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Abstract

Climate change is increasingly recognized as a threat to global peace and security. This paper intends to provide a better understanding of the nature of interactions between climate change and events that undermine peace through a systematic review of recent literature. It highlights major methodological approaches adopted in the literature, elaborates on the geographic focus of the research at the nexus of climate change and peace, and provides further information on how various climatic stressors, such as extreme temperature, floods, sea-level rise, storms, and water stress may be linked to different events that undermine peace (e.g. civil conflict, crime, intercommunal violence, interstate conflict, political conflict, and social conflict) through direct and indirect pathways. Results confirm previous findings that statistical techniques and qualitative case studies are dominant methods in climate-conflict research but show that there has been an increase in the geographic information system based risk analyses and qualitative comparative analyses in the recent years. In line with previous reviews, results show that the literature is mainly focused on certain regions of the world and several major regions that have experienced numerous conflicts over the past few years and/or are vulnerable to adverse climatic events are understudied. However, a new finding is that, in the past few years, there has been an increasing focus on Asia, which contrasts with previous reviews that show an African focus in the literature. Also, there is an unbalanced attention to different climatic stressors and peace-related events. Interactions between water stress/extreme temperature and civil and interstate conflicts have received more attention. A major finding is that, only under certain conditions climatic stressors may act as driving forces or aggravating factors. In fact, there is a strong consensus that climate change is less likely to undermine peace in isolation from a wide range of contextual socio-economic and institutional factors such as political instability, poor governance, poverty, homogeneous livelihood structures, and ethnic fractionalization. However, such contextual factors can contribute to undermining peace via either direct or indirect pathways. The former may occur through direct psychological/physiological effects of climatic impacts or via competition over scarce resources. In contrast, in indirect pathways climate change may lead to conflict through diminishing livelihood capacities and/or inducing migration. In addition to synthesizing literature on contextual factors and direct/indirect pathways, the review identifies gaps that need further research.

1. Introduction

Potential linkages between climate change and events that undermine peace and security are increasingly discussed in science and policy circles (Koubi 2019). Interest in understanding interactions between climate change and peace has, in particular, increased since the publication of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR4) that warned about the potential detrimental impacts of accelerating climate change on global peace and security (IPCC 2007). Also, more recently, the IPCC's Fifth Assessment Report (AR5) included a separate chapter on human security (chapter 12), further highlighting the need for a comprehensive assessment of the climate-conflict nexus question (IPCC 2014). It is worth noting that two major different conceptualizations of peace exist: 'positive peace' and 'negative peace' (Galtung 1969). The main difference between these two is that 'positive peace' indicates conditions conducive to creating and maintaining peaceful communities but 'negative peace' refers to absence of conflict and/or violence (Amadei 2019, IEP 2019). In this study whenever the term 'peace' is mentioned, it refers to 'negative peace'. In order to appraise and update earlier reviews that synthesized evidence of the relationship between climate change and armed conflict, we have focused on recent studies that discuss how climate-induced events may undermine negative peace.

Over the past decade, several review papers have been published that are mainly focused on the nexus between climate change and two events related to the absence of peace, namely armed conflict and direct or physical violence (Burke *et al* 2015, Koubi 2019). Existing review papers report divergent findings on the causal links between climate change and peace. While there are some works demonstrating that climate change impacts trigger and/or accelerate conflict, others challenge the existence of direct causal relationships and caution against overlooking pre-existing conditions that make certain places fertile grounds for the onset of conflict and violence (Burke *et al* 2015, Bonds 2016, Theisen 2017, Koubi 2019). For instance, it is argued that the onset of conflict is more likely in low-income contexts, where livelihoods of people are dependent on land and water resources that are directly affected by climate change (Burke *et al* 2015, Koubi 2017). There are also other socio-economic and political conditions such as poor governance and socio-economic inequalities that erode coping capacity of individuals and communities and make them prone to conflict and violence (Akresh 2016, Koubi 2017, Shaffer 2017, Ide 2018).

Overall, existing review papers have been successful in improving our understanding of the nature of interactions between climate change and peace. However, they are mainly focused on the interactions between climate change and either conflict or

violence and do not differentiate various events and how they undermine peace simultaneously. Although more attention has been paid to the negative impacts of climate change, there is also a relatively smaller number of studies arguing that climate change impacts are likely to offer opportunities for cooperation and conflict resolution (Brzoska 2018). In addition, although existing reviews provide information on different climate-conflict pathways and discuss various pre-existing conditions that may contribute to conflict, there is still a lack of systematic reviews that provide more nuanced information on the nature and typology of interactions between climate change and events that challenge/undermine peace. For instance, the relative frequency distribution of different types of conflicts is unknown; or it is unclear what is the amount of attention paid to different climatic stressors that may influence conflict dynamics. These are major gaps that this study aims to fill through a systematic review of literature published over the past five years. This systematic review also aims to provide further information on pathways through which climate impacts may contribute to conflict and to highlight and categorize important intervening factors that have received more attention in the literature. Furthermore, review of recent literature helps to understand if and how the geographic focus on this field of research has changed over time. Previous studies show an African focus in the literature and it is worth examining if this has changed over time (Hendrix 2017, Adams *et al* 2018).

2. Materials and methods

We developed a broad-based search string composed of a combination of terms related to various events that can undermine peace, such as violence, conflict, tension, war, terror, unrest, crime, protest, riot, murder, and weapons (see the supplementary appendix (S1) (available online at stacks.iop.org/ERL/16/073006/mmedia)). We acknowledge that a holistic view of peace provides a more comprehensive understanding of the relationship between climatic conditions and conflict and a better integration between peace and development (Sharifi *et al* 2021). However, given that we aim to differentiate negative and positive types of peace by focusing on the former, the selection of search terms was limited to specific events, i.e. types of armed conflict and direct or physical violence that undermine negative peace. Hence, terms related to human security (Paris 2001), social justice (Galtung 1969), sustainable development (UN 2015), and attitudes, institutions, and structures that create and maintain peaceful societies (IEP 2019), were excluded. While climate change undoubtedly undermines human security and other conditions that create and maintain a peaceful soci-

ety, there have been debates on whether climate triggers conflict or not. This review synthesizes more recent evidence that inform these debates. Hence, in addition to focusing on events that undermine negative peace, we reviewed the literature according to the pathways in which climate acts as a multiplier of conflict risks due to various political, economic, and social factors (Koubi 2019). Furthermore, this review excludes incidents of natural hazards and anthropogenic environmental disasters because they are not considered as armed conflict or direct (social) violence, although they do result in equally or even more massive loss of lives. However, our search string includes incidents of armed conflict and direct violence following these disasters.

As our intention was to review the recent literature, we have only searched for articles published since 2015. The initial search for this string in the Web of Science returned 2313 articles on 14 April 2019. We understand that more research has been published since the cut-off date of 14 April 2019, but we believe the large number of papers retrieved for the study period would allow us to obtain sufficient information for exploring relationships between climate change and peace.

The titles and abstracts of the retrieved articles were screened by the first two authors to exclude articles that are not directly related to the aims and objectives of this study. At the end of this stage, 290 articles were retained in the database that were used for the systematic review. To follow a deductive coding method, an information extraction sheet (codebook) was developed in Microsoft Excel that was used to collect information related to various issues such as the geographic focus of the research, climatic factor(s), research method(s), events related to peace, natural resources involved in the nexus, nature of pathway, and different pre-existing and intervening factors that may influence the dynamics of the climate-peace nexus. Aligned with the review objectives, this information extraction sheet was developed in a way that allows us to not only gain updated information on the nexus, but also provide more details on the pathways and interactions mentioned in the previous reviews (Koubi 2019).

The selected articles were distributed among the co-authors for detailed review and data extraction. In addition to completing the Excel sheet, each contributing author was also asked to summarize evidence reported on different pathways through which climate change undermines peace and various pre-existing conditions and intervening factors that affect the dynamics of the pathways. Upon completion of the first round of the review, the first author checked all entries and modified the coded data wherever needed. Coding was done following a deductive method and using a codebook (in MS Excel) that was designed based on common classifications in the literature in order to maintain consistency. For instance,

based on Koubi (2019), pathways were determined as either direct or indirect. Also, based on works such as Ide (2017), the following categories were identified for research methods: case study analysis, historical analysis⁹, modeling and scenario making, spatial analysis, statistical analysis, surveys and interviews, and literature review and meta-analysis. The first author also randomly reviewed three articles assigned to each contributing author to check the quality of the work. The updated data sheet along with comments on the quality of the review were fed back to each author for a second round of review. After the results of the second round were returned, the first author did another round of quality control by reading abstracts and conclusions of all the 290 articles in the database. We believe that this multiple-round process has contributed to improving the accuracy of the data extraction process.

Upon completion of the data extraction process, simple statistical analyses were conducted to summarize and categorize the selected data and identify dominant patterns and pathways. In addition, the Tableau software was used to map interactions between different factors related to the nexus between climate change and peace. An important point that needs to be mentioned is that some studies may focus on interactions between multiple factors (e.g. multiple climate-induced stressors). In that case, all of the interactions have been coded and counted separately. For instance, when pathways related to multiple stressors are discussed in a paper, they have all been counted separately and this has been reflected in the Sankey diagrams presented in the following section.

3. Results

Before discussing the results, some basic information related to the reviewed literature is provided and we explain the basis for classification of different types of geographic focus areas, climatic stressors, and events related to peace.

In terms of document type, most of the reviewed articles are research papers (90%), followed by review papers (6.2%), viewpoints and commentaries (2.8%), and letters (1%). In terms of disciplinary focus, according to the Web of Science categories, the reviewed articles are mainly related to environmental sciences, government law, international relations, geography, and economics, as shown in figure S1. The selected articles deal with the climate change-peace nexus at various geographic scales, ranging from local (14%), to national (25%), regional (31%), and global (30%). Papers with a local focus deal with the issue at the sub-national level

⁹ Note that in this study historical analysis refers to studies that have examined climate-peace interactions during historical periods before the 19th century.

(e.g. Akinyemi and Olaniyan 2017). The nationally-focused articles examine the issue at the state level (Azmeah 2016). In contrast, some papers address the issue within the context of several (often neighboring) countries (e.g. Mertz et al 2016). Finally, many papers discuss the issues from a global perspective (e.g. Cattaneo and Bosetti 2017) (table 1 of the appendix (S1)).

The reviewed articles have been published in 168 different journals, indicating that the nexus has a broad base and has been studied by researchers from different disciplines, including but not limited to, peace studies, climate change, political science, geography, disaster management, and earth and environmental sciences. As shown in table 2 of the appendix (S1), *Journal of Peace Research*, *Current Climate Change Reports*, *Global Environmental Change*, *Political Geography* and *World Development* are the top five journals in terms of the number of articles.

Regarding methodological approaches, seven major categories can be identified as shown in table 2 of the appendix. The most common method is using theoretical discourses and literature review to elaborate on the nexus (27%). About 17% have used econometrics methods and statistical analyses such as regression and Granger causality tests to examine causal linkages between climate change and peace (e.g. Lee et al 2016a and Ang and Gupta 2018). Other commonly used methods are (comparative) case studies (17%), surveys and interviews (15%), modeling and scenario making (13%), historical analyses (7%) and spatial analyses (5%). Case studies are often qualitative and based on field observations or ancillary data (e.g. McNamara et al 2018). These are sometimes coupled with household questionnaire surveys, semi-structured interviews, and focus group discussions to obtain primary data on the causes of conflict at local and regional scales (e.g. Okpara et al 2016a and Radel et al 2018). Modeling and scenario making approaches are mostly used to predict impacts of future climatic changes and socio-economic scenarios on the dynamics of the nexus. A good example is the study by Hegre et al (2016) that examines the implications of different shared socio-economic pathways (SSPs) for future armed conflicts. As for historical analysis methods, they have mainly been used by several groups of authors who have studied the impacts of climatic changes on the civil conflicts and wars that have historically occurred in China and Europe (e.g. see Lee et al 2017 and Mrgic 2018). Finally, some studies have adopted spatial analysis using geographic information systems (GIS) and remote sensing to track associations between climatic changes and war and conflict (e.g. Linke et al 2018a and Eklund et al 2017). This categorization of research methods is, to a large extent, aligned with the classification reported in Ide (2017). Our results also confirm Ide's findings that statistical techniques and qualitative case studies are dominant

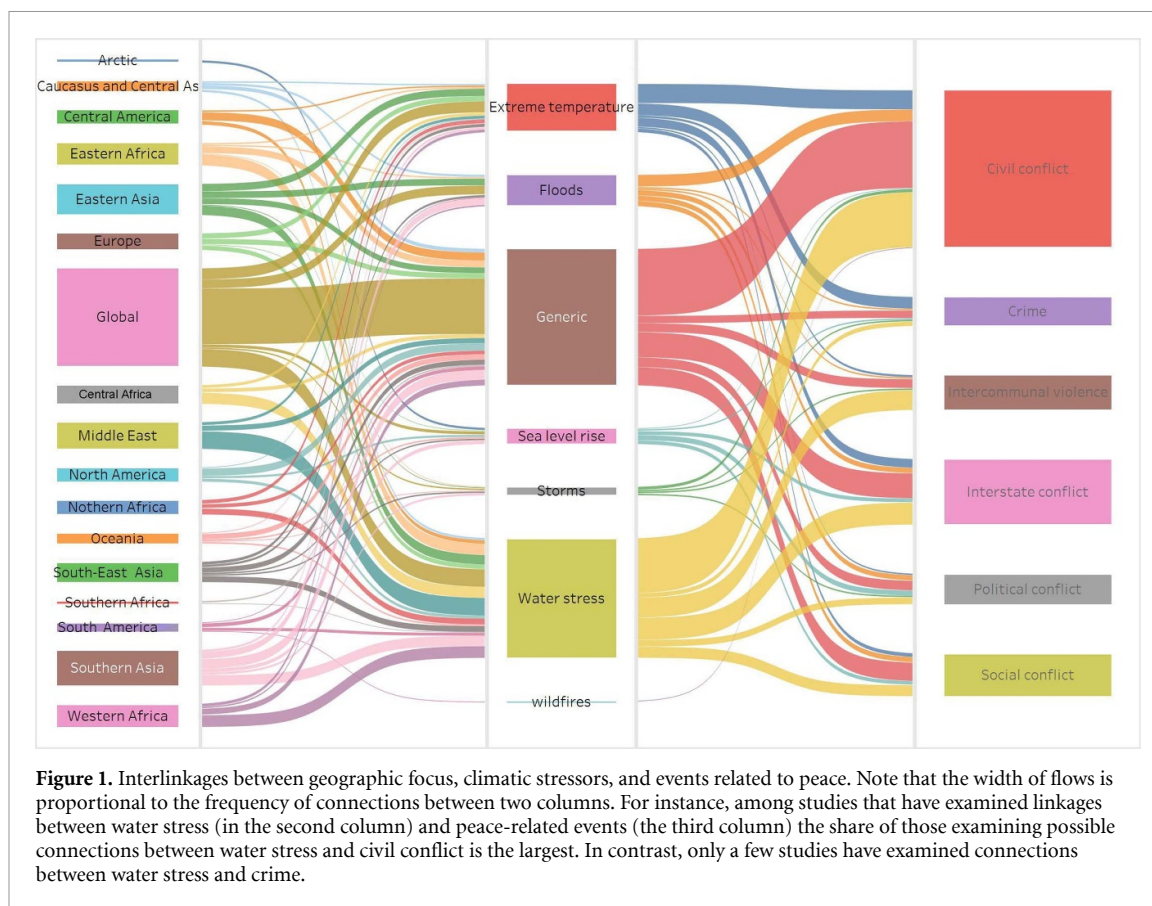
in climate-conflict research, but with more GIS-based risk analyses and qualitative comparative analyses in more recent years.

3.1. Geographic focus of the literature, major climate-induced stressors, and dominant events related to peace

In order to identify the geographic focus of the reviewed articles we followed the classification used by The Armed Conflict Location & Event Data Project (ACLED, see <https://acleddata.com/>)¹⁰. This classification is suitable for the purpose of this study as it allows more granular and context-specific examination of the nexus. For climate-induced stressors, we have used the following categorization: extreme temperature (i.e. extreme heat and cold), floods, sea level rise, storms (e.g. typhoons, tornados, hurricanes, etc), water stress (i.e. drought and other precipitation anomalies), and wildfires. As for events that undermine peace, after the first round of review, we selected the following classes based on the common classifications in the literature: civil conflicts, interstate conflict, intercommunal violence, social conflict, political conflict, and crime (Koubi et al 2018, Koubi 2019). Apart from the latter, these events often occur between different groups (e.g. communities or states). Here, civil conflict refers to acts that often occur within a country and involve violence directed towards the government. Previous research differentiates between civil war (>1000 battle-related deaths) and civil conflict (>25 battle-related death) (Koubi 2019). However, as the number of deaths is not always mentioned in the literature, here we have bundled them together as 'civil conflict'. Interstate conflict is another type of intergroup conflict that involves violent conflict between states. Intercommunal violence refers to events that occur between competing communities within a state. Social conflict refers to low-intensity and relatively less violent conflicts between different groups in a society (e.g. protests, social dispute, tensions between refugees and host communities, etc). Political conflicts in this study refers to conflicts between states over various issues such as resource management, geopolitical security, climate actions, and responsibility to climate refugees. Finally, crime refers to interpersonal acts such as assault, aggression, sexual violence, and robbery.

As figure 1 shows, apart from papers that have a generic focus, recent literature has focused on 16 different regions. Cumulatively, Asian countries have received the most attention (~30% of the reviewed papers). This figure and figure 2 of the appendix (S1) show that Southern Asia has been extensively studied in the literature (~10%) and the focus in this region has mainly been on civil, social, and interstate

¹⁰ Some regions such as Oceania and Eastern Asia are not included in the ACLED database, but we added them because there were some studies focused on them.



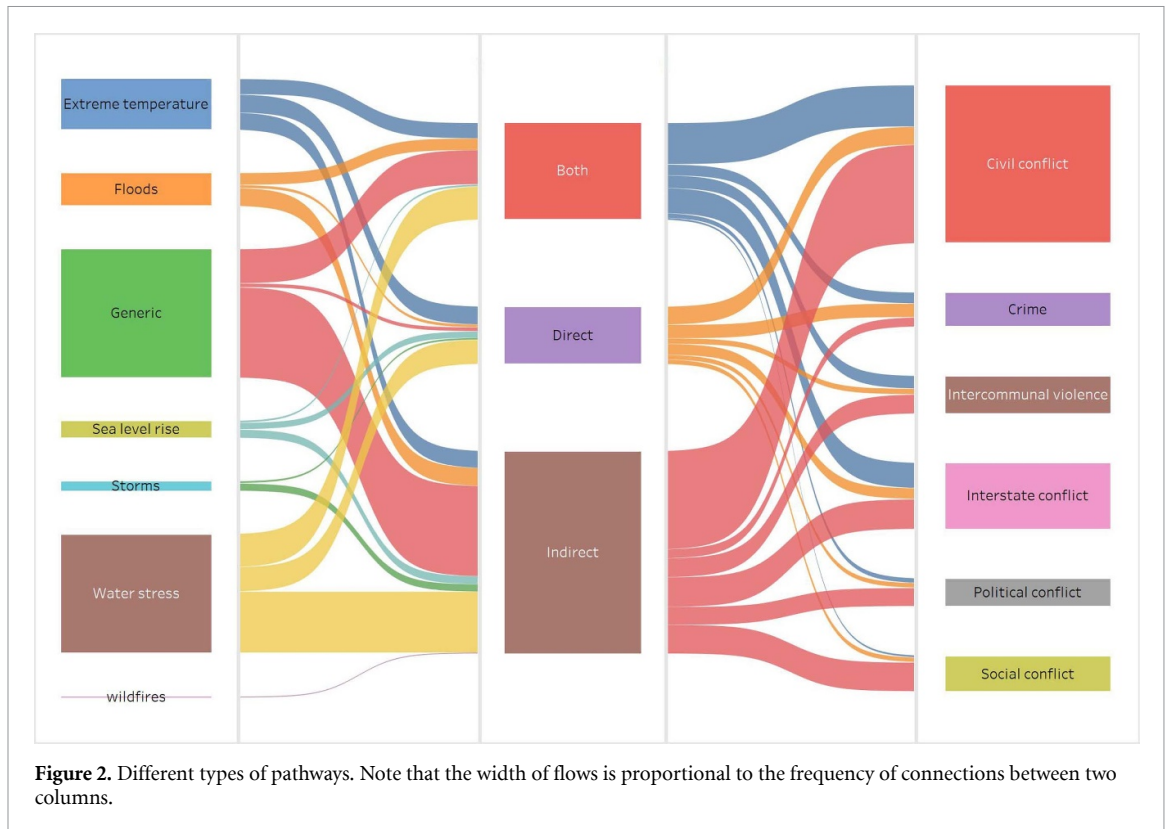
conflicts triggered by water stress, floods, and storms. Eastern Asia has also received considerable attention in the literature ($\sim 8\%$). Literature related to this region is mainly focused on China and involves historical analyses of the impacts of water stress, floods, and extreme temperature on the onset and duration of civil and interstate conflicts (e.g. Su *et al* 2016, Lee *et al* 2016b, Lee 2018). There are also studies examining the linkages between extreme temperature and crime in Japan (Takahashi 2017), Taiwan (Yu *et al* 2017), and China (Hu *et al* 2017). In the Middle East (accounting for $\sim 8\%$) the focus is mainly on civil and interstate conflicts linked with water stress. This includes studies on the long-standing Israeli–Palestinian conflict (Ide and Frohlich 2015), and the recent civil conflict in Syria (Kelley *et al* 2015), Iraq (Eklund *et al* 2017), and Yemen (Weiss 2015). Finally, literature focused on Southeast Asia mainly covers interlinkages between climatic stressors such as water stress, extreme temperature and floods, and civil, interstate, and political conflicts. Noteworthy examples are civil conflicts in the Philippines (Crost *et al* 2018, Eastin 2018) and conflicts over trans-boundary water resources in the Mekong Basin (Yuan *et al* 2019).

Africa is the second most studied continent ($\sim 22\%$). Among different African regions, Eastern Africa ($\sim 6\%$), Western Africa ($\sim 6\%$), Central Africa ($\sim 5\%$), and Northern Africa ($\sim 4\%$) have received more attention. These include multiple

studies focused on sub-Saharan Africa (Detges 2017, Witmer *et al* 2017, Seter *et al* 2018). The figures show that literature focusing on Africa has mainly examined the impacts of water stress on civil conflict and intercommunal violence, and limited attention has been paid to other climatic stressors and events that undermine peace.

Relatively less attention has been given to other regions of the world. About 4% of the papers are focused on Europe that mainly examine historical civil and interstate conflicts related to extreme temperature (Alfani and Grada 2018, Mrgic 2018, De Juan and Wegenast 2019), and social conflicts over resource management (Spijkers and Boonstra 2017, Anshelm *et al* 2018). Similarly, about 4% of the papers are focused on Central America. These papers mainly deal with civil, interstate, and social conflicts. However, unlike Europe, civil and interstate conflicts are mainly about recent developments (Castro-Nunez *et al* 2017, Hunsberger *et al* 2018). Finally, the literature focused on North America mainly deals with crime (Goin *et al* 2017, Sommer *et al* 2018) and political conflicts (He *et al* 2017, Walker and Hipel 2017).

Overall, the analysis of geographic focus is in line with claims in the literature regarding the biased research focus on conflict-ridden areas of the world (Adams *et al* 2018). This raises concerns about the ‘streetlight effect’, the type of bias in research that occurs when researchers are disproportionately



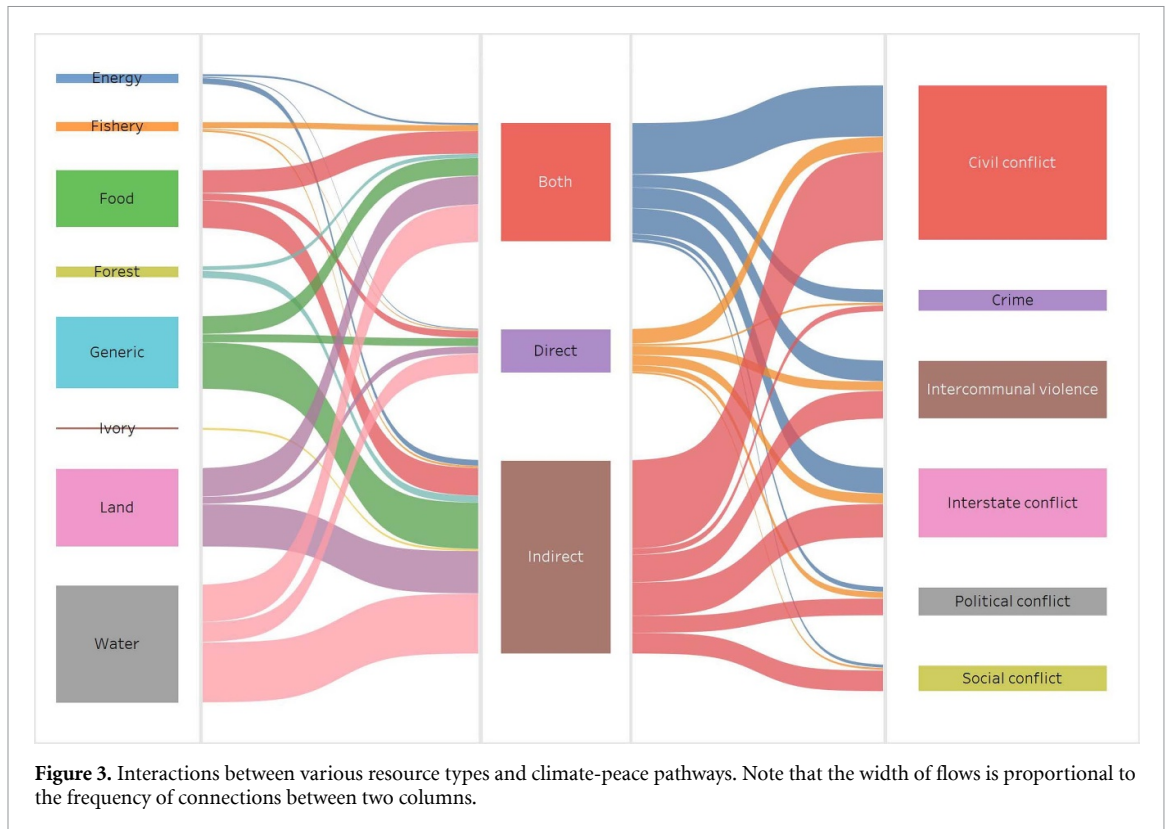
drawn to particular questions and related variables for convenience rather than relevance and validity construction (Hendrix 2017). Therefore, more research on contexts that have suffered from climatic impacts but without experiences of civil and intra-state conflicts is warranted (Adams *et al* 2018, Koubi 2019). More discussions on contextual factors are provided in section 3.3. According to the ACLED database, there are some regions such as Central America and South America that have experienced numerous conflicts over the past few years. However, research on the nexus in these regions is scarce (with few exceptions such as Colombia). Another noteworthy issue is that existing research is mainly focused on civil and interstate conflicts linked to water stress and extreme temperature; other types of climatic stressors and events undermining peace have not been well studied.

3.2. Different pathways

According to Koubi (2019), climate change can be associated with peace through either direct or indirect pathways. The former occurs through direct psychological/physiological effects of climatic impacts or via direct impacts on scarce resources. In contrast, the latter refers to mechanisms through which climatic impacts may indirectly result in events that undermine peace. For instance, this may occur due to alterations in agricultural yield, diminished livelihood capacities, or large-scale climate-induced displacements (Busby 2018, Koubi 2019).

To build on Koubi's work, here we provide more information on these two pathways and their interactions with climatic factors and resource scarcities. For consistency reasons, we have divided discussions regarding direct and indirect pathways into major categories that are mentioned in previous research (Koubi 2019). Direct pathways are divided into two groups: behavioral effects and those related to resource scarcity. In contrast, indirect effects are divided into two groups: diminished economic and livelihood capacities and migration. It should be noted that various contextual and intervening factors exist that determine if climatic impacts can directly or indirectly lead to events that undermine peace. These will be discussed in section 3.3.

Based on figure 2, most studies have only discussed indirect pathways (~57%). In contrast, about 16% have explored direct pathways only. Also, about 27% have discussed both. Figure 2 shows that indirect effects are dominant in most cases. Extreme temperature events and crime events are, however, exceptions in this regard. This may indicate that extreme temperature events are more likely to lead to conflict through direct pathways. Figure 3 complements figure 2 and shows that, irrespective of the nature of pathways, availability and accessibility of resources play important roles in the nexus. As expected, water resources have received the highest amount of attention (~33%), followed by land (~22%), food (~16%), fishery (~3%), forest (~3%), and energy (~3%).



3.2.1. Direct pathways

3.2.1.1. Behavioral/physiological effects

This pathway is mainly related to how climate change may influence the occurrence of crime through influencing behavioral and physiological factors. Crime is a relatively understudied event, and existing evidence is diverging, preventing generalized statements. Also, impacts are different depending on the geographic context and the type of climatic factor. For extreme temperature, there is evidence suggesting that it increases the incidence of property and violent crimes such as robbery and assaults in Malaysia (Habibullah 2017), Beijing (Hu *et al* 2017), India (Blakeslee and Fishman 2018), Japan (Takahashi 2017), and Taiwan (Yu *et al* 2017). Also, global estimates by Mares and Moffett (2016) show that global warming increases homicide rates. However, there is also contradictory evidence showing that street crime rate declines in Dallas, Texas when temperatures are high, as people stay indoors (White 2017). Also, results of a modeling study in New Zealand show that, although irregular rise in daily temperature increases the assault rate, the impacts of future global warming on the incidence of interpersonal violence remain uncertain (Williams *et al* 2015).

Less evidence has been reported regarding the influence of other forms of climatic factors. A study of California drought showed that, contrary to previous findings about the likelihood of increase in violent crime during drought periods, drought does not increase violent crimes (Goin *et al* 2017). For India, Blakeslee and Fishman (2018) show contrasting

results, indicating that water stress increases property and violent crimes. As for the impacts of storms, there is only one study conducted in Taiwan, indicating that effects vary depending on the intensity and duration of the events. Results show that intense typhoons decrease crime rates while long duration typhoons have the opposite impact (Yu *et al* 2017).

3.2.1.2. Resource scarcity and competition

Climate change can directly influence conflict and violence mechanisms through intensifying competition over resources. In other words, it can cause conflicts through reducing the availability of resources, thereby, inducing a mismatch between supply and demand (Le Billon and Duffy 2018). Recent literature is mainly focused on intercommunal violence and civil and interstate conflicts that can be linked to competition over water and land resources (Ambalam 2015, Mertz *et al* 2016, Ngaruiya and Scheffran 2016, Malamud 2018, Sultana *et al* 2019). The empirical evidence is mainly from Africa, South and Southeast Asia and the Middle East. These are regions that are already resource-strained and lack adequate levels of adaptive capacity. Accordingly, there are also claims that climate is not the sole factor inducing conflicts and other pre-existing conditions, and contextual factors are also important (Koubi 2019).

Resource scarcity is caused by either slow-onset climatic stressors such as water stress and temperature change or rapid-onset stressors such as storms and floods. The existing evidence is mainly related to floods and water stress in arid and semi-arid regions

that have traditionally been vulnerable to hazards, and climate change is expected to exacerbate these vulnerabilities by triggering competition and conflict over the management and allocation of water resources (Albrecht *et al* 2018). In their historical analysis of civil conflicts in China, Lee *et al* (2017) and Li *et al* (2017) demonstrate how droughts and floods have played significant roles in driving civil conflicts by causing shortages in water resources and arable land. The positive effects of droughts on the incidence of conflicts have also been demonstrated using recent data in other contexts. Findings from an econometric model show that decreases in precipitation levels increase the possibility of intercommunal violence at the district level in Ethiopia and Kenya (van Weezel 2019). Evidence on intercommunal violence (between different farmer, pastoralist, and fisherman communities) caused by water stress has also been reported in other studies focusing on African communities (Schilling *et al* 2015, Detges 2017, Okpara *et al* 2017). However, these studies acknowledge that other political and socio-economic factors such as homogeneous economic structure and social and political marginalization also contribute to such violence.

Conflicts over transboundary water resources have been discussed in numerous studies. In fact, future climatic changes are expected to aggravate water scarcity by changes in precipitation patterns and evaporation rates. These, in combination with other factors such as rapid population growth, the increasing diversity of water uses, and conflicting interests, are considered as key issues contributing to tensions and conflicts over shared water resources such as lakes and rivers in many regions of the world (Link *et al* 2016, Mourad and Alshihabi 2016, Rai *et al* 2017). For example, several studies have discussed different conflicts that have occurred in the context of the Lake Chad Basin (Asah 2015, Okpara *et al* 2015). Analysis of the Lake Chad Basin between 1855 and 2005 shows that periods of drought have witnessed militarized inter- and intra-state conflicts over competing claims (Okpara *et al* 2015). This issue has also been studied in the context of Southern and Southeast Asia (e.g. the Indus, Ganges-Brahmaputra, and Mekong Basins), where conflicts over use and management of water resources are frequent (Williams 2018). Here it should be mentioned that the literature also acknowledges that resource scarcities may provide opportunities for promoting peace through cooperation (Rai *et al* 2017). For example, Abrahams and Carr (2017) explain that water scarcity has led different groups and countries to adopt cooperative approaches to manage water resources and foster resilience to drought. What can be learned from the literature is that measures such as developing joint plans and mechanisms that ensure regular risk assessment, co-designing regulatory frameworks, and joint management of resources can contribute to dealing

with transboundary resource conflicts (Abrahams and Carr 2017, Rai *et al* 2017).

In addition to water stress, conflicts may also occur due to temperature increases and associated climatic stressors such as sea-level rise (Price and Elu 2017). For instance, a modeling study based on different SSPs shows that in the absence of political reform and improved governance, future temperature rise can increase violent conflict in sub-Saharan Africa (Witmer *et al* 2017). Elsewhere, it is discussed that melting of glaciers can gravely affect water supply in South Asia and submerge low-lying small island states. Both effects can immediately elevate levels of discomfort and aggressiveness in the affected populations that may result in hostility and violence (Barkdull and Harris 2015).

Rapid-onset climatic stressors such as storms and floods may also cause conflicts and other issues that undermine negative peace through damaging community assets and aggravating resource scarcity (Koubi 2019). The effects, however, may vary depending on the intensity of the disaster and the resilience and adaptive capacity of the disaster-hit area. Mixed results have been reported in the literature about the effects of disasters on conflict onset (Siddiqi 2018, Peters *et al* 2019). While in some cases disasters lead to civil conflict and social unrest, particularly in transitional economies with low and middle incomes and limited social and physical infrastructure, in others social mobilization and cooperation may occur (Ghimire and Ferreira 2016, Peters *et al* 2019). Based on a dataset of civil conflicts in 78 provinces in the Philippines, Eastin (2018) analyzed the impact of storms on the incidence and severity of the country's four largest and longest-running civil conflicts. The article argues that natural disasters significantly increase the incidence and severity of insurgents as well as government attacks, and the intensifying effect is larger for the latter (Eastin 2018). However, another study draws more cautious conclusions on the effects of disasters on conflict onset. Through a multivariate analysis of responses to different randomly selected disaster events, the study finds that destabilizing effects are not consistent across all cases and only about 15% of disasters lead to social conflict and political violence (Nardulli *et al* 2015).

Disasters are also argued to intensify and prolong existing conflicts (Brzoska 2018). For instance, analyzing the impacts of flood-induced displacement on civil conflicts based on data from 126 countries, Ghimire *et al* (2015) found that such displacements do not trigger new conflicts but intensify existing ones and extend their duration. This is explained by the increased pressure on the receiving communities and competition over limited resources (Ghimire *et al* 2015). It is also worth noting that, in addition to disasters influencing conflict dynamics, pre-existing conflicts exacerbate vulnerabilities to disaster shocks by limiting the resources that can be allocated

to planning and preparation and, thereby, diminishing communities' absorption and response capacities. This, in turn, may further increase the duration of conflicts (Ghimire and Ferreira 2016, Brzoska 2018).

At the end of this section it should be noted that several authors have criticized efforts aimed at establishing direct causal relationships between climate change and events that undermine peace, using large-N quantitative approaches, on the grounds that they are mechanistic and fail to consider the complex and multi-dimensional nature of the nexus (De Juan 2015, Buhaug 2016, Okpara *et al* 2016b). For instance, Buhaug (2016) argues that climate change does not cause armed conflicts as societal actors do not use force only because of unpredictable changes in temperature or rainfall. However, the impacts of climate change may influence interaction among these actors, depending on specific contexts and conflict drivers. In another study, he emphasizes the need to consider complex and dynamic interactions that occur over long periods as well as context specificities that involve multiple intervening factors (Buhaug 2015). Several other studies argue that, rather than direct causes and drivers of conflict/violence, environmental changes are only risk factors that influence conflict dynamics. In fact, such dynamics are strongly shaped by social and political contexts, confirming the need to carefully consider the complex and multi-dimensional nature of the nexus (Bretthauer 2015, De Juan 2015, Noonan and Kevlihan 2018, Barnett 2019). The issue of contextual factors will be further discussed in section 3.3.

3.2.2. Indirect pathways

As figure 2 shows, recent literature has mainly discussed the nexus through indirect pathways indicating that datasets and evidence related to the influence of indirect pathways are likely to be more readily available and substantiated. This figure also shows that indirect pathways are mainly caused by water stress, extreme temperature, and floods and lead to civil conflict, interstate conflict, social conflict, and intercommunal violence.

3.2.2.1. Diminished economic and livelihood capacities

Apart from a few studies that have demonstrated that an abundance of agricultural yields contributes to conflict (e.g. Koren 2018), existing evidence is mainly related to how climate change contributes to events that undermine peace through reducing agricultural productivity that may in turn cause unemployment, diminish economic capacity, and/or reduce availability, accessibility, and affordability of essential needs such as food. This indicates that the existing research has mainly focused on conflicts in agricultural communities. Similar to the direct pathways, reported evidence is inconclusive and various contextual and intervening factors are argued to

influence the dynamics of the nexus (Ayana *et al* 2016, Hegre *et al* 2016).

Several historical analyses focused on China and Europe demonstrate how temperature fluctuations, floods, and water stress have indirectly triggered inter- and intra-state conflicts. Such climatic changes can lead to decreased agricultural production, poor harvest, and spikes in food prices. Without diverse subsistence and livelihood options, a society will face economic and food security challenges that can lead to wars, famines and epidemics (Lee *et al* 2017). The historical evidence shows that climatic pressures and agricultural shrinkage have often been intensified when coupled with significant population increase (Su *et al* 2016, Lee *et al* 2017). For instance, Su *et al* (2016) show how food security challenges caused by the coupling of extreme temperature and water stress, and population growth of the nomadic groups have led to civil conflicts and intercommunal violence in Northern China between 206BC to AD906.

Recent findings from different contexts, particularly those reliant on rain-fed agriculture, are also in line with the historical evidence (Ambalam 2015, Jun 2017, Iqbal *et al* 2018, Tubi and Feitelson 2019). A global analysis shows that temperature fluctuations result in significant variability in crop yields, thereby causing/prolonging civil conflicts by fueling the desire to dominate other groups and gain control over areas with high potential crop yields (Ang and Gupta 2018). Investigating linkages between droughts and rebel violence in developing countries using a quantitative model based on game theory, Bagozzi *et al* (2017) found that drought is a strong predictor of rebel-perpetuated atrocities against civilians in rural agricultural areas that largely rely on agriculture for food and income. Another study relying on climatic data and a set of socio-economic control variables (for the period 1993–2003) shows that, in Indonesia, temperature increases during the main rice growing season leads to the scarcity of rice, a staple food in the country (Caruso *et al* 2016). Consequently, in many provinces, intercommunal violence occurs due to food scarcity. In the neighboring country, the Philippines, Crost *et al* (2018) examined the effects of rainfall fluctuation on agricultural production and civil conflicts and found that wetter wet seasons and drier dry seasons generate negative impacts on agriculture production and consequently increase civil conflict, particularly in provinces where rice production is dominant. As climate change alters seasonal variation in rainfall, the article suggests that this will negatively influence ongoing civil conflict in the Philippines and probably spark new ones in Southeast Asian countries. This seems particularly the case in countries whose population is heavily dependent on rice for subsistence. However, as previously noted, potential impacts of other factors should not be overlooked. For instance, using spatial analysis to examine the association between various events

(i.e. civil conflicts and intercommunal violence) and environmental stressors (water stress and vegetation cover change) in Eastern Africa, Ayana *et al* (2016) found that precipitation and availability of fodder are only weakly correlated with conflict events and other intervening factors and stressors should also be examined to better understand the dynamics of conflict in the region. This indicates that only focusing on conflict onset and incidence is not enough and detailed examination of different intervening factors, and long-term analysis of the impacts of climate change on conflict are needed to better understand dynamics of conflict.

Limited empirical evidence has been reported regarding indirect pathways that occur through impacts on non-farming livelihood options and/or result in events other than civil conflict and intercommunal violence. In the context of Lake Chad, Okpara *et al* (2016a) explain that environmental stressors have decreased fish catch levels, irrigation water resources, and pasture quality. Coupled with other factors such as weak socio-cultural and political institutions and high taxes, these environmental stressors have diminished livelihood capacities of local fishermen, pastoralists, and farmers. As a result, crime rates and civil and social conflicts have increased. Increase of social conflicts due to rainfall shocks has also been reported in a study conducted in India (Sarsons 2015). This study, however, shows that such social conflicts occur even though availability of alternative irrigation options minimizes the economic impacts of drought. This, again, indicates the complexity of the nexus and the need to consider other intervening factors.

Finally, indirect pathways may also increase other forms of crime, such as gender-based violence. In Bangladesh, extreme weather events destroy crops, assets, and livelihoods, which exacerbate pre-existing vulnerability. To reduce household expenses as a means of coping with these negative impacts, families marry off their young daughters or live in crowded shelters, exposing their daughters to harassment and sexual violence (Ahmed *et al* 2019).

3.2.2.2. Migration

About 37% of the reviewed papers discussed issues related to migration, indicating that migration is likely to lead to events that undermine peace. While migration has mainly been discussed in terms of internal displacement, some studies have also focused on refugee movements. In either case, the dynamics of the processes are complex and may be influenced by different factors such as the type of climatic stressor, the past experiences of the migrants, and the nature of support mechanisms to alleviate the impacts of migration (Koubi *et al* 2018, Koubi 2019). It is argued that migration can lead to conflict under certain circumstances. For instance, it may lead to an increase in crime rates in the absence of

humanitarian support to reduce the socio-economic pressures on migrants. It may also lead to conflict by causing tensions through increasing competition over scarce resources in the host communities (Koubi 2019). Conflicts may also arise when migrants are perceived as a threat to national security, and barriers are built to prevent their movement (Nishimura 2015).

Given the above-mentioned complexities, the evidence reported in the literature on how migration may undermine peace is not always conclusive. However, negative impacts of migration have been highlighted in several studies. A survey in Kenya shows that migration can lead to conflicts, particularly between existing residents and the migrants, due to increased competition over already scarce resources that are going to be further strained in the future due to climatic pressures (Linke *et al* 2018b). Similarly, in Nigeria, Akinyemi and Olaniyan (2017) show that during periods of low rainfall and prolonged drought, grass and water become scarce, driving the cattle herders in the North to migrate to the South where agricultural communities are located. This migratory adaptation then leads to conflict between these groups over access to water, encroachment of farms and grazing areas, and damage to crops and theft of cattle. Similar patterns have been reported in other contexts like Darfur (Bromwich 2018). While reported evidence is mainly related to intercommunal violence and civil and social conflicts, migration may also lead to political and inter-state conflicts. For instance, with climate change intensifying floods and droughts, the climate-induced displacement from Bangladesh to India will likely increase, escalating existing ethnic and religious tensions between the two countries (Alvarez 2017).

Despite such cases of migration leading to or intensifying conflicts, there are several studies arguing that only under certain conditions climatic stressors play important roles. For instance, this has been extensively discussed in the context of the ongoing civil conflict in Syria. Some argue that severe drought has been a major factor contributing to the onset of the conflict. It has damaged the agricultural sector, causing significant loss of livelihoods and triggering massive migrations to the periphery of cities. The migrants' failure to become integrated into the urban economy has, in turn, aggravated the social conflicts and led to the onset of the civil conflict (Kelley *et al* 2015, Hayden 2018, Ide 2018). However, other studies emphasize that the process is more complicated and non-linear. Azmeh (2016) argues that oft-cited conflict drivers, such as population growth, rising inequality, climate change, and unemployment, only offer a partial understanding of the conflict. He contends that the socio-economic and political discontent that pushed people to stage protests are rooted in the failure of the Syrian government to meet the twin demands of building national institutions

and redistributing political and economic power. Similarly, other studies show that climate change-migration nexus does not lead to conflicts in all contexts (Weinthal *et al* 2015, Byravan and Rajan 2017). Appropriate dispute resolution resources and mechanisms and adaptation strategies and policies that incorporate migration and address socio-economic and psychological needs of the migrants can mitigate the security issues and conflicts stemming from migration (Bhavnani and Lacina 2015, Nishimura 2015, Nine 2016, Cattaneo and Bosetti 2017).

3.3. Major contextual factors and their influence on the climate-peace dynamics

Interactions between climate change and peace are often mediated by various contextual and intervening factors. Our review showed that such factors have been discussed in about 68% of the literature, indicating an increasing acknowledgement of the complex and non-linear nature of the nexus. Generally, these factors can be divided into three major categories, namely, political/institutional, economic and social. While factors related to these three categories are not isolated from each other, here we present them separately for simplicity.

3.3.1. Political/institutional

Major factors related to policies and institutions are political instability (Malamud 2018), poor governance (Kelley *et al* 2015), weak and insufficient institutions (Weiss 2015), fragile state-citizen relations and lack of democratic and inclusive governance (Ghimire and Ferreira 2016, Detges 2017), political marginalization of some groups (Nishimura 2015), lack of governmental ability to coordinate activities of different actors (Staff 2017), lack of adaptation plans and mechanisms to enhance adaptive capacity (Ayana *et al* 2016), lack of policies for crime prevention (Goin *et al* 2017), lack of trust between countries (Rai *et al* 2017), lack of agreements and treaties between neighboring countries or lack of mechanisms to enforce them (Williams 2018), and history of past conflicts (Noonan and Kevlihan 2018). For example, poor governance and political marginalization are argued to be major factors contributing to the Syrian civil conflict (Kelley *et al* 2015, Azmeh 2016). In Kenya, Ngaruiya and Scheffran (2016) discuss that natural resource regulations and governance arrangements are crucial in solving resource conflicts. Another study focusing on 23 African countries argues that drought cannot influence political violence unless it intersects with social and political marginalization (Detges 2017). The article suggests that state-citizen relationships can determine the vulnerability of people to extreme climate events such as drought. Ultimately, 'political exclusion exacerbates climate-related hardships and can thus give rise to social tensions and grievance in the wake of drought' (*ibid*, p 95).

3.3.2. Economic

Regarding the economy and economic development, important contextual factors such as poverty (Ghimire and Ferreira 2016), employment level (Habibullah 2017), homogeneous livelihood structure dependent on agriculture or ecosystem services (Tubi and Feitelson 2019), economic inequality and inequitable distribution of resources (Bell and Keys 2018), land tenure security (De Juan 2015), and access to infrastructure services (Detges 2016, Muller *et al* 2016) have been identified.

Poverty and lack of access to resources are frequently mentioned as major pre-existing conditions that aggravate vulnerability to climatic impacts and can foment conflict (Ghimire and Ferreira 2016, Hegre *et al* 2016, Abrahams 2019). Homogenous livelihood structures dependent on agriculture are also recurring contextual factors in the reviewed literature. Such structures are more vulnerable to climatic impacts and can lead to unemployment and subsistence insecurity, thereby causing conflicts and violence. For example, the Bedouin groups in Israel are argued to be directly impacted by climate change as their livelihood is closely related to precipitation. This drives them into intercommunal violence with farming communities to gain access to resources (Tubi and Feitelson 2019). This shows the significance of social protection and planning mechanisms in diversifying the economic structure of households and communities. Other noteworthy factors are availability and equitable distribution of resources and infrastructure, the lack of which may lead to or aggravate conflicts (Scott and Smith 2017). Analyzing the nexus between water stress and armed conflicts in sub-Saharan Africa, Detges (2016) demonstrates that regional differences in the availability and access to key infrastructures such as road networks and water infrastructure influence the risk of incidence of civil conflict and intercommunal violence.

3.3.3. Social

Contextual social factors mentioned in the literature are related to demographic changes (Alfani and Grada 2018), ethnic tensions (Schleussner *et al* 2016), social capital (Cattaneo and Bosetti 2017), and level of education (Bretthauer 2015). Studies focused on historical as well as recent events have highlighted the importance of population growth for increasing the likelihood of conflicts over scarce resources (Alfani and Grada 2018, Farinosi *et al* 2018). Moreover, in the context of competition over scarce resources, migration, and climate-induced disasters, conflict and violence are more likely in areas with pre-existing ethnic tensions (Schleussner *et al* 2016, Tubi and Feitelson 2019). Evidence of heightened tensions and conflicts in ethnically fractionalized locations, following climate-induced disasters and/or displacements, has been reported in the literature (Schleussner *et al* 2016, Peregrine 2019, Weesie 2019). Closely linked

to ethnic fractionalization is the issue of social capital. Related factors such as trust, solidarity, and shared interests are believed to contribute to preventing the outbreak of violence in the face of adverse events induced by climate change (Malamud 2018, Barnett 2019). Finally, level of education can be a defining factor of the climate-peace nexus dynamics. Bretthauer (2015) explains that high levels of tertiary education in combination, with other socio-economic and institutional factors such as low levels of poverty, diversified livelihood strategies, lack of ethnic fractionalization, and strong intuitions, can contribute to minimizing conflicts (Bretthauer 2015).

4. Conclusions

Climate change is increasingly recognized as a threat multiplier and linked to security risks. The main aim of this review was to gain a better understanding of the underlying mechanisms of the nexus between climate change and peace. We examined how different climatic stressors such as extreme temperature, floods, sea level rise, storms, and water stress are linked with various events related to peace, such as civil conflict, crime, intercommunal violence, interstate conflict, political conflict, and social conflict through direct and indirect pathways.

Results show that research on this nexus is unbalanced in terms of geographic coverage and addressing different climatic stressors and events that undermine peace. In line with the findings from previous studies that considered literature since the 1990s (Hendrix 2017, Adams *et al* 2018, Koubi 2019), it was found that the literature in our review is also mainly focused on some conflict-ridden regions located in Asia and Africa. A noteworthy finding is that, in the past few years, there has been an increasing focus on Asia, which contrasts with previous studies that show an African focus in the literature (Busby and Krishnan 2017, Hendrix 2017, Adams *et al* 2018). While previous studies have examined evidence since early 1990s and/or 2000s, in this study only research published since 2015 was included. This shows that previous research has been successful in highlighting the need to focus on Asia. Despite this, more work on other regions is also needed. Indeed, to reduce the streetlight effect more research is needed in regions where climatic stressors do not coincide with conflict. This may also allow one to gain a better understanding of conflict dynamics. In fact, the existing research is mainly focused on conflict onset and incidence and more research is needed to further probe how climate change and other intervening factors may affect conflict dynamics. Another new finding is that even in some conflict-ridden areas such as South America evidence is scarce, warranting further research. Regarding climatic stressors and events that may undermine negative peace, the literature is dominated by evidence regarding civil and/or interstate

conflicts linked with water stress and/or extreme temperature. The nexus has a multi-dimensional nature and other climatic stressors and events related to negative peace should be further explored in future research. Also, most of the reviewed articles focus on the implications of individual climatic factors on peace, and there is a lack of research on the combined effects of multiple factors.

Climate change and peace interact in either direct or indirect pathways, but the evidence on the pathways is divergent and inconclusive because interactions are complex and hard to disentangle. Indirect pathways, which occur via reduced livelihood capacities and/or massive climate-induced human displacements, dominate the literature. These pathways are mainly discussed in relation to agricultural and pastoralist communities. Future climatic impacts are likely to affect the livelihood options of different other groups and professions and this should be further studied. It was discussed that indirect pathways may occur due to migration. Our analysis showed that migration-related evidence mainly refers to cases on internal displacement and issues related to refugee movements are relatively less discussed. Future research should pay more attention to the impacts of refugee movements and also examine if such impacts are different from those of internal displacement.

Direct pathways, in contrast, happen through direct psychological/physiological effects of climatic impacts or via competition over scarce resources, with water and land as the most frequently discussed in the literature. Surprisingly, very limited evidence has been reported on energy resources. This could be partly due to relatively fewer conflicts over energy resources and limited modeling studies on the potential impacts of climate change on the availability of energy resources across the world.

Overall, evidence about the existence of direct and indirect linkages between climate change and events that undermine peace remains contested and equivocal. Many studies have argued that climate change does not necessarily lead to events that undermine peace and the nexus is mediated by multiple contextual socio-economic, political, and institutional factors that can make some places ripe for conflict and violence. These studies confirm the complexity of the nexus, raising caution over simplified interpretations of its linkages and overstated impact of climate change on peace (Buhaug 2015, Selby *et al* 2017). Several political/institutional, economic, and social factors bridge climate change to peace. Some of these factors are political instability, weak institutions, poor governance, lack of adaptation plans, poverty, homogeneous livelihood structures, socio-economic inequality, ethnic fractionalization, and lack of social capital. However, while these factors are frequently mentioned in the literature, there is still a lack of knowledge about their relative

importance. Further, there is still limited understanding of how the interplay between them and climatic factors affects the dynamics of the nexus. In particular, there is a lack of knowledge about the impacts of different future climatic scenarios on the nature of interactions between climatic and contextual factors. More research is needed to fill this gap. Also, further research into locations that are frequently hit by climate-induced stressors and disasters but do not experience conflicts is needed to better understand contextual factors that contribute to maintaining peaceful conditions. This will also help minimize the streetlight effect that was mentioned earlier and may lead to limited understanding of the underlying dynamic and complex interactions that govern and regulate the nexus between climate and peace. One important issue is that many of these contextual factors are underlying elements of adaptive capacity. This indicates the importance of developing appropriate plans to enhance adaptation and adaptive capacity through various measures such as improving governance mechanisms, empowering low-income groups, and diversifying livelihood options. In fact, there is now a good consensus that adaptation to climate change is essential for maintaining peace (Buhaug 2015, Jun 2017, Schweizer 2019). There are also some modeling studies aiming to estimate the consequences of inaction and/or maladaptation. For instance, using SSPs that provide an integrated framework to examine the combined effects of different future climate change and socio-economic scenarios, Hegre *et al* (2016) found that scenarios with higher levels of mitigation and adaptation challenges are linked to higher levels of future armed conflict. In fact, as the global climate change persists, critical thresholds and tipping points might be surpassed not only in developing countries, but also in developed ones that until now have rarely experienced conflicts induced by climatic impacts. This can aggravate existing vulnerabilities and have significant repercussions for global peace and security. Therefore, further research is also needed to better understand the dynamics of the nexus under different future climate scenarios and positive peace conditions that enable the creation and maintenance of peaceful societies.

Data availability statement

All data that support the findings of this study are included within the article (and any supplementary files).

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