Measuring the climate security nexus: the Integrated Climate Security Framework

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Abstract

International, regional, and national organizations and policymakers are increasingly acknowledging the implications of climate on peace and security, but robust research approaches that embrace the complexity of this nexus are lacking. In this paper, we present the Integrated Climate Security Framework (ICSF), a mixed-methods framework to understand the mechanisms of climate–conflict linkages at different scales. The framework uses conventional and non-conventional methods and data to provide state-of-the-art policy-relevant evidence that addresses four main questions: how, where and for whom climate and conflict risks occur, and what can be done to mitigate this vicious circle. The framework provides a comprehensive assessment of the complex social-ecological dynamics, adopting systems approaches that rely on a combination of epistemological stances, thereby leveraging diverse qualitative, quantitative, locally relevant, and multifaceted data sources; and on a diversity of actors involved in the co-production of knowledge. Using a case study from Kenya, we show that the climate security nexus is highly complex and that there exists strong, theoretical, and statistical evidence that access to natural resources, livelihoods and food security are important pathways whereby climate can increase the risk of conflict, and that conflict undermines resilience objectives. We also find that communities in climate security hotspots are aware and highly knowledgeable about the risk that the climate crisis poses on existing drivers of conflict and yet, online issue mapping and policy coherence analysis indicate that policymakers have not been acknowledging the nexus appropriately. The policy-relevant evidence that is collected through the ICSF and collated in the CGIAR Climate Security Observatory aims to fill this gap and to help transform climate adaptation into an “instrument for peace”.

Keyword

Climate security, conflict, peace, adaptation, resilience.

Introduction

Unpacking the relationship between climate and peace and security, otherwise called the "climate security nexus" has become a priority for many national, regional, and international policymakers (1–3) This is because increasingly unpredictable, more frequent, and more violent climate impacts are exacerbating human insecurity risks of the most vulnerable (4–7). Climate impacts are reinforcing common drivers of conflict, and conflict and fragility are making people more vulnerable to climate hazards, creating a "vicious circle" where the most vulnerable are locked into a trap of increased marginalization, poverty, inequality and conflict-related fragilities (8,9).

Nonetheless, producing policy-relevant evidence on the nexus has proved a challenging task, as the climate security nexus is a highly complex and multifaceted phenomenon that involves intricate and dynamic interactions between environmental, social, cultural, economic, and political factors (10). This complexity makes it challenging to understand how, where, for whom, and to what extent climate and security connections emerge to inform policy decisions.

One of the main complexity challenges of the nexus originates from the existence of *multiple pathways* or mechanisms whereby climate can exacerbate existing risks and vulnerabilities and ultimately contribute to intensifying conflicts, and where conflict, on the other hand, can undermine capacities for resilience. Examples of plausible pathways include competition over scarce resources (e.g., water, land and forest), food insecurity, mobility and displacement, changes in livelihood opportunities and economic performances, increased exposure to extreme events, and amplified grievances against the state, to mention a few (11).

The interplay between these pathways and their interactions with socio-political dynamics can also vary significantly across contexts (*context specificity*) (12). Different regions, countries and communities face unique environmental, socio-economic, and political circumstances that shape their vulnerability to climate impacts, which in turn can inform the likelihood and intensity of conflict. Factors such as governance structures, institutional capacities, social cohesion, historical legacies, and cultural norms play a significant role in shaping how climate-related stressors translate into conflict risks and vice versa (13).

Climate change and conflict also usually exhibit nonlinear dynamics, meaning that the relationship between them is not always linear or proportional (14). Small changes in climate or environmental conditions can have disproportionately large impacts on social systems and conflict outcomes. Feedback loops and tipping points may occur, where climate-induced changes can amplify existing vulnerabilities, social tensions, and conflict dynamics (15).

In addition, the climate-conflict nexus involves a wide range of actors operating at different scales, from local communities to national governments, international organizations, and transnational networks (*multiple actors and scales*). These actors have different interests, priorities, and capacities to address climate-related challenges and conflict prevention, and understanding these nuances is critical to inform policy decisions (16).

Finally, spatial and temporal scales of data used in climate security analyses are important aspects to account for to understand general and context-specific climate security dynamics (17,18). The increasing availability of data on *multiple geographical and temporal scales*, and the fact that different studies are conducted at different scales, makes comparisons across studies challenging (17), (19).

Previous attempts to study the climate security nexus have struggled to generate a consensus on the interface of climate and security as, apart from a few notable exceptions (e.g. (10,19)), the complexity of the nexus has been ignored or marginally addressed. For instance, many authors have attempted to characterize the climate security nexus by using statistical models to look for a causal, direct, long-term effect of climate on conflict or lack of peace (20–23). These approaches, by using secondary data and employing linear statistical models, fail to account for many of the complex dimensions of the nexus. They assume, instead, that no other intermediary mechanism exists between climate and conflict; they ignore the temporal heterogeneity of the impacts by only considering longer term climate change events; compute global, regional, and national averages of the effects, and therefore ignore the context specificity of the nexus and, finally, do not account for indigenous and multi-faceted knowledge that local stakeholders and affected communities can provide.

To address some of these limitations, other authors have preferred focusing on short-term hazards resulting from climate change (climate variability) rather than larger and longer changes in climatic conditions (climate change). They have used methods to account for intermediary effects and have embarked in more qualitative approaches to elicit indigenous knowledge (24–28). These studies acknowledge that climate does not have a direct, linear effect on peace and security but, rather, that it acts as a "multiplier", exacerbating existing socio-economic risks and insecurities such as agricultural losses, food insecurity, forced migration, and inequality, which can increase the risk, duration, and intensity of tensions and conflicts and therefore impact on peace and security (7,22,29–31). Some of these authors also explicitly recognize part of the complexity of the nexus by studying how both climate and conflict risks are influenced by, and interconnected through, a multiplicity of these intermediary factors that make up climate-insecurity feedback loops through a "vicious circle", where climate can indirectly affect conflict dynamics and conflict can increase vulnerabilities to future climate hazards (8,10). Another strand of the literature has challenged methods aiming to find causation or quantitative links between climate and conflict (12,32). By focusing entirely on qualitative, ethnographic, and anthropological approaches, these authors intend to define the relation between climate and conflict by understanding how populations experience these risks in an overlapping and compounding manner, and by situating insecurity and vulnerability in a historical and cultural context (33).

Despite addressing a few of the complexity challenges of the climate security nexus, such as multi-dimensionality, context specificity, and non-linearity, these studies rarely use mixed method approaches to generate an integrated view of the nexus and triangulate results (34). A recent systematic review of climate security literature shows that, out of 142 studies on the climate security nexus, only 6 used a mixed-method approach to triangulate findings (12) and to the best of our knowledge, none of the previous studies or approaches provide a comprehensive assessment of *how* climate is exacerbating root causes of conflict, *where* this is happening and for *whom* and, even more rarely, identify solutions (*what*) to mitigate the climate security nexus. We aim to fill this gap.

In line with Beaumont & Coning (2022) (36), we argue that comprehensive assessments of the complex social-ecological dynamics that comprise this nexus require adopting systems approaches that rely on a combination of epistemological stances, thereby relying on diverse qualitative and quantitative, locally-relevant, and multifaceted data sources; as well as on a diversity of actors involved in the co-production of knowledge. The Integrated Climate Security Framework (ICSF) presented in this paper uses conventional and innovative approaches and data to qualify and quantify the climate security nexus, addressing the five main complexity challenges (multiple pathways, context specificity, non-linear dynamics, multiple geographical and temporal scales, and multiple sectors and actors). The framework is innovative as it uses state-of-the-art science and research methods to elicit robust, policy relevant evidence and to provide tools to inform targeting, programming and the design of effective climate security sensitive policy and investments that are tailored to specific contexts. To demonstrate how the framework works in practice, we present the results of the ICSF from a pilot in Kenya.

Adopting such a systems approach is crucial not only to help policymakers target and prioritize areas and groups of the population that are most affected by compound risks and insecurities but also to transform climate adaptation and make it an “instrument for peace” by aligning climate resilience to peacebuilding objectives and thereby reshaping food, land and water systems to sustain peace in a changing climate.

The rest of the paper is structured as follows: Section 1 describes the framework; Section 2 presents a case study for Kenya and Section 3 concludes.

Section 1. An integrated framework to assess the climate security nexus

The Integrated Climate Security Framework (ICSF - Fig. 1) is a systems-thinking framework that provides a 360-degree multi-dimensional perspective of the climate security nexus by utilizing conventional and non-conventional data and approaches; by leveraging local knowledge and expertise at global, regional, national, and sub-national levels, and by providing the means to assess and co-design with affected communities and decision makers climate adaptation policies, programs and investments that do no harm but contribute actively to sustaining peace. The ICSF is embedded in the , a global decision support tool that collates the evidence generated by the framework across climate security hotspots. The framework addresses the main complexity challenges of the climate security nexus (multiple pathways, context specificity, non-linear dynamics, multiple geographical and temporal scales and multiple sectors and actors), by answering four main analytical questions:

1) *HOW does climate exacerbate the root causes of conflict?*
2) *WHERE are the areas most vulnerable to climate-related insecurity and risk?*
3) *WHO are the groups vulnerable to climate and security risks that should be targeted?*
4) *WHAT needs to be done to break the vicious cycle between climate and conflict?*

Figure 1 shows the specific methods, objectives and related research questions that are used to address the above. They are discussed in detail in the next sections.

HOW does climate exacerbate the root causes of conflict?

Three qualitative (Climate Security Pathway Analysis – CSPA – and Social Learning participatory approaches – expert workshop and fieldwork – SL) and two quantitative methods (Network Analysis – NA – and Mediation Modelling – MM) are used to understand the multiple relationships – or *pathways* – between climate and security and to untangle the complex web of interrelationships from different perspectives. The qualitative approaches are used to identify climate security pathways through revision of existing literature and by leveraging regional, national, and local expertise from affected communities and stakeholders. The quantitative approaches are used to quantify some of the dynamics identified and to test the strength of the most recurrent pathways of the climate security nexus. The results of the different methods are then integrated to provide a more comprehensive picture of the intermediate dynamics that result in compound climate security risks.

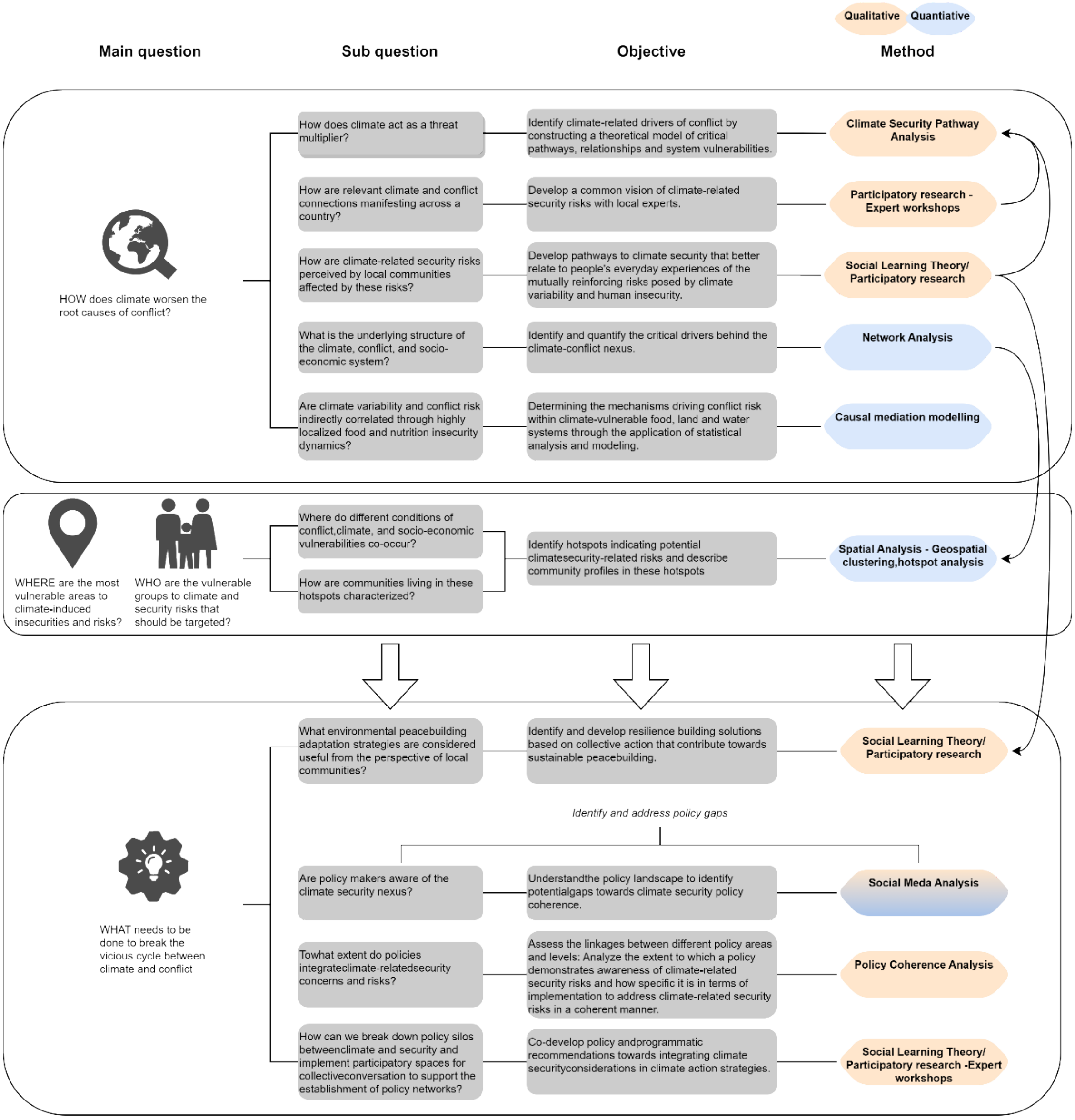

Figure 1 A visual representation of the Integrated Climate Security Framework. For each analytical question (how, where, who and what) sub-questions, objectives of the specific research areas and the methods used are reported.

The Climate Security Pathways Analysis, CSPA, is a conceptual model that describes relationships and pathways between climate, conflict, and the vulnerabilities of (food, land, water) systems based on a comprehensive literature review (37). The concept of "pathways" is an important tool for capturing and navigating the complex relationships between climate change, peace, and security. By looking in detail at the intervening variables that matter, it underscores the relevance of social, political, and economic structures and dynamics, but does not claim that climate change is a direct cause of conflict, violence, or insecurity (38). Quantitative research exploring causal linkages is limited in many regions due to a lack of relevant data (34). Hence, the qualitative pathways approach aims to complement quantitative climate security research to provide policy advice by offering a detailed understanding of the climate security nexus that decision makers need (19,34). The approach also allows for the synthesis of available literature in geographic areas where there is little research on climate, peace, and security, enabling the development of a theoretical understanding of the nexus (Examples of CSPAs can be found in(39–46)).

Highly localized multiple climate security pathways are also identified using social learning theory and participatory research, i.e., as perceived and experienced by regional and national stakeholders as well as local communities affected by these risks (47,48). An approach drawn from social learning theory and participatory action research enables the development of climate security pathways that relate to people's everyday experiences of the mutually reinforcing risks posed by climate variability and human insecurity, as well as the multidirectional linkages between these factors. Local stakeholders and community members are engaged, through workshops and fieldwork, as citizen scientists and experts to understand the various vulnerabilities that affect them and to propose needed changes for the better. One advantage of such qualitative methods is that they acquire and examine data in a less structured and more ethnographic manner before distilling it into a story about how climate change and conflict are related (12). They furthermore demonstrate how these relationships are profoundly ingrained in and consequently created by larger sociopolitical processes, hence accounting for local contexts and complexity for which no quantitative datasets are available (e.g. 45,46). The results of the engagement with regional and national stakeholders are published in a "Towards a common vision on climate security" report which is co-branded and co-authored by the participants and used for advocacy purposes in the targeted geography (49,50) and in a memory report (51,52). The findings of the community fieldwork are instead published in a series of "Community Voices" briefs and reports, which are also disseminated back with the participant communities and stakeholders (e.g. 50,51). The overall results of both social learning activities inform the theoretically identified pathways and complement the literature review of the CSPA presented above.

From a quantitative perspective, network analysis (55) is used to understand the overall structure of the climate, conflict, and socioeconomic system and identify critical factors. Network analysis is a powerful tool that contributes to a deeper understanding of the structure and organization of complex systems by focusing on the relationships between the components of the system (56). It has applications in a variety of fields, including social sciences, biology, computer science, economics, transportation, and many others (57–59). It breaks down the complexity of the climate-conflict nexus by assigning different levels of structure to its components via nodes as single influencers, edges as links, or compartments as groups of nodes that share strong connections. It also identifies the central nodes or the most influential factors that can play a crucial role in controlling or influencing other socioeconomic factors. In addition, it helps to understand the flow of influence and any cascading effects within the different socioeconomic and climate-related factors, and to capture the behavior of the system under different stress scenarios. As such, it can be used as a quantitative tool to inform the decision-making process (examples of these analyses can be found in: (60–67)).

The final method to answer the "how" question uses a mediation modeling approach, specifically a structural equation model, to quantify how climate variability and conflict risks are indirectly linked through highly localized food and nutrition insecurity dynamics (68). Mediation analysis is a statistical framework for studying indirect pathways or mechanisms (69). Imai et al. (2013) defined a mechanism as a process in which a variable of interest influences an outcome through a mediator that stands between the variable of interest and the outcome variables (70). Thus, rather than focusing only on the overall effect, pathway analysis helps to understand social and economic phenomena. Decisions by policy makers can be made more effectively as the structural equation model allows us to identify both the indirect effect of a selected mediator (food insecurity) and the residual effect caused by unexplored channels (71,72). This is a more flexible model compared to the instrumental variable (IV) approach, which is commonly used in econometrics to test the effects of climate on a dependent variable (e.g., conflict or migration) through an intervening factor. The IV approach assumes that climate (to be a valid instrument) can only affect the dependent variable through the mediator (73). Such an assumption may sound unrealistic when applied to the relationship between climate and conflict, which is generally very complex and involves many interacting factors (74–76) (examples of this analysis can be found in: (77,78).

WHERE are the areas most vulnerable to climate-related insecurity and risk? And WHO are the groups vulnerable to climate and security risks that should be targeted?

Spatial clustering and hotspot analyses are used to answer the "where" and "who" questions (79). Spatial analysis enables rapid detection and descriptive analysis of places and communities at risk from climate, security, and socioeconomic impacts. Clusters describing different climate and conflict conditions are created and overlaid with socioeconomic hotspots to identify the geographic coincidence of specific combinations of conflict, climate conditions, and socioeconomic vulnerabilities. The selection of socioeconomic variables for hotspot mapping is based on the results of the network analysis, which identified key socioeconomic drivers associated with various conflict variables. Multiple data layers on demographics and socioeconomics are used to characterize community profiles within the different hotspots. This approach is simple enough to process large datasets even when little prior information is available. The climate clustering approach exploits the idea that all categorical raster data can be characterized by spatial patterns inherent in variables. These spatial patterns are computed using integrated co-occurrence histograms, which quantify the composition (number of pixels for each category in an area) and configurations (context) of spatial patterns in an area using several climate hazard indices (see (80)) Examples of these analyses can be found in CGIAR Climate Security Observatory under the "*where"* and "*who"* questions.

WHAT needs to be done to break the vicious cycle between climate and conflict?

The approaches used to answer the "*what*" question provide multi-perspective entry points for potential solutions in terms of climate security-sensitive decision making and programming that respond to context specific needs while representing a multitude of actors and scales. For this purpose, we use two types of Social Learning Participatory Approach (SL), one that engages at community levels and the other that works with actors at the global, regional, national, and sub-national levels; Social Media Analysis (SMA), and Policy Coherence and Awareness Analysis (PCAA).

The first Social Learning approach builds on the idea that climate-related security risks and adaptation strategies for environmental peacebuilding must be assessed by communities affected by these risks, i.e. located in climate security hotspots. Therefore, community members that participate in this framework become active citizen communicators of the various vulnerabilities that affect them and propose the necessary changes to mitigate the impact of climate on local conflict and to improve climate resilience in conflict and fragile settings. Using similar elicitation methods as for the HOW questions above (47), this approach directly asks communities located in climate security hotspots to identify resilience-building solutions based on collective action that contribute to sustainable peacebuilding (53,54).

The development of concrete solutions at different scales also requires an in-depth understanding of priorities in different policy domains, levels of government and decision-making processes. We apply an online issue mapping approach (81) through analysis of social media content to examine how climate, conflict, and socioeconomic risks and uncertainties are represented in the public discourses of a different array of policy actors at national level (82). Twitter is widely recognized as an important venue for institutional communications and a proxy for wider public discourse and engagement. As such, policy actors have utilized the platform as a space for official statements and position taking, with news media also relying on these conversations as credible sources. The platform's potential as a real-time, topic-driven platform enables detecting trends and uncovering discourse dynamics (83). In particular, machine-driven content analysis techniques enable identification of trends in political agendas over time and across geographies (84). While extensive research about climate change discourses on social media have been conducted, focusing on various subjects such as issue polarization, disinformation, activism, and climate communication (see (85,86), among many others), this analysis is the first to explore narratives and dynamics pertaining to the climate security nexus from a policy perspective. Insights emerging from this analysis identify political entry points and evidence gaps for the development of policy relevant evidence and engagement strategies within the science-policy interface, so that effective responses to climate change are sensitive to the interlinkages with the human security context in the country (examples of this analysis can be found: (87–93)).

We also use Policy Coherence and Awareness Analysis (PCAA) to assess the state of integrated climate security programming in policies (94). PCAA is a research method that seeks to evaluate the consistency and alignment of policy objectives, instruments, and strategies across multiple levels of governance and various sectors, as well as detect the in-text presence of specific themes and concepts (94). This method places emphasis on three key components: thematic engagement, the presence of cogent policy instruments and objectives, and multi-level integration. Thematic engagement refers to the degree to which policy documents address and demonstrate awareness of pertinent themes, issues, and solutions related to the topics of interest. The presence of cogent policy instruments and objectives is an assessment of the operability of policies and the extent to which thematic engagement is transformed into specific implementation measures. Multi-level integration is an evaluation of the consistency and alignment of policies within or across different governance levels, capturing both horizontal and vertical integration. This method uses a dataset of policy documents originating from sectors deemed relevant for the themes under study, such as climate, agriculture, food systems and security. The PCAA method's unique utility lies in its capacity to evaluate the extent to which and how complex, multi-variate phenomena across several thematic areas are discussed and understood within relevant policy and strategy documents, based on which targeted and practical recommendations can be produced for policymakers. Examples of these analyses can be found in (90,91).

Finally, context-specific policy and programmatic recommendations for integrating climate security considerations into climate change mitigation strategies are developed through social learning expert workshops that engage with global, regional, national, and sub-national actors linked to the climate security nexus (48). The complex nature of climate-related security risks embodies a collective action problem that requires the coordinated and collaborative effort of a diverse set of actors. However, the exact makeup of actor coalitions and the mechanisms whereby an effective integration of multi-sectoral approaches to programming could become institutionalized, remain something to be explored under distinct governance systems. The shared vision on climate security workshops bring together a diversity of stakeholders from the climate, development and peacebuilding sectors to jointly explore the nature of climate-related security risks as experienced in their context of work, to define a set of multistakeholder platforms that could serve as a coordinating space to take forward a national-level climate security agenda, and to develop a set of action proposals towards fostering a community of practice for climate security in the country (49,50).

The results of the how, where, who and what questions are then integrated in a "Country Profile", a short document that aims to help national decision-makers prioritize dimensions and systems, areas and groups of populations, and a specific package of interventions that will transform climate adaptation and make it an instrument for peace and stability. Examples of Climate Security Country Profiles can be found in (96,97). The next section presents the findings of the ICSF for Kenya.

Session 2. The Climate Security Nexus in Kenya

Kenya is one of the fastest growing economies in Sub-Saharan Africa. With a devolved governance system, it can be characterized as a relatively peaceful context when compared to most of its neighboring countries. However, due to a combination of political, agroecological, and socioeconomic factors, Kenya has been recognized as one of the most vulnerable African countries to the impacts of climate change (98). Extreme weather events and shifting climatic patterns, primarily in the form of heat waves, rainfall variability and droughts, are increasingly affecting the country's crop and livestock systems, with severe implications for the income, employment, and food production of the entire Kenyan population (99). Recurrent floods and droughts have major repercussions on water, energy, and land availability, thus leading the country to lose large cropland areas, limit production, and experience more water scarcity, as well as food and nutrition insecurity (98–100). Vulnerability to climate variability and extremes poses significant challenges not only to the country's economy but also to overall social stability, especially when climatic events disproportionately affect already vulnerable groups (Ibid.). Rural poor households, for instance, are particularly vulnerable to economic collapse and unable to cope with these shocks if repeatedly exposed to weather-related stressors and ecological deterioration (101). In addition, shocks like the COVID-19 pandemic and the war in Ukraine have widened existing inequalities. Hence, while climate may not be directly driving localized conflict dynamics, its context specific interactions with socio-economic and political factors can shape and exacerbate risks of human insecurity and conflict (96).

Following the ICSF, in the next sections we present the results of the analysis across the four main analytical questions of the framework.

HOW does climate exacerbate the root causes of conflict?

The objective of this question is to identify mechanisms whereby climate and conflict risks interact within the climate security nexus. Figure 2 presents the integrated findings of both quantitative and qualitative approaches. For all the field studies reported in this section a rigorous ethics assessment was conducted by the Leibniz Centre for Agricultural Landscape Research (ZALF), which approved the research. In the field, participants also provided verbal consent for their engagement in the research prior to the execution of the activities. No minors were involved in the research.

The combination of Climate Security Pathway Analysys (40) and Social Learning Participatory Approaches (49,53) resulted in the identification of three main climate security pathways. The first is the **resource availability and access pathway**, in which climate-related impacts limit the availability of natural resources, making their access highly contested. This is especially true in the country's arid and semi-arid lands, which cover more than 80% of Kenya's land area and where small-scale resource-related conflicts between pastoral groups are facilitated by the proliferation of small arms, as well as grievances fed by marginalization, a lack of basic services, limited employment opportunities, weak governance, and erosion of formal institutions.

The second is the **livelihood and food insecurity pathway**, where rising temperatures, erratic rainfall, and flooding threaten climate-sensitive livelihoods and food security by reducing agricultural productivity. Rural populations may migrate to other areas in response to food insecurity and a lack of alternative livelihood options. The strain on infrastructure and resources can exacerbate tensions between host communities and migrants. Those who remain in rural areas, particularly dissatisfied youth who lack access to education and employment, may become targets for recruitment by armed groups.

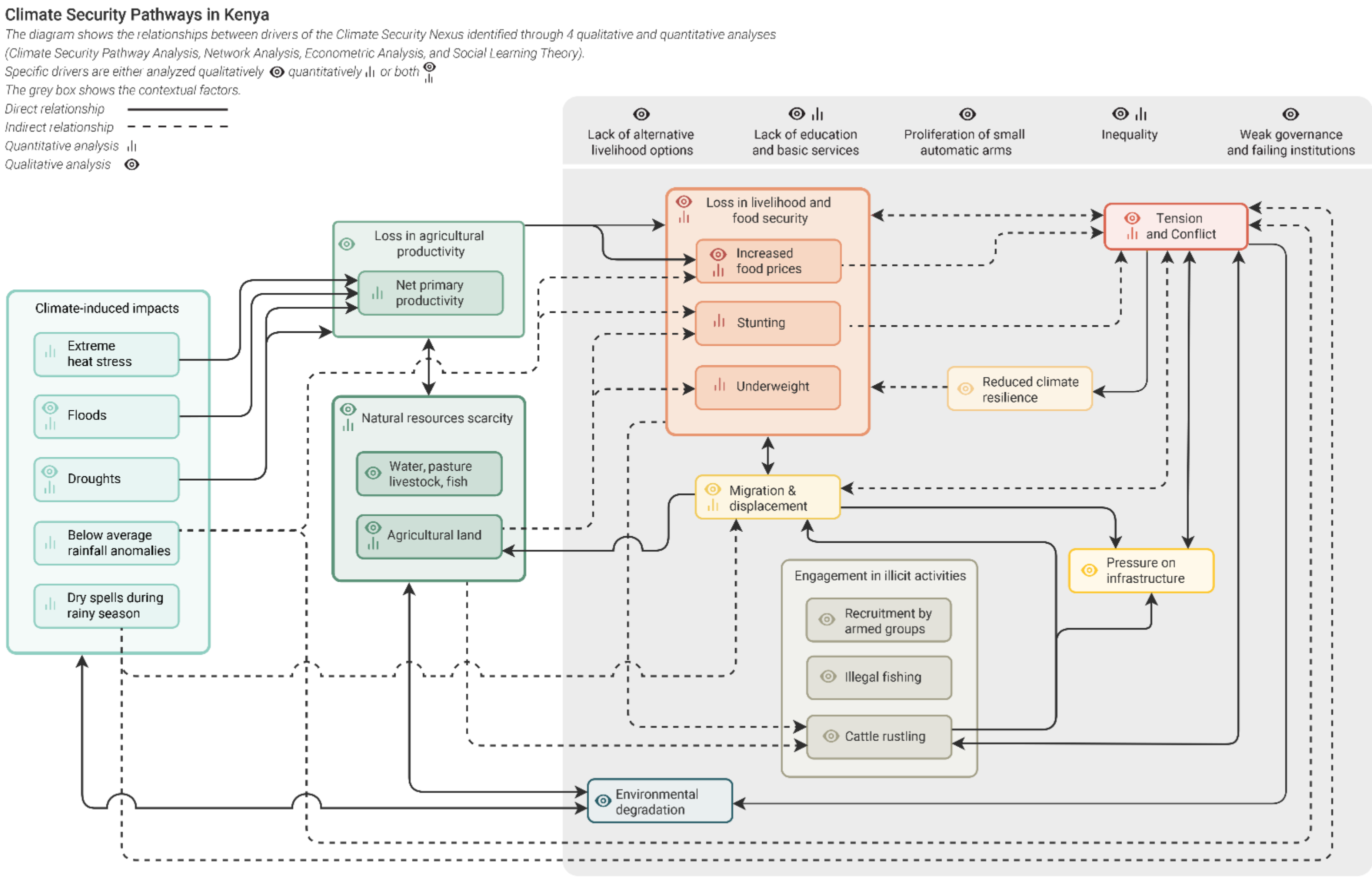

Figure 2 A visual representation of the mechanisms and pathways whereby climate is worsening common drivers of conflict and how conflict interacts with common vulnerabilities to climate impacts. The figure integrates findings from the CSPA, SL fieldwork activities, Network Analysis and Mediational Modelling. Straight lines indicate the existence of a direct relationship, while dotted lines refer to indirect linkages. The "bar plot" symbol indicate that the mechanisms or pathway has been tested or identified using quantitative methods while the "eye" symbol refer to qualitative findings.

Lastly, **the conflict and (climate) resilience pathway** shows that protracted conflict undermines access to public and social services and public infrastructure. This can further exacerbate existing poverty and marginalization, reducing people's ability to manage climate driven risks. Conflict also limits food and livestock production and access to markets, is a major cause of displacement, and hampers pastoralists' ability to migrate in search of pasture and water. These various impacts not only undermine livelihoods and food security, but also increase people's dependence on natural resources, foster maladaptive responses, and contribute to environmental degradation, hence aggravating climate change and variability.

The social learning approach applied through fieldwork in local communities elicits additional context specific pathways, based on local knowledge and people's lived experiences of climate security risks (53). In the Yaaku community in Laikipia County, conflicts between the Yaaku and the Samburu communities around access and use of Mukogodo forest are intensifying because of recent droughts. Members of the Yaaku villages within the forest report to be the victims of cattle rustling, mostly by Samburu pastoralists to the north, around once per week. These attacks have recently increased both in intensity and frequency, leading to harsher impacts over Yaaku wellbeing. Yaaku populations perceive this increase in rustling as related to the effects of drought in pastoral communities.

The Banyala community in Busia County have largely transitioned to subsistence farming and small-scale cash crop production since the 1990s, due to the plummeting of fish stocks in Lake Victoria and increasingly harsh regulations from Kenyan and Ugandan governments. However, increases in flooding have also made it increasingly difficult for the Banyala community to find alternative sources of livelihood, and they are now forced to go deeper into the lake and across the Ugandan border to fish. This is putting them at risk of arrest, torture, destruction of property, and death by Ugandan authorities and pirates. In this sense, the effects of climate change are forcing populations to maintain a livelihood strategy that puts them at risk of lawbreaking and insecurity.

The Endoróis community in Baringo County has been subjected to violent attacks from the neighboring Pokoot communities since 2005. The effects of this conflict on population wellbeing have been significant. Members of the Endoróis understand that high levels of vulnerability, poverty, and marginalization among Pokoot populations make them more susceptible to recruitment by bandits. This is enhanced by the effect of climate change, mainly through the loss of agricultural productivity and livelihoods during extreme droughts. These impacts are now higher due to the widespread presence of internally displaced people across their territory and affect the loss of life and livelihoods due to the impacts of violence.

Building on qualitative research, the network analysis (NA) and the mediation modelling (MM) quantify components of the nexus to deepen our understanding of the dynamics and strength of those linkages.

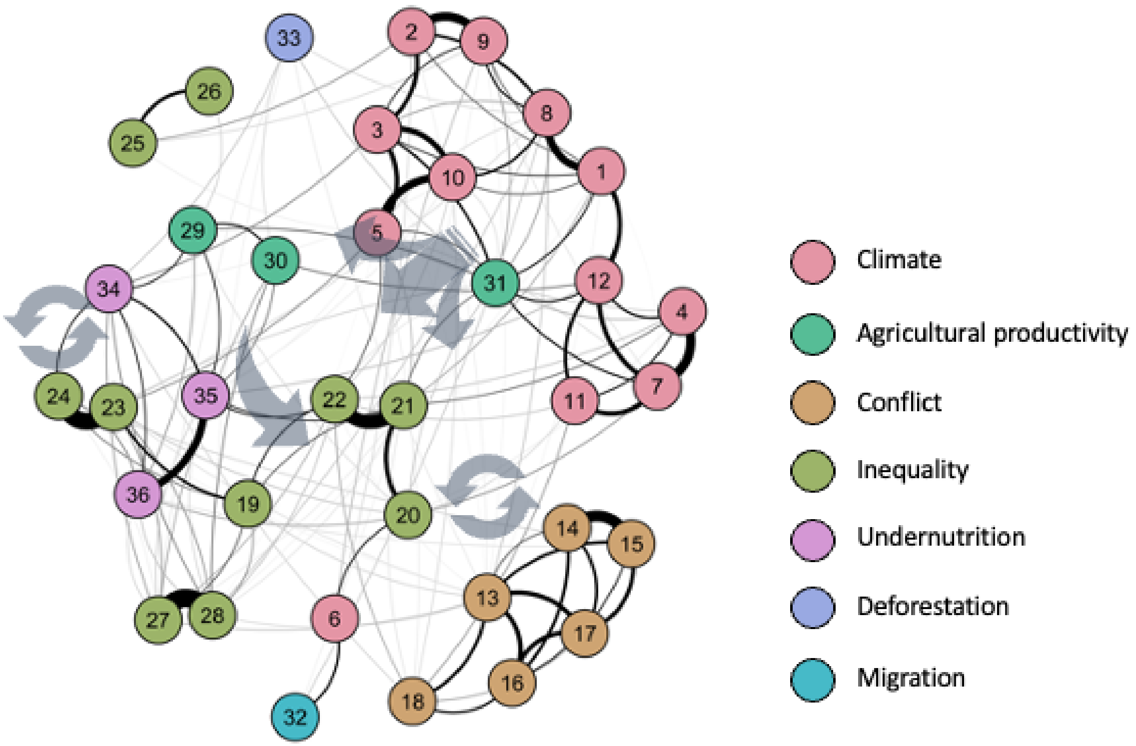

Figure 3 The Climate Security network in Kenya. The figure shows how climate, agriculture, conflict, inequality, undernutrition, deforestation and migration variables and data are connected in Kenya. Stronger relationships are visualised with thicker lines. Arrows show higher level connections and feedback loops. Key variables referenced in text are Climate water deficit (multi-annual average) #1; Number of days with ratio of actual to potential evapotranspiration ratio below 0.5 (multi-annual average) #3; Number of days with waterlogging (multi-annual 90th percentile) #5; Frequency of 5-day dry spell within rainy seasons (multi-annual average) #6; Heat stress on cattle (THI) (multi-annual average) #7; Maximum temperature (multi-annual 90th percentile) #12; Total number of conflict events #13; Total number of unique conflict sub-type events #15; Total number of conflict fatalities #18; Accessibility to healthcare services at 2019 #19; Difference of years of education (male - female) (multi-annual median) #20; Years of education male (multi-annual median) #22; Population density (multi-annual average) #23; Population density (multi-annual trend: Sen's slope) #24; Absolute wealth index #27; Relative wealth index #28; Net primary production (multi-annual upper bound) #31; Estimated Net Migration (multi-annual 90th percentile) #32; Deforestation #33. All other variables can be found in (55).

Figure 3 provides a quantitative overview of how each component of the nexus is connected and a general flow of events. At a higher level the network indicates how climate extremes are strongly connected to agricultural productivity, which are then connected to socioeconomic indicators. There are a number of strong feedback loops within these components (between undernutrition and inequality) and then some further connections to instability and eventually conflict.

More specifically, agriculture, encompassing crops and livestock, is a crucial sector in Kenya's economy. However, it is highly vulnerable to climate change due to increasing temperatures, shifting rainfall patterns, and extreme weather events. The agricultural production node (net primary production #31) is situated at the heart of the climate cluster and is negatively correlated to many climate extremes, such as drought (number of days with a ratio of actual to potential evapotranspiration below 0.5 #3) and heat stress (climate water deficit #1, heat stress on cattle #7, maximum temperature #12). This highlights the strong connection between climate extremes and the agricultural sector. Another extreme climate indicator (frequency of 5-day dry spells within rainy seasons #6) has a strong connection to **migration #32 and education inequalities** (difference in years of education between males and females #20). This suggests that a significant climate event, when combined with particular socio-economic conditions, could be a critical factor in migration or instability in Kenya.

As figure 3 shows, central nodes within the Kenyan climate-socio-economic-conflict network are the number of conflict events, net primary agricultural production, wealth indicators (relative #28 and absolute wealth indexes #27), and a rainfall pattern indicator (number of days with waterlogging #5). Amongst all subcategories of socio-economic variables, inequality variables have the most connections (in terms of number and width of edges) with conflict variables. The total number of conflict events is linked to several inequality factors (years of education for males #22, wealth index #28, population density #24, healthcare #19). This indicates that inequality is one of the primary pathways to instability in Kenya. Moreover, the total number of conflict events is also associated with resource scarcity which is manifested as deforestation #33. Secondarily, other conflict variables (number of fatalities #18, and the diversity of conflict sub-events #15) also show significant association with undernutrition variables.

The Mediation Modelling approach provides insights into Kenya's complex and indirect climate security linkages via food and nutrition security. Our analysis, carried out with a Structural Equation Model, shows that climate variability, in the form of below-average rainfall anomalies, increases malnutrition and stunting prevalence among most vulnerable groups. More specifically, an increase in one standard deviation in below-average rainfall anomalies (computed over 12 months prior to the households' interviews) from the historical distribution is associated with an increase of 18.8 percentage points in the share of households with at least one stunted child in a 20 square km area. This might have been caused by the impact that drought and reduced frequency of precipitation might have had on food and agricultural production, on food prices and overall food availability and accessibility in the country (102). Our results also show that climate indirectly increases the frequency of future violent conflicts in the country through malnutrition. Specifically, each standard deviation increase in below-average rainfall anomalies is associated with a 7.5% increase in foreseen violent conflicts in a 20 square km area as mediated by malnutrition.

Where are the most vulnerable areas to climate induced insecurities and risks, and who are the most vulnerable groups that should be targeted?

In Kenya, high conflict areas co-occur with adverse climate conditions, that is, in areas that also experience high levels of drought and low precipitation, in particular in the northwest of the country, pastoral and fishing zones of Turkana and Marsabit counties. The map in figure 4 shows areas where different level of conflict (conflict clusters) co-occur with different conditions of climate (climate clusters). The red to yellow gradient refers to highly adverse to suitable climate i.e., from high to low levels of drought and low to high levels of precipitation. Conflict clusters refer to low to high conflict areas, based on six conflict-related indicators. The high conflict cluster is characterized, among others, by a high number of conflict events (72 median count) and high number of fatalities (116 median count). Climate clusters describe a range of suitable to adverse climate conditions, based on six agroclimatic indicators. The adverse climate cluster is characterized, among others, by low precipitation (median of 239.27 mm), and high to moderate climate water deficit (1402.87 mm). Both clusterings represent aggregates of multi-annual time series data. High conflict areas (conflict clusters) across Kenya during 1997-2021 occur in the counties: Bungoma, Garissa, Homa Bay, Isiolo, Kakamega, Kiambu, Kilifi, Kisii, Kisumu, Kwale, Lamu, Mandera, Marsabit, Meru, Migori, Mombasa, Nairobi, Nakuru, Nandi, Nyamira, Nyandarua, Tana River, Trans Nzoia, Turkana, Vihiga, Wajir. In the high conflict cluster, the most frequent conflict events were riots, violence against civilians, and protests. Violence against civilians and battles were responsible for most fatalities. Overlaid socio-economic hotspots identify four main Climate Security Hotspot areas: **Illeret (1); Nakalale, Kakuma, Letea, Lopur and Songot (2); Turkwel, Kanamkemer, Kang'Atotha, and Lodwar Township (3); and Lake Zone (4).** An area is identified as a hotspot if indicators related to undernutrition (measured as wasting), inequality (measured as a combination of absolute and relative wealth index, years of education female or male, Population density, Accessibility to healthcare services at 2019) or natural resource scarcity (measured as a combination of Livestock Shannon diversity index, Tropical Livestock Units, Crop and pasture area, Soil organic carbon content (fertility), Irrigated area (number of km2), Piped water (% of households with piped water), Percentage of Forest loss per year, Soil organic carbon content, Net Primary Production (NPP) average, Upper bound NPP) categories are below the 10% or above the 90% percentile.

Climate Security Hotspots are exposed to different combinations of socio-economic and environmental vulnerabilities (Table 1). Compared to national averages, the communities are characterized by high population density, low socio-economic status, such as low levels of education, high food insecurity, high proportions of economic dependence, and limited access to public services. For instance, all four areas present considerably lower levels of both male and female education compared to the national average, with the Lake Zone in particular presenting figures more than seven times below the 7.01 years for female education and 7.69 years for male education, at 0.37 and 1.04, respectively. Similarly, the percentage of sanitation facilities available indicates a lack of access; while nationally this figure stands at 4.35%, only Ileret presents a figure above 1 percent (at 2.53%). A third indicator that is lower than the national average across the four regions is the absolute wealth index, for which the estimated wealth at household level in the Lake Zone represents only 15% of the national figure, 25% in Ileret, 57% in the hotspot area comprising Nakalale, Kakuma, Letea, Lopur and Songot, and 60% in the hotspot area containing Turkwel, Kanamkemer, Kang'Atotha, and Lodwar Township.

What can be done to break the cycle between climate and conflict?

During fieldwork activities in the Baringo, Busia and Laikipia counties, communities and local stakeholders identified potential solutions that could mitigate the climate security nexus. According to these communities and local stakeholders, it is crucial to account for social and ecological conditions and insecurity dynamics at the local level when developing potential interventions. More specifically, the extent and mode to which the climate-smart management of natural resources and agriculture can be used to foster social cohesion among conflictive parties is extremely dependent on local particularities. The solutions identified build upon specific natural resources available in each area, the concrete climate threats that communities face, and the nature of conflictive relations between the involved actors.

To address conflicts related to the use of natural resources, as in the Laikipia county, common proposals included the creation of multi-ethnic resource management committees (53). For example, to manage pasturelands, forests, and water, with the aim to increase the decision-making power of community members and engagement across ethnic groups. These committees would also work together with community patrol reserves, formed by recruits from multiple ethnic groups that would be charged with monitoring violations to resource use bylaws and instances of violence, such as cattle rustling.

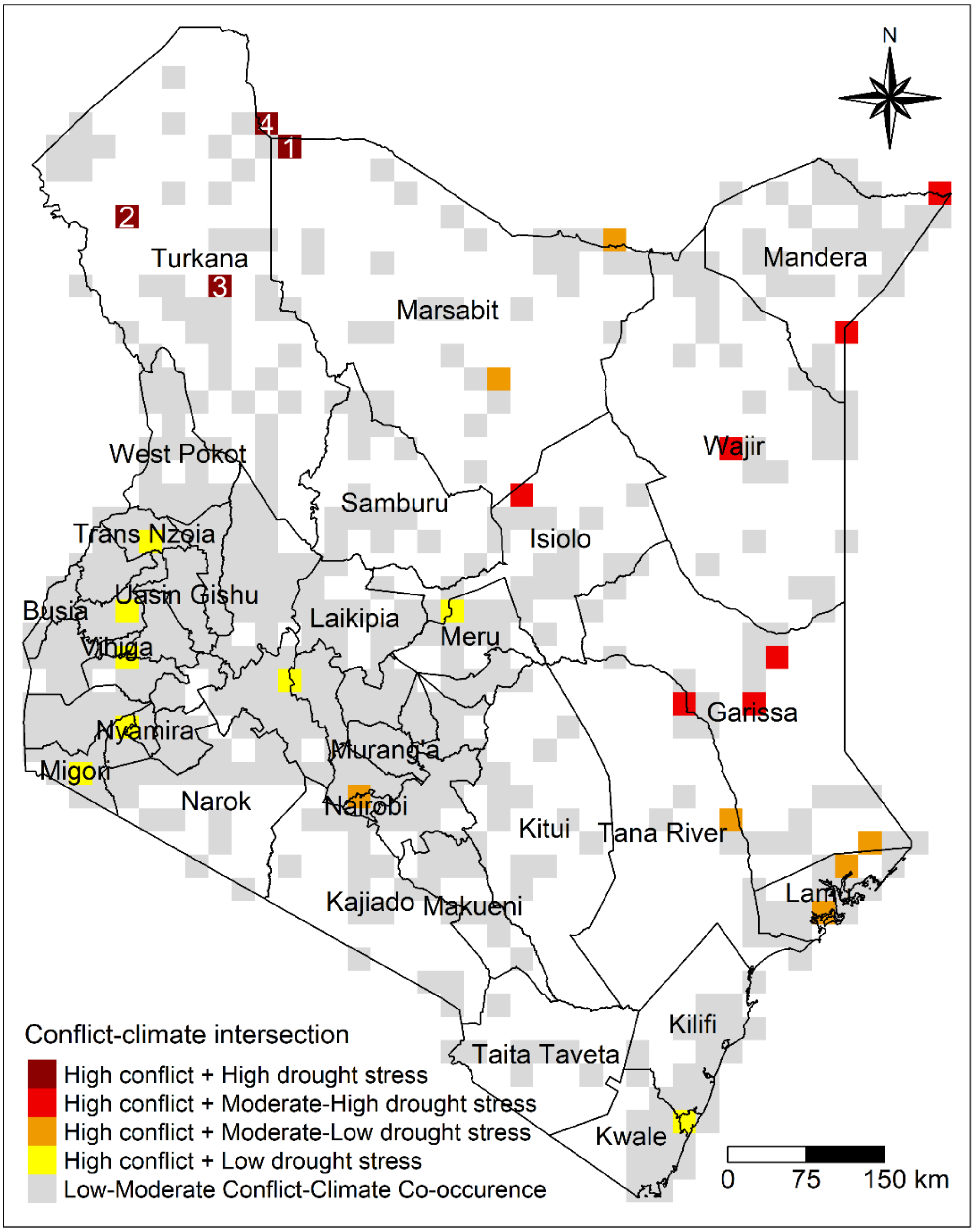

Figure 4 Climate Security Hotspots in Kenya, defined as co-occurrence of conflict (high – red/orange - to moderate/low – grey), climate and socio-economic risks. The dark red dots identify macro-pixels of 20 Km^2 where high level of conflict co-occurs with harsh climatic condition (high drought stress) and high level of socio-economic risks. In (1) Illeret high level of conflict and high drought stress co-occur with high level of undernutrition (wasting) and high level of inequality (years of education of males and females). In (2) Nakalale; Kakuma; Letea; Lopur; Songot and (3) Turkwel; Kanamkemer; Kang'Atotha; Lodwar Township high level of conflict and high drought stress co-occur with high level of inequality and resource scarcity (estimated using a combination of the following variables: Livestock Shannon diversity index, Tropical Livestock Units, Crop and pasture area, Soil organic carbon content (fertility), Irrigated area (number of km^2), Piped water (% of households with piped water), Percentage of Forest loss per year, Soil organic carbon content, Net Primary Production (NPP) average, Upper bound NPP). In (4) Lake Zone high level of conflict and high drought stress co-occur with high level of inequality. Disclaimer: This map is not an authority on boundaries even though effort has been to use country specific accepted boundaries

Table 1: Selected socio-economic descriptive statistics of climate security hotspots, where high level of conflict and harsh climatic condition interacts with high level of socio-economic vulnerabilities

Climate Security Hotspots		**Illeret**	**Nakalale; Kakuma; Letea; Lopur; Songot**	**Turkwel; Kanamkemer; Kang'Atotha; Lodwar Township**	**Lake Zone**	**National**
Main socio-economic risks		Undernutrition(U); Inequality(I)	Inequality(I); Resource Scarcity (RS)	Inequality(I); Resource Scarcity (RS)	Inequality(I)	
Name Variable	**Units**	#	#	#	#	#
Population density	Total number of people per 20 Km² (#)	604	57897	32579	598	2726
Years of education female	Number of years (#)	0.79	0.93	2.07	0.37	7.01
Years of education male	Number of years (#)	2.11	1.78	3.3	1.04	7.69
Wasting prevalence	Percentage of children under 5 years old that are wasted (%)	22.62	7.64	8	4.19	7.01
Nightlights	Average reflectance value (#)	0	0.22	0.38	0	5.92
Piped water	Percentage of household with piped water (%)	10.04	40.6	44.05	8.36	29.55
Sanitation facilities	Percentage of household with sanitation facilities (%)	2.53	0.82	0.5	0.83	4.35
Estimated Net Migration	Average of difference between in-migration and out-migration over 5 km²	-0.13	-2.55	-1.26	-0.07	820.24
Absolute wealth index	Estimated as in (99)	545.46	1247.27	1309.99	337.96	2191.5
Dependency Ratio	Percentage of economic dependent population over economically productive population (%)	90.26	85.69	85.69	79.74	80.33
Livelihood zones*	*See notes*	Pastoral, Fishing	Pastoral	Pastoral	Fishing	*See notes*
Food security**	*See notes*	Crisis	Crisis	Crisis	Crisis	*See notes*

Notes: *Kenya is divided in the following livelihoods zones: Central Highlands, High Potential Zone, Northern Pastoral Zone, Western Agropastoral Zone, Southeastern Marginal Mixed Farming Zone, Southeastern Medium Potential, Mixed Farming Zone, Southern Agropastoral Zone, Southern Pastoral Zone, Western Medium Potential Zone, Coastal Marginal Agricultural Mixed Farming Zone, Coastal Medium Potential Farming Zone, Southeastern Pastoral Zone, Eastern Pastoral Zone, Lake Turkana Fishing, Northwestern Pastoral Zone, Lake Victoria Fishing Zone, Marsabit Marginal Mixed Farming Zone, Northeastern Agropastoral Zone, Northeastern Pastoral Zone, Mandera Riverine Zone, Northwestern Agropastoral Zone, Tana Riverine Zone, Turkwell Riverine Zone, Western High Potential Zone, Western Lakeshore Marginal Mixed Farming Zone. SOURCE: https://fews.net/data/livelihood-zones ** Food security categories: Phase 1 – MINIMAL: More than 80 percent of households in an area are experiencing Phase 1 outcomes , and acute malnutrition rates are expected to be below 5 percent; Phase 2 – STRESSED: At least 20 percent of households in an area are experiencing Phase 2 or worse outcomes, and acute malnutrition rates are expected to be between 5 and 10 percent; Phase 3 – CRISIS: At least 20 percent of households in an area are experiencing Phase 3 or worse outcomes, and acute malnutrition rates are expected to be between 10 and 15 percent; Phase 4 – EMERGENCY: At least 20 percent of households in an area are experiencing Phase 4 or worse outcomes, and acute malnutrition rates are expected to be between 15 and 30 percent; Phase 5 – FAMINE: At least 20 percent of households in an area are experiencing Phase 5 outcomes, acute malnutrition levels exceed 30 percent, and more than 2 per 1,000 people are dying each day. SOURCE: https://www.usaid.gov/food-assistance/integrated-food-security-phase-classification-ipc-explainer.

Landscape restoration programs were also proposed as a mechanism to manage territorial conflicts where parties are less willing to engage in peacebuilding dialogue, as is the case of the Endoróis Indigenous Peoples and Pokoot pastoralists in the Baringo county. These would employ young people from all relevant ethnic groups, and could operate across conflictive territorial boundaries, fostering engagement and interdependence between all involved social groups and creating alternative livelihoods for those who need to reduce their dependency on conflict-related natural resources, such as cattle.

Solutions to enhance state-society relations were also prioritized, especially in contexts where conflict is not influenced by ethnic divides, but rather by political boundaries and a lack of responsive institutions. For example, fishing communities around Lake Victoria prioritized strengthening local institutions for fishery management and enforcement of bylaws regulating fishing practices, along with receiving support to increase the capacity of fisherfolk to comply with fishing laws both in Kenya and across the border in Uganda.

Local solutions however do not match with national level political will and awareness regarding the climate security nexus. Both the social media analysis and policy coherence analysis identify significant policy gaps.

Assessment of the salience of climate security in the social media communications of Kenyan policy actors found that the pathways that link climate stressors, socioeconomic risks, and conflict are largely disassociated in the narratives of government bodies (Carneiro et al., 2019). The analysis of publicly available Twitter content from the official accounts of central government bodies, ministries of agriculture, environment, and natural resources, as well as national security bodies detected the prevalence of topics related to the climate-security nexus. 'Water' and 'Livestock' were the most regularly mentioned topics, followed by socio-economic variables 'Poverty', 'Hunger', and 'Food security'. The most frequent climate- and conflict-related topics were 'Rain' and 'Armed conflict', respectively.

To unpack any interlinkages between different themes, a measure of correlation was established to identify when terms were present within the same body of text. A positive correlation indicated that the terms consistently occurred within the same tweet, whereas a negative correlation denoted they occurred in separate tweets. While tweets that addressed different types of conflict did show some association to ecological threats, most climate and conflict variables were negatively correlated. The strongest positive associations between climate-related topics and conflict-related topics comprised 'Armed conflicts' with 'Deforestation' and 'Rain'. However, as most other topics presented negative associations, the connections between climate and conflict seem to be missing from the official discourse of Kenyan government actors on Twitter. Hence, while the different dimensions of the climate-security nexus are represented in the public conversations of policy makers, the analysis suggests an entry point for increasing awareness and strengthening exchanges between national security and climate adaptation and mitigation actors.

The examination of policy and strategy documents extracted from climate- and peace and security-related sectors produced at the national level in Kenya revealed that even though policies from across different sectors show evidence of understanding how climate-related security risks may emerge, translating this awareness into concrete programmatic initiatives and outcomes remains a persistent challenge. Policy documents were found to be much more likely to acknowledge climate-conflict linkages and the presence of climate-related security risks than they were to put forward climate security-sensitive programming that explicitly sought to prevent such risks (94).

These analyses reveal that there exist a fundamental knowledge and policy gap about where and when adaptation and mitigation interventions and programs can form entry points for conflict prevention, conflict transformation, and peacebuilding. In practice, this could mean embedding integrated objectives relating to climate resilience, peace, and social cohesion from the very beginning of program design, as well as integrating key indicators around more intangible values such as social cohesion, trust, and cooperation into ex-post program monitoring and evaluation exercises.

Secondly, existing integrated and consciously multi-dimensional programmatic initiatives, such as the National Drought Management Authority's (NDMA) Common Programme Framework for Ending Drought Emergencies, are currently predominantly present only as part of disaster risk reduction efforts and are not incorporated into longer-term adaptation efforts. Thirdly, there are limited institutional spaces for interaction and coordination between those working on climate and those working on peace and security and there is not institutional body with a mandate specific to identifying entry points for the purposes of improved coordination and knowledge sharing.

The stakeholders' consultations carried out during the social learning expert workshop, which brought together over 40 experts and practitioners working across the humanitarian, development, and peace sectors in Kenya confirmed these gaps. One of the objectives of the workshop was to co-develop policy and programmatic recommendations that aimed to integrate climate security considerations in climate action strategies. They are summarized below:

1. Multilevel governance: fostering a community of practice for climate security in Kenya. Given that governance frameworks for climate change and peace have traditionally evolved independently due to inadequate cross-sectoral collaboration, a significant degree of institutional learning is required to effectively integrate climate security as a topic of concern in Kenya's policies and governance systems. The creation of an entirely new institutional body - or community of practice - that operates across sectors and scales and with a mandate specific to identifying entry points for the purposes of improved coordination and knowledge sharing is critical to facilitate institutional learning and innovation, whilst improved knowledge and data generation between such actors in turn creates conditions ripe for the design of integrated climate-peace programming.
2. Programmatic planning: facilitate the design of initiatives and programs that actively contribute to climate adaptation and peacebuilding in Kenya. Strengthen the capacities of peacebuilding and climate actors to conduct conflict assessments that incorporate a climate perspective, as well as vulnerability assessments that take into account the risks associated with conflict. Foster technical coordination and collaboration between peace and climate actors throughout the entire process of program planning and implementation.
3. Research and evidence gaps: better understanding of how climate variability and extremes could potentially exacerbate different conflict risks that afflict Kenyan populations. This entails expanding climate modelling capabilities to gain a deeper insight into future risks, while acknowledging the uncertainties inherent in modelling work and recognizing the intricate and non-linear interactions

that are crucial for decision-making processes. Moreover, addressing evidence gaps should involve actively engaging community voices and incorporating traditional coping strategies to develop context-specific assessments of climate security. It is crucial to integrate the experiences of those living and working in areas affected by emerging climate-related security risks and complement their findings with data-driven analyses for a more comprehensive understanding.

4. Finance for climate security: leverage pre-existing networks to support the development, implementation, and scaling of financial interventions for climate resilience that actively contribute to peace. This involves deploying climate-smart agricultural investments in regions affected by conflict, which can help address the root causes of resource-related violence. Achieving this goal entails involving local civil society organizations in the design of investments and as recipients of financial support, participating in multi-stakeholder platforms to mainstream climate security issues, and establishing a climate security budget at various levels of government.

Conclusion

Discourses on how to qualify and quantify the “climate security nexus” have increased significantly in the past decade (103). This is because the accelerating climate crisis is visibly exacerbating a combination of human security risks and often causing tensions and conflicts. Our reading of the climate security nexus does not embrace the securitization of climate, which has been largely criticized by scholars and policy makers as it would imply attributing to climate causes of conflicts that are inherently cultural, social and political (104). Nevertheless, our research clearly points out that a nexus between climate and root causes of vulnerabilities that could lead to or intensify pre-existing drivers of conflict exists (5). The main challenge of this discourse and research, though, is to identify the right analytical framework that does not simplistically qualifies these intricate and complex relationships and dynamics, that identifies multiple pathways, that does not draw linear causal associations, that accounts for context specificity, and that gives voices to affected communities and represent the views of multiple actors at multiple scales.

In this paper we present the Integrated Climate Security Framework, which deliberately attempts to address the multiple complexity challenges of the climate security nexus. The framework uses conventional and non-conventional methods and data to provide state-of-the-art policy relevant evidence that address four main questions: how, where and for whom climate and conflict risks occur and what can be done to mitigate this vicious circle. The framework provides a comprehensive assessment of the complex social-ecological dynamics adopting systems approaches that rely on a combination of epistemological stances, thereby relying on diverse qualitative and quantitative, locally relevant, and multifaceted data sources; and on a diversity of actors involved in the co-production of knowledge.

The framework presented in this paper has, however, some limitations. Systems approaches are per se intrinsically complex and difficult to integrate. Sequencing of different methods could be improved, so that quantitative analyses could better inform or be informed by qualitative findings. However, findings generated from multiple, conceptually, and analytically different methods are often at different geographical and temporal scales that cannot be easily compared to each other. Units of analysis also change based on the method and available data. Data, themselves, are scarce, especially in terms of values and important cultural aspects, and not systematically available across multiple geographies and geographical scales. Discussions on security issues are also quite sensitive and communities or groups within the communities, especially the most marginalized and vulnerable, but also policymakers and stakeholders, are often reluctant in discussing matters related to tensions and conflicts. This is most evident for instance in more peaceful countries. Even when policy makers are open to the climate security discussion, it is often challenging to translate sciencific knowledge into policy decisions.

Despite these limitations, we firmly believe that adopting such a systems approach that embraces the complexity but produces policy relevant messages is crucial for to support policymakers navigate the implication of compound risks and insecurities that the climate security nexus represents. The CGIAR Climate Security Observatory, a decision support platform that collates the evidence generated by the

ICSF provides a space where science meets policy by translating robust science into easily digestible messages.

Providing policy relevant evidence that brings together existing literature, data, policies, social media, and gives voice to affected communities and stakeholders at multiple scales will help to identify and prioritize areas and groups of the population that are most affected by compound risks and insecurities, as well as help to design more effective and sustainable climate adaptation interventions that do not do any harm but become true “instruments for peace”.

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