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Experts' Perceptions of Water Security in Central Asia: results from a Delphi study

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Abstract

Water security in Central Asia has been discussed by researchers and international organizations using hydrological, engineering, and modeling approaches. Various frameworks conceptualize water security through technical, socio-economic, and environmental aspects. This study attempts to identify the current trends of perceptions of experts about water security in Central Asian countries and Afghanistan as assessed through different regional and international experts with relevant knowledge and experience. The experts originate from diverse professional backgrounds like ministries, NGOs, international organizations, research, and academic institutes. The analysis was conducted through the Delphi approach, which has been widely used to identify experts' views by reaching a consensus on various subjects. The Delphi method assisted in the elicitation of experts' opinions about different water security dimensions in the overall region and each Central Asian country that have been suggested from the relevant literature. The two-round questionnaire was developed to infer the experts' views (round 1) on water security in Central Asia and then identify the agreement's rate with the initial findings (round 2). The results have shown that, while the relevant scientific literature gives priority to environmental factors, the experts emphasize water security's economic aspects. Experts suggested including transboundary challenges, legislative and institutional weaknesses in assessing water security in Central Asia and Afghanistan. Respondents highlighted the low effectiveness or ineffectiveness of the current institutions and mechanisms that dealt with water security-related issues in Central Asia and suggested strengthening water governance in the region.

Keywords: water resources, Aral Sea basin, water governance, Delphi method

Paper type: Research paper

1. Introduction

Water security is fundamental for sustainable development and economic well-being (GWP, 2000; UN, 2007). Countries worldwide are dealing with similar water challenges with regard to aging water infrastructure, water pollution, lack of funding, and inadequate water governance mechanisms (ADB, 2013, 2016; WB, 2020). Moreover, water-related risks such as drought, floods, unsafe drinking water, and environmental pollution press on water security (GWP, 2000; OECD, 2013). Strengthening water security requires integrated policy-making under an uncertain and rapidly changing environment (ADB, 2013, 2016, 2020).

The concept of water security has been widely used in various disciplines in the last decade to address water challenges and cope with water-related risks (Cook & Bakker, 2012). There are multiple definitions of water security. For example, the recent Asian Water Development Outlook 2020 on Advancing Water Security developed by the Asian Development Bank provides the following definition of water security "*the availability of adequate water to ensure safe and affordable water supply, inclusive sanitation for all, improved livelihoods, and healthy ecosystems, with reduced water-related risks toward supporting sustainable and resilient rural-urban economies*" (ADB, 2020, p.xviii). However, water security is often interpreted only in terms of the physical availability of freshwater resources and analyzed as water availability per capita, representing water security in a fragmented manner *(Cook & Bakker, 2012; ADB, 2013; Gain et al.*, 2016).

The assessment of water security is conducted by international organizations and academic communities from socio-economic, engineering, environmental, and governance aspects (ADB, 2013, 2016; OECD, 2013; WB, 2020). The divergence in framing water security highlights the complexity and multidimensionality of the concept. As a result, policy-makers and scholars from various disciplines use water security in different contexts that lead to different interpretations and policy agendas. Indeed, water security can be perceived and interpreted differently among policymakers, experts, and scholars because of geographical, socio-economic, and political conditions. However, different water security interpretations among users of a shared transboundary water resource could be a reason for disputes and an obstacle for better water management. Therefore, reaching a joint understanding of water security among stakeholders and water users of transboundary water resources might strengthen cooperation; develop a shared vision for better water governance and integrated water resources management.

Water security was always important in Central Asia, but the dissolution of the Union of Soviet Socialist Republics (hereafter USSR) brought new challenges to water security and made it a more urgent topic (Stucki & Sojamo, 2012; Xenarios *et al.*, 2020). In the Soviet era, when all Central Asian countries were members of the Soviet Union, water security was understood and ensured by a set of large-scale engineering projects of surface water management, mainly for irrigation in downstream republics and partially for water storage and hydropower generation in upstream republics (Chan, 2010; Granit *et al.*, 2012; Jalilov *et al.*, 2016; Xenarios *et al.*, 2018). In the USSR, an integrated water-energy scheme existed between

upstream states (Tajikistan and Kyrgyzstan) and downstream countries (Kazakhstan, Uzbekistan, and Turkmenistan). Namely, upstream water-abundant countries ensured water for irrigation in summer to downstream states. In exchange, they were supplied with energy sources (gas, coal) in winter (Chan, 2010; Stucki & Sojamo, 2012; Wegerich *et al.*, 2015). Thus, the water-energy trade-off was balanced in the region. However, the environmental aspect was neglected in the water-energy trade-off resulting in the Aral Sea catastrophe. With the end of the USSR, the former regional approach to water and energy management was replaced by national strategies, which raise conflict of interests between upstream and downstream neighbors. This new management style has put water security on the agenda of Central Asian countries.

Nowadays, water security is discussed mainly in terms of water allocation in the region (Granit *et al.*, 2012; Xenarios *et al.*, 2019). Kyrgyzstan and Tajikistan, which are upstream mountainous countries, perceive water as a tool for energy security and economic development through hydropower expansion. For downstream countries such as Kazakhstan, Turkmenistan, and Uzbekistan, water is mainly a source for irrigation and food production. In this study, Afghanistan was also included since it shares the Amudarya transboundary river with Tajikistan, Turkmenistan, and Uzbekistan. In terms of water-rich upstream states and energy-rich downstream countries, regional fragmentation has become the primary source of friction (Zakhirova, 2013; Ziganshina, 2019). Moreover, the complex transboundary water system in Central Asia puts further stress on achieving water security. Thus, understanding the water security perceptions of experts in Central Asia, who may influence policymaking, might help to strengthen cooperation and develop a water security strategy in the region since countries share transboundary rivers.

This study attempts to identify the perceptions of experts about water security in Central Asian countries and Afghanistan as assessed through different regional and international experts with relevant knowledge and expertise and reach a consensus among experts on water security priorities for each country. Recently, Xenarios *et al.* (2020) conducted a bibliometric review of Central Asia's water security concept. They analyzed the most relevant studies on water security in the region published in peer-reviewed journals from 1991 to 2019. The Delphi questions in this study are developed based on the literature review findings of Xenarios *et al.* (2020). The analysis of Xenarios *et al.* (2020) revealed that water security in Central Asia is interpreted through technical and infrastructural approaches to protect livelihoods against climate change and promote economic growth; in contrast, water management and governance are overlooked.

In the next section, I discuss the motivation of applying the Delphi approach to identify the current trends of water security perceptions in Central Asian countries and Afghanistan among stakeholders. I also mention the methodology of developing two rounds of questionnaires. In the Results section, I describe the main findings and the background of the participants. Furthermore, the main consensus and disagreements among participants on water security dimensions, water security trends, and priorities for each country will be discussed.

Finally, I conclude by answering the research question: *how do regional and international experts perceive water security in Central Asian countries and Afghanistan*?

2. Methodology

The analysis of experts' views on water security in Central Asia and Afghanistan was conducted using the Delphi approach, which has been widely used to identify experts' perceptions by reaching a consensus on various subjects. The Delphi method is a structured group communication technique through multi-round questionnaires to gather experts' opinions to forecast future trends, reach a common understanding and consensus on specific issues, and group decision-making (Day & Bobeva, 2005; Yousuf, 2007; Belton *et al.*, 2019). The Rand Corporation pioneered the Delphi technique in the 1950s to reach an agreement among military experts on sensitive issues. Delphi's initial intent was a forecasting approach (Hsu, 2007; Yousuf, 2007). Since then, the Delphi method has been modified and applied in various areas. Some scholars used Delphi in education to assess training tools (Calabor *et al.*, 2019) and develop a framework for Science Shop processes (Urias *et al.*, 2020); in healthcare to identify performance measures (Normand *et al.*, 1998) and to reach a consensus among professionals on children treatment measures (Bishop *et al.*, 2016); in environmental sciences to estimate flood vulnerability (Lee et al., 2013) and cost-benefit analysis of ecological discounting (Martínez-Paz *et al.*, 2016), etc. Delphi's main benefit is reaching consensus among panel members on areas with high uncertainties, complexities, lack of information, and causal links (Avella, 2016). Agreement among panel members in the Delphi studies can be reached through several rounds of questionnaires with iterative feedback (Dalkey & Helmer, 1963; Okoli & Pawlowski, 2004).

The Delphi method's application can be a continuation and verification of findings from a bibliometric review and scenario development (Belton *et al.*, 2019). Delphi's approach attempts to address questions "what could/should be" (Hsu, 2007). Delphi also helps to define areas of consensus and disagreements when there is a lack of knowledge or evidence on a topic explored. Delphi studies mainly have qualitative nature since they attempt to understand and interpret certain concepts. However, there are also quantitative studies aiming to test and validate finding with the Delphi approach. For example, in positivist research, Delphi helps test a theory or general propositions (Day & Bobeva, 2005; Avella, 2016). While for interpretive studies, Delphi can be used to develop a framework and theory.

The Delphi method was applied in this study to elicit experts' opinions regarding the suggested dimensions and attributes of water security derived from a scientific literature review about water security in Central Asia conducted by Xenarios *et al.* (2020). They collected 150 peer-reviewed research articles published in the English language, focusing on water security in Central Asia and Afghanistan. Water security in Central Asia was assessed using the following factors (i.e., dimensions): urban & household, economic, environmental, hazards, and water governance. They also introduce different subfactors (i.e., attributes) for each dimension.

As Normand *et al.* (1998) noted, "*experts' opinions can provide valuable information when there is conflicting or incomplete information*" (p.258). We chose a Delphi method instead of the traditional survey since we are interested in not only the water security perceptions of individual experts but also in the agreement among experts of water security dimensions and priorities in Central Asia. The Delphi method was applied in this study since it is a systematic, interactive forecasting method that relies on experts' opinions and expertise. According to Okoli & Pawlowski (2004), studies applying the Delphi approach have at least two rounds for reaching consensus among panelists since the first round usually combines individual opinions and subsequent rounds attempts to reach an agreement.

Two sequential rounds were conducted using the Qualtrics software in English and Russian languages in June-October 2020. Individual e-mail invitations in both rounds were also sent via Qualtrics software. One of the key characteristics of the Delphi method is the anonymity of respondents. Thus, we did not know who participated in the first round, and therefore an invitation to the second round was sent to all panelists. The questionnaires were developed initially in the English language and later translated to the Russian language, commonly used in Central Asia for negotiations, education, and trade. Each questionnaire was piloted with three experts in English and Russian before questionnaire distribution to experts.

In the first round, each correspondent received a questionnaire about (1) the proposed dimensions and (2) attributes of water security in Central Asia obtained from the scientific literature analysis. The survey consisted of questions about (3) the trends of water security dimensions and implications on a policy level in Central Asia, (4) ranking factors related to water security in six countries, (5) current institutions' effectiveness, and mechanisms dealing with regional water security issues. The participants were also able to comment and introduce new aspects. The detailed content of the questionnaire is presented in Annex 1.

After the first round, we compiled and shared the interim outcomes among experts in the next round of the questionnaire. In round two, the respondents were asked to consent or object to the results collected from the first round by explaining their position's reasoning. At this stage, we attempted to gain consensus among experts on (1) the ranking of water security dimensions, (2) the most critical factors that may affect each water security dimension in Central Asia, (3) implications on the policy level, and (4) the most important factors that may affect water security in each Central Asian country and Afghanistan. For example, water security dimensions consist of factors that contribute to each dimension. In the first round, we asked experts to rate the relevance of different factors (four factors for each dimension) in the context of Central Asia. In the second round, we asked whether they consent or oppose the findings from the first round.

Delphi studies' results do not rely on a statistical representative sample; rather, the Delphi approach depends on participants' qualifications (Okoli & Pawlowski, 2004; Martínez-Paz *et al.*, 2016). The majority of Delphi studies apply purposive and snowball sampling rather than random sampling. The Delphi panel sample is widely discussed in the literature; however, there are disagreements on the appropriate sample size (Okoli & Pawlowski, 2004;

Lee *et al.*, 2013; Martínez-Paz *et al.*, 2016). To mitigate subjective judgment, group bias, and homogeneous bias, Bonaccorsi *et al.* (2020) proposed panel diversification.

Panel members play a crucial role in the Delphi study. Panelists should be experts who have the required qualification, expertise, and interest in the investigated research question. Avella (2016) highlighted that criteria should be specific and measurable for panel member inclusion and not based on researcher opinion. This study used assessment based on externally available criteria for selecting experts, including job position, publication, past performance, membership of certain organizations and institutions related to water resources in Central Asia and Afghanistan. We invited experts from the region and international experts with expertise and experience in the region's water sector, giving panel members geographical dispersion. Panel members have relevant knowledge and expertise in water resources, agriculture, climate change, hazards management, economics, international relations, and public policy. Our panel of experts represents a heterogeneous group including scholars, practitioners, policymakers, and consultants who work in the water sector or sectors related to water resources. The respondents were identified through different sources such as media and research articles, web searches, social media, professional organization listings, referrals, and experts already acquainted with the research team. Overall, we invited 417-panel members in both rounds of the questionnaire.

3. Results

Among 417 panel members, 112 experts participated in the first round and 118 in the second round. The number of completed responses increased slightly, probably due to several reasons such as timing (the first round was sent in summer when some experts might have vacation) and length (the survey in the second round was shorter). We also presented results from the first survey in the second round, which may increase participants' interest. Table I shows that panel members' participation rate stayed around 30% out of 417 experts invited in both rounds. Responses in the Russian language increased from 36% in the first round to 44% in the second round since more professionals from Central Asia and Afghanistan joined in the second round. Table I also presents that two-thirds of participants have citizenship from Central Asian countries and Afghanistan, not including those who did not indicate their citizenship and residence (N/A); however, about 20% reside abroad. We also noticed an increase in international experts' interest in this study by the end of the second round.

Table I. Distribution of Responses

	1st Round	**2nd Round**
Time	June - July 2020	September- October 2020
Number of invited experts	417	417
Completed responses	**112**	**118**
Language	Russian- 40 English -72	Russian- 52 English -66
Citizenship	Regional* - 65 International - 30 n/a* - 17	Regional - 70 International – 39 n/a – 9
Residence	Regional– 50 International - 46 n/a - 16	Regional – 56 International – 47 n/a – 15

*Note: Regional- Central Asia and Afghanistan; n/a- not available

Participation of male respondents increased from 52% in the first round to 61% in the second round. In the first round, the largest age grouping was participants aged 35-44. However, more experienced experts in the 45 and older age groups increased dramatically in the second round. Experts from 24 countries took part in the first round and from 25 countries in the second round. Correspondents from Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Afghanistan, Germany, Switzerland, the Netherlands, the U.S., and China were most active.

Figure 1 A, B, C shows respondents' professional backgrounds, including education, employment, and experience in the water sector in Central Asia and Afghanistan. In both surveys, the majority of respondents have a Master's degree and Doctorate. Some experts indicated a post-doctorate degree, as well as “aspirant” and “candidate degree” according to the Soviet educational system. Most participants work in universities/research organizations, government agencies, and international organizations. According to Figure 1C, almost half of the respondents in both rounds are experienced and professional experts with more than ten years of experience in Central Asia's water resources aspects. In both surveys, respondents chose to skip questions; hence not available (n/a) responses are also indicated.

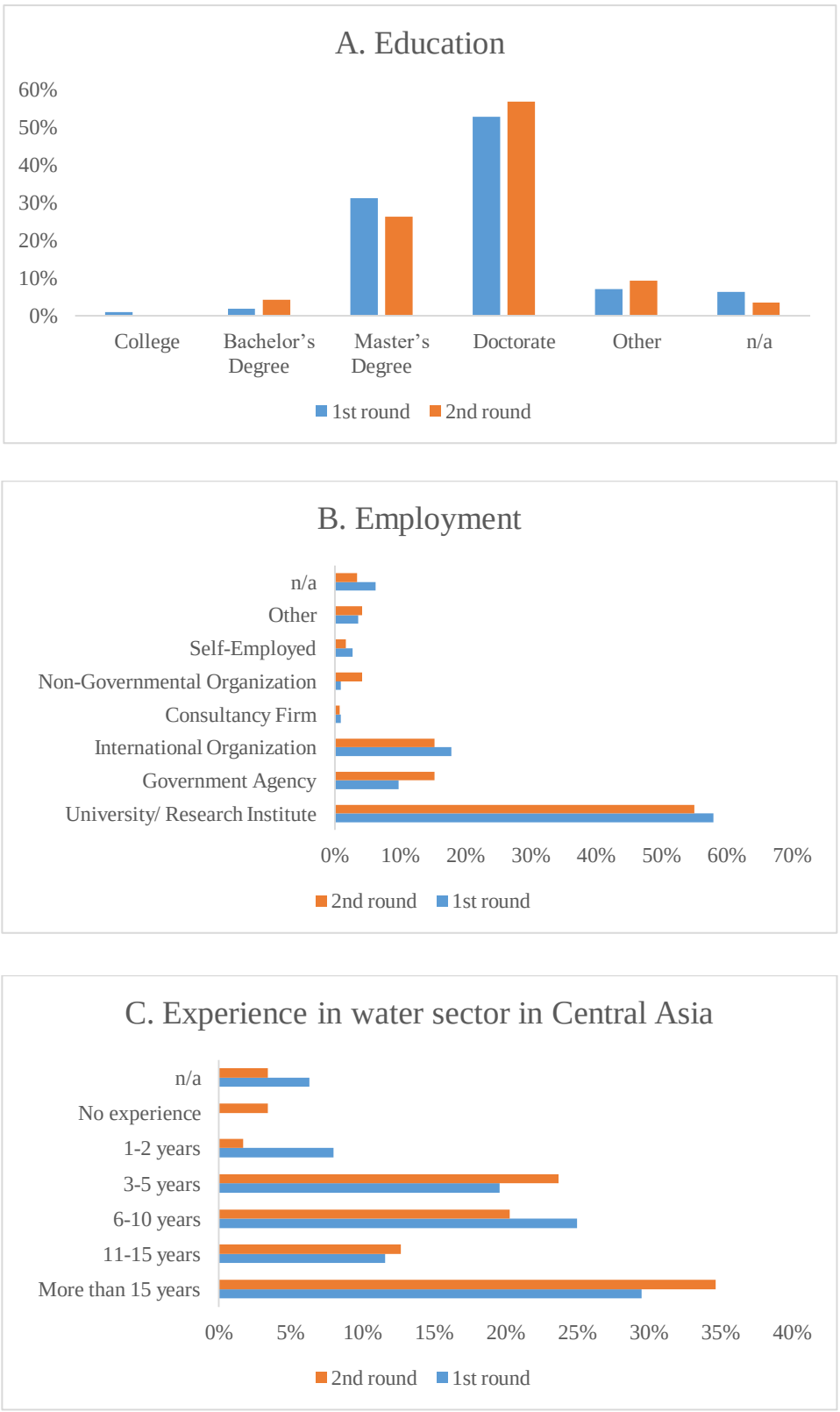

Figure 1 (A, B, C). The professional background of participants
Note: n/a- not available

In the first round, we asked participants to rate the relevance of water security dimensions in the context of Central Asia and Afghanistan and rank them according to their expertise and experience. Table II-A shows experts' ranking in the first round follows the order: 1st –economic activities (e.g., irrigation, hydropower), 2nd – urban & household facilities (e.g., sanitation, drinking water), 3rd - natural hazards (e.g., floods, droughts), and 4th – environmental aspects (e.g., river and lake ecosystems). In the second round, we asked the experts whether they agree/disagree with the previous round ranking based on the group opinion. Table II-A shows that 80% of participants in the second round agreed with the first round ranking.

The most important factors (attributes) that may affect each water security dimension in Central Asia based on experts' opinions are presented in Table II B. About 66% of experts highlighted the relevance of construction and management of irrigation systems for economic activities dimensions in the first round, and the agreement rate on this attribute reached 94% in the second round. For urban & household facilities, 59% of correspondents underlined the construction and management of drinking water supply facilities, and the consensus rate was 84% on this attribute in the second round. The agreement rate was also high for the most crucial environmental aspect: management and conservation of rivers and river basins, 75% and 84%, respectively. However, in the natural hazards dimension, 68% of experts emphasized the management and protection from drought in the first round, but 26% of correspondents disagreed with this attribute in the second round.

Table II (A, B). Consensus rate on water security dimensions and attributes

	1st round *Relevance*	2nd round *Agreement rate*
A. Ranking of water security dimensions		
1st Economic activities	72%	80%
2nd Urban & Household facilities	60%	
3rd Natural hazards	53%	
4th Environmental aspects	50%	
B. The most important attributes of water security dimensions		
Economic activities dimension: construction and management of irrigation systems	66%	94%

Urban & Household facilities dimension: construction and management of drinking water supply facilities	59%	84%
Natural Hazards dimension: management and protection from droughts	68%	67% *(26%- disagree)*
Environmental aspects dimension: management and conservation of rivers and river basins	75%	84%

The next section of the surveys focused on water security trends at the policy level and the effectiveness of the current institutions and mechanisms that deal with water security-related issues in Central Asia. In the first round, we proposed the significance given to the water security dimensions within the period 2001-2019 according to the literature findings of Xenarios *et al.*(2020) and question whether this is the situation on the policy level (e.g., state initiatives, laws, by-laws, etc.) in Central Asia according to experts' experience. Respondents evaluated four broad trends that emerged from the literature analysis. Table III presents the agreement on water security trends in the literature and policy level in Central Asia. Three-fourths of the respondents agreed on the environmental aspects of water security in Central Asia, which has been widely discussed at the policy level in the last ten years. Simultaneously, the agreement on whether water-related hazards have gained more attention at the policy level in the previous ten years remained at 65-67%. However, the agreement rate decreased from 47 % in the first round to 43 % in the second round on the trend of the urban & household aspects in Central Asia being significant in the policy agenda until ten years ago and then declining in significance present day. The consensus rate also decreased on the economic aspects, gaining importance over the last ten years, however, at a slower pace than the environmental-related dimension. The consensus rate among experts increased from 64% to 83%, with the low effectiveness or ineffectiveness of the current institutions and mechanisms that deal with water security-related issues in Central Asia. The majority of experts (around 77 % in both rounds) suggested establishing new mechanisms and institutions dealing with water security issues in Central Asia.

Table III. Water security trends in policy level in Central Asia and Afghanistan

	Consensus rate	
	1st round	2nd round
The Economic aspects are also gaining importance in the last ten years, however, at a slower pace than the environmental-related aspects	64%	63% (24%- disagree)
The Urban & Household water security aspects in Central Asia were significant in the policy agenda until ten years ago but	47%	43% (36%- I don't

now are in decline		know)
The Water-related Hazards have gained more attention on the policy level in the last ten years	65%	67%
The Environmental aspects of water security in Central Asia are widely discussed in the last ten years	64%	72%

In the final part of the survey, we asked participants to assess the most important factors that may affect water security in each Central Asian country and Afghanistan based on literature findings and experts' opinions. In the first round, experts ranked factors derived from the literature analysis related to water security in each country of Xenarios *et al. (*2020) and suggested other factors. After that, respondents assessed the priorities that experts highlighted in the previous round. According to Figure 2, experts reached by the end of the second round the highest agreement rate of 84% for Uzbekistan with the most crucial factor - improvement of irrigation management for agriculture; 73% for Kazakhstan with priority on improvement of river basin management plans; 65% for Afghanistan with prioritizing the improvement of drinking water use in rural and urban areas; and 60% for Tajikistan with the important factor - improvement of irrigation management for agriculture. The lowest consensus was reached in Turkmenistan's case - improvement of drinking water use in rural and urban areas (47%) and Kyrgyzstan to prioritize hazard plans for landslides (49%).

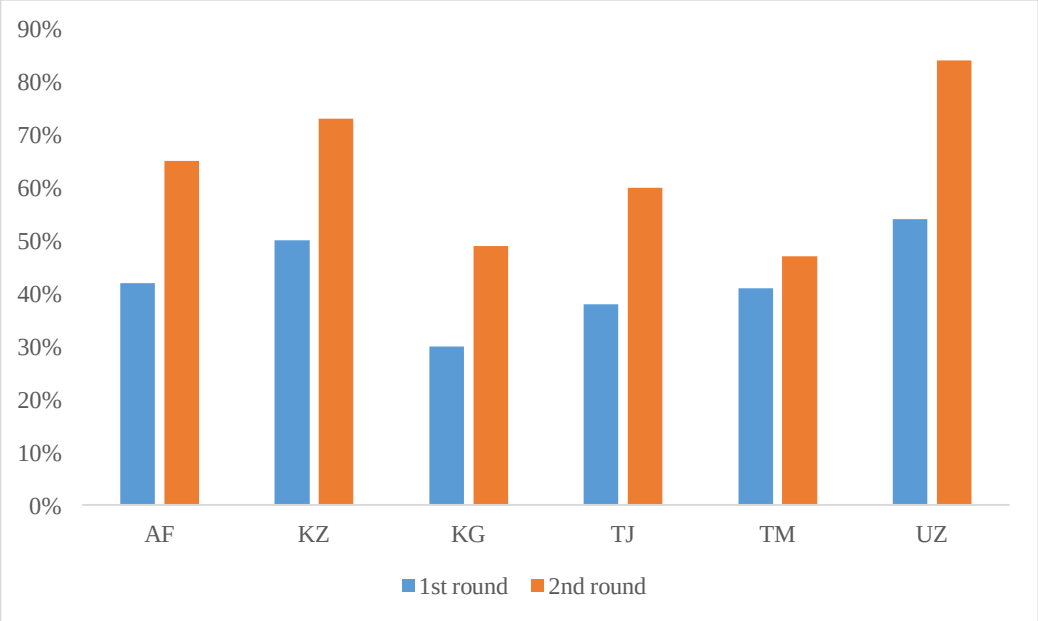

Figure 2. Consensus rate on water security priorities for Central Asian countries and Afghanistan

Note: AF-Afghanistan: improvement of drinking water use in rural and urban areas;
KZ- Kazakhstan: improvement of river basin management plans;
KG- Kyrgyzstan: improvement of hazard plans for landslides;

TJ- Tajikistan: improvement of irrigation management for agriculture;
TM- Turkmenistan: improvement of drinking water use in rural and urban areas;
UZ- Uzbekistan: improvement of irrigation management for agriculture.

4. Discussion

The Delphi method helped in the elicitation of experts' opinions about different water security dimensions in the Central Asia region and water security priorities in each country that has been suggested from the relevant literature. Delphi studies' compromise is achieved when about 80% of respondents select two categories on a seven-point Likert scale, or 70% of participants choose three and higher on a four-point Likert scale (Hsu, 2007). In this study, the agreement rate on the ranking of water security dimensions for Central Asia and Afghanistan reached about 80% by the end of the second round. A possible explanation for the high level of agreement on the ranking of water security dimensions might be that experts prioritize water resources for economic development and invest in drinking water and water supply systems for better human health. Moreover, experts made suggestions to include transboundary complexity, legislative weaknesses, and institutional weaknesses in assessing water security in Central Asia and Afghanistan.

We noticed a low consensus rate among participants on the attribute for the natural hazards dimension: management and protection from drought. Some respondents mention that risks from water-related hazards such as droughts, floods, landslides, and avalanches are increasing due to climate change in the Central Asia region and lack of hazard mitigation plans. Experts also disagreed in both rounds that the urban & household water security aspects in Central Asia were significant in the policy agenda until ten years ago but now are in decline, as shown in the academic literature. There are several possible explanations for disagreement on the urban & household water security trend. Firstly, the urban & household dimension of water security is positively linked with the national health and hygienic strategies set by the Sustainable Development Goal No.6 (SDG 6) on clean water and sanitation, which is currently included in the policy agenda of all Central Asian countries (Baubekova & Kvasha, 2019). Secondly, Central Asian states have attempted to mobilize extensive credits from international banks to improve drinking water infrastructure in the last ten years (Abdullaev & Rakhmatullaev, 2016). Therefore, experts highlighted the importance of the urban & household dimension in strengthening water security in the region.

Participants set diverse water security priorities for Central Asian countries and Afghanistan. The highest consensus rate among participants was reached on prioritizing the improvement of irrigation management in agriculture in Uzbekistan. The result is in alignment with the recent World Bank report (WB, 2020) suggesting targeted infrastructure investment, especially in irrigation modernization and increasing water use, productivity, and efficiency to sustain economic growth; this takes into account the potential impact of climate change, primarily when Uzbekistan’s economy heavily depends on agricultural production with an arid climate and high water dependency on neighboring countries (Khaydarov & Gerlitz,

2019). Experts prioritize the improvement of river basin management plans to strengthen water security in Kazakhstan. River basin management planning is based on an integrated approach of sustainable water use, protection, regulation, and stakeholder engagement. Especially Kazakhstan should improve river basin management planning since seven out of eight river basins share transboundary rivers with Central Asian countries, China, and Russia (Van Dijk, 2019).

The majority of experts gave high importance to the improvement of drinking water users in rural and urban areas of Afghanistan. According to data from the Joint Monitoring Programme (JMP), managed by the WHO and UNICEF, only 67 % of the population has access to basic drinking water services. About 44 % of the population has unimproved and limited sanitation & hygiene services in Afghanistan. Moreover, 11% of Afghanistan's population takes drinking water directly from surface water, such as rivers, lakes, canals, and dams. These could be a potential reason behind participants' choice to prioritize clean water and sanitation in Afghanistan for better population health, especially when access to water supply services varies dramatically between urban and rural areas.

Upstream countries in Central Asia prioritize water use for energy production. However, participants suggested strengthening water security by improving irrigation management for Tajikistan and improving hazard plans for landslides in Kyrgyzstan. In the case of Tajikistan, agriculture contributes about 20% to domestic GDP, where over half of the population is employed. This could be a potential explanation of the preferences of participants. Even though half of the participants highlighted the improvement of hazard plans for landslides in Kyrgyzstan, we noticed a high disagreement on this despite the existence of risks from natural hazards. In the case of Turkmenistan, only half of the respondents agreed with the high ranking of drinking water use in rural and urban areas. Indeed, according to the Joint Monitoring Programme (JMP), 94 % of the population has access to safely managed drinking water and basic sanitation and hygiene facilities. Furthermore, many experts admit a lack of information on water security issues in Turkmenistan.

Overall, experts set different water security priorities for Central Asian countries and Afghanistan. The result shows that each country is different and therefore has also different water security priorities and challenges. Regional and international experts differentiate between the countries and do not treat the whole of Central Asia as the same. I have attempted to interpret and understand the reason behind these priorities. However, future studies could analyze drivers and pressures behind different water security priorities, develop a common water security strategy in the region, and understand whether Central Asian countries and Afghanistan are interested in a common water security strategy.

The Delphi method helped to elicit expert opinions assuring full anonymity among respondents, without group pressure on consensus and flexibility in terms of location and time to respond to surveys (Normand *et al.*, 1998; Okoli & Pawlowski, 2004; Day & Bobeva, 2005; Lee *et al.*, 2013). However, the Delphi method may be criticized for the subjectivity of results and homogeneous or professional bias (Hsu, 2007; Yousuf, 2007; Avella, 2016). To minimize this limitation, we included our database experts from different countries and

backgrounds; however, with expertise and knowledge in water resources issues in Central Asia to ensure the validity of results. The experts originate from diverse professional backgrounds like ministries, NGOs, international organizations, research institutes, and universities. We are interested in experts' perceptions since they might, directly and indirectly, impact decision-making related to water security in the region. Martínez-Paz *et al.* (2016) emphasized that the Delphi method consists of experts' subjective judgment and group vision on the investigated subject. As Lee *et al.* (2013), Okoli & Pawlowski (2004) pointed out, the Delphi method is considered objective and rational because of the absence of group pressure towards consensus.

Another limitation of this study is the number of rounds. As Okoli & Pawlowski (2004) noted, Delphi studies should have at least two rounds. In this study, two rounds were conducted. We admit that the consensus rate may differ in the case of running one more round. However, scholars pointed out a decrease in response rate with additional rounds. Indeed, the response rate was about 30% in both rounds. Moreover, these results need to be interpreted with caution because of a selection bias since experts need to know English or Russian to understand and respond to the questionnaires. Even though Central Asia is a post-Soviet region where the Russian language is widely used for negotiations, trade, and education, there is a risk that some regional experts might have difficulties in understanding and answer to the questions since each Central Asian country and Afghanistan has its national language.

Water security is an abstract and multidimensional concept. As Markmann *et al.* (2020) argued, questions with abstract concepts are context-specific and depend on subjective interpretations. Different understanding of water security might reduce the reliability of experts' assessment and bias to certain aspects of water security. Moreover, our study was conducted in English and Russian languages among regional and international experts that might also impact different interpretations and assessments of water security status in the region.

5. Conclusion

This study attempts to identify the current trends of perceptions of experts about water security in Central Asian countries and Afghanistan as assessed through different regional and international experts with relevant knowledge and expertise and reach consensus among experts on water security priorities. We developed a two-round questionnaire to infer the experts' views on water security in Central Asia and then identify the initial findings' agreement rate. This study's primary result is the agreement on ranking the relevance of water security dimensions in Central Asia and Afghanistan in the following order: 1st - economic activities, 2nd - urban & household facilities, 3rd - natural hazards, and 4th -environmental aspects. The findings have shown that the experts emphasize water security's economic aspects, while the academic literature has focused on environmental parameters.

As stated before, the concept of water security is complex and multidimensional. Despite abundant water resources in the region, Central Asian countries and Afghanistan may be criticized for lack of agreement on water allocation and inadequate water governance mechanisms. Strengthening water security in each Central Asian country and Afghanistan for economic growth and human health and wellbeing depends on socio-economic, hydrological, geographic, and political factors. In this study, experts set different water security priorities for all six countries. A high consensus was reached on prioritizing irrigation modernization in Uzbekistan, river basin planning in Kazakhstan, and clean drinking water and sanitation in Afghanistan. Moreover, this study promoted learning from experts and learning among experts on water security issues in the region. Finally, respondents highlighted the low effectiveness or ineffectiveness of the current institutions and mechanisms that dealt with water security-related issues in Central Asia and suggested strengthening water governance in the region.

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Annex

The content of the Delphi survey

Questions in the 1st round & 2nd round

1. **Water security dimensions**

- Urban & Household facilities
- Economic activities
- Environmental aspects
- Natural hazards

2. **Attributes of water security dimensions**

Urban & Household facilities:

- Construction and management of sanitation and hygiene facilities
- Implementation of sustainable development goal 6 (SDG 6)-water use
- Construction and management of wastewater treatment facilities
- Construction and management of drinking water supply facilities
- Other (please specify)

Economic activities:

- Construction and management of irrigation systems
- Construction and management of hydropower energy systems
- Water used for industrial purposes
- The concept of water-energy-food (WEF) nexus
- Other (please specify)

Environmental aspects:

- Management and conservation of rivers and river basins
- Management and conservation of mountains and wider mountainous regions
- Management and conservation of lakes and lake ecosystems
- Wider management and conservation of natural environment
- Other (please specify)

Natural Hazards:

- Management and protection from landslides
- Management and protection from floods
- Management and protection from droughts
- Management and protection from avalanches
- Other (please specify)

3. **Trends of water security dimensions and implications on a policy level in Central Asia**
4. **Ranking water security factors in six countries**

Afghanistan

- Development of mountainous conservation for water storage and hazard (e.g. floods,

droughts) protection
- Development of hydropower plants for electricity and agricultural (irrigation) use in Afghanistan
- Improvement of drinking water user in rural and urban areas of Afghanistan
- Other (please clarify)

Kazakhstan
- Improvement of river basin management plans in Kazakhstan
- Improvement of drinking water use in rural and urban areas in Kazakhstan
- Improvement of irrigation management for agriculture in Kazakhstan
- Other (please clarify)

Kyrgyzstan
- Improvement of hazard plans for landslides in Kyrgyzstan
- Improvement of drinking water use in rural and urban areas of Kyrgyzstan
- Improvement of river basin management plans in Kyrgyzstan
- Other (please clarify)

Tajikistan
- Improvement of irrigation management for agriculture in Tajikistan
- Improvement of river basin management plans in Tajikistan
- Improvement of drought management plans in Tajikistan
- Other (please clarify)

Turkmenistan
- Improvement of river basin management plans in Turkmenistan
- Improvement of drinking water use in rural and urban areas of Turkmenistan
- Improvement of drought management plans in Turkmenistan
- Other (please clarify)

Uzbekistan
- Improvement of irrigation management for agriculture in Uzbekistan
- Improvement of river basin management plans in Uzbekistan
- Improvement of drought management plans in Uzbekistan
- Other (please clarify)

5. **Assessment of effectiveness of current institutions and mechanisms dealing with regional water security issues**
6. **Demographic profile**

- Gender
- Age
- Education
- Employment
- Citizenship
- Experience