

Development of master curricula in ecological monitoring and aquatic bioassessment for Western Balkans HEIs / ECOBIAS

Task 1.4 REPORT

Project acronym:	ECOBIA
Project full title:	Development of master curricula in ecological monitoring and aquatic bioassessment for Western Balkans HEIs
Project No:	609967-EPP-1-2019-1-RS-EPPKA2-CBHE-JP
Number of grant contracts:	2019-1991 / 001-001
The web address of the project:	www.ecobiaserasmus.com
Funding Scheme:	ERASMUS+
Coordinator Institution:	University of Novi Sad
Coordinator:	Prof. dr. Snežana Radulović
Project duration:	15/01/2020 - 14/01/2023
Work package:	WP-1 Preparation
Lead organization of WP1:	University of Niš
Task 1.4	Analysis of labour market needs relevant to EMAB in PCs
Task leader:	University of Niš, Serbia
The version of the document:	V.01
Date:	02/06/2020

Status: Draft

Responsible partner: UNS

Dissemination level: External



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The purpose of this survey was to investigate and analyze labour market needs in ecological monitoring and bioassessment of freshwaters in Partner Countries, Bosnia and Herzegovina and Montenegro, to estimate optimal annual number of MSC ECOBIAS students and LLL training participants.

According to EU Water Framework Directive (WFD), not only highly industrialized, but also developing countries are obliged to protect and restore all their aquatic ecosystems in order for their water bodies (lakes, rivers, and groundwater bodies, transitional, and coastal waters) to be in good ecological condition by 2027 at the latest. Based on annexes II and V of this directive, an integrated system is used to evaluate the “ecological status” of rivers based on various environmental and biotic features, the so-called quality elements (QE): water chemistry, hydro-morphology and biological communities.

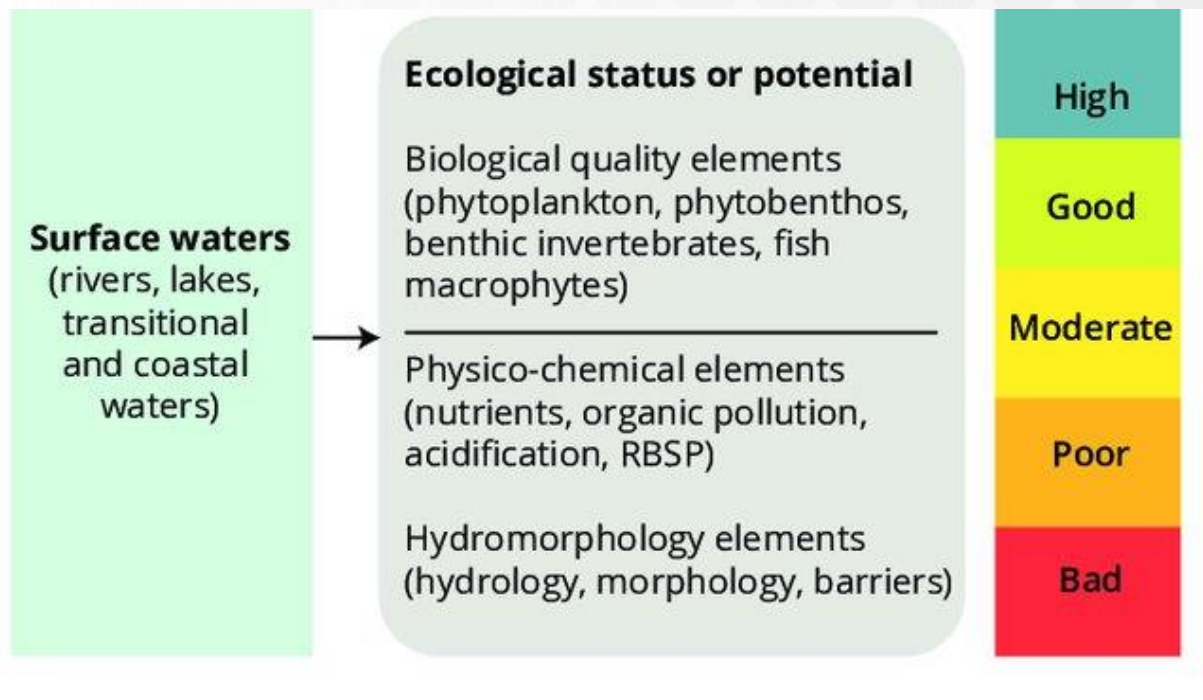


Figure 2. Assessment of ecological status of surface water bodies

The assessment of the ecological status considers the analysis of the structure of biological communities of algae, macrophytes, phytoplankton, benthic invertebrates, and fish. The classification scheme for the ecological status of water bodies includes five status classes: (1) very good; (2) good; (3) moderate; (4) poor; and (5) bad. Based on the assessment results of the single quality elements (QEs), the worst assessment result for a biological quality elements (BQEs) determines the overall assessment result (the “one-out-all-out” principle) (Schmutz & Sendzimir, 2018).

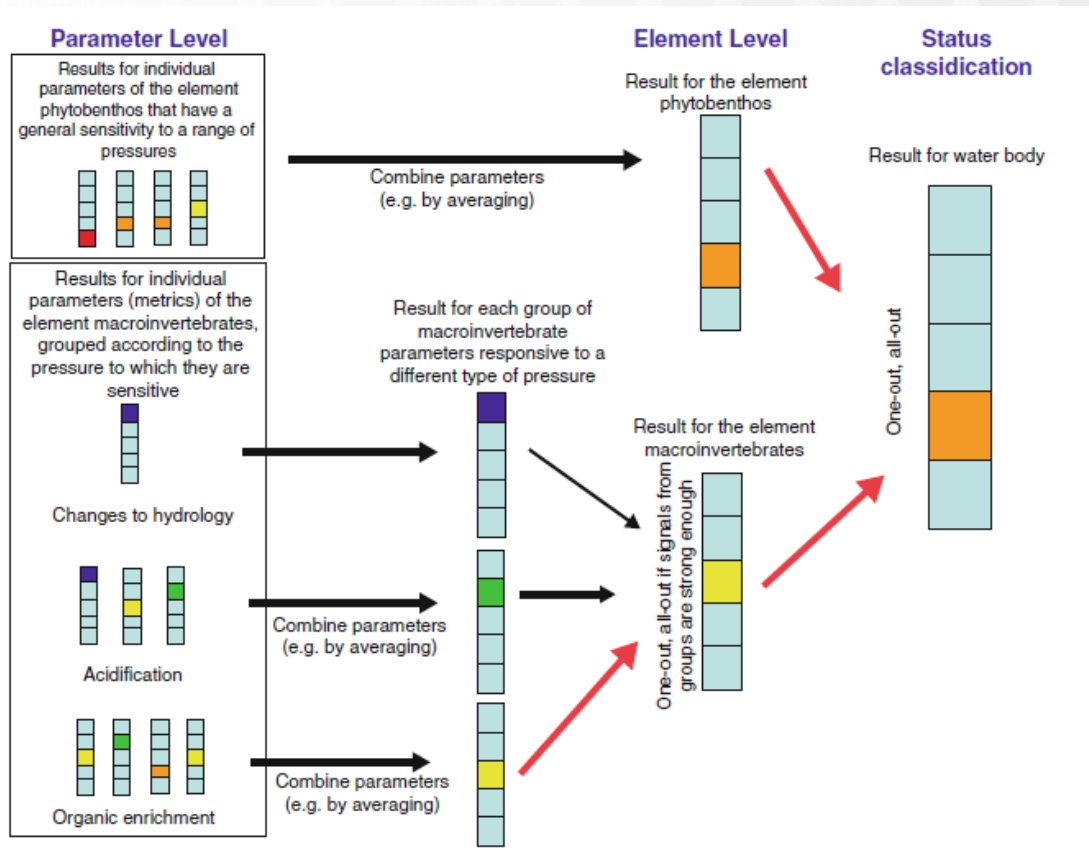


Figure 2. The one-out-all-out principle of the EU Water Framework Directive (WFD CIS Guidance Document No. 13: Overall Approach to the Classification of Ecological Status and Ecological Potential)

Various organisms have been proposed to be used in the assessment of the water quality and ecological status assessment of aquatic ecosystems, including bacteria, protozoans, algae, macrophytes, benthic invertebrates, fish, and birds (Roux et al. 1993; Barbour et al. 1999; Bryce et al. 2002). However, the most frequently used groups are benthic invertebrates, algae, macrophytes, and fish. To avoid redundant information and thus unnecessary costs, those groups are used to indicate effects of specific stressors on the environment in the most effective way. For instance, algae are reliable indicators to describe the effects of nutrients and eutrophication. Macrophyte bioindication is perfect to document the effects of long-term nutrient aspects and hydro-morphological impairments. Benthic invertebrates are good indicators of (organic) pollution and hydro-morphological deficits at the micro-habitat scale. And finally, fish fauna is considered as a mandatory group of aquatic biota in the evaluation of the ecological status of aquatic ecosystems and supreme indicators to study the effects of hydro-morphological deficits on the meso-habitat and reach scale, including lateral and longitudinal connectivity up to the basin scale.

Bioindication and biomonitoring have a great tradition in using freshwater biota as reliable indicators of the aquatic ecosystem health. Different groups at a different level of organization (individual, population, community, and ecosystem) have been used worldwide by national water authorities in defining the regional specific routine monitoring programs. The EU WFD requires the employment of different multimetric assessment systems. The EU funded many projects that had the main objective to develop a framework for a future European stream assessment system based on algae, benthic macroinvertebrates, aquatic macrophytes, and fish that had an output in multimetric indices (AQEM, 2002; Fame Consortium, 2004; 2009; Schmutz & Sendzimir, 2018).

Next, many additional functional skills and knowledge are necessary for successful ecological monitoring and bioassessment which mainly refers to the data processing skills and administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems. Moreover, data analysis presents the most important step to achieve a reliable outcome and required information. Data analysis is a process of collecting, transforming, cleaning, and modelling data which requires specific knowledge and skills.

Bearing all this in mind, management of freshwater ecosystems should be governed by a long-term vision that is agreed to by consensus between all major stakeholders. The vision must give equal weight to the three pillars of sustainable development—economic, social, and environmental concerns. Many governmental and non-governmental institutions stress the need to maintain and restore ecosystem services and biodiversity in order to enhance local livelihoods. Thus, the investment of adequate financial and human resources into capacity building and participation processes is one of the keys to successful freshwater monitoring and bioassessment, especially in developing countries in Europe where existing capacity is likely to be most limited. Freshwater monitoring and bioassessment must be based on scientific data and an understanding of freshwater ecosystems and their component key hydrological and ecological processes. Similarly, socioeconomic analyses are essential for understanding the drivers behind water use and abuse. All institutions which work in domain of freshwater monitoring and bioassessment should provide an optimal number of employees having adequate skills to facilitate the transfer of scientific data analysis to the broader public in order to inform and raise awareness on critical issues. At the same time, the illustrations are used to improve and advance policy processes on national, regional, and global levels.

Finally, modernization of master programs in the Balkan countries and consequently education of future professionals, with specific skills in freshwater monitoring and bioassessment, is a crucial step to provide different profiles on the labor market in Bosnia and Montenegro. Availability

of all necessary profiles in domain of freshwater biomonitoring and ecological engineering will enable an efficient monitoring in accordance with the WFD in the future.

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ANALYSIS OF LABOUR MARKET NEEDS RELEVANT TO EMAB IN PARTNER COUNTRIES

1. RESULTS OF QUESTIONNAIRES RELATE BOSNIAN LABOUR MARKET NEEDS

The survey was sent and successfully conducted in 18 institutions dealing ecological monitoring and bioassessment of freshwaters in Bosnia. The main goal was to estimate approximate number of new job position and/or number of prequalifications needed. The target institutions will be asked to estimate number of new job positions and trainings required for the following skills:

- monitoring of aquatic macrophytes
- monitoring of macroinvertebrates
- microbiological monitoring of aquatic ecosystems
- monitoring and assessing of fish stock
- GIS and remote sensing monitoring
- environmental engineering and water protection technologies
- monitoring of riparian habitats
- monitoring of macroalgae and cryptogamic flora
- data processing
- administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems
- writing project proposals
- molecular methods for routine aquatic monitoring

1.1. TUZLA CANTON

Filled questioners were sent back from seven Institutions working in EMAB sector: ENERGOSISTEM Brčko Distrikt, GIKIL Lukavac, JP Vodovod i kanalizacija SREBRENİK, KOMUS Gračanica, SISECAM SODA D.O.O Lukavac, SPREČA Tuzla and TQM d.o.o. Lukavac. The public utility company “Vodovod i kanalizacija” SREBRENİK showed the greatest need for prequalification of present employees, mainly in the area of GIS and remote sensing monitoring and environmental engineering and water protection technologies (10 positions). In contrast, SISECAM SODA D.O.O Lukavac, The public utility company SPREČA Tuzla did not show any requirements in terms of new job positions and/or prequalifications.

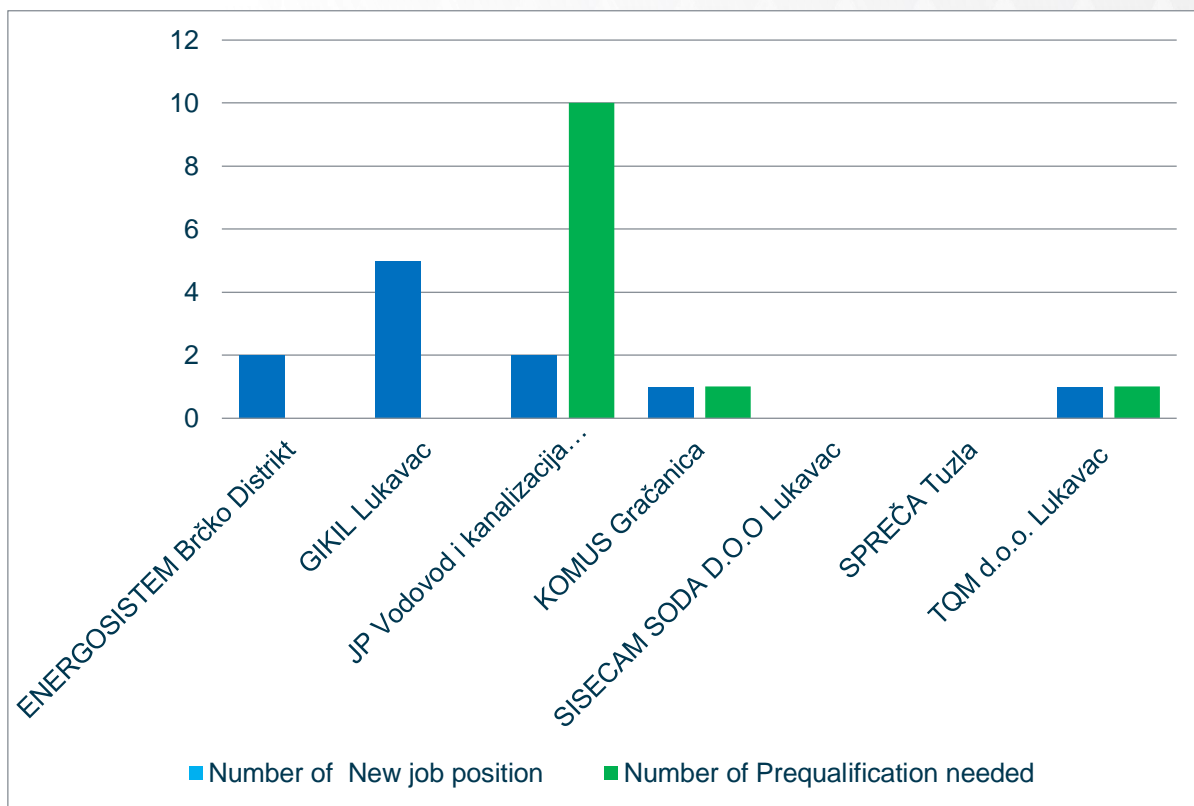


Figure 3. Approximation of labour market needs in Tuzla Canton

Table 1. Number of required job positions in Tuzla Canton

	Number of new job position	Number of prequalifications needed
Monitoring of aquatic macrophytes		
Monitoring of macroinvertebrates		
Microbiological monitoring of aquatic ecosystems		
Monitoring and assessing of fish stock		
GIS and remote sensing monitoring	1	4
Environmental engineering and water protection technologies	4	7
Monitoring of riparian habitats		
Monitoring of macroalgae and cryptogamic flora		
Data processing		
Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems	3	
Writing project proposals	3	1
Molecular methods for routine aquatic		

1.2. SARAJEVO CANTON

Labour market needs for three institutions were analyzed in Sarajevo Canton: Una Consulting, River Sava Basin Agency and Adriatic Sea Watershed Agency and Prevent leather technologies. The highest number for the both, new job positions and/or prequalifications, is needed for River Sava Basin Agency and Adriatic Sea Watershed Agency for the following skills: monitoring of aquatic macrophytes, environmental engineering and water protection technologies and monitoring of riparian habitats.

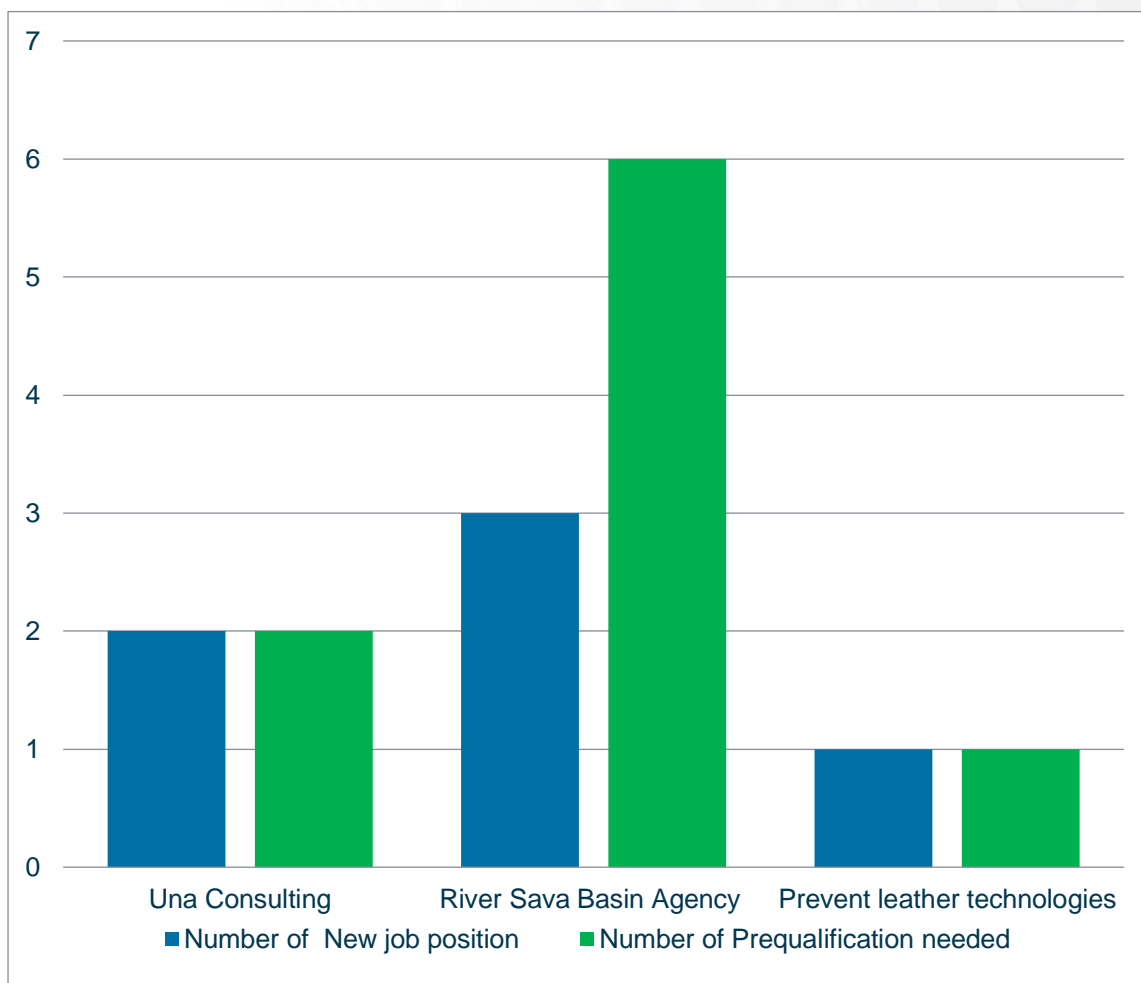


Figure 4. Approximation of labour market needs in Sarajevo Canton

Table 2. Number of required job positions in Sarajevo Canton

	Number of new job position	Number of prequalifications needed
Monitoring of aquatic macrophytes	1	1
Monitoring of macroinvertebrates		
Microbiological monitoring of aquatic ecosystems		
Monitoring and assessing of fish stock		
GIS and remote sensing monitoring		
Environmental engineering and water protection technologies	3	4
Monitoring of riparian habitats	1	2
Monitoring of macroalgae and cryptogamic flora		
Data processing		
Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems	1	2
Writing project proposals		
Molecular methods for routine aquatic		

1.3. HERZEGOVINA-NERETVA CANTON

In this Canton two institutions were pleased to answer the questionnaire: The Faculty of Science and Education at the University of Mostar and Legal entity for water management for the Adriatic Sea catchment area. Even 15 prequalifications are needed the Faculty of Science and Education at the University of Mostar to be able to successfully conduct ecological monitoring and bioassessment of freshwaters, requiring the experts in all proposed skills. Two people are needed to be employed to do monitoring of macroinvertebrates and administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems. Legal entity for water management for the Adriatic Sea catchment area plan to employ two persons to work in the field of environmental engineering and water protection technologies and data

processing, while six prequalifications are needed for: monitoring of macroinvertebrates, GIS and remote sensing monitoring, environmental engineering and water protection technologies, data processing, administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems and writing project proposals.

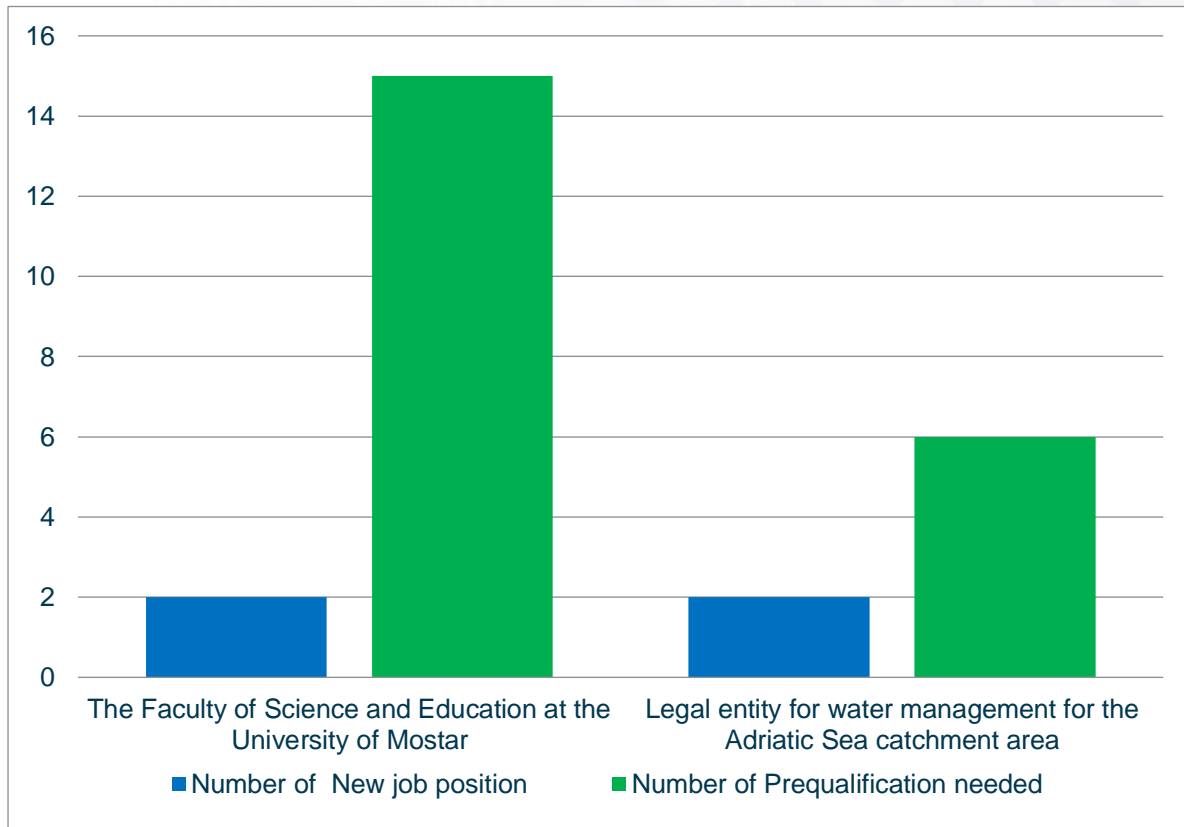


Figure 5. Approximation of labour market needs in Hercegovina-Neretva Canton

Table 3. Number of required job positions in Hercegovina-Neretva Canton

	Number of new job position	Number of prequalifications needed
Monitoring of aquatic macrophytes		1
Monitoring of macroinvertebrates	1	2
Microbiological monitoring of aquatic ecosystems		2
Monitoring and assessing of fish stock		1
GIS and remote sensing monitoring		2
Environmental engineering and water protection technologies	1	2
Monitoring of riparian habitats		1
Monitoring of macroalgae and cryptogamic flora		1
Data processing	1	2
Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems	1	2
Writing project proposals		3
Molecular methods for routine aquatic		2

1.4. CENTRAL BOSNIA CANTON

In Central Bosnia Canton only one company was surveyed.

Table 4. Number of required job positions in Central Bosnia Canton

	Number of new job position	Number of prequalifications needed
Monitoring of aquatic macrophytes		
Monitoring of macroinvertebrates		
Microbiological monitoring of aquatic ecosystems		
Monitoring and assessing of fish stock		
GIS and remote sensing monitoring		1
Environmental engineering and water protection technologies		1
Monitoring of riparian habitats		
Monitoring of macroalgae and cryptogamic flora		
Data processing		1
Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems		1
Writing project proposals		1
Molecular methods for routine aquatic		

1.5. REPUBLIC OF SRPSKA

Labour market needs are investigated in Republic of Srpska in two cities: Banja Luka and Zvornik. For this purpose, the questionnaire was sent to five institutions: Civil Engineering Institute IG, Public Health Institute RS and Vode Srpske in Banja Luka and Public Health Institute Zvornik and The Faculty of Technology in Zvornik. Only Public Health Institute RS and The Faculty of Technology in Zvornik offer new job positions (5). Also, Public Health Institute RS and Civil Engineering Institute have specific needs for prequalifications (6, 6, 5, respectively).

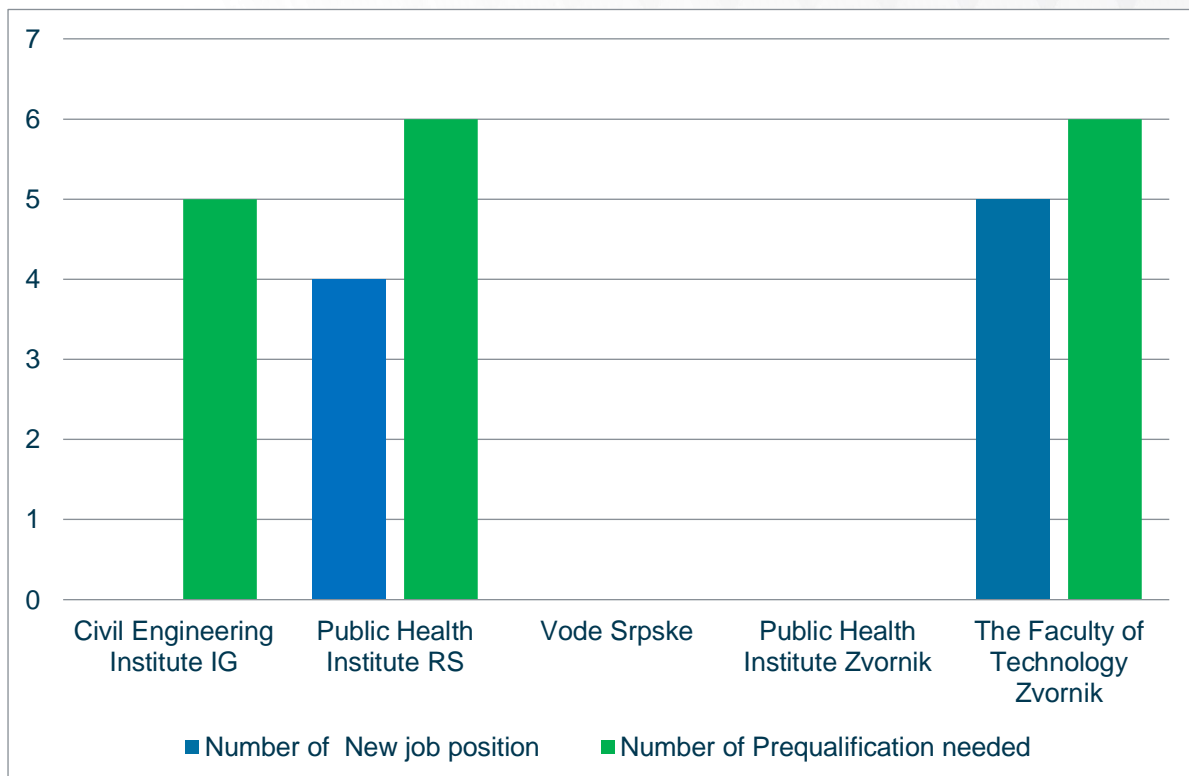


Figure 6. Approximation of labour market needs in Republic of Srpska

Table 5. Number of required job positions in Republic of Srpska

	Number of new job position	Number of prequalifications needed
Monitoring of aquatic macrophytes		
Monitoring of macroinvertebrates	1	1
Microbiological monitoring of aquatic ecosystems		1
Monitoring and assessing of fish stock	1	
GIS and remote sensing monitoring		1
Environmental engineering and water protection technologies	2	4
Monitoring of riparian habitats	1	
Monitoring of macroalgae and cryptogamic flora	1	1
Data processing	1	1
Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems		4
Writing project proposals	2	3
Molecular methods for routine aquatic		

1.6. ANALYSIS OF LABOUR MARKET NEEDS IN BOSNIA

Based on the data, collected from surveys conducted in 18 institutions in Bosnia, 29 (32%) new job positions and 62 (68%) prequalifications of existing job positions are required.

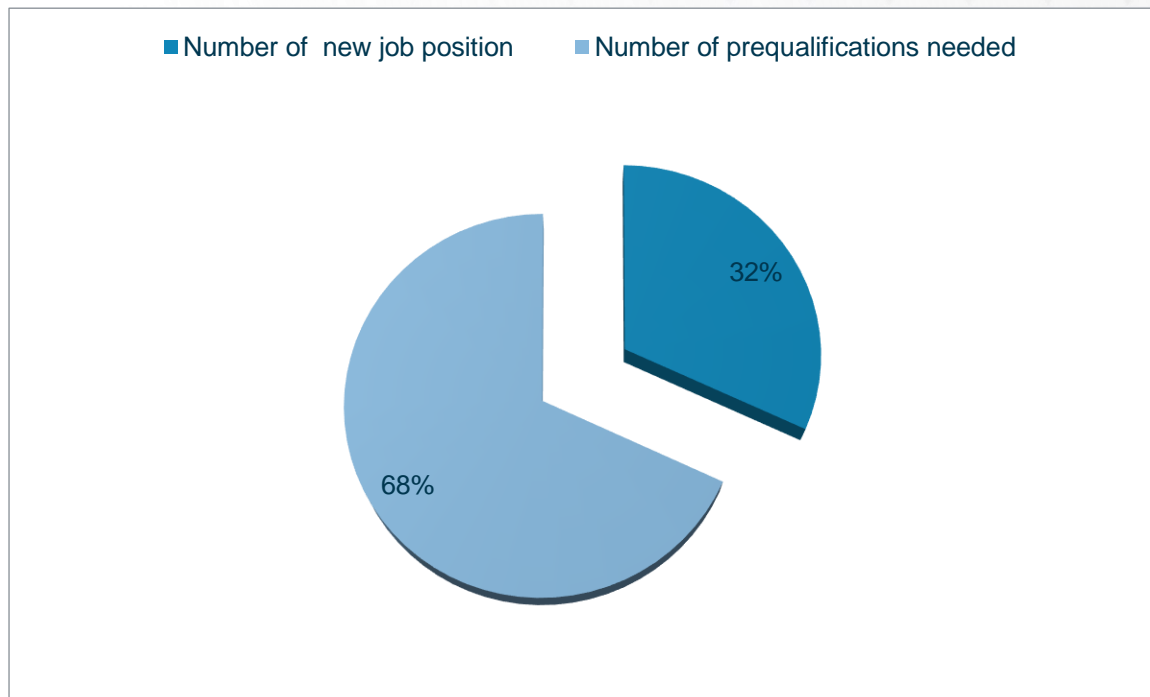


Figure 7. Percentage of new job positions vs prequalifications needed in Bosnia

The highest number of new job positions is in Republic of Srpska and Sarajevo Canton. No new job positions are need in Central Bosnia Canton. However, this information may not be convenient since labour market needs for only one company was available.

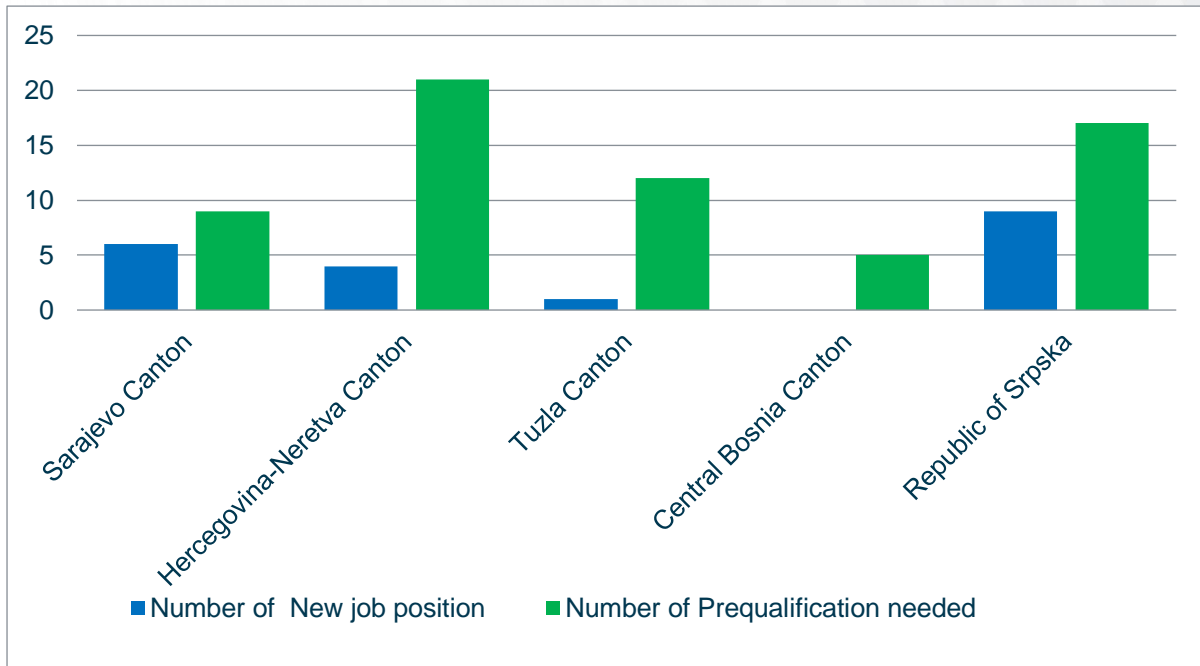


Figure 8. Number of new job positions vs prequalifications needed per Canton in Bosnia

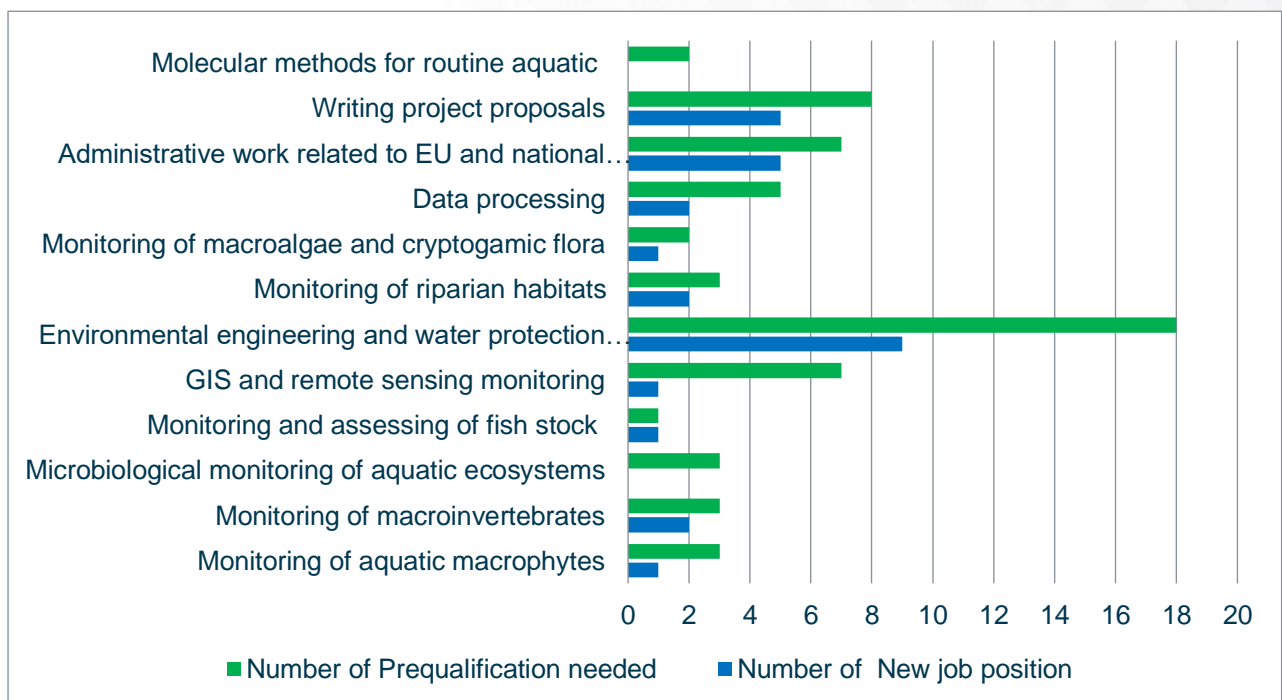


Figure 9. Number of new jobs and prequalifications required in Bosnia per different skills in freshwater monitoring and bioassessment

Environmental engineering and water protection technologies showed the highest labour market needs in Bosnia in term of the both, new job position and prequalification. Next the most needed profile is for Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems and Writing project proposal, followed by GIS and remote sensing monitoring and Data processing.

2. RESULTS OF QUESTIONNAIRES RELATE MONTENEGRIN LABOUR MARKET NEEDS

The survey was sent and successfully conducted in 7 governmental and 6 non-governmental institutions dealing ecological monitoring and bioassessment of freshwaters in Bosnia. The same as in Bosnia, the main goal was to estimate approximate number of new job position and/or number of prequalifications needed. The target institutions will be asked to estimate number of new job positions and trainings required for the following skills:

- monitoring of aquatic macrophytes
- monitoring of macroinvertebrates
- microbiological monitoring of aquatic ecosystems
- monitoring and assessing of fish stock
- GIS and remote sensing monitoring
- environmental engineering and water protection technologies
- monitoring of riparian habitats
- monitoring of macroalgae and cryptogamic flora
- data processing
- administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems
- writing project proposals
- molecular methods for routine aquatic monitoring

2.1. GOVERNMENTAL INSTITUTIONS

The labour market needs in Montenegrin governmental institutions were successfully investigated according to information given from 7 companies: PROCORN, Directorate of Water Management, The Environmental Protection Agency of Montenegro, Institute of Hydrometeorology and Seismology of Montenegro, Water administration, National Parks of Montenegro and Natural history museum. Only Natural history museum did not show any labour market needs considering the both, new job positions and prequalifications of existing positions. The highest number of new job positions were requested from Institute of Hydrometeorology and Seismology of Montenegro and Water administration (6), followed by Directorate of Water Management (5). Qualifications needed for required new job positions mainly consider following skills: monitoring and assessing of fish stock, GIS and remote sensing monitoring, environmental engineering and water protection technologies, monitoring of riparian habitats, monitoring of macroalgae and cryptogamic flora, data processing, administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems, writing project proposals and molecular methods for routine aquatic monitoring.

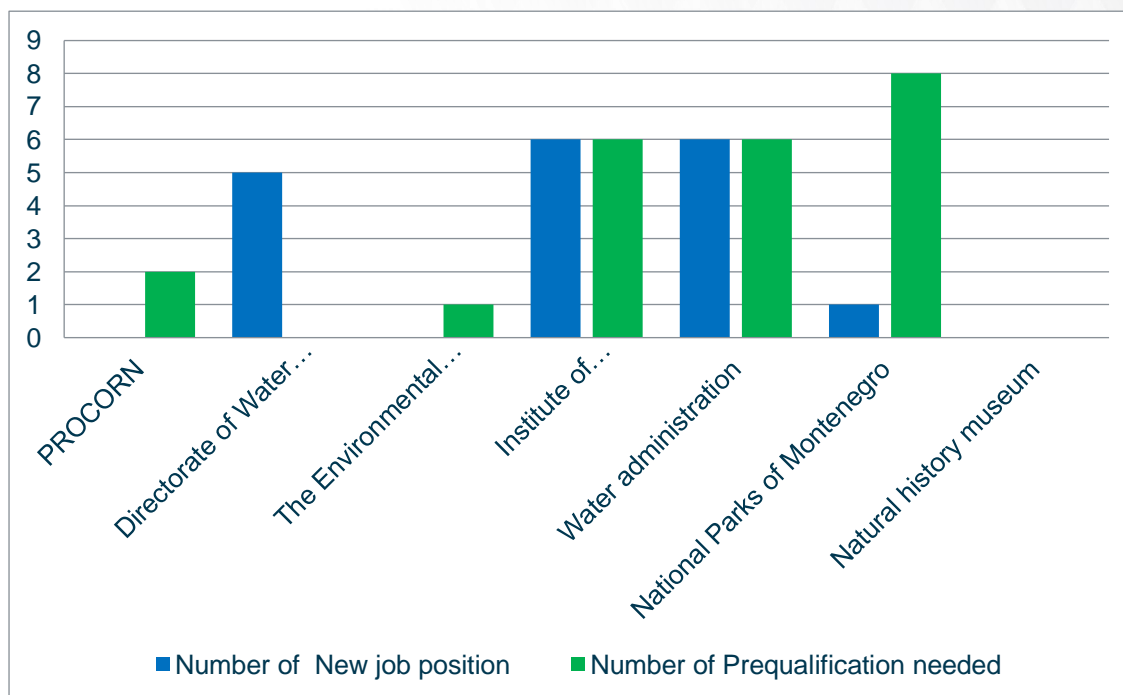


Figure 10. Approximation of labour market needs in governmental institutions in Montenegro

Table 6. Number of required job positions in governmental institutions in Montenegro

	Number of new job position	Number of prequalifications needed
Monitoring of aquatic macrophytes	1	
Monitoring of macroinvertebrates		1
Microbiological monitoring of aquatic ecosystems		1
Monitoring and assessing of fish stock	2	3
GIS and remote sensing monitoring	2	4
Environmental engineering and water protection technologies	2	2
Monitoring of riparian habitats	1	
Monitoring of macroalgae and cryptogamic flora	1	
Data processing	1	3
Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems	4	6
Writing project proposals	3	3
Molecular methods for routine aquatic monitoring	1	

The highest number of prequalifications required are noticed in three institutions: National Parks of Montenegro (8) and Institute of Hydrometeorology and Seismology of Montenegro and Water administration (6). The most needed skills are: monitoring of macroinvertebrates, microbiological monitoring of aquatic ecosystems, monitoring and assessing of fish stock, GIS and remote sensing monitoring, environmental engineering and water protection technologies, data processing, administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems and writing project proposals.

2.2. NON-GOVERNMENTAL INSTITUTIONS

The labour market needs in non-governmental institutions of Montenegro were successfully investigated according to information given from 6 companies: Center for Protection and Research of Birds (CZIP), KOD, EnvPro, Montenegrin Ecologists Society (MES), Centre for climate change, natural resources and energy (CCCNRE) and Institute for entrepreneurship and economic development (IPER). All most all investigated non-governmental institutions need new employees except CZIP. Moreover, Montenegrin Ecologists Society requested nine new job positions, while other companies need less: CCCNRE and KOD - 4, EnvPro – 3 and IPER – 1. New job positions are required for almost all proposed skills from the list, except microbiological monitoring of aquatic ecosystems and molecular methods for routine aquatic monitoring.

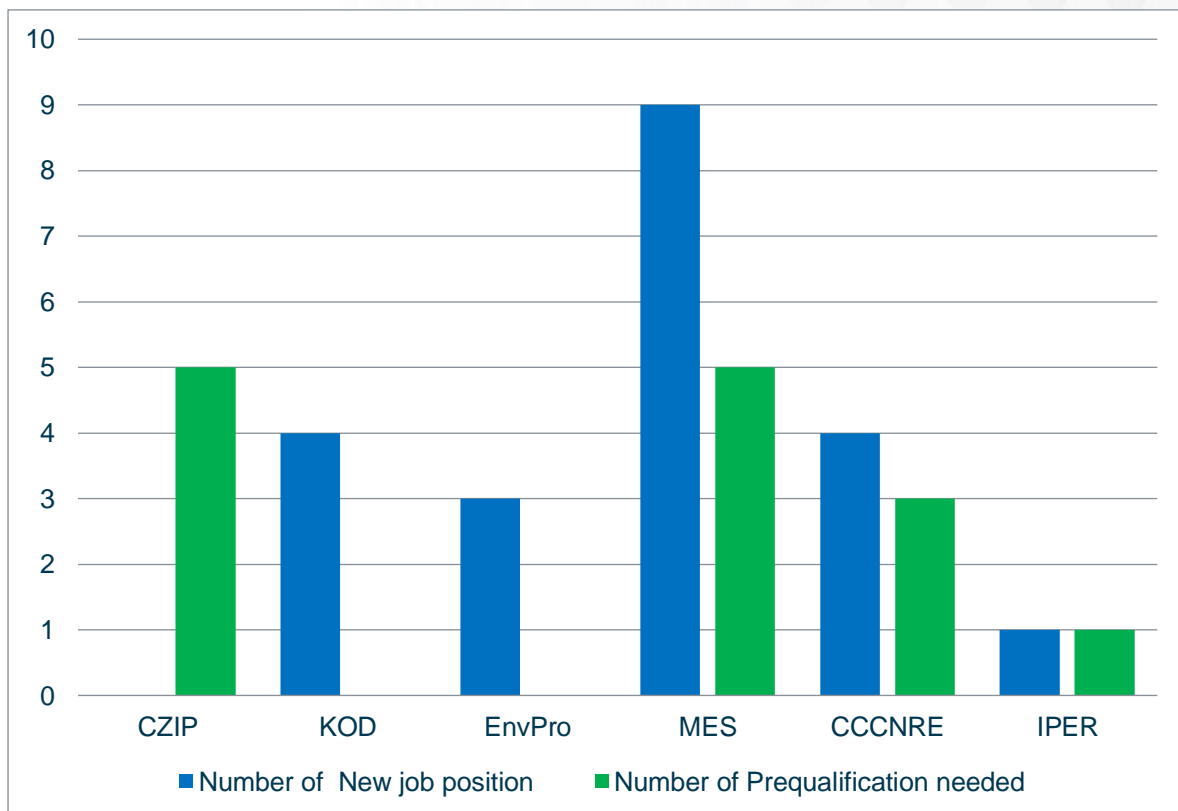


Figure 11. Approximate labour market needs in non-governmental institutions in Montenegro

The highest number of prequalifications required are noticed in two institutions: CZIP and MES (5). Needed prequalification consider mainly knowledge improvement in the field of GIS and remote sensing monitoring, monitoring of riparian habitats, data processing, administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems and writing project proposals.

Table 7. Number of required job positions in governmental institutions in Montenegro

	Number of new job position	Number of prequalifications needed
Monitoring of aquatic macrophytes	2	
Monitoring of macroinvertebrates	1	
Microbiological monitoring of aquatic ecosystems		
Monitoring and assessing of fish stock	2	
GIS and remote sensing monitoring	2	4
Environmental engineering and water protection technologies	2	
Monitoring of riparian habitats	2	2
Monitoring of macroalgae and cryptogamic flora	1	
Data processing	3	3
Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems	3	2
Writing project proposals	3	2
Molecular methods for routine aquatic monitoring		1

2.3. ANALYSIS OF LABOUR MARKET NEEDS IN MONTENEGRO

According to the relevant data, achieved from several governmental and six non-governmental institutions, 39 (51%) new job positions and 37 (49%) prequalifications of existing job positions are required.

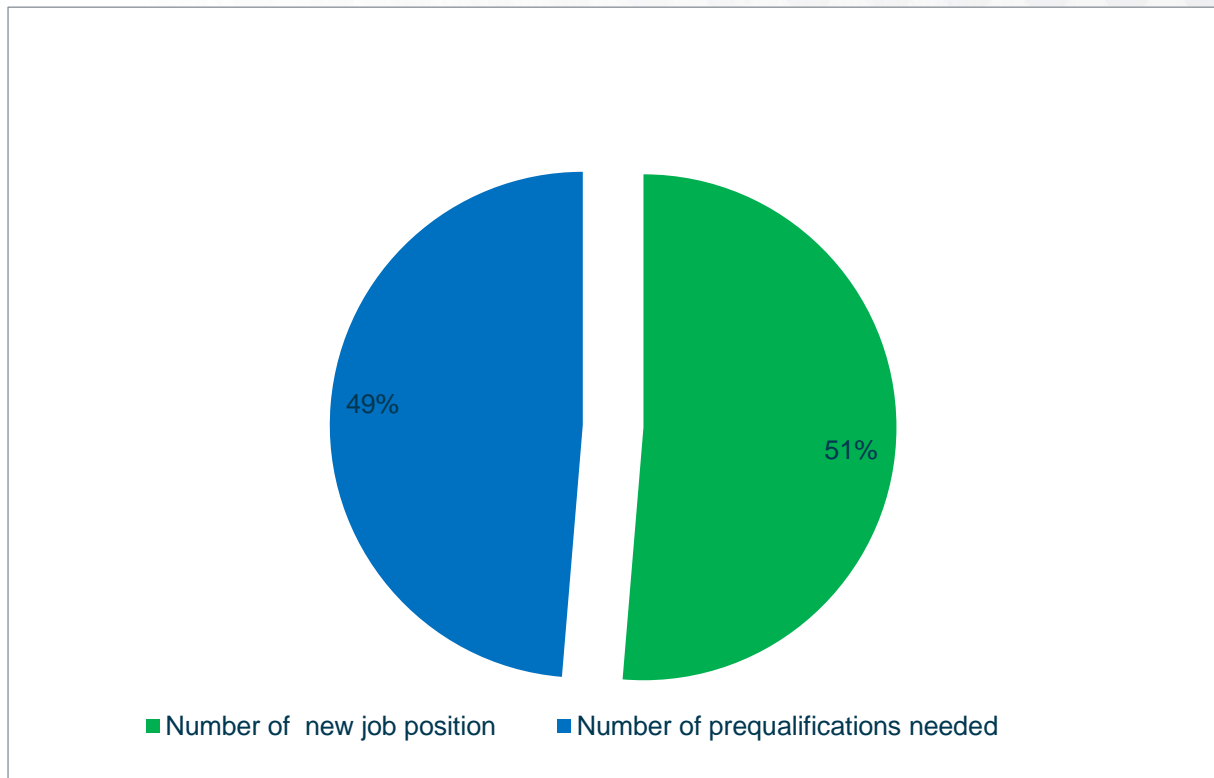


Figure 12. Percentage of new job positions vs prequalifications needed in Montenegro

In non-governmental sector, higher number of new job positions are needed (21) while for the governmental institutions is lower (18). However, in significantly higher number of prequalifications are required for governmental institutions (23) in comparison to the non-governmental institutions (14).

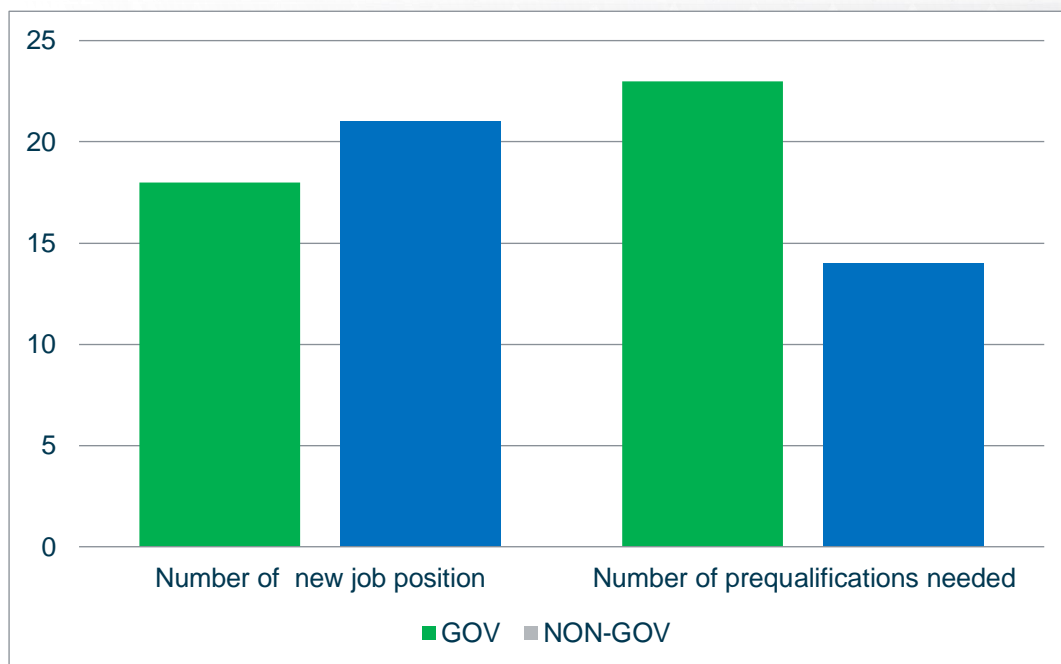


Figure 13. Number of new job positions vs prequalifications needed governmental vs non-governmental sector in Montenegro

Considering different skills for freshwater monitoring, proposed by questionnaire, the highest interest was shown for GIS and remote sensing monitoring and Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems, considering either new job or prequalification positions. New job positions are mainly opened for Writing projects proposals (6) and Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems (7), followed by Monitoring and assessing of fish stock, GIS and remote sensing monitoring, Environmental engineering and water protection technologies and Data processing (4) as well as Monitoring of aquatic macrophytes and Monitoring of riparian habitats (3). No new job positions in Montenegro are required for Microbiological monitoring of aquatic ecosystems. Considering potential prequalifications, eight positions need to enhance the knowledge in term of GIS and remote sensing monitoring and Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems, and then for Data processing (6), Writing projects proposals (5) and Monitoring and assessing of fish stock (3).

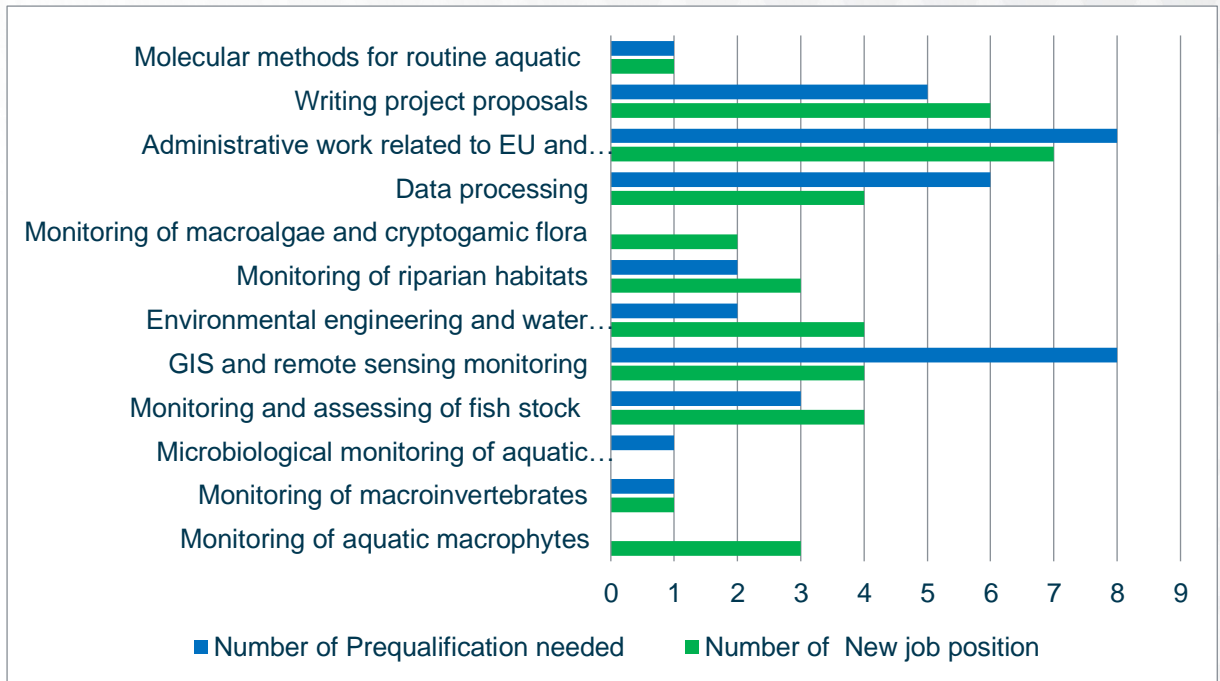


Figure 14. Number of new jobs and prequalifications required in Montenegro per different skills in freshwater monitoring and bioassessment

3. CONCLUSIONS

The general conclusion obtained from this research is that labour market needs are higher in Bosnia in comparison to Montenegro, when the both, prequalification and new job needs are considered. Nevertheless, new job offers are significantly higher in Montenegro, especially in non-governmental institutions.

The highest interest was noticed for several skills: GIS and remote sensing monitoring, Administrative work related to EU and national legislation and policy in water quality and conservation of freshwater ecosystems and Writing project proposals in Montenegro and Environmental engineering and water protection technologies in Bosnia. None of new job position are needed for Molecular methods for routine aquatic and Microbiological monitoring of aquatic ecosystems in Bosnia and Microbiological monitoring of aquatic ecosystems in Montenegro.

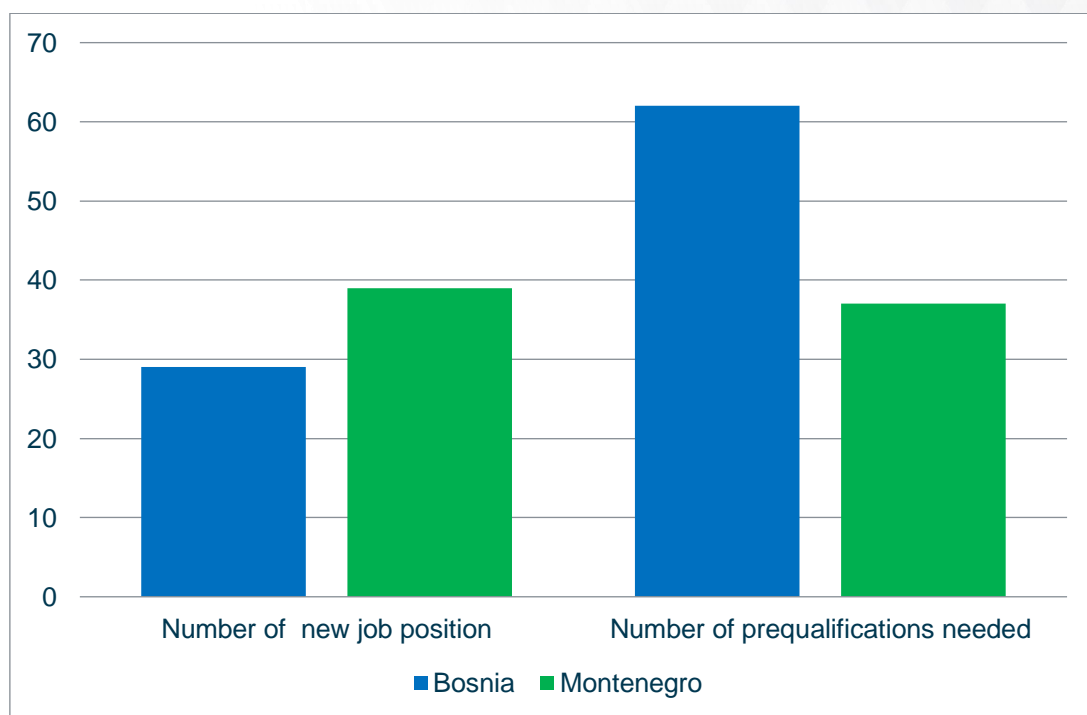


Figure 15. Number of new job positions vs prequalifications needed in Bosnia and Montenegro

This survey was based on labour market needs in total of 31 companies in Bosnia and Montenegro. Global Corona Virus Pandemic significantly affected the number of companies where surveys were successfully conducted. During the investigation, many problems in communication with relevant institutions appears as a consequence of the present state of emergency and specific circumstances in target countries.

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