Training Specialists in Water Resources in Russia: Typology of Educational Programs

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Abstract: - This article provides a typology of higher education educational programs in the field of water resource management. Data for the study were obtained from the statistical reporting form "VPO-1" for 2017-2023. Data processing and analysis were performed using the pandas, numpy, matplotlib, seaborn, sklearn libraries for the general-purpose Python programming language. To determine the typology of regions, the Gaussian Mixture Model (GMM) clustering method was used. Clustering was performed for the entire period from 2017 to 2023 according to the parameters of the number of applicants and admitted students, resulting in three models. The training of specialists in the field of water resources is structured and hierarchical, encompassing three mainstream educational tracks implemented at both the bachelor's and master's levels: "Environmental management and water use," "Aquatic bioresources and aquaculture," and "Water transport management and hydrographic support of navigation." All three models feature only one bachelor's degree program: "Environmental Management and Water Use", implemented in Moscow in 2021 in official state universities. According to the first model, it is classified as "traditional", according to the second - as "popular", according to the strings - as "growing popularity". Typology of training programs of a regional nature. All three economic models represent programs either from regions where water management is an important part (Astrakhan region - 2 programs and Krasnodar Territory - 1 program), or implemented in Moscow and St. Petersburg, which confirms the centripetal dynamics of the Russian economy that determines advanced research. Higher education systems. Consequently, St. Petersburg is not only a second educational center but also a region with a developed economy in the field of water resources due to its access to the Baltic Sea.

Key-Words: - Higher education, Water resources, Bachelor's programs, Environmental management and water use, Aquatic bioresources and aquaculture, Water transport management and hydrographic support of navigation.

Received: July 14, 2024. Revised: November 22, 2024. Accepted: December 17, 2024. Published: December 31, 2024.

1 Introduction

Effective and rational utilization and management of water, land, and biological resources are unattainable without the preparation of qualified specialists in the relevant fields. Currently, in modern Russia, there is a sectoral character in the management of higher education institutions (universities). About one-third of students in state universities are enrolled in sectoral faculties. The largest numbers of in-demand specialists in the fields of agriculture, forestry, and water management, including natural resource management, environmental safety, and ecological engineering, are prepared in agricultural universities, [1]. There are many works that study the problems of higher education in the field of water resources management. There is a body of work that has investigated in problems of higher education in the field of water resources management. In their seminal work "Water Resources Systems Planning and Management," the authors have summarized the substantive aspects of water resources education, [2]. Integrated water resources management (IWRM), [3], [4] and the nexus approach are considered universal concepts for water resources education, [5]. It is worth noting thar, a literature review was conducted to identify existing studies that include deep learning methods in the water sector regarding the monitoring, management, and communication of water resources, [6]. The students' level of water literacy was evaluated, which enabled them to effectively deliberate on hydrological concepts that underpin socio-hydrological problems, [7]. Descriptions of

comprehensive water resource management educational programs in the USA were provided, [8], [9]. The advantages of employing innovative teaching methods for water resource-related subjects at higher education institutions in Central Asia include improving the effectiveness of university interactions through networking, [10]. One study described the design, development, and assessment of an undergraduate learning module that develops students' skills in data analysis and numerical modeling for the analysis and design of engineering water resource projects, [11]. Archetypes of problems were identified as a common foundation for education in water resources management, [12]. The experience of using educational resources for higher education, developed in the field of "Geoethics and Water Resources Management" funded under the Erasmus+ program, was summarized, [13]. Taught courses and the interests of faculty members of geography departments in the USA were cataloged, revealing 129 departments where both courses and faculty have experience in water resources, [14]. According to some authors, to accelerate the transition to practice-oriented learning, the issue of water resources restoration should be integrated into new higher education curricula to prepare the next generation of young professionals in environmental engineering, [15]. The peculiarities of implementing educational innovations in the fields of hydrology and water resources engineering were studied, [16]. The literature also considers the pedagogical views of teachers with experience in remote sensing, geomorphology, human geography, environmental sciences, ecology, and private business. The reflections of these teachers provide insight into contemporary approaches to teaching water and geospatial methods, [17]. The status of water resources management education provided in higher education institutions in India has been identified, and a gap has been between what is taught and what is needed in this field, [18]. A case of partnership between local communities and two universities in Ecuador was examined, which allowed for gathering information on water reserves, extraction processes, replenishment of aquifers, and resource management, [19]. New approaches to developing educational programs in water resources systems planning and management in the Western Balkans were analyzed, [20]. A case of student participation in water consumption management, conservation, and economy, and the management of water reuse on the campus of a university in Taiwan [21], China [22] and USA [23].

In summarizing the literature analysis, it should be noted that most studies generally consider the specifics of student education in water in general, and studies considering regional specifics are lacking. This article investigates the typology of Russian regions according to the number of students and training directions in the field of water resources.

2 Materials and Methods

The VPO-1 form contains generalized information on the development of the higher education system in the Russian Federation. This report can be accessed on the website of the Ministry of Higher Education and Science of the Russian Federation. The VPO-1 form is presented separately for each region according to the forms of education (full-time, part-time, correspondence) and types of universities (state or non-state universities). This distribution of information results in six source files in xls format being provided for most regions, with the name of the region and indications of the form of education and type of university in the title. Information about students admitted at the expense of the federal budget of the Russian Federation for the first course is contained in each file on an MS Excel sheet named "R2_1_1". For analysis, only educational programs that contain various forms of the word "water" in their title were selected. With a Python programming language script, all source files were combined into one dataset for seven years from 2017 to 2023. The article uses a dataset that includes the following variables: region - the subject of the Russian Federation, priem_all_budget - number of students admitted at the expense of the state budget, priem_vnebudget – number of students admitted under tuition payment agreements, zaiyvl_budget - number of applications of applicants submitted for study at the expense of the state budget, konkurs_budget – as the ratio of the number of applications to the number of accepted students to study at the expense of the state budget, napravlenie - direction of student training, code – code of the training direction, allowing to determine the level of education (bachelor, master, specialist), vuz_type – type of university (state or private), form of education – form of education (full-time, part-time, correspondence). Data processing and analysis were conducted using the pandas, numpy, matplotlib, seaborn, sklearn libraries for the general-purpose programming language Python. To identify the typology of the regions, a clustering method was used namely – the Gaussian Mixture Model (GMM). This model assumes that clusters can be

modeled using at Gaussian distribution. GMM holds significant importance in statistics and data analysis. It has been used since the late 19th century when Pearson (1894) proposed it for studying the morphometry of crabs. In the 21st century, with the advancement of computer technology, GMM has become a crucial tool for analyzing big data and complex systems, [24]. The mixture model has proven its effectiveness in modeling clustered data, making it indispensable in statistics, [25]. GMM allows for determining the number of different component distributions, making it viable for handling complex systems, [26], [27]. Clustering was performed out within three models, with two parameters. Clustering was conducted for the entire period from 2017 to 2023. To determine the optimal number of clusters, we used the Bayesian Information Criterion (BIC) and the elbow method (also known as the "scree plot method"), after which the silhouette coefficient was calculated. The parameter is defined to assess the quality of clusters created by the algorithm. Scores range from -1 to +1: the higher the silhouette score, the better the model. The Bayesian Information Criterion (BIC) is used to determine the optimal number of clusters in cluster analysis because it accounts for model complexity by adding a penalty for the number of parameters, helping to avoid overfitting, [28]. It allows for the comparison of different models, with the model having the lowest BIC value being considered the best, [29]. BIC helps select models that generalize well to new data, ensuring they are not just fitting the training data, [30]. Additionally, models chosen using BIC are usually more interpretable due to having fewer parameters, making the results easier to understand, [31].

3 Result

The number of students admitted to educational programs for the years 2017-2023 is presented in Table 1.

Two uneven groups of higher education programs are distinguished. The last four programs by number are highly specialized, with three of the four programs admitting less than 100 people, and are not represented in most universities. For these reasons, these subjects were excluded from our further analysis. The first six programs by student number represent a complete system of two levels of training: each bachelor's direction corresponds to its own master's training direction.

Table 1. Number of students admitted to educational programs for 2017-2023

Degree program	Degree program code	Number of students	Master's to bachelor's ratio
Environmental management and water use	20.03.02	9052	0,44
Aquatic bioresources and aquaculture	35.03.08	6812	0,21
Water transport management and hydrographic support of navigation	26.03.01	4179	0,25
Environmental management and water use	20.04.02	4005	
Aquatic bioresources and aquaculture	35.04.07	1445	
Water transport management and hydrographic support of navigation	26.04.01	1065	
Waterways, ports, and hydraulic structures	26.03.03	238	
Application and operation of technical systems of surface ships and submarines	26.05.04	84	
Engineering and economic support of water transport technologies and business processes	26.03.04	28	
Construction, repair, and search and rescue support of surface ships and submarines	26.05.03	13	

Source: Data processing with Python

In the training direction "Environmental management and water use," 9,052 bachelors and 4,005 masters are educated, with a high masters-to-bachelors ratio of 0.44. In the training direction "Aquatic bioresources and aquaculture," 6,812 bachelors and 1,445 masters are educated, with a low masters-to-bachelors ratio of 0.21. In the training direction "Water transport management and hydrographic support of navigation," 4,179 bachelors and 1,065 masters were educated, with a low masters-to-bachelors ratio of 0.25. To identify the typology of training specialists in the field of water resources, we constructed three clustering models. The parameters of each model are listed in Table 2.

Table 2. The clustering model parameters

Parameters	Model 1	Model 2	Model 3
priem_all_budget - number of students admitted at the expense of the state budget	+	+	+
priem_vnebudget – number of students admitted under tuition payment agreements	+		
zaiyvl_budget - number of applications of applicants submitted for study at the expense of the state budget		+	
konkurs_budget –as the ratio of the number of applications to the number of accepted students to study at the expense of the state budget			+

Source: Compiled by the authors

For the first model, we selected only training directions and regions where at least 80 students were admitted on a state-funded basis. For the second model, we selected only training directions and regions where at least 300 applications were submitted by prospective students. For the third model, we selected only training directions and regions where at least 50 students were admitted on a state-funded basis.

The significance coefficients of the clustering models are presented in Table 3.

Table 3. Significance coefficients of the clustering model

Cluster	Model 1	Model 2	Model 3
2	0.74	0.70	0.47
3	0.57	0.60	0.62
4	0.54	0.56	0.60
5	0.34	0.50	0.50
6	0.37	0.50	0.48
7	0.34	0.47	0.43

Source: Data processing with Python

The distribution of 2-7 clusters of the Gaussian mixture model (GMM) model is presented in Figure 1 (Appendix). For analysis in model 1, we used a model with 3 clusters, and the significance coefficient of the model was 0.57, indicating a satisfactory level of clustering. The typology of educational programs in Model 1 is presented in Table 4.

Based on the data in Figure 1 (Appendix), it can be seen that the first cluster includes two educational programs, while the second cluster comprises seven educational programs. The distribution of educational programs according to Model 1 is shown in Table 5 (Appendix).

Table 4. The typology of educational programs in Model 1

Type	Priem_all_budget	Priem_vnebudget
underdog	low	low
developing	low	medium
in demand	low	high
dynamic	medium	low
balanced	medium	medium
stable	medium	high
traditional	high	low
stable	high	medium
leader	high	high

Source: Compiled by the authors

From the data in Table 5 (Appendix), we observe that the first cluster includes two bachelor's programs in the field of "Aquatic bioresources and aquaculture". The first program, according to our classification of educational program types for Model 1, can be categorized as "in demand". In 2021, it admitted 129 students under a non-budgetary form of education and 16 students at the expense of the state budget. The form of education for this program is correspondence. The second program can be classified as "developing", with 69 students admitted in 2020 under a non-budgetary form of education and 30 students at the expense of the state budget. The form of education for this program is full-time. Both programs are implemented in state universities in the Astrakhan region. The surface waters of the Astrakhan region are represented by the Volga River which has numerous watercourses (about 900 units), fresh and saline water bodies (about 1000 units), and the largest enclosed water body on the planet - the Caspian Sea.

Water resources in the Astrakhan region constitute an important economic sector. The fisheries complex of the Astrakhan region encompasses all major activities: harvesting aquatic bioresources, reproduction, commercial fish farming (aquaculture), processing raw materials, and producing various types of fish products. The natural and climatic conditions of the Astrakhan region favor the development of aquaculture, which is one of the leading sectors of the region's agriculture. The presence of enterprises indicates a demand for professions in the market. Some applicants are willing to pay for their education independently, understanding that there is a demand for workers in the field of "Aquatic bioresources and aquaculture" among employers in the region. The second cluster included seven bachelor's training directions classified as "traditional". Six programs were implemented under "Environmental Management and water use" in Moscow, in state

universities with a full-time form of education from 2016 to 2021. We can observe a trend of annual reduction in the number of students admitted at the expense of the state budget from 145 people in 2016 to 119 people in 2021. The number of students admitted under paid education contracts was 13 people in 2016, 7 people in 2021, and fluctuated between 1 to 5 people in other years. Moscow, being the leader of the Russian higher education system, shows a systematic reduction in the number of state-funded places in metropolitan universities, indicating that the state requires fewer specialists in "Environmental management and water use". The second cluster also included one bachelor's direction "Water transport management and hydrographic support of navigation" implemented in state universities of Saint Petersburg with a full-time form of education in 2021. With a considerable number of students admitted at the expense of the state budget - 130, 31 people are educated under contracts for paid educational services. The typology of educational programs in Model 2 is presented in Table 6. Compared to the first model, we changed the typology of educational programs. For Model 1, the basis for distinguishing types was the principle of balance, where a program became a leader with a large number of students admitted both at the expense of the state budget and under contracts for paid education.

Table 6. Typology of educational programs in Model 2

Type	Priem_all_budget	Zaiyvl_budget
not popular	low	low
developing	low	medium
scarce	low	high
decline in popularity	medium	low
balanced	medium	medium
stable	medium	high
priority for the state, not popular among applicants	high	low
growing popularity	high	medium
popular	high	high

Source: Compiled by the authors

For Model 2, the distinction of types was based on the principle of popularity, where we assessed the popularity among applicants through the number of applications and significance for the state through the number of allocated quotas.

The distribution of 2-7 clusters of the Gaussian mixture model (GMM) model 2 is presented in Figure 1 (Appendix).

For analysis in model 2, we used a model with 3 clusters, and the significance coefficient of the model was 0.6, which shows a satisfactory level of clustering. Based on the data from Figure 2 (Appendix), we see that the first cluster includes 6 training directions. The distribution of educational programs according to Model 2 is presented in Table 7 (Appendix). Based on the data from Table 7 (Appendix), we see that the first cluster consists of two types of bachelor's programs. One bachelor's program belongs to the "popular" type under the training direction "Environmental management and water use", admitted in 2021 to state universities in Moscow. It admitted 119 students at the expense of the state budget with 1231 applications. The form of education for this program is full-time. Six training directions belong to the "stable" type, all implemented in state universities with a full-time form of education. Four out of five training directions are implemented in Saint Petersburg and one in the Krasnodar region.

Three out of five training directions implemented in Saint Petersburg belong to the training direction "Aquatic bioresources and aquaculture" implemented in 2021-2023. It should be noted that each of these programs has a higher number of applications submitted by applicants than the "popular" type program, but the number of allocated quotas is less. Two out of five training directions belong to the training direction "Water transport management and hydrographic support of navigation" implemented in 2022-2023. The water resources of Saint Petersburg belong to the basin of the Gulf of Finland of the Baltic Sea. In total, within the city limits and the territories administratively subordinate to it, there are 64 rivers, 48 canals, and 34 streams, with a total length of 555.5 km, including directly within the city limits – 40 rivers, branches, channels, and canals with a total length of 217.5 km. By the number and length of watercourses, Saint Petersburg occupies one of the first places among the cities of the world. This largely bases the large number of quotas for education at the expense of the state budget and the importance of training specialists in water resources for Saint Petersburg.

For the training direction "Environmental management and water use" implemented in the Krasnodar region, 50 students were admitted with 1161 applications. The water resources of the Krasnodar region are extensive; the length of the Black Sea coastline is 470 km, and the Sea of Azov is 550 km, playing an important role in the region's economy.

The typology of educational programs in Model 8 is presented in Table 8.

Table 8. Typology of educational programs in Model 3

Type	Priem_all_budget	Konkurs_budget
not popular	low	low
developing	low	medium
scarce	low	high
decline in popularity	medium	low
balanced	medium	medium
stable	medium	high
priority for the state, not popular among applicants	high	low
growing popularity	high	medium
popular	high	high

Source: Compiled by the authors

Compared to the second model, we did not change the typology of training directions for Model 3. This is because the second indicator of the typology of training directions of Model 3, konkurs_budget, is derived from the clustering indicator zaiyvl_budget in Model 2. This is because the second indicator of typology for training directions in Model 3, konkurs_budget, is derived from the clustering indicator zaiyvl_budget in Model 2. The konkurs_budget indicator was calculated by us as the ratio of the number of applications from prospective students for a specific training direction to the number of quotas allocated for education funded by the state budget. The difference between Model 2 and Model 3 is that the second indicator in Model 3, konkurs_budget, is relative, unlike the absolute indicator zaiyvl_budget in Model 2. This means that konkurs_budget takes into account the proportional ratio of applications to quotas, which allows for a more accurate assessment of the competitive situation for a specific area of study. While zaiyvl_budget represents the absolute number of applications, without taking into account the number of available quotas, which may lead to a less accurate assessment of the competitive situation.

The distribution of 2-7 clusters of the Gaussian mixture model (GMM) model 3 is presented in Figure 3 (Appendix). For analysis in model 3, we used a model with 4 clusters, and the significance coefficient of the model was 0.6, indicating a satisfactory level of clustering. Based on the data shown in Figure 3 (Appendix), we find that the first cluster includes 6 training directions.

The distribution of educational programs according to Model 3 is presented in Table 9 (Appendix). Based on the data in Table 9 (Appendix), we find that the first cluster consists of two types of bachelor's programs.

Two bachelor's programs are categorized as "growing popularity". One of them is in the field of "Environmental management and water use", admitted in 2021 to state universities in Moscow. It admitted 119 students at the expense of the state budget with a competition rate of 10.34 applicants per place.

The form of education for this program is full-time. The second is in the field of "Water transport management and hydrographic support of navigation" for the year 2021, at state universities in Saint Petersburg. It admitted 130 students at the expense of the state budget, with a competition rate of 7.86 applicants per place. Five training directions are classified as "priority for the state, not popular among applicants", all implemented in state universities in Moscow with a full-time form of education. All are in the field of "Environmental management and water use" for the years 2016 - 2020, with the number of students admitted on a quota ranging from 121 to 145 for education funded by the state budget, with a competition rate ranging from 7.43 to 5.56 applicants per place. Table 10 (Appendix) shows the distribution of areas of training that are represented in at least two models.

Table 10 (Appendix) presented the distribution of training directions that are represented in at least two models. Based on the analysis of the data in Table 10 (Appendix), we find that only one direction, "Environmental management and water use" implemented in Moscow in 2021, is presented in all three models. Within Model 1, this direction is classified as "traditional", in Model 2 as "popular", and in Model 3 as "growing popularity". All other directions are represented simultaneously in Model 1 and Model 3. The direction "Environmental management and water use" implemented in Moscow from 2016 to 2020 is classified as "traditional" in Model 1 and as "priority for the state, not popular among applicants" in Model 3. The direction "Water transport management and hydrographic support of navigation" implemented in Saint Petersburg in 2021 was classified as "traditional" in Model 1 and as "growing popularity" in Model 3.

4 Discussion

The training of specialists in the field of water resources is structured and hierarchical,

encompassing three mainstream educational tracks implemented at both the bachelor's and master's levels: "Environmental Management and Water Use," "Aquatic Bioresources and Aquaculture," and "Water Transport Management and Hydrographic Support of Navigation." Our study revealed that from 2017 to 2023, most students were admitted to these tracks. The state demonstrates its interest by allocating quotas for free education in these areas. The interest of applicants in water resource management training is evident at the bachelor's level in state universities and has a regional character. Among the students admitted under contracts for the provision of paid educational services, the "Aquatic Bioresources and Aquaculture" programs stand out, with two educational programs implemented in the Astrakhan region in 2021 in a distance learning format and in 2020 in a full-time format. The first program was classified as "in demand," while the second program was considered "developing." In terms of the number of applications submitted for admission funded by the state budget, the "Environmental Management and Water Use" track, implemented in Moscow in 2021 in a full-time format, is distinguished as "popular." This program was categorized as "growing popularity" based on competition for a state-funded place. The same category applies to the "Water Transport Management and Hydrographic" program implemented in Saint Petersburg in 2021 in a full-time format. Comparing the demand for educational programs among applicants and the interest of the state, we identified that only one program was presented in three models—the "Environmental Management and Water Use" track, implemented in Moscow in 2021 in a full-time format. According to the first model, it is classified as "traditional," according to the second model as "popular," and according to the third model as "growing popularity."

5 Conclusion

In general, the regional aspect in our typology is represented by the inclusion of educational programs from regions where water resource management is an important part of the economy (Astrakhan region – 2 programs and Krasnodar Krai – 1 programm). All other programs are implemented in Moscow and Saint Petersburg, which corresponds to the centripetal trend of the Russian higher education system identified in other studies [32], [33], [34], [35], [36], [37], [38] where a significant portion of students overall are educated. Saint Petersburg, besides being the second educational center, is also a region with a developed economy in the field of water resources due to its access to the Baltic Sea. However, despite these results, the study has some limitations. Specifically, it is constrained by the available data and does not account for some important factors, such as the quality of education offered by universities or the reasons that influence students' choice of study direction. Future research could be supplemented by analyzing the preferences of regions and training directions of students who received secondary education in the region where they are currently obtaining higher education. The results of this study can be used to form future quotas for scholarships for student education in Russian universities. Our research contributes to the understanding of trends in water resource management education in Russia and highlights the importance of adapting educational programs to regional characteristics and labor market needs.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work the authors used "ChatGPT(version 3.5; OpenAI" for language editing. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

The authors equally contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

No funding was received for conducting this study.

Conflict of Interest

The authors have no conflicts of interest to declare.

APPENDIX

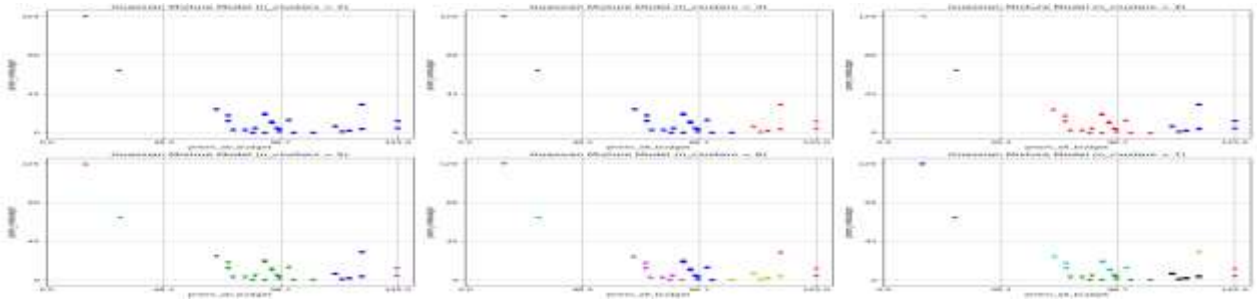

Fig. 1: Distribution of 2-7 clusters of the Gaussian mixture model (GMM) model 1
Source: Data processing with Python

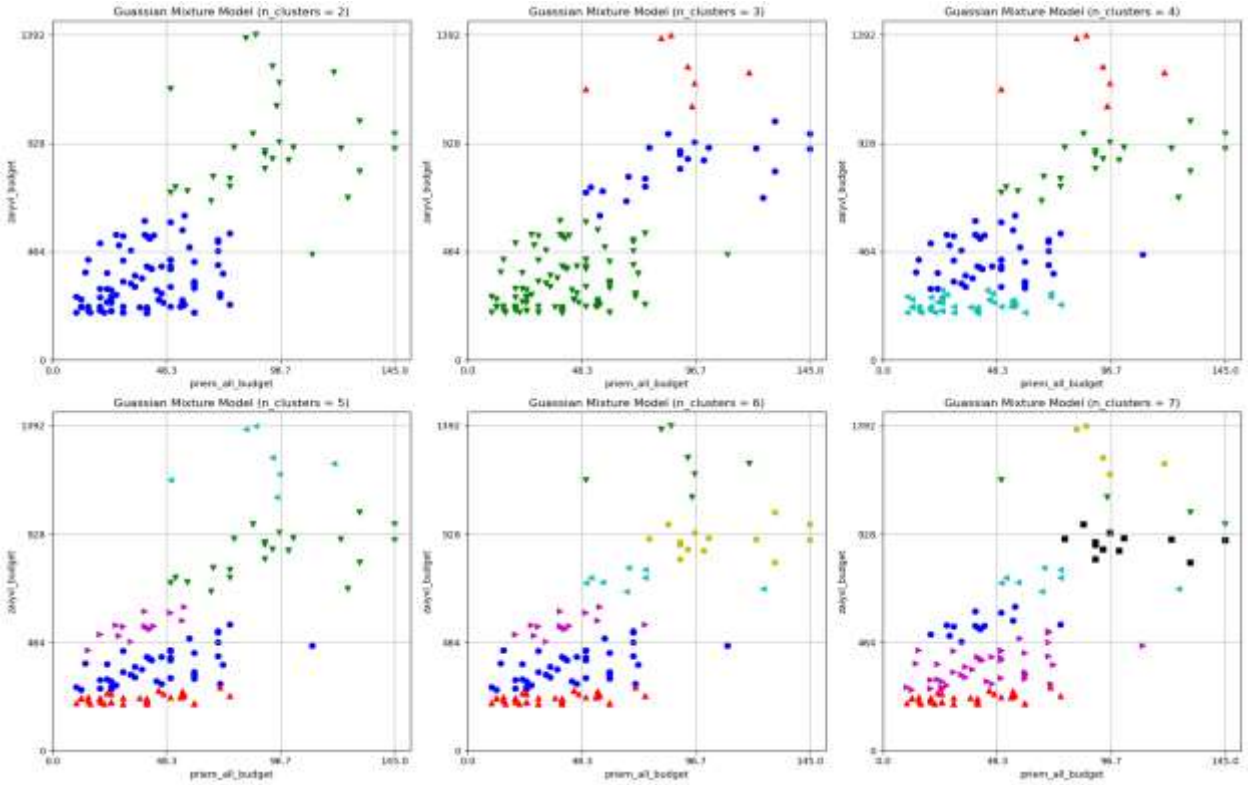

Fig. 2: Distribution of 2-7 clusters of the Gaussian mixture model (GMM) model 2
Source: Data processing with Python

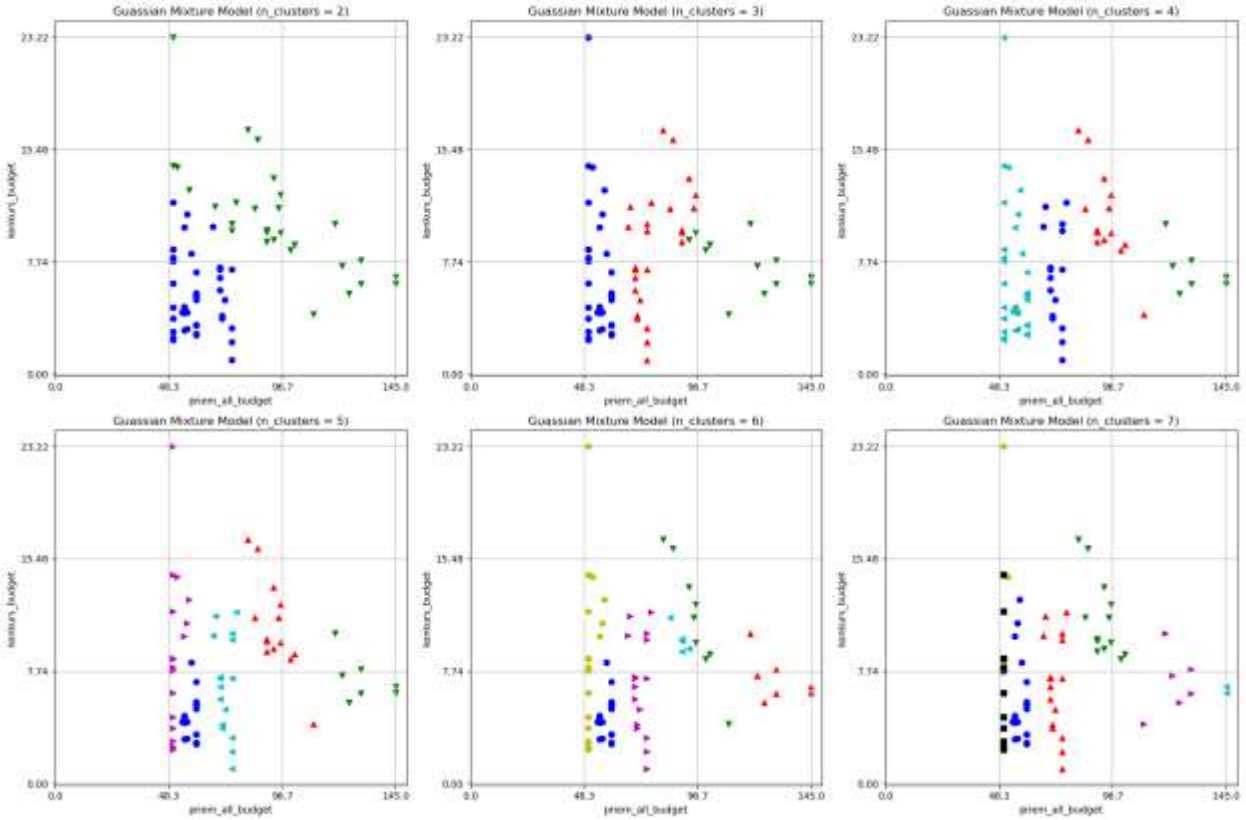

Fig. 3: Distribution of 2-7 clusters of the Gaussian mixture model (GMM) model 3
Source: Data processing with Python

Table 5. Distribution of educational programs in Model 1

Napravlenie	Code	Cluster	Type	Priem_ vne budget	Priem_ all_ budget	Year	Region	Vuz_ type	Form of education
Aquatic bioresources and aquaculture	35.03.08	1	developing	69	30	2020	Astrakhan region	state	full-time
Aquatic bioresources and aquaculture	35.03.08	1	in demand	129	16	2021	Astrakhan region	state	correspondence
Environmental management and water use	20.03.02	2	traditional	13	145	2016	Moscow	state	full-time
Environmental management and water use	20.03.02	2	traditional	5	145	2017	Moscow	state	full-time
Environmental management and water use	20.03.02	2	traditional	4	130	2018	Moscow	state	full-time
Environmental management and water use	20.03.02	2	traditional	2	125	2019	Moscow	state	full-time
Environmental management and water use	20.03.02	2	traditional	1	122	2020	Moscow	state	full-time
Environmental management and water use	20.03.02	2	traditional	7	119	2021	Moscow	state	full-time
Water transport management and hydrographic support of navigation	26.03.01	2	traditional	31	130	2021	Saint Petersburg	state	full-time

Source: Data processing with Python

Table 7. Distribution of educational programs in Model 2

Napravlenie	Code	Cluster	Type	Priem_ all budget	Zaiyvl_ budget	Year	Region	Vuz_ type	Form of education
Environmental management and water use	20.03.02	1	popular	119	1231	2021	Moscow	state	full-time
Aquatic bioresources and aquaculture	35.03.08	1	stable	86	1392	2023	Saint Petersburg	state	full-time
Aquatic bioresources and aquaculture	35.03.08	1	stable	82	1379	2022	Saint Petersburg	state	full-time
Aquatic bioresources and aquaculture	35.03.08	1	stable	93	1257	2021	Saint Petersburg	state	full-time
Water transport management and hydrographic support of navigation	26.03.01	1	stable	96	1186	2022	Saint Petersburg	state	full-time
Environmental management and water use	20.03.02	1	stable	50	1161	2023	Krasnodar region	state	full-time
Water transport management and hydrographic support of navigation	26.03.01	1	stable	95	1087	2023	Saint Petersburg	state	full-time

Source: Data processing with Python

Table 9. Distribution of educational programs in Model 3

Napravlenie	Code	Cluster	Type	Priem_ all budget	Konkurs _budget	Year	Region	Vuz_ type	Form of education
Environmental management and water use	20.03.02	1	growing popularity	119	10,34	2021	Moscow	state	full-time
Water transport management and hydrographic support of navigation	26.03.01	1	growing popularity	130	7,86	2021	Saint Petersburg	state	full-time
Environmental management and water use	20.03.02	1	priority for the state, not popular among applicants	122	7,43	2020	Moscow	state	full-time
Environmental management and water use	20.03.02	1		145	6,69	2017	Moscow	state	full-time
Environmental management and water use	20.03.02	1		145	6,23	2016	Moscow	state	full-time
Environmental management and water use	20.03.02	1		130	6,22	2018	Moscow	state	full-time
Environmental management and water use	20.03.02	1		125	5,56	2019	Moscow	state	full-time

Source: Data processing with Python

Table 10. Distribution of training directions by types in Models 1-3 (state university, form of education full-time)

Napravlenie	Type_1	Type_2	Type_3	Priem_vne_budget	Priem_all_budget	Zaiyvl_budget	Konkurs_budget	Year	Region
Environmental management and water use	traditional		priority for the state, not popular among applicants	13	145		6,23	2016	Moscow
				5	145		6,69	2017	Moscow
				4	130		6,22	2018	Moscow
				2	125		5,56	2019	Moscow
				1	122		7,43	2020	Moscow
		popular	growing popularity	7	119	1231	10,34	2021	Moscow
Water transport management and hydrographic support of navigation	traditional		growing popularity	31	130		7,86	2021	Saint Petersburg

Source: Data processing with Python