Climate Change Science and Policy in Central Asia: Current Situation and Future Perspectives

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Abstract Central Asia is already experiencing negative climate change impacts. Projections show that future climatic change will negatively affect many climate-sensitive economic activities in the region, particularly agricultural production and associated livelihoods. Mitigating and adapting to climate change in Central Asia requires a significant increase in investment in climate change research, as well as the mainstreaming of adaptation actions into public policies. This paper assesses the current state of climate change science in the region and the key trends, based on a bibliometric and content analysis review. It provides a perspective on investment priorities for climate change-related research, as well as measures that will build synergies between climate actions and other priorities for sustainable development in the region. The paper calls for an expansion in open access to data; increased investment in climate change research, especially in the social sciences; development of local climate change modelling capacities; and support for regional knowledge and scientific exchange on the topic of climate change.

Keywords Bibliometric analysis · Climate change literature · Science policy · Research investment · Central Asia

1 Highlights

- The climate crisis is already having a strong impact on many aspects of the social and economic lives of Central Asia populations, and these are set to increase.
- The scientific literature on climate change in Central Asia has also been growing rapidly, but remains very small.
- Promising areas for investment to promote climate change science in Central Asia include improving open access to data, investing more in the social sciences,

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developing local climate modelling capacities and supporting the emergence of regional scientific journals focusing on climate change and broader environmental issues.

2 Introduction

The climate crisis is already having a significant impact on many aspects of people's social and economic lives in all regions of the world (IPCC 2021, 2022), while also influencing international relations in terms of trade, political and economic alliances and scientific collaboration (Friel et al. 2020; Mirzabaev et al. 2021; Ortiz et al. 2021). Central Asia is deeply involved in many of these processes and significantly affected by climate change, in some ways more so than other regions of the world. In this context, science plays a critically important role in enhancing people's understanding of the present and future impacts of climatic changes, and in climate change adaptation and mitigation in the region. Over the last two decades, globally the scientific literature on climate change has grown exponentially (Wheeler and von Braun 2013; Nalau and Verrall 2021; IPCC 2022). The climate change theme is also advancing, slowly but surely, to the forefront of policy discussions in Central Asian countries. Although climate change does not dominate national conversations in the region in the same way as it does in some other countries around the world, regional decision makers are increasingly attentive to issues related to climate change impacts, loss and damage and climate change adaptation and mitigation, because global efforts to address climate change are reshaping the nature of international relations, international trade and global economic competitiveness. Moreover, observed changes in extreme weather events (e.g. heatwaves in summer, more frequent dust storms, droughts) are starting to influence social awareness of climate change in the region and peoples' expectations from their governments to deal with this problem.

In parallel with these evolving policy and social contexts in Central Asia, the scientific literature on climate change in Central Asia has also been expanding rapidly. However, as we will see in the following sections, the current state of research activities and scientific outputs from Central Asian countries on climate change issues remain insufficient. To ensure successful development in Central Asia, science needs to provide viable policy advice, information, knowledge and solutions for the climate crisis. The objective of this paper is to assess the current state of climate change science in the region, identify major areas of success and key gaps and provide a perspective on investment priorities for climate change-related research and development. This paper, thus, adds to the emerging literature on the state and priorities for climate change research in Central Asia (Vakulchuk et al. 2022). This paper seeks to help fill this critical gap, highlighting promising directions for climate change science investment in the region.

3 Methodology

A number of methodologies are frequently used to analyse the evolution and contemporary state of scientific literature. These include systematic reviews, meta-analyses, narrative reviews (Greenhalgh et al. 2018; Harari et al. 2020; Rethlefsen et al. 2021) and bibliometric, visualisation and content analysis reviews (Nalau and Verrall 2021). In this paper, a bibliometric and content analysis approach is used, because this approach involves analysis of the meta-data of publications on climate change in Central Asia in a quantitative way that enables us to summarise large amounts of very diverse literature according to specific dimensions, such as key themes, key authors and major donors supporting the research behind the publications. Systematic reviews, meta-analyses and narrative reviews are usually used to answer very specific theme-focused research questions, and cannot provide an easy and visually accessible overview of such diverse literature spanning multiple disciplines.

The underlying databases for this analysis come from the Scopus and Web of Science indexing services. In each of these indexing services, a literature search was conducted using key words: 'climate change', in combination with 'Central Asia', 'Kazakhstan', 'Kyrgyzstan', 'Tajikistan', 'Turkmenistan' and 'Uzbekistan' in the titles of the publications. The search was done on the publication titles to ensure that the selected papers were specifically focused on climate change issues in Central Asia or in specific Central Asian countries, rather than focusing only briefly on Central Asia while having a broader geographic coverage.

In addition, a similar search was conducted in Google scholar and the Russian Language Scientific Electronic Library eLIBRARY.RU, in order to triangulate the findings from the Scopus and Web of Science indexing services. Scopus and Web of Science are primarily focused on literature published in the English language in scientific journals and books, whereas Google Scholar also contains information about other forms of publication, such as doctoral theses, preprints and technical reports. The scientific community in Central Asia actively uses the Russian language in research and writing, hence the use of eLIBRARY.RU, which indexes scholarly work in Russian.

The highest return of publications was in the Google scholar search (601), while the eLIBRARY.RU search resulted in 143 publications, Scopus—185 and Web of Science—166. All of the indexes have been used (in different ways) in the analysis that follows. However, since Scopus and Web of Science are expected to index high quality scientific literature, which has been exposed to rigorous international peer review, the content analysis has been limited to the papers indexed in those sources. Moreover, there is a significant overlap between publications indexed in Scopus, Web of Science and Google Scholar, but only little overlap with those publications written in Russian. For this reason, although the analysis presented here is considered to be largely representative of the key study themes and disciplines, it is not fully representative of the sources of funding. It was not possible to collect information

about funding sources from the Russian language publications indexed in eLIBRARY.RU. Publications produced in Russian are more likely to be funded by local or Russian sources.

4 Current State of Climate Change Science in Central Asia

The search results in Google Scholar provide a comprehensive overview of English-language publications on the topic of climate change in Central Asia (Fig. 1). These results highlight a rapid growth in the scientific literature on climate change issues in the region over the last two decades, but especially during the last five years. Most publications (325) have a regional character, i.e. they investigate aspects of climate change relevant for the entire Central Asian region. In addition, there are country-specific publications on climate change, with the largest number focusing on Kazakhstan (104), followed by Uzbekistan (69), Tajikistan (65), Kyrgyzstan (35) and Turkmenistan (5). For comparison, a similar literature search in Google Scholar for China returned 6770 publications, for Pakistan—921 and for Mongolia—407 publications, all of which are considerably higher than for any individual country in Central Asia, even after taking into account the differences in populations. While the total numbers of publications, both at regional level and for specific Central Asian countries, are therefore highly insufficient. The very few publications dedicated to climate change issues in Turkmenistan are of particular concern.

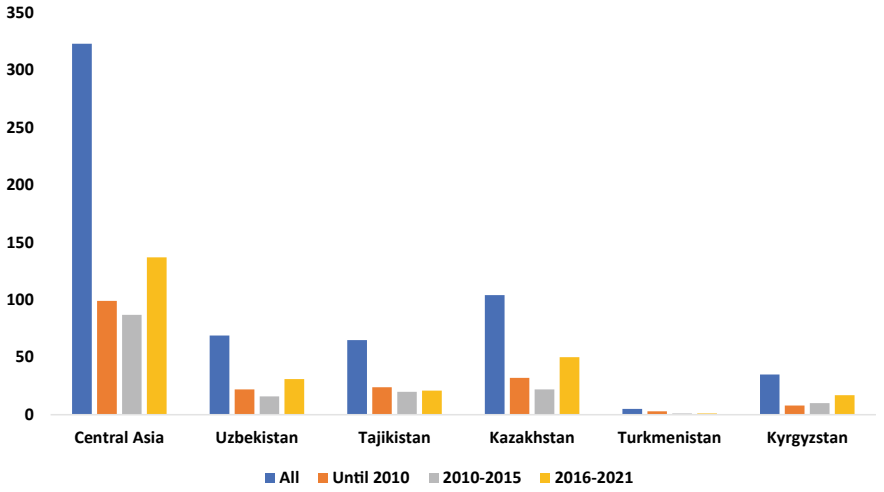

Fig. 1 The number of publications specifically devoted to climate change issues in Central Asia (in English language). *Source* Based on Google Scholar search (as of 10.12.2021)

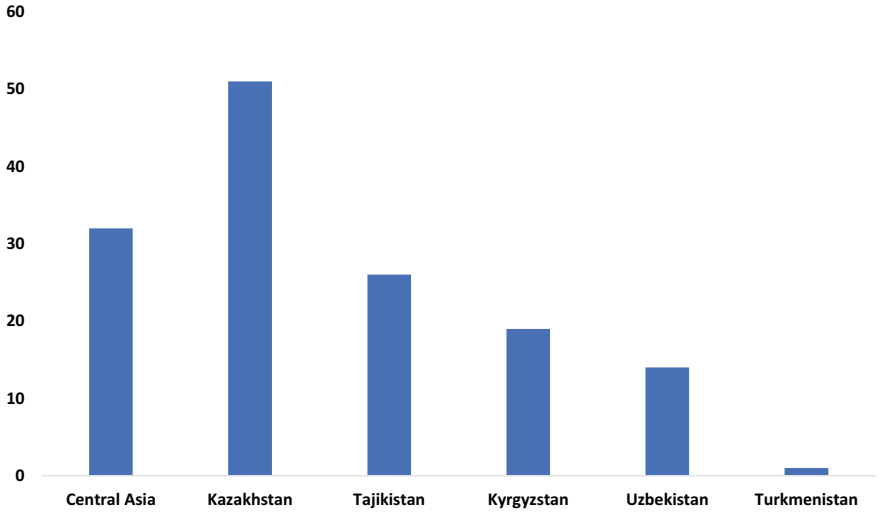

Fig. 2 The number of publications specifically devoted to climate change issues in Central Asia in Russian language. *Source* Based on Scientific Electronic Library eLIBRARY.RU (as of 22.02.2022)

These numbers do not change significantly when Russian language publications are accounted for (Fig. 2). Here, eLIBRARY.RU indexes 32 publications for Central Asia as a whole. By country, the figures were 51 publications for Kazakhstan, followed by Tajikistan (26), Kyrgyzstan (19), Uzbekistan (14) and Turkmenistan (1). This broadly confirms the patterns in the Google Scholar search, although publications on climate change focusing on Uzbekistan appear more likely to have been written in English rather than Russian, while significantly fewer have been written about Central Asia as a whole in Russian compared to the English-language publications. There were also significantly fewer publications written about Central Asia as a whole in Russian compared to English-language publications (32 compared to 325).

The analysis of the content of the abstracts of the peer-reviewed journal papers, books and book chapters indexed by Scopus shows that they could be broadly clustered into five themes: (1) ecosystem services, biodiversity and the carbon cycle; (2) paleoclimate; (3) water resources; (4) crop production; and (5) environmental management and land-use change. No strict allocation of publications into these five clusters is possible, since any given publication may have contributed to two or more of these clusters.

These results show that publications on climate change in Central Asia have been primarily dedicated to the biophysical impacts of climate change. There have been relatively few studies investigating the socioeconomic impacts of climate change, issues related to people's vulnerability to climate change and the social and economic dimensions of climate change adaptation. This is indicated by the failure of related

words ('socioeconomic', 'human vulnerability', 'social impacts', 'adaptation', etc.) to emerge prominently during the textual analysis of these publications.

These results are corroborated by disciplinary classification of the climate change literature on Central Asia indexed by Web of Science, which also clearly highlights the under-representation of social science publications compared to other disciplines. Only about 5% of those publications cover socioeconomic topics, while 95% of the publications focus on various natural sciences, predominantly, environmental sciences and ecology, geosciences, physical geography and water resources.

Analysis of the authors who wrote these publications indicates that a majority of these peer-reviewed publications on climate change impacts in Central Asia have been authored by Chinese researchers. The analysis of linkages between authors reveals a dominant role of Chinese researchers and smaller number of publications by other research groups made up of authors from Central Asia and other countries, mainly Europe and North America. Moreover, there are close and strong links between various Chinese researchers through joint authorship of publications. In this regard, a particularly important role is played by the Xinjiang Institute of Ecology and Geography of the Chinese Academy of Sciences in Urumqi, which practically serves as the central hub of Chinese research on climate change issues in Central Asia. There are some peripheral co-authorship collaborations between Chinese authors and Central Asian authors, but overall it appears that this is relatively limited with all-Chinese author groups dominating most of these publications.

The peer-reviewed English-language journals which have most frequently been published on climate change in Central Asia are The Science of the Total Environment and Quaternary International. Other frequently used journals are Sustainability, the Journal of Arid Land, Global and Planetary Change, and Sustainability. In this regard, it is worthwhile to note that the Journal of Arid Land is published by Springer in collaboration with the Xinjiang Institute of Ecology and Geography.

Overall, the results show that the number of scientific publications on climate change in Central Asia has been growing rapidly, but remains relatively low compared to publications on climate change relating to other neighbouring world regions. A majority of these publications was produced by Chinese researchers and other international research groups. Only a relatively limited number of these publications were written exclusively by local research teams. Almost all of these publications were written under natural science disciplines, with extremely few of the publications coming from the social sciences.

Socio-economic research on climate change impacts, evolving vulnerabilities to climate change, distributional dimensions of climate change impacts and analysis of adaptation options and policy responses to climate change represents an absolutely essential enabling element for successful adaptation to climate change. The current limited nature of such research in the region is a very grave threat to the sustainable development of Central Asian countries in the context of a changing climate, even in the short- to medium-term in the next 2–3 decades. Central Asian countries might be intending to deal with the emerging challenges of climate change as they emerge. However, ad hoc measures in response to emerging weather and climatic extremes are both costly and economically inefficient (Gerber and Mirzabaev 2017). What

is needed is proactive actions to strengthen adaptive capacities and reduce vulnerabilities to climate change in the region. Increasing investment into climate change research, particularly in the social sciences, would be a crucial cornerstone of such a transition towards smart, proactive and efficient climate change adaptation policies.

5 Key Areas for Investment in Climate Change Science in Central Asia

The textual analysis of information about the donors who funded the publications on climate change in Central Asia clearly highlights the dominance of Chinese government organisations, including the Chinese Academy of Sciences and National Science Foundation of China. The analysis also indicates the involvement of European science funders such as German Research Foundation (DFG), the German Federal Ministry of Education and Research (BMBF) and the United Kingdom's UK Research and Innovation (UKRI). The government of Kazakhstan is also represented among these donors, but the national science donors from the other countries of Central Asia are not prominent among the donors of publications in reputed international journals. This can be partially explained by the linguistic dimension, with many locally funded climate change-related publications being primarily published in local languages or Russian. However, even after some level of accounting for this, the overall picture in terms of local funding for climate change research comes out to be very insufficient. This calls for a rapid and substantial increase in investment from the Central Asian governments for climate change research.

In this regard, in my view, the major opportunities for research investment on climate change science that will create multiple beneficial synergies between climate change adaptation and other priorities for sustainable development in the region are the following:

Open access to data. For expanding research on climate change, the meteorological and statistical agencies across Central Asian countries need to provide easy and open access to long-term weather and hydrological data, high-resolution statistics on agricultural, environmental and land-use impacts (e.g. at district levels), as well as to the results of agricultural and other household surveys, as is done in other countries and regions in the world. Currently, there is a dearth of household survey results available for Central Asian countries. More investment needs to be directed towards conducting representative and periodic surveys of households and of climate change impacts on households. Naturally, data privacy issues need to be addressed before giving public access to the results of any such household surveys, but these are technical issues that can easily be resolved. Without access to these sources of data, there is very little opportunity for rigorous socioeconomic research on climate change in the region.

More investment in climate change research in the social sciences. This is particularly important for research on such themes as climate change impacts,

vulnerability and adaptation. It will be extremely inadequate for decision making on climate change adaption policies if the available research is only on the environmental dimensions of climate change. Policymakers' major interest in climate change research is due to their need to understand better how climate change affects people and societies. Environmental research on climate change provides a valuable first entry point in understanding climate change, but it is essential that social sciences then use that environmental research to investigate climate change impacts on people and propose solutions. Without such social science research happening in parallel, environmental research on climate change by itself has a relatively limited social value.

Developing local climate modelling capacities. There is still a huge gap in terms of high-resolution local projections of climate change in the region. Global models, whose projections are often used in describing future climate changes in the region, do not fully take into account a myriad of local factors in sufficient detail. These local factors will have a crucial effect on the way in which regional climate change impacts (e.g. local land-use changes, sand and dust storms, the role of irrigation, the knock-on effects of the Aral Sea desiccation, the role of water reservoirs). Hence, investment needs to be directed to develop highly localised models of climate change forecasting.

Establish regional journals focusing on climate change. There is a strong need to boost scientific collaboration, exchange of knowledge and information on climate change among the research communities in Central Asian countries. Despite the rapid spread of English language use in scientific publications in the region over the last decade, still the lack of knowledge of English remains an important barrier to international publishing of climate change research produced by Central Asian researchers. As a result, many studies conducted in the region do not benefit from high quality, rigorous and constructive peer-review processes. The establishment of regional scientific journals dedicated to climate change, adopting transparent, high-quality peer-review procedures (e.g. following the peer-review style of the Frontiers journals), will help both to improve the quality of scientific publications and to promote mutual learning.

6 Conclusions

Climate change projections show that Central Asia will experience major climatic changes in the coming decades. This requires well-planned proactive measures to adapt to these changes. Climate change research should play an essential role in this adaptation process. However, the current state of climate change science in the region is not up to the task. There is a need for a significant increase in investment in climate research in all countries of Central Asia. Potential priority areas with a high social return on investment might include: expanding open access to data; increasing

investment in climate change research (especially in the social sciences); developing local climate change modelling capacities; and facilitating regional knowledge and scientific exchanges on climate change, for instance through the establishment of regional scientific journals.

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