220. https://doi.org/10.1098/rsta.2017.0295
Wellstead MA, Howlett M, Rayner J (2013) The neglect of governance in forest sector vulnerability assessments: Structural functionalism and 'Black Box' problems in climate change adaptation planning. Ecol Soc 18(3):23–31. https://doi.org/10.5751/ES-05685-180323
Werners SE, Wise RM, Butler JRA, Totin E, Vincent K (2021) Adaptation pathways: A review of approaches and a learning framework. Environ Sci Policy 116:266–275. https://doi.org/10.1016/j.envsci.2020.11.003
Wilby LR, Charles PS, Zorita E, Timbal B, Whetton P et al (2004) Guidelines for use of climate scenarios developed from statistical downscaling methods. Environment Agency of England, Wales, UK. Pp.1–27
Windfeld JE, Ford DJ, Berrang-Ford L, McDowell G (2019) How do community-level climate change vulnerability assessments treat future vulnerability and integrate diverse datasets? A review of the literature. Environ Rev 27(4):427–434. https://doi.org/10.1139/er-2018-0102
Zhang Q, Zhao X, Tang H (2019) Vulnerability of communities to climate change: Application of the livelihood vulnerability index to an environmentally sensitive region of China. Climate Dev 11(6):525–542. https://doi.org/10.1080/17565529.2018.1442808