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Experts views on water scarcity and flooding from six countries around the Black Sea region

George N. Zaimes[a,*], Chrysovalantis Kiosses[b]

[a]*UNESCO Chair Con-E-Ect, Conservation and Ecotourism of Riparian and Deltaic Ecosystems; Laboratory of Geomorphology, Edaphology and Riparian Areas (GERi Lab), Department of Forest and Natural Environment Sciences; International Hellenic University (IHU), 1st km Drama-Microhoriou, Drama, Greece 66100, Tel. +30 25210-60416; Fax: +30 25210-60411; email: zaimesg@teiemt.gr/zaimesg@for.ihu.gr*
[b]*Man and Water Program, Department of Forestry and Natural Environment; International Hellenic University (IHU), 1st km Drama, Mikrohoriou, Drama 66100, Greece, email: valantiskio@yahoo.com*

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ABSTRACT

Two of the major problems related to water, are scarcity and flooding. Climate change is expected to increase the frequency and intensity of both phenomena. The Black Sea region is of special interest to water resources because it is a closed basin with European Union and non-European Union countries. The sustainable management of the water resources requires the collaboration of all the countries of the Basin. In this study, the views of water management experts in the Black Sea region of six countries in regard to water scarcity, flooding, climate change impacts, and their interactions were collected and analyzed with an online web questionnaire. The participants of the questionnaire were from: Greece, Moldova, Romania, Turkey, and Ukraine. The results of such a questionnaire are important because experts and stakeholders views will help implement socially acceptable water management plans. Based on the participants answers water scarcity was considered a serious problem in four of the countries. In contrast, all countries considered flooding a serious problem. Most participants considered that these problems will increase in the future and that measures need to be taken. These suggested measures included better water and forest management, improving equipment and infrastructure, utilizing new technologies and enhancing awareness.

Keywords: Awareness; Climate change; Forest management; New technologies; Sustainability; Water management; Water scarcity

1. Introduction

The availability of freshwater resources is essential for the development and welfare of regions, countries, and communities. Freshwater resources are already under pressure that will continue to grow due to demographic trends, economic development, land-use, and lifestyle changes [1]. Integrated water resources management (IWRM) approaches that take into consideration economic, ecological, and social aspects, are necessary for their sustainability [2]. In such approaches, stakeholders and experts' involvement is necessary for the implementation of socially acceptable and sustainable management plans [3]. Several studies have found that the inclusion of stakeholders can significantly improve the effectiveness of IWRM plans [4–6] and should be mandatory in all such approaches.

Readily available freshwater resources are limited and unequally distributed, spatially, and temporally [7]. Agriculture is currently consuming the largest share of water in most regions worldwide [8] but as the world's

* Corresponding author.

population continues to grow the demands from other sectors (urban and industrial needs) are adding more pressures [9]. Urban, industrial, and agricultural activities are also reducing the quality of the freshwater resources [8]. Climate change models forecast that the frequency and magnitude of droughts and floods will increase that will further compound the pressures on freshwater resources [10].

The great diversity of water resource stakeholders, with in many cases conflicting views on water management, further complicates decision making. This is why experts and stakeholders' involvement is necessary for sustainable solutions. Europe has the most transboundary basins of all continents. To achieve the effective management of transboundary basins, it is essential to have proper communication and collaborative agreements on the use of waters among the sharing countries [11]. Therefore, the European Union developed the Water Framework Directive (WFD) to develop IWRM plans based on ecosystem-based and river basin management principles [12].

The freshwater resources of the Black Sea region are of special interest, because it's running water bodies end in a closed sea. The EU considers that the Black Sea region includes parts of Greece, Bulgaria, Romania, Ukraine, Russia, and Turkey and the entire countries of Moldova, Georgia, Armenia, and Azerbaijan [13]. The Black Sea Commission's has provided the legal framework through the "Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea" (2009) that recommends riparian countries of the region should work together to prevent, reduce, and control pollution [13]. Still, water problems exist in the region [14]. Another intriguing aspect of the region is that only some of its countries are EU members. This mean that aligning a legal framework, developing common policies and strategies, and harmonizing standards and methods is complicated and difficult. Improving the understanding of the policies and enhancing communication among the water managers, policy-makers, and societies across the neighboring countries should be prioritized [13].

Agriculture within the Black Sea Basin is fundamental for several national economies [15]. A decline in irrigated areas has been observed in Eastern Europe but the majority of water is still utilized by agriculture [15]. Climate change, will further increase water demand for irrigation purposes and the competition with the other water sectors [16]. Finally, the Black Sea region has high biodiversity and this competition for freshwater could negatively impact the ecosystem's integrity [15].

This study examines the views and opinions of water management experts in the six countries of the Black Sea region in regard to water scarcity, flooding, climate change impacts, and their interactions. The new emerging conditions due to climate change make it a priority to understand if the authorities, organizations, and agencies responsible for water resources are prepared for the new socio-economic and climate change implications. To implement adaptable innovative strategies that align competing interests in water-related issues experts and stakeholders' opinions need to be incorporated [17]. This is the first study, to our knowledge, to focus on the water scarcity, flooding, and climate change of the Black Sea region with participants from so many different countries (Armenia, Greece, Moldova, Romania, Turkey, and Ukraine). The participants' answers enhanced the region and each participating country understanding on: (a) water scarcity, (b) flooding, (c) climate change impacts, (d) the preparedness of the responsible organization and agencies to face current and future water problems, and (e) water management changes required to face water scarcity and flooding.

2. Methodology

2.1. Selection of participants

The selected participants were experts from water agencies and organizations or stakeholders that were interested in water management. Specifically, invitations were sent to water managing authorities, forest services, municipalities, regional authorities, ministries, fire departments, management bodies, non-governmental agencies, private companies to select, and recommend their experts that deal with water management that could participate. They originated from six Black Sea countries; specifically, Armenia, Greece, Moldova, Romania, Turkey, and Ukraine that were willing to participate (Fig. 1). The questionnaire was part of the EU funded Black Sea project with the acronym "Streams-2-SUPPRESS-Fires". The project had partners only from these six countries and this was the reason we focused on participants from these countries. Having partners allowed easy access and a greater willingness of participation from the suitable and necessary water experts from these countries. While these countries are in the same region they differ in geographical and environmental aspects and water availability and vulnerability (Table 1).

2.2. Web-based questionnaire

This study utilized an online web-based questionnaire and obtained reliable and valid data by [18,19]: (a) completing and contacting a list of experts with the appropriate background in every country. These lists were compiled by the partner of the Black Sea project "Streams-2-SUPPRESS-Fires" from each country. (b) These experts were asked to suggest other appropriate participants for the study. This "snowball" referral sampling process provides the most representative results when the personal experience of participants is crucial [20]. (c) Once the lists were completed, an email invitation was sent to all potential participants. (d) Participation in the questionnaire required registration on the questionnaire website. (e) All registered participants were sent a second email, on which the "send the receipt to the sender" option had been enabled. Only questionnaires with a sender receipt were considered for further analysis.

The first draft of the questionnaire was based on the literature and discussions with water managers, experts, and academics from the surveyed countries. Afterward, the questionnaire was pre-tested with four experts from each country and modified based on their comments to alleviate the biased, misleading, or confusing questions. The final questionnaire consisted of four parts (Table 2). In its first part, the participants provided profile information such as their nationality, gender age, and work experience (total of five questions). We decided not to ask where

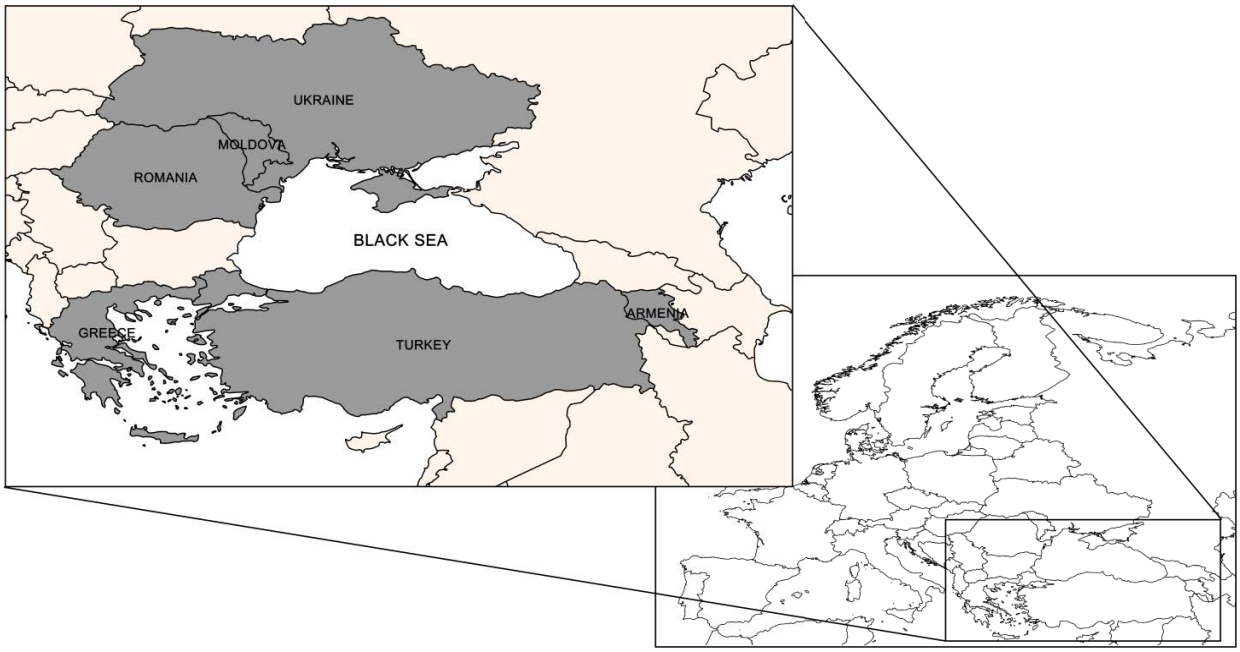

Fig. 1. Survey participants were from six countries (in dark grey) of the Black Sea region.

Table 1
General and water resources characteristics of the countries of the survey participants

Characteristic	Armenia	Greece	Moldova	Romania	Turkey	Ukraine
Population (2017), million[a]	3.04	10.74	3.42	21.52	80.85	44.03
Area land (2018), km^2[a]	28.203	130.647	32.891	229.891	769.632	579.330
Area of water (2018), km^2[a]	1.540	1.310	960	8.500	13.930	24.220
Population density (2017), # people/km^2[a]	102.38	81.61	102.63	90.31	103.18	72.96
GDP (2017), billion $[a]	27.21	299.5	20.07	474	2.133	366.4
Precipitation, mm[a]	562	652	450	637	593	565
Freshwater withdrawals total (km^3/y) (domestic/industrial/agricultural %)[a]	2.9 (40/6/54)	9.5 (9/2/89)	1.07 (14/83/4)	6.9 (22/61/17)	40.1 (14/10/76)	19.24 (24/69/7)
Freshwater withdrawals per capita (m^3/y)[a]	929.7	841.4	290.0	320.8	572.9	415.7
Total renewable water resources, km^3[a]	7.8	74.3	11.7	211.9	211.6	139.6
Agricultural land, %[a]	59.7	63.4	74.9	60.7	49.7	71.2
Arable land, %[a]	15.8	19.7	55.1	39.1	26.7	56.1
Irrigated land (2014), % of total agricultural land[a]	9.23 (2015)	16.61	9.25 (2010)	1.05	13.52	0.75
Forested area, %[a]	9.1	30.5	11.9	28.7	15.2	16.8
Large lakes, # and area (km^2)[b]	4 and 1,224	15 and 677	3 and NA	4 and ~247	16 and 8,302	7 and ~247
Large rivers, # and length (km)[b]	15 and 1,562	9 and 1,509	8 and ~909	8 and 2,993	12 and 7,449	7 and ~8,231
Major floods, #[c]	–	16	5	6	20	2

[a]https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html; [b]http://sdwebx.worldbank.org; [c]http://floodlist.com

they work hoping to get more truthful answers about the current conditions on water management. The second part, with eight questions, focused on the participants' opinions on (i) water scarcity, (ii) flooding in their countries, and (iii) the interconnections between water scarcity and flooding. The third part (total of four questions) investigated the perspectives on the potential impacts of climate change in the future, on water scarcity and flooding. The questions of the second and third parts were of the closed, binomial (yes/no) type because of the language barriers of

Table 2
Questions that were asked to the participants of the online questionnaire

PART ONE
Which country are you from?
What is your gender?
What is your age?
Do you have experience in water management?
If yes in previous question, for how many years?
PART TWO
Is a water scarcity serious problem in your country?
Are floods a serious problem in your country?
Do the governmental agencies have enough personnel to face water scarcity?
Are the governmental agencies well equipped to face water scarcity?
Do the governmental agencies utilize new technologies to face water scarcity?
Do the governmental agencies have enough personnel to face floods?
Are the governmental agencies well equipped to face floods?
Do the governmental agencies utilize new technologies to face floods?
Is there an interconnection between water scarcity and floods?
PART THREE
Will climate change impact water scarcity in your country?
Do you expect water scarcity to increase in the future in your country?
Will climate change impact floods in your country?
Do you expect floods to increase in the future in your country?
PART FOUR
What do you believe is the most important management measure for water scarcity that should be implemented?
What do you believe is the most important management measure for floods that should be implemented?

the participants. The fourth part had two questions were the participants were asked to describe activities that they considered important to mitigate water scarcity and flooding, respectively (open ended, short answer).

The same questionnaire was distributed in all participating countries although in some of the countries (Armenia, Moldova, Romania, and Ukraine), where the comprehension of English was limited, the questionnaire was translated in the native language to increase participation.

2.3. Statistical analysis

The data were analyzed with the software IBM SPSS Statistics 21.0. The maximum likelihood χ^2 test ($p \leq 0.05$) was used to find statistically significant differences. In addition, the answers of the open-ended questions were encoded and, when possible, grouped into different categories to facilitate the statistical analysis. Categorical principal components analysis (CATPCA) was also used in order to identify consistencies between categories of variables based on the study participants' responses. CATPCA is a generalization of principal components analysis (PCA) which reduces the variables in a dataset to a small number of principal components that represents the information in the variables as closely as possible [20]. This optimal quantification of the categorical modalities of each variable can be obtained through an iterative alternating least squares (ALS) [21]. The ability of CATPCA to handle variables of different analysis levels (nominal, ordinal, and numerical) simultaneously and to deal with nonlinear relationships between variables has resulted in its use as an exploratory technique in many empirical surveys [22,23].

3. Results

A total of 248 questionnaires were completed online, with participants from all six countries (Table 3). Approximately 750 invitations were sent to all countries. Armenia had the lowest number of participants and Romania the most. Most participants were male (77.4%) and in the 26–45 age group (Table 3).

3.1. Water scarcity

The slight majority of all survey participants regarded water scarcity as a serious problem for their country (Table 4). However, an analysis by country revealed a different situation (χ^2 statistic = 63.386, df = 5, and $p < 0.0001$). In Armenia, Greece, Moldova, and Turkey there is a very high percentage that considers water scarcity as a serious problem (>58%). This percentage was the greatest in Moldova and Armenia. In Romania, water scarcity was considered a less severe problem (~40.0%). Finally, in Ukraine, most participants stated that they do not face water scarcity problems (2.1%).

Table 3
Socio-demographic characteristics of the survey participants

Country	Armenia	Greece	Moldova	Romania	Turkey	Ukraine
Percentage	5.6	18.5	14.9	22.2	19.4	19.4
Age group	18–25	26–35	36–45	46–55	56–65	>65
Percentage	5.6	31.9	39.9	16.9	5.2	0.0

In all countries except Turkey, participants satisfaction in regard to the existing personnel was higher compared to the satisfaction for the equipment used and the implementation of information and communication technologies (ICT) (Table 5). Even for personnel (χ^2 statistic = 55.179, df = 5, and $p < 0.0001$), the survey participants in most countries stated that the number of personnel were inadequate (<50%) except in Romania (58.2%) and Ukraine (85.4%). Characteristic is the case of Ukraine, where the current personnel and equipment (χ^2 statistic = 53.059, df = 5, and $p < 0.0001$), are considered to be at a very high level, whereas the use of ICT was practically considered non-existent. In respect to ICT (χ^2 statistic = 98.945, df = 5, and $p < 0.0001$), only in Turkey the participants answered that they were adequately used.

Participants in most countries stated that water scarcity will increase in the future (χ^2 statistic = 98.945, df = 5, $p < 0.0001$; Table 6). The percentage in all countries except in Ukraine was greater than 80%, indicating that water scarcity is really expected to worsen. In most countries, climate change was recognized to also impact water scarcity (>85%) (χ^2 statistic = 101.383, df = 5, and $p < 0.0001$). Only in Ukraine most participants stated that climate change will not impact water scarcity where it was not considered a serious problem.

3.2. Water flooding

The majority (73.7%) of all participants regarded water flooding as a serious problem for their country (Table 4) (χ^2 statistic = 13,198, df = 5, and $p < 0.022$). Romanian and Ukrainian respondents (>85%) considered flooding a very severe problem. The current personnel and equipment do not seem to be able to fulfill the needs (<50%) for the effective management of the flooding in all countries except in Ukraine (Table 5). This satisfaction percentage was less than 30% in regard to the personnel in Armenia and Greece (χ^2 statistic = 52.183, df = 5, and $p < 0.0001$) and in regard to the equipment in Armenia, Greece, and Moldova (χ^2 statistic = 35.678, df = 5, and $p < 0.0001$). The greatest need in the region appears to be the implementation and use of ICT (most countries < 41%) (χ^2 statistic = 56.807, df = 5, and $p < 0.022$). This was not the case in Turkey, where the rate was the highest (60.4%).

The participants opinions differed on water flooding increasing in the future, (χ^2 statistic = 62.038, df = 5, and $p < 0.0001$; Table 6). In Greece, Romania, and Turkey the majority of the participants stated the floods would increase (>70%) while in Ukraine most participants (81.2%) did not believe floods would increase in the future. The

Table 4
Percentage of survey participants that considered water scarcity or water floods as a serious problem in their country and if there is an interconnection among water scarcity and floods

Country	Water scarcity (%)	Water floods (%)	Interconnection between water scarcity and floods (%)
Armenia	71.4	57.1	78.6
Greece	58.7	67.4	63.0
Moldova	78.4	70.3	37.8
Romania	40.0	89.1	63.6
Turkey	62.5	72.9	89.6
Ukraine	2.1	85.4	–
All participants	52.2	73.7	66.5

Table 5
Satisfaction of the survey participants for the current number of personnel, equipment, and implementation of information and communication technologies (ICT) in regard to the management of water scarcity or flooding in the countries under investigation

	Armenia	Greece	Moldova	Romania	Turkey	Ukraine	All participants
				Management of water scarcity			
Personnel (%)	42.9	15.2	27.0	58.2	43.8	85.4	47.2
Equipment (%)	0.0	2.2	10.8	32.7	31.3	60.4	27.0
ICT (%)	0.0	6.5	24.3	32.7	62.5	4.2	25.0
				Management of flooding			
Personnel (%)	14.3	26.1	32.4	47.3	45.8	89.6	47.2
Equipment (%)	7.1	21.7	10.8	32.7	43.8	62.5	33.9
ICT (%)	0.0	6.5	40.5	30.9	60.4	6.3	27.0

Table 6
Percentage of survey participants that considered that water scarcity or water floods will increase in the future in their countries and climate change will impact them

Country	Increase in water scarcity (%)	Increase in water floods (%)	Climate change impacts on water scarcity (%)	Climate change impacts on water floods (%)
Armenia	92.9	50.0	100.0	85.7
Greece	84.8	82.6	87.0	81.8
Moldova	81.1	43.2	91.9	97.3
Romania	81.8	81.8	86.5	85.2
Turkey	89.6	70.8	93.8	91.7
Ukraine	14.6	18.8	22.9	8.3
All participants	71.4	60.1	77.1	72.7

role of climate change enhancing flooding was considered important in five of the countries (>81%) except Ukraine (<15%) (χ^2 statistic = 127.321, df = 5, and $p < 0.0001$; Table 6).

3.3. Interactions between water scarcity and flooding

Most participants' (66.5%) (χ^2 statistic = 98.316, df = 5, and $p < 0.0001$) stated that water scarcity and flooding are interconnected (Table 4). Participants from Armenia and Turkey had the greatest awareness of this interconnection (>78%). No Ukrainian participants answered this question.

3.4. Categorical principal components analysis

Ten variables were used for the CATPCA that were: age group (ordinal, 1–5), country of origin (nominal, 1–6), gender (nominal, 1–2), water scarcity as serious problem (nominal, 1–2), floods as serious problem (nominal, 1–2), climate change impacting water scarcity (nominal, 1–2), climate change impacting floods (nominal, 1–2), the interconnection between water scarcity and water floods (nominal, 1–2), water scarcity index (numeric, 0–4), and waterflood index (numeric, 0–4). The convergence criterion value of 0.00001 was met after 13 iterations. The two-dimensional solution resulted in eigenvalues of $\lambda 1 = 3.634$ and $\lambda 2 = 1.489$ for the first (PC1) and second principal component (PC2), respectively. Each of these eigenvalues exceeded the acceptance value of 1 [23]. This fact and because 89.4% of the total variance were explained in relation to PC1 and PC2, respectively, suggested the use of a two-dimensional analysis for this dataset is proper.

The values of the variable loadings for the two principal components are described in Table 7. The variables "country of origin" and "climate change impacting both water scarcity and flooding", presented very high positive loadings in relation to PC1 and formed a group that could be interpreted as local conditions. Similarly, the variables "are floods a serious problem in your country?" and "water scarcity index" formed a second group due to their high positive loadings in relation to PC2 that could also be interpreted as local conditions. "Age group" and "gender" had the most negative loading in relation to PC2 that could be interpreted as participant characteristics. The CATPCA provides scores to the variables, and a dispersion diagram was created (Fig. 2). The coordinates for the variables were along each dimension. With regard to the first dimension, there was consistency (variable values above 0.5 or below –0.5 in both dimensions) between the following: "age group: 18–25 and 25–36", "gender: female" and "Are floods a serious

Table 7
Component loadings of the variables used in the categorical principal components' analysis

Component loadings		
Variable	Dimension	
	1	2
Country of origin	0.850	–0.265
Gender	0.268	–0.446
Age group	0.041	–0.575
Is water scarcity a serious problem in your country?	0.617	0.011
Will climate change impact water scarcity in your country?	0.798	–0.068
Are floods a serious problem in your country?	0.087	0.574
Will climate change impact floods in your country?	0.794	–0.042
Is there an interconnection between water scarcity and floods?	0.641	–0.278
Water scarcity index	0.680	0.379
Water floods index	0.556	0.576

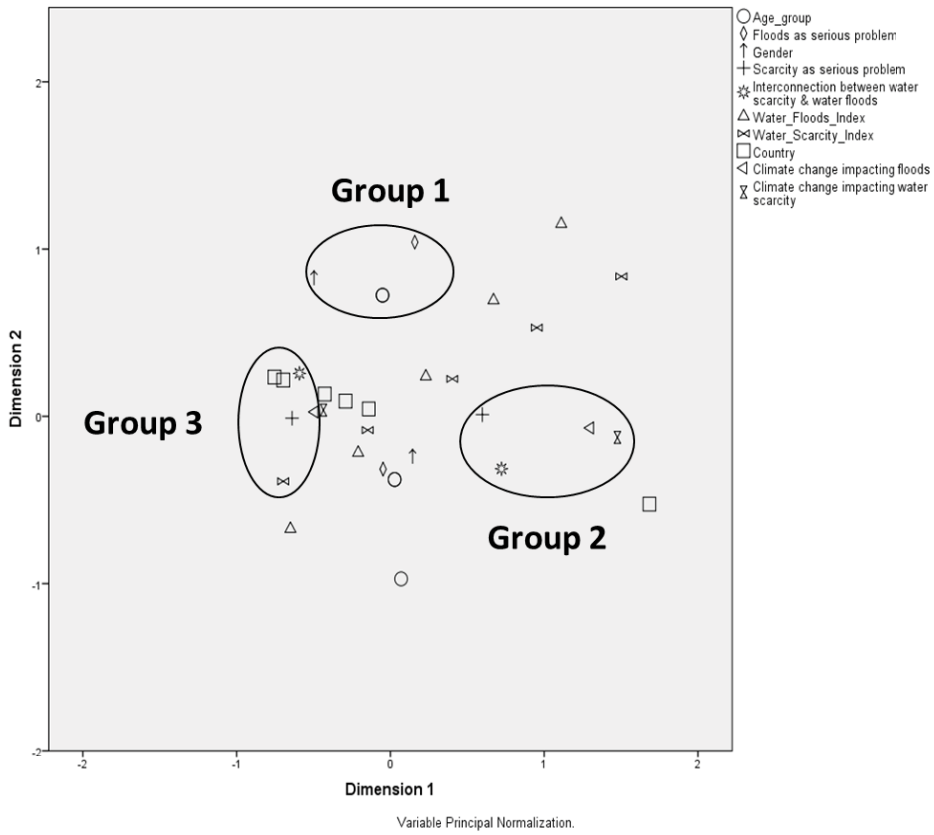

Fig. 2. Joint plot of the variable categories used in the categorical principal components analysis (CATPCA).

problem in your country?: No" (Group 1). Group 2 consisted of the variables "Is water scarcity a serious problem in your country?: No", "Is there an interconnection between water scarcity and floods?: No", "Will climate change impact water scarcity in your country?: No", and "Will climate change impact floods in your country?: No". Finally, the variables "Country of origin: Armenia and Turkey", "Is there an interconnection between water scarcity and floods?: Yes", "Is water scarcity a serious problem in your country?: Yes," "Will climate change impact floods in your country?: Yes" and "Water Scarcity Index: 0", formed Group 3.

3.5. Mitigation measures

Different mitigation measures were suggested by the survey participants (Table 8). Improvements in infrastructures came first for both water scarcity and flooding. Better water management was also tied for first to mitigate water scarcity. To enhance flooding mitigation, the second most recommended measure was better forest management.

In Greece, Turkey, and Ukraine, the participants stated that changes in water management were the most important measure to mitigate water scarcity (Table 8). In Moldova and Romania, the most important measure to mitigate water scarcity was to improve the current infrastructures while the second most important were changes in water management. Finally, in Armenia, more preventive measures were the most important, followed by improvements in the infrastructure and water management. In Greece and Turkey, increased public awareness, and in Greece and Moldova, forest management was also important measure. Finally, Romanian participants stated the use of new technologies would really enhance water scarcity mitigation.

Forest management was the most important measure to mitigate flooding in Greece, Turkey, and Ukraine and the second most important in Armenia, Moldova, and Romania. In Armenia, Moldova, and Romania participants recommended improvements in the current infrastructure as the most important, that was the second most important measure in Greece and Turkey. Water management was also considered important to help mitigate flooding in Armenia and Romania. Improving prevention measures (Greece), legislative changes (Turkey), incorporating new technologies (Turkey), and better monitoring (Moldova) were other mitigation measures suggested.

4. Discussion

All southern Black Sea countries (Armenia, Greece, and Turkey) that have dry summers, considered water scarcity a serious problem. The CATPCA (Group 4) also indicated that Armenia and Turkey were more aware that water scarcity is a serious problem that the other countries. Moldavian participants had the highest percentage, regarding water scarcity as a serious problem,

Table 8
Top three per country and top five for the Black Sea region, participants' suggestions on measures aimed to mitigate water scarcity and floods

Country	Measures aimed to mitigate water scarcity	Frequency (%)	Measures aimed to mitigate water flooding	Frequency
Armenia	Prevention	25.0	Improve infrastructures	29.0
	Improve infrastructures	25.0	Forest management	29.0
	Water management	21.0	Water management	24.0
Greece	Water management	26.0	Forest management	21.0
	Education of public	18.0	Improve infrastructures	18.0
	Forest management	13.0	Prevention	16.0
	Prevention	13.0		
	Improve infrastructures	13.0		
Moldova	Improve infrastructures	33.0	Improve infrastructures	35.0
	Water management	22.0	Forest management	13.0
	Forest management	14.0	Better monitoring	13.0
Romania	Improve infrastructures	28.0	Improve infrastructures	35.0
	Water management	18.0	Forest management	13.0
	Prevention	15.0	Water management	13.0
	New technologies	15.0		
Turkey	Water management	29.0	Forest management	28.0
	Education of public	20.0	Improve infrastructures	21.0
	Prevention	20.0	New technologies	14.0
			Legislation	14.0
Ukraine	Water management	50.0	Forest management	100.0
	Other	50.0		
Black Sea Area	Improve infrastructures	23.0	Improve infrastructures	29.0
	Water management	23.0	Forest management	19.0
	Prevention	15.0	Water management	11.0
	Forest management	12.0	Prevention	8.0
	Education of public	12.0	New technologies	7.0

corresponding well to having the lowest annual precipitation of all participating countries (Table 1). All participating countries had more than 49% of their land in agriculture (Table 1). The three southern countries had agriculture as the main freshwater use while for the other three it was industry (Table 1). The countries that considered water scarcity a serious problem had more than 9% of their agricultural land irrigated (Table 1). Other studies have indicated that the countries of the Black Sea region due to socio-economic changes and development, and with economies dependent on tourism or being agrarian will face water scarcity problems [24–27]. Finally, the group of participants (Group 3 of CATPCA) that stated that water scarcity was a serious problem in their country, also expected future water scarcity problems (water scarcity index), climate change impacts on flooding, and were highly aware of the interconnection between water scarcity and flooding.

All country participants (except Turkey) had a substantially higher satisfaction for the existing personnel in mitigating water scarcity, compared to the equipment and ICT used. The implementation of ICT for water scarcity in most countries is minimal (satisfaction < 41%). In Armenia (0%) and Greece (<7%) major efforts should be made to improve the equipment and increase the utilization of ICT to mitigate water scarcity. The use of models can help cost-effectively plan the mitigation of water scarcity problems [26,28].

The participants' answers from Armenia, Greece, Turkey, and Romania that water scarcity will increase in the future (Table 5) corresponded well with the results of Luo et al. [29] study. In the Luo et al. [29] study, the first 3 countries in 2040 are expected to have extremely high risk of water stress while Romania to have a low risk [29]. Surprisingly, Ukraine was considered high risk although the participants of our study considered that water scarcity would not increase while Moldavian participants with the highest percentage in water scarcity increase had a medium to high risk in 2040 [29]. This increased water scarcity in the future is partially because of climate change impacts [30]. More frequent and intense summer droughts across Europe, especially in southern Europe have been projected [31,32]. The impeding impacts by climate change were recognized by the participants of all countries except Ukraine. More awareness on future water scarcity and climate change impacts is a necessity for Ukraine.

Participants for all countries stated that floods are a serious problem. Flooding impacts have more immediate, evident, and devastating negative impacts than water scarcity. The age groups of 18–25 and 26–35, along with females (Group 1 of CATPCA) were less aware of flooding being a serious problem indicating awareness activities should target the younger generation and especially females. The countries with the highest percentage stating that flooding is a serious problem were Romania and Ukraine that considered water scarcity a small or not a problem at all, respectively. In all countries, other studies have found floods as a serious problem and that mitigation measures need to be taken [26,33–37].

In all countries except Ukraine, a percentage lower than 50% on the satisfaction with the current personnel indicated that more should be hired for flood management. In Greece, 64.8% of the stakeholders surveyed in another study had low trust in the responsible authorities for flood protection [38]. Turkey was the only country where the implementation of ICT for flood mitigation was considered adequate (~60%). In the rest of the countries the percentage was less than 50%, while in Armenia, Greece, and Ukraine it was less than 7%. The use of ICT such as, indices, GIS, and satellite images and their adoption by the responsible agencies of the region could help improve flood mitigation substantially [26,39]. Finally, in all countries except Ukraine, the satisfaction stated by the participants for the equipment used was less than 41% indicating the need for new or servicing the current equipment. Such equipment for the region could include GPS-equipped mobile phones and mobile flood barriers [40].

Floods in Europe have been increasing and are expected to continue increasing in the future in magnitude and frequency because of climate change [41,42]. Stahl et al. [43] observed increases in runoff and decreases in low summer flows in hundreds of near-natural catchments in Europe. Most participants in five of the countries of this study and especially those from Armenia and Turkey (Group 3 of CATPCA) expected similar trends in the future. Only the participants from Ukraine stated that they do not expect increases of flooding in the future because of climate change. Despite the recognition by most of the climate change impacting flooding, few countries in Europe have developed flood mitigation guidelines that incorporate climate change [44].

Participants from Turkey and Armenia were highly aware of the interconnection (Group 3 of CATPCA) between water flooding and scarcity [45]. The awareness from participants from Moldova was low while Ukrainian participants did not answer this question. In addition, participants aware of the interconnection also stated water scarcity is a serious problem (water scarcity index) and that climate change will impact flooding (Group 3 of CATPCA). In contrast, participants not aware of the interconnection stated that climate change would not impact water scarcity and flooding (Group 2 of CATPCA).

Changes in water and forest management to mitigate water scarcity and flooding were the main suggestions (Table 3). The reason for forest management being so high for flood mitigation is because basins with high percentages of forested areas have high infiltration and evapotranspiration rates that reduce significantly surface runoff and erosion but also reinforced aquifer recharge [46]. In addition, with the re-establishment of riparian forested areas, surface runoff is reduced from reaching the stream channel, stream bank erosion is reduced, and aquifer recharge is increased [47,48]. Both management practices (reforestation of the basin and riparian areas) can help significantly reduce flood frequency and magnitude and increase groundwater levels. Overall, the implementation of nature-based solutions should be prioritized because they can sustainably mitigate flooding and water scarcity [49]. In regard to water management, firstly the EU countries but also the other non-EU countries should complete the WFD activities. Efforts should be made for the adoption and implementation of IWRM [50] in the Black Sea Region. The EU has also established the Flood Directive that should also be implemented in the region.

Complimentary to the implementation of the two EU Directives and/or IWRM would be, the improvement of current infrastructures and prevention measures for water scarcity and flooding (Table 3). Minimizing water losses in urban and agricultural water distribution systems should be a priority [51]. These problems are the result of the socio-economic changes in the former Warsaw Pact countries (Armenia, Moldova, Romania, and Ukraine) and the economic crises of other countries (Greece). Utilizing more sustainable irrigation systems such as drip irrigation in the region are another important measure (agriculture uses most of the freshwater) [52]. Regarding flooding, the development of new infrastructures or servicing of the old infrastructures (e.g., levees) should be prioritized. Another issue is that urban areas are developed along or in ephemeral torrents. These areas have a very high risk of flash flooding that in many cases could also lead to fatalities (e.g., Mandra, Greece) [33]. Preventive measures for natural disasters are more cost-effective than measures after the disasters [53]. Policy-makers are typically reluctant to take preventive measures and only the pressure from the general public and stakeholders would lead to their implementation. The awareness efforts should be on measures before, during, and after a natural disaster. These efforts should also focus on certain groups (e.g., Age groups 18–25 and 26–35 and females – Group 1 of CATPCA) (did not believe that water scarcity and flooding was a problem – Group 2 of CATPCA) and be more intensive in certain countries (e.g., Ukraine). Finally, the implementation of new technologies was expected to be a top suggestion since most participants had stated that the current equipment are outdated and more ICT need to be implemented (Table 3). New technologies such early warning systems, drought indices might require more funds upfront but in the long-term would be more cost-effective by reducing the number of natural disasters [54,55].

5. Conclusions

Water scarcity intensity and flooding frequency and magnitudes are expected to increase because of climate, geopolitical, and economic changes in the Black Sea region. New sustainable water management plans need to be implemented with a stronger cooperation among the countries

of the region. These plans should include improved water and forest management based on innovative approaches (e.g., ecosystem-based approaches and nature-based solutions), upgrading existing equipment, improving current infrastructure, increasing public awareness, and utilizing new technologies and ICT. The differences in the participants views of the different countries showcase the need for enhanced cooperation among countries of the region that can only be achieved by understanding similarities and differences. Such information along with recommendations for sustainable water management were determined through this questionnaire. Overall, the water management authorities, agencies, and organizations of the region need to be proactive to sustainably adapt to climate change impacts on water scarcity and flooding.

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