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RESEARCH ARTICLE



A void in Central Asia research: climate change

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ABSTRACT

This article assesses the extent to which the academic community engaged with climate change in Central Asia between 1991 and 2021. The article finds that climate change has been neglected in the field of Central Asia area studies. Out of a total 13,488 journal articles in eight key journals for Central Asia research, only 33 articles (0.24%) were on climate change or a related topic. Climate change has been similarly neglected at the events of 17 Central Asia area studies associations. Out of 1305 conference panels, none was focused on climate change. Out of 10,249 individual presentations, only two (0.02%) were focused on climate change. The very same scholars who have been most active in the securitization of Central Asia have ignored the severe security threats that climate change poses to the region. The article contributes to the field of Central Asian studies by drawing attention to severe knowledge gaps that hinder the Central Asian countries from adapting to climate change. It concludes with six recommendations.

KEYWORDS

Central Asia research; climate change; systematic review; publishing channels; conferences

Introduction

According to the Intergovernmental Panel on Climate Change (IPCC), Central Asia is highly vulnerable to climate change. Temperatures in the five countries that make up this region are rising faster than the global average (IPCC 2019). The consequences of climate change for the Central Asian states are likely to come in the form of shrinking glaciers, destabilized river flow, increasing aridity, and impacts on agriculture and fisheries (IPCC 2001). Tensions over already scarce water resources may grow, putting strain on relations among the Central Asian states. Eco-migration is also likely to grow, with further social, economic and political implications. Socio-economic inequalities and intrastate political tensions may be aggravated (Lioubimtseva and Henebry 2009; Peng et al. 2018).

According to the IPCC (2014), there is less available research and data on observed and projected climate change impacts in Central Asia than any other region in Asia, including

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North Asia, East Asia, Southeast Asia and South Asia. The IPCC identified 54 thematic areas that are critical to understanding the major impacts of climate change that are relevant for Central Asia. In only three of these areas was sufficient information available on Central Asia; in the remaining 51 thematic areas there were critical knowledge gaps or no data at all (see Appendix 1 in the supplemental data online). However, the IPCC made these observations in 2014. The purpose of our article is to provide an update on the status quo for climate-related research on Central Asia to ascertain whether the situation has improved after the adoption of the Paris Agreement and to identify remaining research gaps. These gaps urgently need to be filled. Doing so can help inform local populations, raise climate change awareness, facilitate the development of targeted adaptation policies and contribute to evidence-based decision-making in Central Asia. The article also contributes to the field of Central Asian studies by drawing attention to the lack of research on climate change in the region.

The remainder of the paper is structured as follows. In the next section we present our methodology. This is followed by an analysis of the macrorends in research on climate change in Central Asia over the 1991–2021 period. In the subsequent sections we outline and examine the thematic focus areas of the literature, compare the social science, natural science and grey literatures, and examine the attention given to climate change in academic events on Central Asia. The concluding section sums up our findings and offers recommendations for how Central Asian studies can deal with climate-related issues.

Data and methodology

We collected, reviewed and mapped the academic literature on climate change impacts, adaptation and mitigation in Central Asia published between 1991 and 2021. The systematic review method was used. This was popularized for the medical sciences by Cochrane but has later spread to other fields of research, including the social sciences.

We examined two types of literature: we checked whether Central Asia is covered in general climate-related publications, and whether publications produced by the Central Asian area studies community deal with climate-related topics.

Our review covers articles in peer-reviewed journals, books and grey literature. We cover the English-language academic literature published during the post-Soviet period. The fact that we deal only with the English-language literature is a limitation of this study. However, English has been the main language for international knowledge production on climate change since the 1990s and we hope that our study can inspire other scholars to review the literature in other languages.

To identify relevant literature in a systematic manner, we employed a two-part Boolean search string¹ coupling any one of many climate-related keywords with either the term 'Central Asia' or the names of the individual states in the region:

('climate change' OR 'climate mitigation' OR 'climate adaptation' OR 'global warming' OR 'greenhouse effect' OR 'greenhouse gas' OR 'GHG' OR 'CO2 emissions' OR 'decarbonization' OR 'climate policy' OR 'UNFCCC' OR 'United Nations Framework Convention on Climate Change' OR 'Intergovernmental Panel on Climate Change' OR 'IPCC' OR 'Kyoto Protocol' OR 'Paris Agreement' OR 'nationally determined contribution' OR 'INDC' OR 'climate negotiation' OR 'climate action' OR 'climate justice' OR 'climate ethics' OR 'climate sceptic' OR 'climate

denial' 'climate migration' OR 'climate refugees' OR 'rising temperature' 'melting glacier' OR 'cap and trade' OR 'emissions trading' OR 'carbon tax' OR 'CO2 equivalent' OR 'carbon sink' OR 'climate feedback' OR 'carbon footprint' OR 'carbon offset' OR 'carbon neutral' OR 'climate model' OR 'carbon cycle' OR 'climate feedback' OR 'climate sensitivity' OR 'climate risk' OR 'climate impacts' OR 'extreme weather' OR 'Glacial Lake Outburst Floods' OR 'GLOFs' OR 'landslides' OR 'melting permafrost' OR 'Coordinated Regional Climate Downscaling Experiment' OR 'CORDEX' OR 'Coupled Model Intercomparison Project' OR 'CMIP' OR 'climate agriculture' OR 'climate farming' OR 'climate livelihood' OR 'climate migration' OR 'climate gender')

AND

('Central Asia' OR 'Kazakh*' OR 'Kyrgyz*' OR 'Tajik*' OR 'Turkmen*' OR 'Uzbek*')

The first part of the search string containing generic climate-related terms was based on those initially developed by Overland and Sovacool (2020) and Overland et al. (2021). However, we added terms such as 'melting glacier', 'landslide', 'Coupled Model Intercomparison Project' and 'Coordinated Regional Climate Downscaling Experiment' because of their relevance for climate-induced environmental change in Central Asia.

We applied our search string to the search engines/databases Crossref, Google, Google Scholar, Scopus and Web of Science. Using the same string, we also queried the archives of eight key journals for Central Asian area studies (Table 1). We erred on the side of caution: if a publication dealt with broader environmental issues and climate change was only a minor part of its subject matter, we would still count it as being concerned with climate change.

The direct and broad investigative approach using the search string was complemented by snowballing, in which we examined the cited references of already identified publications on climate change in Central Asia to find linkages to related literature which might have been accidentally omitted. Publications exclusively about weather or climatic research unrelated to anthropogenic climate change were not included in our results.

Finally, we looked beyond academic publications and searched the records of Central Asia events to identify how many events included activities on the topic of climate change between 1991 and 2020. This included conferences, workshops and seminars organized by 17 international associations of Central Asia studies, as well as one-off events on Central Asia at universities and research institutions. Events were assessed by applying our search string to event programmes.

The next sections present detailed results of the review of the literature. First, we give an overarching summary of our results, next we zoom in on the literature on the physical

Table 1. Climate change-focused articles in proportion to all articles published in area studies journals, January 1991–May 2021.

Central Asian area studies journal	Total articles	Climate change articles	Percentage of total publications
<i>Eurasian Geography and Economics</i>	1081	22	2.04%
<i>Central Asian Survey</i> ^a	1205	4	0.33%
<i>Journal of Eurasian Studies</i>	223	2	0.90%
<i>Post-Soviet Affairs</i>	439	2	0.46%
<i>Central Asian Affairs</i> ^a	116	1	0.86%
<i>Problems of Post-Communism</i>	6530	1	0.01%
<i>Europe–Asia Studies</i>	2905	1	0.03%
<i>Communist and Post-Communist Studies</i>	989	0	0.00%

Note: ^aJournals that cover Central Asia only.

impacts of climate change in Central Asia, then the societal aspects of climate change in the region, then the grey literature.

General results

We identified a total of 292 publications on climate change (primarily dealing with climate change impacts and adaptation) in Central Asia, including both peer-reviewed and grey literature. This number includes 165 academic publications in the natural sciences, 89 academic publications in the social sciences, and 38 technical reports published by international organizations and non-governmental organizations (NGOs) (grey literature).

Nothing was published on climate change in Central Asia between 1991 and 1995. This has three possible explanations. First, in the early years of the post-Soviet transition, political instability and the civil war in Tajikistan made it difficult to carry out research in the region (Lynch 2001; Straub 2013), especially in the high-mountain areas of Tajikistan that are important for research on glaciers. Second, climate-related data were scarce in Central Asia due to limited glacier monitoring, lack of scientists working at the meteorological stations and other issues (Tajikistan Government 2014). Third, little funding was available for research on climate change in Central Asia in the early 1990s and the international scientific community therefore had only a few projects.

As shown in Figure 1, from 1996 and onwards, scholarship on climate-related issues in Central Asia grew gradually over time, especially after 2010. The reasons for this development are unclear. Some possibilities include increased availability of research funding and growing interest in the region within the IPCC after 2010.

There was a spike in interest in Central Asia in the natural sciences in 2013. As for the social sciences, scholarly interest appears to have peaked or plateaued in 2015. This is surprising, considering the severe knowledge gaps identified by IPCC in 2014 and the signing of the Paris Agreement in 2015. The decline between 2020 and 2021 may have something to do with the Covid-19 pandemic. However, the general downward trend in the data is clear.

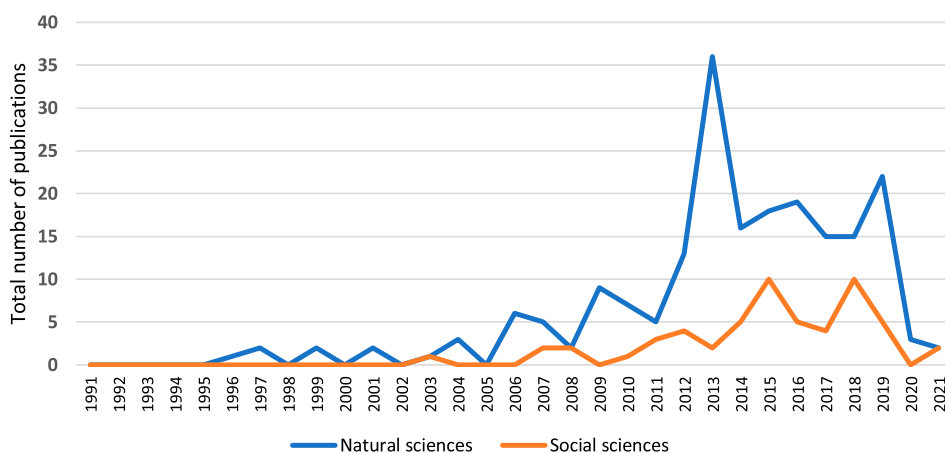


Figure 1. Comparison of academic publications on climate change in Central Asia in the natural and social sciences, 1991–2021.

Central Asia in its entirety is covered by 128 of the publications. Others cover between one and four countries. As many as 39 publications are dedicated to Kyrgyzstan, one of the smallest countries in the region in terms of population, surface area and economy. This may reflect the greater ease of conducting academic research in Kyrgyzstan compared with the other Central Asian states. Moreover, throughout the post-Soviet period, Kyrgyzstan has actively cooperated with international donors and development agencies, which have often provided funds for research on the country.

Central Asia-based research teams account for 64% of all published works, while non-Central Asia-based research teams account for 36% of publications. As we do not have data on the total number of research teams based inside and outside Central Asia, we cannot say with certainty whether these numbers are skewed. However, it appears that local researchers are more aware of climate change despite the lack of climate awareness in the Central Asian states, while international researchers are less aware of climate change despite the large amount of attention it is receiving internationally.

Figure 2 presents the social science literature by academic discipline. Sociology accounts for the largest number of publications. In several other disciplines, the literature is sparse. Anthropology, international relations, and public health are the least active disciplines in the study of climate-related issues in Central Asia. Although anthropology plays an important role in Central Asian studies in general, we found that few anthropological publications directly address climate change (e.g., Piersall and Halvorson 2014; Williams and Golovnev 2015).

The physical impacts of climate change in Central Asia: one of the most vulnerable parts of the world

In this section we provide an overview of the natural science literature on climate change in Central Asia. This research lays the foundation for the research on societal aspects of climate change, which we turn to in the next section.

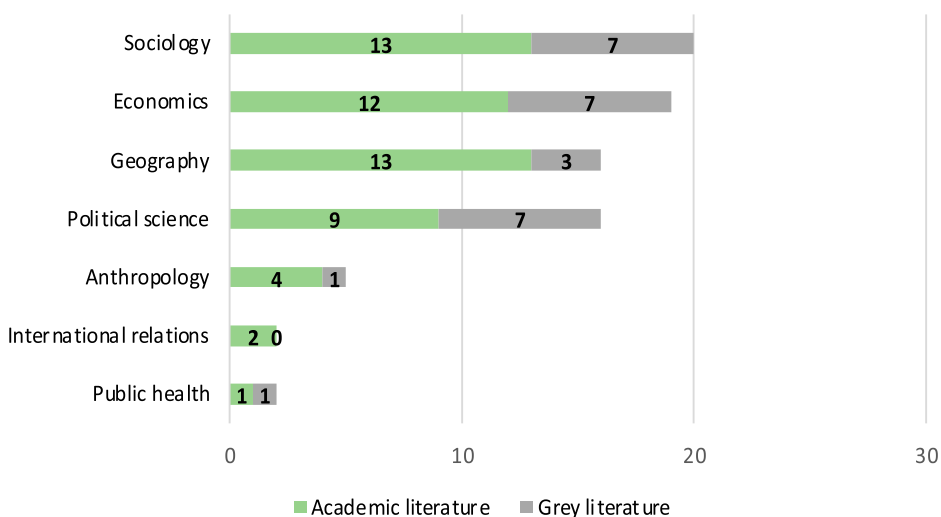


Figure 2. Social science literature on climate change in Central Asia by discipline, 1991–2021.

Climate change has several faces in Central Asia. Figure A in Appendix 2 in the supplemental data online summarizes the existing natural science literature, describing the historical and projected impacts of climate change in the region. It presents all the works covered in this part of our review. This is useful both because the physical impacts of climate change underpin social science research on climate issues in Central Asia and because it is interesting to compare research on the region in the social sciences to that in the natural sciences.

Many studies have shown that temperatures in Central Asia are rising faster than the global average and that this divergence is likely to continue (see references in the box 'Temperature' in Figure A in Appendix 2 in the supplemental data online). As a result, high-altitude permafrost soils are melting, snow cover and snowfall are declining, and glaciers are shrinking. Many glaciers in Central Asia are expected to continue on this path, with some exceptions in the Tien Shan. In the Karakoram, mostly located in China, India and Pakistan, there are even more such exceptions, referred to as the 'Karakoram Anomaly' (Farinotti et al. 2020; Dimri 2021). However, the overall trend for glaciers in Central Asia is that they are shrinking. The runoff from glaciers in Central Asia may therefore increase threefold by 2050. Some studies have also shown other important impacts on the mountainous parts of the region, such as a rise in "oods, landslides, avalanches and glacial lake outburst "oods (GLOFs) (see references in the box 'GLOFs' in Figure A in Appendix 2 in the supplemental data online).

Changes in precipitation are documented but are highly heterogeneous, both annually and seasonally. The significance of the changes depends on the location and dataset examined for both the historical climate and future projections. Only a few studies have looked at extreme weather events, such as heatwaves and droughts (e.g., Salnikov et al. 2014; Feng et al. 2018). That said, an increase in extreme temperatures, in the frequency of droughts, and in the frequency, intensity and duration of heatwaves is expected. Accordingly, several studies predict increased aridity (e.g., Reyer et al. 2017; Jiang et al. 2019). This will cause challenges for agriculture in the region, which we review in the next paragraphs, and may also lead to increased conflict between villages, regions and countries over water resources for irrigation purposes as well as hydropower.

The scholarship on the agricultural impacts of climate change in the region is more substantial and multifaceted than the scholarship on other topics; the research mainly deals with agriculture and irrigation systems in an agronomic perspective, although it often takes an interdisciplinary approach (see references in the box 'Agriculture' in Figure A in Appendix 2 in the supplemental data online).

The rural–urban migration dimension resulting from deteriorating irrigation has received some attention (Bekchanov and Lamers 2016), particularly in the context of its effects on food security (Aleksandrova et al. 2014) and the subsequent deleterious effects on agricultural labour productivity (Reyer et al. 2017).

Climate change is expected to have considerable impact on agricultural productivity in Central Asia. The projected temperature increases will directly impact crop agriculture, with a high degree of local variance (Swinnen et al. 2017; Mitchell et al. 2017; Conrad et al. 2013; Shiferaw et al. 2013; Teixeira et al. 2013). There is also evidence of soil desiccation and receding shrub and other vegetation due to rising temperatures, particularly for the Karakum and Kyzylkum desert zone, the Ustyurt plateau and the wetlands of the Large Aral Sea (see the box 'Agriculture' in Figure A in Appendix 2 in the supplemental data online).

The literature on the physical impacts of climate change reviewed in this section lays the basis for research on the social, economic, and political consequences of climate change. We turn to this in the next section.

Societal aspects of climate change in Central Asia: limited academic attention and severe knowledge gaps

Overview of the issue-areas covered

Climate change has a negligible presence in the area studies journals that cover Central Asia (Table 1). Out of the total 13,488 articles published by eight area studies journals during the 1991–2021 period, only 33 (0.24%) were about climate change. Moreover, most of the 33 articles address climate change in Central Asia only in a small way, for example, referring to the issue in one or two paragraphs or at most dedicating a section to it.

The journal *Eurasian Geography and Economics* published 22 articles on a broad array of climate-related issues, including the Aral Sea, albeit with limited direct focus on climate change and its impacts. Blondin (2018) explores climate change and eco-migration and is a rare example of an area-studies approach to the issue.

Journals specializing in climate research have given more space to research on climate-related issues in Central Asia. Figure 3 shows the thematic distribution of academic social science publications. It presents all the works covered in this review. Livelihoods and economic impact feature prominently. However, most of the social science literature on climate change focuses on narrow technical issues and pays little attention to the broader social and political context. In this sense, the existing literature neglects significant and far-reaching macro-economic, political, health, geopolitical and broader socio-logical dimensions of climate change.

The impact of climate change on irrigation has received more attention than other issue areas in social science literature. Several studies suggest that rising temperatures, droughts, shrinking glaciers and the changed timing of rainfall will increase the need for water resources in agriculture, which may in turn spur socio-economic, political and even military conflict (Li et al. 2020; Tischbein et al. 2013; Propastin 2012; Litvak, Nemaltseva and Poddubnaya 2011). Changes in water availability could also affect livestock agriculture (Jiang et al. 2017). At the same time, some scholars note that the positive effects of implementing new technologies (e.g., drought-resistant seeds, drip irrigation and shelter beds) have also been established in Central Asia (Akhtar, Tischbein and Awan 2013; Thevs et al. 2017). Several studies call for higher prioritization of agricultural climate adaptation in governance and planning (Abdullaev and Rakhmatullaev 2016; Karatayev et al. 2017).

The literature is sparse when it comes to quantitative assessments of climate change impacts on regional economies. The existing economic analyses deal with the adaptation of Kazakhstan's economy to climate change (Yessenbekova, Adieva and Sharipkhanov 2016; Esenbekova and Alan 2018), the impact of climate change on farmer incomes (Closset, Dhehibi and Aden Aw-Hassan 2015), and the region's continued reliance on fossil fuelled economic growth (Rasoulinezhad and Saboori 2018; Günel 2019).

It is encouraging that scholars have paid attention to climate change adaptation efforts at the community level (e.g., Qi et al. 2012; Mustaeva and Kartayeva 2019), although significant research gaps remain. Some works note the gendered impacts of climate change,

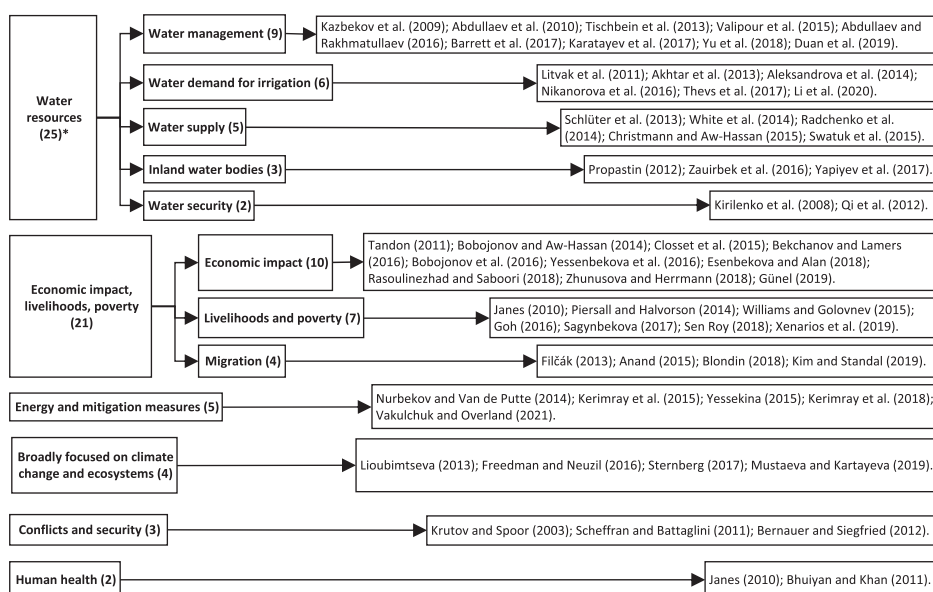


Figure 3. Academic publications on climate change in Central Asia in the social sciences, by theme, 1991–2021.

Note: *Numbers of publications are shown in parentheses.

including with regard to water resources (Sen Roy 2018), social security (Goh 2016) and agriculture, as women are often smallholder or subsistence farmers with limited access to relevant markets and networks (Tandon 2011). Climate-induced migration results in women, children and the elderly becoming responsible for farming activities (Kim and Standal 2019).

The climate change–health nexus is covered by only three publications: one report about Uzbekistan (United Nations Development Programme (UNDP) 2011), one article about Kazakhstan and another about Central Asia as a whole (Bhuiyan and Khan 2011; Janes 2010). This is one of the major gaps in the literature that needs to be addressed. Combined with the poor state of health systems in the region, failure to understand the severe health impacts of climate change may undermine future adaptation policies.

Another gap in the literature is the study of mitigation policies which have been explored only by a few scholars (e.g., Kerimray et al. 2009, 2015; Yessekina 2015). Few academic publications touch upon energy transition and the phasing out of fossil fuels in the region (e.g., Vakulchuk and Overland 2021).

Scholarship on security in Central Asia: no place for climate change?

For decades, Central Asia has been approached through the lens of security studies by international scholars. As Heathershaw and Megoran (2011) put it, the region was long framed through a ‘discourse of danger’ with numerous security problems. Security scholars, especially those based in the United States, formed the early post-Soviet academic debate about Central Asia and its place in international affairs. The region’s endowment with hydrocarbons, the September 11, 2001 events and the proximity of Afghanistan attracted security scholars who viewed Central Asia as a permanent source of instability,

conflict and danger. As a result, security, conflict and international relations studies were one of the dominant lines of scholarship on Central Asia since the 1990s (Allison 2008; Collins 2009; Peimani 2009; Zabortseva 2012; Laruelle and Peyrouse 2013; Cooley 2017). Even though the region has been often securitized in an excessive and exaggerated manner (Heathershaw and Megoran 2011), this is not to say that Central Asia has had no conflicts since the early 1990s. In particular, water scarcity and access to water have been a source of tensions among Kyrgyzstan, Tajikistan and Uzbekistan (Micklin 2002; Zakhir-ova 2013; Abdolvand et al. 2015; Zhupankhan et al. 2017; Zinzani and Menga 2017; Zinzani 2018).

The very same scholars who over-securitized Central Asia, have ignored the looming and real security threats that climate change poses to the region. Therefore, little is known about how climate change has been influencing security and relations among the states in Central Asia. Only three publications examine the impact of climate change on security (Krutov and Spoor 2003; Scheffran and Battaglini 2011; Bernauer and Siegfried 2012). Climate change can complicate regional relations over scarce resources; exacerbate existing water disputes; cause conflicts around food security; generate more eco-migration and transform it into a foreign policy issue. The economic cost of climate change can also destabilize the region in many ways.

Accordingly, the likelihood of old and new conflicts arising from climate change in Central Asia is understudied. This is especially surprising given that climate change has been increasingly characterized as a global security issue by international scholars since the early 2000s (Mayer 2012; McDonald 2018), and the climate change–conflict nexus has been comprehensively studied in other parts of the world such as the Middle East, Sub-Saharan Africa and Southeast Asia (e.g., Couttenier and Soubeyran 2013; Gleick 2014; Buhaug et al. 2015; Caruso, Petrarca and Ricciuti 2016; Overland and Vakulchuk 2017).

One body of academic scholarship has focused on the interaction between climate change, water, drought, and conflict in the Middle East (e.g., Gleick 2014). This analytical framework is particularly relevant to Central Asia where water scarcity and drought are the main outcomes of the changing climate. Conflicts related to access to water are likely to take place between communities and countries in Central Asia unless evidence-based research on the topic is conducted and proper preventive and adaptation policies are developed.

In the next section, we transition to looking at the grey literature, reports and policy papers that are not published by peer-reviewed academic journals or publishers. These are often published by multilateral organizations or NGOs.

Grey literature: international organizations raise awareness about climate change

We identified 38 reports and policy papers on climate-related issues in Central Asia published by international organizations or NGOs. Similar to the academic literature, only three reports deal with the security risks that climate change poses to the region (Organization for Security and Co-operation in Europe (OSCE) 2017; 2019; Stockholm International Peace Research Institute (SIPRI) 2018). Other reports discuss the implications of

climate change for poverty (e.g., Asian Development Bank (ADB) 2009; World Bank 2009; Oxfam 2009; Heltberg, Reva and Zaidi 2012; Organisation for Economic Co-operation and Development (OECD) 2016a, 2016b, 2016c, 2016d) and sustainable water management in Central Asia (Eurasian Development Bank 2009; ADB 2014).

Often, the reports on climate change on Central Asia tend to be broad and lack depth. For instance, a portion of the grey literature studies the impact of climate change on social structures and livelihoods in Central Asia through a sociological lens, cycling through a broad array of topics including migration, socio-cultural adaptation, community adaptation, socio-ecological changes, land rights, income, credit, social geographies, changes in livelihoods and migration (Bichsel, Hostettler and Strasser 2005; UNDP 2008; Prevention Web 2009; The Water Nexus 2011; Koubi et al. 2012; Mukhamedova and Wegerich 2014; Scalise and Undeland 2016).

The grey, policy-oriented literature does not emphasize the political dynamics directly related to climate change but rather focuses on macro-level, national policy adaptation responses to climate change as a multifaceted threat (Kirilenko, Dronin and Ashakeeva 2008; Kryspin-Watson, Pollner and Nieuwejaar 2008; World Bank 2009; Dazé 2016; Zholdosheva et al. 2017). Carmin and Zhang (2009) are among the few authors who explored climate adaptation strategies in urban areas in Central Asia, an area where in-depth research is urgently needed due to a large proportion of the population in Central Asia living in large cities and suffering from worsening ecology caused by climate change.

Similar to the academic literature, the grey literature also pays little attention to climate change and gender. The studies that do exist on this topic find that women are often under-represented in decision-making processes concerning water and pastureland in Kyrgyzstan (e.g., United Nations 2012). Other implications of climate change for gender in Central Asia remain understudied.

International organizations are the main source of grey literature on climate-related issues in Central Asia and have played an active role in terms of raising awareness about this issue area. Many of them – the OSCE, World Bank, ADB, Aga Khan Development Network, German Corporation for International Cooperation (GIZ), Swiss Agency for Development and Cooperation, UNDP, United Nations Educational, Scientific and Cultural Organization (UNESCO) – have also been implementing climate change adaptation projects in Central Asia after 2010. Compared with the paucity of academic literature on the topic, many climate change aid programmes have been implemented by international organizations.²

In the next section we present the results of the review of academic events organized by international academic communities and networks working on Central Asia.

Academic events on climate change in Central Asia: a drop in the ocean

The limited interest in climate change in the academic social science community working on Central Asia is reflected in the negligible role it plays in scholarly events on the region. After an extensive survey of academic communities and networks working on Central Asia, only three were identified as having annual events, few of which featured environmental topics (Table 2). Out of 1305 conference panels we were able to identify, none was focused on climate change. Out of 10,249 individual

Table 2. Coverage of climate change at academic events on Central Asia, 1991–2020.

	Period	Panels		Presentations		Remarks
		Total	On climate change	Total	On climate change	
Central Eurasian Studies Society (CESS)	2000–18	1134	0	3187	2	50 panels on environmental issues
European Society for Central Asian Studies (ESCAS)	1995–2020	^a	0	^a	0	Two panels on environmental issues ^b
Cambridge Central Asia Forum (CCAF)	2007–19	61 ^c	0	61	0	Four speakers on environmental issues
International Council for Central and East European Studies (ICCEES)	1991–2019 ^d	1244	0	7001	0	Zero
Sums		1305	0	10,249	2	

Notes: ^aSome ESCAS conference programmes were unavailable. In those cases, we located the calls for papers, ascertained the themes of each conference and found that climate change was never among them.

^bThe 2017 ESCAS–CESS joint conference was the only one of the eight fully mapped ESCAS programmes that featured environmental panels, but they were not about climate change.

^cThe forum has individual speakers rather than panels with multiple speakers.

^dThe panel format was only adopted by the ICCEES World Congresses from 2005 onwards, and the aggregate number of panels here therefore excludes the earlier congresses.

presentations, only two (0.02%) were focused on climate change. Both of these were at conferences of the Central Eurasian Studies Society (CESS). By contrast, panels on topics such as identity, language and security were among the most frequent at academic events on Central Asia.

The European Society for Central Asian Studies (ESCAS) and Cambridge Central Asia Forum have on rare occasions featured speakers focusing on environmental issues. However, mentions of climate change and the environment are generally absent from the ESCAS's calls for papers and conference programmes and the regular seminar series of the Cambridge Central Asia Forum (CCAF). In addition to the three regularly held conferences dedicated to Central Asia, we also examined the congresses of the International Council for Central and East European Studies (ICCEES). We found that, while its quinquennial congresses regularly feature Central Asian topics, they included no speakers or panels on climate change in the region. We also exhaustively mapped 12 other academic networks on Central Asia (see Appendix 3 in the supplemental data online) in a fruitless search for contributions on climate change in Central Asia (however, the availability of detailed event programmes varied).

Conclusions

Discussion of the main results

Central Asia is highly vulnerable to the impacts of climate change. The available research, however, is miniscule compared with the magnitude of the problem. Limited knowledge about climate change impacts and consequences may result in greater than necessary human, environmental, and economic costs for the region. Addressing these knowledge gaps is thus of great importance. New in-depth studies are urgently needed as a basis for effective climate adaptation policies. New knowledge can help better inform local populations, raise climate change awareness, and promote evidence-based decision-making across Central Asia.

The existing literature on climate change in Central Asia shows that the region is already affected by climate change and will be even more so in the future. In the literature on the physical impacts of climate change, glaciers are the most frequent topic (33%). These studies are mainly based on fieldwork with a narrow geographical scope and there is a lack of studies covering the whole region. Furthermore, most of the work is on the Tien Shan, and there is a need for more studies of the Pamir-Karakorum mountains.

There are also numerous publications that examine changes in mean temperature (23%) and precipitation (20%). Although changes in temperature are quite homogeneous and clear across the region, changes in precipitation are highly heterogeneous. This latter field of research clearly needs more attention, as it has major implications for water availability in Central Asia. Furthermore, only a few publications examined the tail of the distributions in temperature and precipitation (7%). Extreme weather events clearly also deserve more attention. However, such studies require climate data with high spatial and temporal resolutions, which are not always available for this region. Obtaining such data would require significant investment in modern meteorological equipment and high-resolution data from international satellite data providers.

Within the social sciences literature, only one area received substantial scholarly attention: climate-induced water scarcity and its implications for agriculture. Other climate change impacts have been studied only to a limited extent since 1991, despite its profound and growing impact on the region. The region's dependence on water, agriculture, and fossil fuels is critical, and both climate change and climate policy can have major impacts on these sectors. Left unaddressed, this will have diverse but largely negative consequences for regional economies and may exacerbate income inequality, poverty, health, food security, migration, gender, culture, political stability, security, and foreign policy.

The existing social science research, while often interdisciplinary, is highly specialized and often has a narrow geographical scope. Knowledge about the interface between climate change and other vulnerabilities in Central Asia is alarmingly scarce (e.g., the connection between climate change and food security, health, water scarcity, eco-migration, poverty, or conflict). For example, climate change and poverty are explored in only one academic publication and no grey literature sources. We found only one peer-reviewed publication and one grey literature publication on climate change and health, although the health impacts of climate change are likely to have social, economic, and potentially even political ramifications.

Similarly, there is also a lack of research on how local populations perceive climate change, its impacts, and risks. This is important because communities in Central Asia, especially in rural areas, are particularly vulnerable to the impacts of climate change. Their livelihoods depend on resource availability which degrades due to rising temperatures and natural disasters (floods, aridity, etc.) caused by climate change (Ibañez-Tirado 2015). According to Blondin (2021), 'climate variability in dry and mountainous areas directly threatens populations, infrastructure, and arable land.' Perception of increased risk of natural disasters causes parts of the rural population to migrate to other areas. Eco-migration in Central Asia has received only limited scholarly attention. In addition, this also raises the issue of climate justice for the rural population, which contributes much less to greenhouse gas emissions than the urban population. As our review has shown, the issue of climate justice in Central Asia has received no scholarly attention while it needs to be one of the priority areas for researchers and governments alike.

Moreover, while the region and its international relations and security dynamics have been studied extensively in the past, the prospect of climate change influencing security and affairs among the states in the region has so far not been studied properly. The very same scholars who over-secritized Central Asia have ignored the real security threats stemming from climate change. Therefore, little is known about how climate change affects and will affect security and relations among the states in Central Asia. Climate change can cause conflicts around food security; exacerbate eco-migration and transform it into a foreign policy issue; complicate regional relations over scarce resources and exacerbate existing water disputes. Water-related tensions are likely to rise in Central Asia unless evidence-based research on the topic is carried out and proper preventive and adaptation policies are developed.

In a similar vein, the existing literature does not discuss the position of Central Asia on the Paris agreement. No studies examine the roles of the Central Asian states in international climate change negotiations or climate scepticism and activism in the region.

Recommendations

Based on our study, we make six recommendations that can accelerate knowledge building on climate change in Central Asia:

- *Prioritize funding of social science research on climate change in Central Asia.* International organizations, donors, governments, think tanks, private research institutes and universities could channel more funds and grants into studying the social impacts of climate change in Central Asia, considering that these have been studied to a lesser degree than physical impacts. Overland and Sovacool (2020) found that global climate funding is disproportionately allocated to the natural sciences, and we observe that this also applies in the case of Central Asia.
- *Expand research on climate impacts in Central Asia.* Better modelling and observational datasets are needed to understand climate-related phenomena such as changes in permafrost, avalanches or GLOFs but also extreme weather events such as droughts or floods. These phenomena are only addressed by a few publications, even though they are highly important for the region, and for social science studies of the region.
- *Encourage area studies scholars to turn their attention to climate change.* Area studies researchers, journals and organizations need to pay more attention to the multifaceted issue of climate change. A study exploring the reasons why climate change has been neglected by area studies scholars could also be helpful.
- *Organize special calls for papers to create demand for research.* Area studies journals could have regular – annual or biannual – calls for papers on climate change and its societal implications in Central Asia.
- *Expand the representation of climate change research at academic events.* Central Asian studies societies such as CESS and ESCAS and others could make calls for panels and papers on the societal implications of climate change in Central Asia at their conferences, workshops, congresses and other events.
- *Facilitate collaboration between researchers, NGOs, international organizations and government agencies.* Our analysis has shown that international humanitarian and development actors have been more actively engaged in climate change issues in the

region than academic researchers. They have also actively been providing humanitarian aid to impacted communities. Yet, their interaction with researchers has been limited. To facilitate the work of aid agencies and researchers, it is important that the two sides regularly exchange ideas, experience, and findings. Governments in the region could help facilitate such interaction.

Notes

1. A Boolean search is a specific type of search that uses modifiers such as AND, NOT and OR to search through a large amount of data and produce relevant results (Beal 2007).
2. For instance, some of the notable programmes are the World Bank's 'Climate and Environment (CLIENT) Analytical Program in Central Asia'; the UNDP's 'Climate Change Adaptation in Europe and Central Asia'; and the UNESCO-Adaptation Fund's project 'Reducing Vulnerabilities of Populations in the Central Asia Region from Glacier Lake Outburst Floods in a Changing Climate' (GLOFCA).

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