sustainability

MDPI

Review

Sustainable Management of Transboundary Groundwater Resources: Past and Future

Ekaterina Golovina [1,*], Svetlana Pasternak [1], Pavel Tsiglianu [1] and Nikolay Tselischev [2]

[1] Department of Economics, Organization and Management, Saint-Petersburg Mining University, 21st Line 2, 199106 St. Petersburg, Russia; Pasternak_SN2@pers.spmi.ru (S.P.); Pavel.Tsiglianu@gmail.com (P.T.)
[2] Department of Hydrogeology and Engineering Geology, Saint-Petersburg Mining University, 21st Line 2, 199106 St. Petersburg, Russia; celishhev97@mail.ru
* Correspondence: Golovina_EI@pers.spmi.ru

Abstract: Groundwater resources at all times have provided and continue to provide a significant impact on the economic, social, and often political activities of any state, especially if the reserves of this strategic resource are limited. Coordinated groundwater resources management is one of the main conditions for the sustainable development of countries' transboundary basins, affecting all aspects of human activity, including water supply, agriculture, industry, hydropower, water transport, environment, and the very quality of human life. Modern international trends in the field of transboundary groundwater resources management is undergoing significant changes. This article dwells upon the features of groundwater as a mineral, the structure of state groundwater management in the Russian Federation, the regulation of transboundary groundwater use, and protection at the international and domestic levels are analyzed. The system of management of the transboundary aquifers of Kazakhstan and Belarus is considered in more detail. The unitization approach used for coordinated development of oil and gas fields can, to some extent, serve as a model for managing common groundwater aquifers located on the border of neighboring states. Dogmatic and comparative legal methods consisting of analyzing the applicable legal regulations on the use and protection of groundwater were used. Several recommendations for improving the system of state sustainable management of groundwater resources at the global level are proposed.

Keywords: groundwater; aquifer; transboundary territory; groundwater resource management; regulation; reserves; sustainability

Citation: Golovina, E.; Pasternak, S.; Tsiglianu, P.; Tselischev, N. Sustainable Management of Transboundary Groundwater Resources: Past and Future. *Sustainability* **2021**, *13*, 12102. https://doi.org/10.3390/su132112102

Academic Editors: Izabela Jonek-Kowalska and Lilla Knop

Received: 12 September 2021
Accepted: 28 October 2021
Published: 2 November 2021

1. Introduction

Over the past century, the population of the Earth has tripled, while the volume of water resources withdrawal during the same time increased more than six times and reached almost 4000 cubic kilometers per year. According to the UN, as a result of unreasonable exploitation of resources and environmental changes, almost a fifth of the world's population does not have access to safe sources of drinking water, and around 40% of the world's population does not have basic sanitary conditions [1].

Fresh water supplies are unevenly distributed around the planet. More than 80 countries in the world are experiencing serious water shortages. To even out this imbalance, technological, engineering, and economic solutions are used, such as the construction of hydraulic structures for the purification, desalination, transportation, and storage of water, the import of water-intensive products and electricity, and direct supplies of bottled water [1].

The problems of the water industry of any country can be conditionally divided into legal, regulatory, technical, financial, personnel, and environmental problems. This article provides an analysis of the problems of state regulation of groundwater use on the example of the Russian Federation, Kazakhstan, and Belarus.

Groundwater occupies a special position among all types of natural resources. On the one hand, they are contained in the subsoil and have the main features of minerals,

and on the other hand, they are part of the total water resources of the land. At the same time, groundwater has a number of features that distinguish them from other types of minerals, which determine the fundamental differences in the formation of their operational reserves as a process that occurs not only during geological time but directly during the development of deposits. The underground waters of the free water exchange zone are hydraulically connected with the surface waters and participate in the general water cycle in nature [2].

The peculiarities of groundwater, primarily their renewability, are the reason for the wide discussion in the legal literature on the advisability of classifying them as minerals.

Over the past several decades, the groundwater resource in the states where this resource is found in abundance was treated as a free and inexhaustible raw material. In this regard, the question of mineral valuation, in contrast to any other, has not yet been resolved. In today's situation, when the economic and environmental aspects of water use are of increasing importance, it is groundwater that gains strategic value due to a set of unique properties. Such features can be named as follows:

(1) stable chemical and microbiological composition;
(2) protection from anthropogenic factors;
(3) stability of dynamic characteristics, subject to the observance of rational subsoil use;
(4) the possibility of various intended use (versatility);
(5) uniqueness in terms of territorial proximity to consumer goods;
(6) social significance.

One of the amazing features of water is that it cannot be kept within the boundaries of a particular state. The use and protection of transboundary water bodies is a complex process that requires maximum openness and readiness for cooperation from border states. Currently, transboundary groundwater pollution can cause serious problems for any country [1].

Contemporary international trends in the sphere of transboundary groundwater resources management are undergoing significant changes. First of all, this is due to the need to define the very concept of "transboundary aquifer". Not all states perceive the peculiarity of groundwater as a special kind of mineral resources.

Groundwater in the latest UN conventions on water use begins to be perceived as an integral part of geological structures, while having dynamic characteristics such as direction of natural flow, recharge and discharge areas, and the interaction of the aquifer with neighboring aquifers and surface watercourses. All these characteristics in combination with hydrogeological parameters (filtration, reservoir, and hydrochemical ones) give a set of concepts about the resource potential of aquifers.

Such scientists as Berezko O.A., Vasneva O.V. [3], Bolgov M.V., Demin A.P., Shatalova K.Yu. [4], Danilov-Danilyan V.I., Khranovich I.L. [5], Frumin G.T., Timofeeva L.A. [6], Kuchin A.G. [7], Mironova A.V., Molsky E.V., Rumanin V.G. [8], Nikanorova A.D., Egorov S.A. [9], Podolny O.V. [10], and Zektser I.S. [11] have been actively engaged in the problem of groundwater resources management in transboundary territories.

A very successful approach has been implemented in joint projects in the cross-border areas of Russia–Estonia, France–Switzerland, and Russia–Kazakhstan. However, in international practice, such examples are rather isolated, and this is largely due to the inconsistency of the legislative bases of different states. It is often quite difficult to harmonize the methodology in the field of subsoil management due to different scientific schools and the potential of knowledge. There is an acute shortage of such studies in the scientific literature, in contrast to the oil and gas sector or the problems of the exploitation of open reservoirs and watercourses in transboundary territories.

The goal of this paper is to improve the system of state management of groundwater production for various purposes and categories of subsoil users, to introduce practical recommendations for systematizing and adjusting the legal framework governing the procedure for subsoil use in the modern geopolitical model of economic development.

In accordance with the goal of this paper, it is proposed to analyze the system of groundwater extraction management from the side of the state (example of Russia). The administration system plays a key role in the development of water industry. According to Karlov G.A., "currently in Russia (as well as in a number of many advanced countries) there is no unified water management system, which, due to its versatility and scale, 'does not fit into the sphere of interests' of any of the existing ministries". According to the "Water Strategy of the Russian Federation for the Period until 2020", the issues of regulating the use of water resources are being introduced by 14 federal executive bodies, according to expert estimates of such departments, including those controlling more than 30. As a result, the industry, which was advanced at the turn of the 1970s and 1980s, is degrading by world standards [1].

The Government of the Russian Federation has several government bodies (structures) in charge of issues related to the use and protection of transboundary water bodies. These include the Ministry of Foreign Affairs of the Russian Federation, the Ministry of Natural Resources and Ecology of the Russian Federation, the Federal Service for Hydrometeorology and Environmental Monitoring, the Federal Agency for Water Resources, the Federal Agency for Fisheries, the Federal Agency for Maritime and River Transport, and the Federal Agency for the Development of the State Border Russian Federation. In the central offices of each of these structures, there are departments or divisions in charge of international cooperation. In parallel, the territorial bodies of ministries and agencies are doing significant work in this direction [4].

Currently, the Ministry of Natural Resources and Ecology of Russia, unfortunately, plays the role of a purely controlling agency. The adoption of the modern version of the Law of the Russian Federation "On Subsoil" made it possible to abandon the assessment of reserves for low-flow water intakes (up to 100 m^3/day), which, in turn, led to an uncontrolled process of groundwater extraction in vast areas [12]. Many single collective water intakes (for example, in country house settlements) receive licenses for just such volumes of production. The concept of assessing reserves for them loses all meaning; such objects simply do not fall into the annual monitoring reports. This is where the problem of groundwater resources management arises, and, consequently, the construction of forecast calculations will lead to serious errors. Technically, the procedure for assessing reserves requires certain qualifications and knowledge, but in the old days, any hydrogeologist could cope with this task.

After the commissioning of the water intake facility, the auditing state committees practically do not control its activities, except for sanitary standards. This was the essential task of the profile ministry of Geology in the USSR. The specific features of the related subsoil use within the transboundary zone are complete absolute control and planning of all water intake facilities without exception, since the transboundary zone is the territory of responsibility to a neighboring state. It is also necessary to have a special cross-sectional monitoring regime, implying a two-way system of observation points (wells), the location of which is determined by the parameters of the aquifer or complex, as well as the degree of loading during the aquifer exploitation or the presence of mining enterprises, in whose activities drainage is implied. Such objects in the transboundary zone usually have an additional pressure on the underground aquifer system, both in terms of the depletion of reserves and a potential change in the chemical composition of groundwater.

In the work called "Sustainable development and use of water resources: global, regional and local (national) scale" (2015) Alimov, A.A., it is said, that "With regard to regional characteristics of the economic mechanism of water use, it should be noted that organizationally charging for water use is manifested in two different systems. The first system (scheme) is implemented in Australia and the countries of Asia and Africa. It is based on strict government regulation and control over fees. All payments received from the water user go to the state budget. This allows to accumulate financial resources for the maintenance and development of water management systems and structures" [13].

The second approach, used in Western European countries, is based on corporate sustainable management of the use and protection of water resources by water users who form the respective basin associations [13].

State regulation in the field of water law in the Russian Federation is carried out taking into account political norms and principles of international water legislation. Most of the interstate agreements signed in the Russian Federation at the present time imply a common management mechanism in transboundary territories, which takes into account such factors as conducting mutual monitoring in adjacent territories; the exchange of the results of hydrogeological research and the results of regime observations; the exchange of data on geological studies of subsoil; and agreements between the parties on changes in the subsoil use regime, namely, the construction of mining enterprises in the area of the cross-border territory. This is combined with the model agreements on transboundary groundwaters ratified by the UN [14].

Currently, water resources management based on the basin principle is widely used in countries with both strong centralized and decentralized power and federal structures. These states include France, Great Britain, Germany, Spain, the United States, and Austria (the Murray–Darling basin system, created in 1987). The practice of water resources management using the basin principle goes back several decades. Among the leaders in this area are the Netherlands and Germany, where they started to implement it long ago and achieved significant results. Over the past decade, many countries have undergone a reorganization of water management systems with the aim of introducing the basin principle and increasing its effectiveness [15].

According to assistant to a deputy of the State Duma, adviser to the state civil service of the 2nd class V.V. Kashirin, "the French model is currently among the most advanced one at basin regulation" [15]. This option is the result of the adaptation of water resources management structures to the centralization policy that was implemented in the early 1960s and changes in the needs of the water sector in general.

The basin principle of water resources management is used not only within the borders of one state but also on an international basis. It was reflected in the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes, which stipulates that the riparian parties establish the boundaries of the water intake or its part(s), in respect to which they cooperate and establish joint bodies for its development. A clear definition of the spatial boundaries of its action is of key importance in basin management [15].

Aquifers, considered earlier in 1990s to the early 2000 in relation to the basin zoning, today are increasingly considered as independent groundwater bodies. However, it is necessary to analyze the evolutionary changes in the definition, regulation, and reference of transboundary groundwater resources in international legislation (using concepts and classifications of groundwater).

2. Materials and Methods

In the course of the study, a complex method, including the analysis and synthesis of data presented in publications of Russian and foreign authors, scientific publications of leading experts in the field of economics, hydrogeology, ecology, reports of government hearings, reference publications of specialized institutes and agencies in the field of study, as well as an advisory method with leading foreign experts, is used. In addition, dogmatic and comparative legal methods consisting of analyzing the applicable legal regulations on the use and protection of groundwater were used.

The procedure for the use and protection of transboundary groundwater is regulated at the international and domestic levels.

In Russia, the solution of transboundary waters issues falls within the competence of the federal authorities. These issues are resolved with neighboring states through the conclusion of bilateral agreements. Such agreements were concluded in different historical periods of the Russian statehood, but they are still valid today. The treaties in force today between

Russia and other states on the use of transboundary water resources include (in chronological order) a trilateral agreement with Finland and the Kingdom of Norway—1959, with Finland—1964, with Ukraine—1992, with Mongolia—1995, with Estonia—1997, with the Republic of Belarus—2002, with China—2008, with Kazakhstan—2010, with Azerbaijan—2010, and with Abkhazia—2011.

The subject of regulation in the above agreements is the principles and procedure for the rational use and protection of transboundary water bodies, which include any surface and groundwater that denotes or crosses borders between two or more states or located on such borders (Article 1 of the Agreement with Kazakhstan, Article 1 Agreement of the with Mongolia, etc.). At the same time, groundwater is listed together with surface water bodies and is not distinguished as an independent object of legal regulation, which implies the application of the same principles and rules to the procedure for their protection and use.

These principles determine the direction of activities of the countries participating in the Agreements and, in order to prevent transboundary impact on water bodies, instruct them to refrain from actions or inaction that could lead to a deterioration in the state of transboundary waters, including their hydrogeological and hydrochemical regime, to carry out various measures aimed at the prevention, limitation, reduction, as well as elimination of pollution of transboundary water bodies; take measures to prevent or mitigate negative consequences that may arise as a result of changes in the state of transboundary water bodies (for example, as a result of floods, coastal erosion, etc.); and take measures to ensure maintenance of hydraulic structures in good technical condition.

Cooperation of the participating states to the Agreements on the use and protection of transboundary water bodies can be carried out in various forms. First of all, the use and protection of transboundary water resources should be carried out on the basis of the principle of rationality and water resources, their quality, as well as channel, water, hydrobiological, and hydrochemical regimes should be carefully studied in order to prevent floods and prevent their negative consequences. The participating states should exchange hydrological information, develop new technologies and modern methods for preventing and eliminating the consequences of negative impacts on water bodies, as well as protect them from pollution and control their quality.

According to the procedure stipulated by most agreements on the use and protection of transboundary waters, for the implementation of all the above measures, the countries participating in the agreement form a joint Commission (for example, Article 5 of the Agreement with Azerbaijan, Article 4 of the Agreement with China, etc.). The competence of the joint commission includes coordination of actions of the parties to the agreement, development of schemes for the joint use of transboundary waters and their protection, development and establishment of uniform standards and indicators of the quality of transboundary waters, as well as programs for their monitoring.

In the event of a dispute or harm, the participating countries are obliged to act in accordance with the above principles and resolve issues through consultations and agreements.

Domestic regulation of the mechanism for the use of transboundary water bodies in Russia is carried out in accordance with generally accepted international principles and rules, as evidenced by the reference norms contained in the preamble of most of the above agreements with neighboring states. When concluding them, states were guided, as a rule, by two conventions: the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes [16] and the 1997 Convention on the Law of the Non-Navigational Uses of International Watercourses [17].

In international legal regulation of the procedure for transboundary water use, over the past decades, a tendency to allocate transboundary groundwater as an independent object of legal regulation has been formed. Initially, attention was paid only to surface waters in order to ensure navigation (for example, the Convention on the regime of navigation on the Danube 1948 [18,19]).

In the future, the needs of states for fresh water are increasing, and not only surface water bodies but also groundwater, which is a valuable source of drinking water and plays

an important role in maintaining aquatic and terrestrial ecosystems, become the object of legal regulation in international acts. In particular, the 1966 Helsinki Rules for the Use of the Waters of International Rivers already indicate two objects of legal regulation—surface and ground waters—and delineate water resources and water bodies that make up the drainage basin. In accordance with Art. I and II of the Rules, the provisions of this legal act regulate the procedure for the use of waters of international drainage basins. In this case, an international drainage basin is considered to be a geographical space that covers two or more states and is determined by the boundaries of a drainage basin, including groundwater and surface waters flowing into a common destination. The Helsinki Rules for groundwater and surface waters establish the same legal regime for use based on the principles of equality and the right of each coastal state to a reasonable and equitable share of the beneficial use of the waters of an international river basin. To determine the reasonableness and fairness of the share, the states were recommended to conclude bilateral agreements [20,21].

The 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes was the first universal international legal act in which water was considered as a transboundary natural resource. The Convention referred to transboundary waters any surface and groundwater that mark, cross borders between two or more states, or are located at such borders. The main focus of the Convention was on measures to prevent, reduce, and limit any transboundary impact and forms of cooperation between riparian states to implement such measures. In matters of water management, the 1992 Convention was based on the concept of "river basins", the essence of which is the recognition of a river basin as a unit of a natural complex for the purpose of water use [16,22].

The next step in the development of international law in the field of protection and use of transboundary water resources was made by the 1997 Convention on the Law of the Non-navigational Uses of International Watercourses (Russia does not participate in this convention). Instead of "groundwater", it uses the concept of "subterranean water" and introduces the concept of "international watercourse", which refers to a system of surface and groundwaters, which, due to their physical relationship, constitute a single whole and usually a common ending. Thus, the said Convention applies to transboundary aquifers directly related to surface water bodies. In this regard, in 2013, the United Nations Economic Commission for Europe clarified the concept of groundwater in the Guidelines for the Implementation of the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes, clarifying that transboundary groundwaters should not be limited to only water bodies such as a lake or a river but should cover the entire recharge area of the water body.

The above conventions laid the foundation for the subsequent work of international organizations on the codification of the law of transboundary water resources.

In 2000, the EU Water Framework Directive 2000/60/EC was adopted. The aim of the Directive was to establish a protection regime for inland surface, transnational, marine coastal, and ground waters in Europe.According to Art. 2 Directives, groundwater is applied to all waters below the surface of the Earth in the saturation zone and in direct contact with the earth or subsoil. The water resources management system in the Directive is based on the concept of river basins established by the 1992 Helsinki Convention. According to the provisions of the Directive, EU member states are obliged to develop a system of measures for the protection and restoration of waters for each river basin in Europe [23].

In 2007 and 2011, the UN Economic Commission for Europe, within the framework of the 1992 Convention on the Protection and Use of Watercourses, assessed the state of transboundary rivers, lakes, and groundwater [24,25] and in 2014 developed Model Regulations on transboundary groundwaters, which provide practical guidance for States in applying the general principles of the 1992 Helsinki Convention to the characteristics of groundwaters. These Model Provisions are non-binding and intended to improve transboundary groundwater cooperation between States Parties to the Convention [26].

A significant step in the formation of the legal framework in the field of regulation, protection, and use of transboundary groundwaters was made by adoption of the Resolution on the law of transboundary aquifers on 11 December 2008 by the UN General Assembly [27]. It contains 19 articles and actually summarizes the experience gained in previous years in regulating the protection and use of groundwater. The Resolution is targeted at transboundary aquifers. It contains clear definitions of an aquifer and a transboundary aquifer and enshrines the principle of state sovereignty over a part of a transboundary aquifer or aquifer system located within the borders of a given state.

According to Article 5 of the Resolution, transboundary aquifers should be used by the state on the basis of the principles of justice and rationality, as well as taking into account many factors, such as the needs of the state, the size of the population dependent on the aquifer, and the characteristics of the aquifer itself. In addition, the state undertakes not to damage the aquifer, to cooperate with other states-users of the aquifer, exchange information with them, and settle all issues through the conclusion of bilateral agreements.

The UN General Assembly resolution is of a recommendatory nature and can serve as a guide for modern states in the field of organizing transboundary groundwater management.

Thus, the legal regulation of the protection and use of transboundary groundwater is carried out at the domestic and international levels. International legal regulation is carried out on the basis of the principles of extending the sovereignty of the state to the natural resources located on its territory, including groundwater, and cooperation with other states in the protection and use of transboundary aquifers. Domestic regulation of the use of groundwater is carried out on the basis of generally accepted international principles and rules and through the conclusion of bilateral and multilateral agreements with neighboring states. Both domestic and international legal acts regulating the protection and use of transboundary water bodies contain general provisions and principles that should guide neighboring states in solving narrower issues of exploitation of specific aquifers.

3. Results

The regional hydrogeological structure of the Russian Federation on the borders with the former republics of the USSR is characterized by the presence of several transboundary aquifers on the borders with Kazakhstan, Estonia, Belarus, and Ukraine. Due to the fact that the issues of international treaties are highly susceptible to the geopolitical component of the life of states, at present, some agreements have been reached with some countries, while a period of stagnation is still observed with others.

To visualize the involvement of groundwater regulation issues in the post-Soviet space in the legal field, it is advisable to use the SDG data (Sustainable Development Goals [28], Goal No. 6—clean water and sanitation) collected by the UN General Assembly from 2016 to 2019 as a blueprint for a better and more sustainable future for all on transboundary waters in Ukraine, Belarus, Kazakhstan, Latvia, and Estonia.

According to long-term data of hydrogeological and hydrological monitoring, the percentage of transboundary water bodies in the territories of the countries sounded, which is regulated by cooperation agreements with other countries, including the Russian Federation, varies greatly: if for Latvia and Estonia it is about 97–100%, then for Kazakhstan, Ukraine, and Belarus, it is in the range of 61 to 67%

The Republic of Belarus can be cited as an example of organizing a successfully operating system for managing groundwater resources.

Figure 1 shows that the scheme of state groundwater resources management is built on the principles of centralizing one ministry with the allocation of a head profile department associated with a scientific unitary enterprise. That is, the policy in the field of subsoil use combines the principles of the observation, accounting, and distribution of groundwater resources, analysis, and planning since, without solving forecast problems, it is impossible to model any regional problem, including the transboundary one.

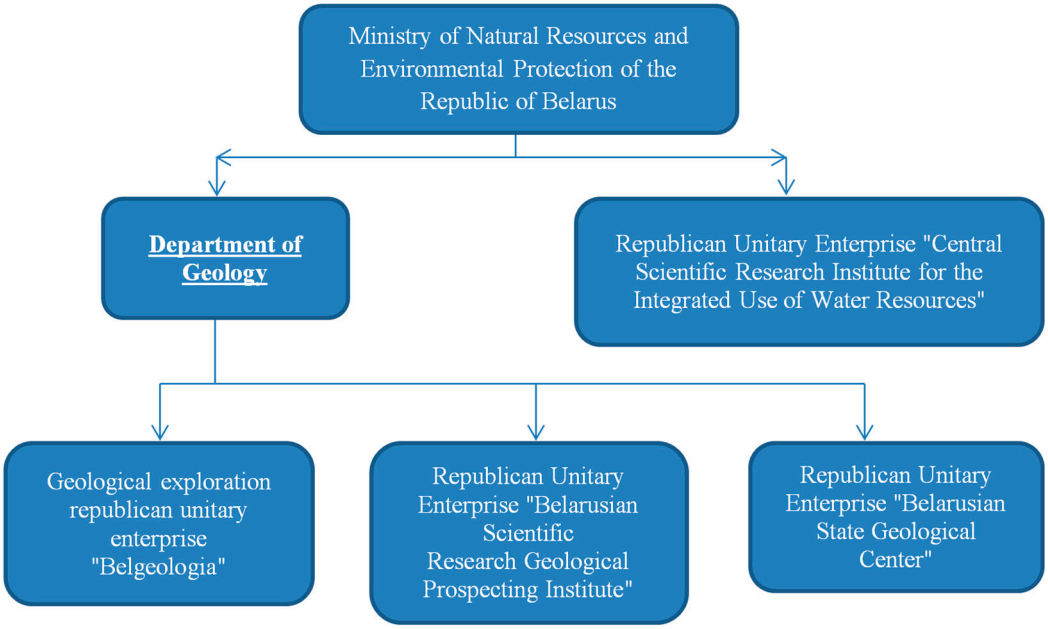

Figure 1. Scheme of groundwater management in Belarus. Source: [3].

Despite the existence of an agreement between the Government of the Republic of Belarus and the Russian Federation "On cooperation in the field of protection and rational use of transboundary water bodies" [29], there are certain difficulties in its implementation, as follows:

- Transboundary groundwaters are the subject of an agreement. However, experts on groundwater are not included in the working groups and transboundary groundwaters issues are not considered (unlike surface waters).
- Joint (interstate) bodies do not deal with groundwater.

Thus, it is now necessary to include the consideration of transboundary groundwater issues in existing and future international agreements due to the fact that the role of groundwater in meeting the world's water needs is increasing every year.

According to the Belarusian side, there are similar problems in groundwater management at the national and transboundary levels as follows:

- problems related to legislation;
- problems associated with the lack of integrated management of transboundary underground and surface waters;
- problems associated with the lack of a unified monitoring network for surface and groundwater;
- problems associated with the lack of joint groundwater monitoring programs and regulations for the exchange of information;
- problems associated with the lack of agreed criteria for assessing the quality of groundwater.

Measures to improve groundwater management at the national and transboundary levels include the following:

- unification of the system of regulatory documents of the Republic of Belarus related to groundwater management with the European system, taking into account national specifics;
- improving information exchange and coordination between ministries and departments;
- the unification of networks for monitoring surface and ground waters;
- the development of special agreements and joint programs for groundwater monitoring;
- improving public awareness of groundwater-related issues [3].

Such activities can indeed improve the transboundary groundwater management policy, and this applies not only to this example. However, a controversial point is the absence of a limitation of management functions in terms of binding to a certain area of

responsibility. For example, in the Russian Federation, the area of some aquifers exceeds the size of entire European states.

As a second example, the system of transboundary aquifers management in Kazakhstan, formerly part of the USSR and now a sovereign state, is considered. The UNGA [27] defines a "transboundary aquifer" or "transboundary aquifer system" as an aquifer (or system) of which parts are located in different states. Thus, the area of a transboundary aquifer (or system) is defined as the area of its distribution on both sides of the state border. For confined aquifers, bounded from above by an aquiclude, this condition is fully feasible. The extraction of groundwater by one of the countries often leads to transboundary problems.

However, for the first unconfined aquifer from the surface, which may have a large area of distribution, which most often coincides with the recharge area, transboundary effects do not exist.

Therefore, all transboundary water problems affecting groundwater resources can be divided into two groups. The organization of the monitoring and assessment of transboundary groundwater, as well as the management of the use of their resources within these groups differ significantly.

Group 1: Transboundary water problems related to the qualitative and quantitative state of groundwater in the transboundary river basin. The reason for such problems is the exploitation of groundwater aquifers associated with the river, leading to a reduction in river flow or the pollution of groundwater in the catchment areas and the filtration of these polluted waters into a transboundary river, which leads to a deterioration in the quality of river waters.

Group 2: Actual transboundary problems associated with the state of groundwater quality and quantity when the resources and reserves of groundwater are reduced due to exploitation or other measures on the adjacent side or contaminated groundwater flows across the border to the adjacent side. In this case, the methods of integrated water resources management acquire a certain transboundary (interstate) specificity [30].

Currently, Kazakhstan has 15 transboundary groundwater basins, most of which are confined to Quaternary sediments (Figure 2).

According to the results of the dissertation work of A.G. Kuchin [7], where a large-scale schematization of regional hydrogeological conditions is carried out and four types of risks of transboundary problems are identified, there is a possibility of the depletion of the Tashkent transboundary basin, confined to the Cretaceous sediments, caused by the uncontrolled intensive extraction of groundwater from Uzbekistan and Kazakhstan. Moreover, the parties made no attempts to agree on the conditions for water extraction and organize a joint monitoring network of observation wells. Less painful is the situation with the Irtysh transboundary basin on the border with the Russian Federation, where, as a result of the active extraction of groundwater from Russia for the purposes of household and drinking water supply to the cities of Novosibirsk, Barnaul, and a number of other settlements, a systematic, quasi-stationary decrease in the piezometric levels of the chalk horizons in the Pavlodar region of Kazakhstan is observed. A.G. Kuchin points to the threat of the depletion of the reserves of this basin; however, due to more intensive production from the Russian Federation, the depletion of reserves will sooner occur on the territory of the Russian Federation. Quite fair in his abstract is the call for the organization of an agreed upon operating regime and the creation of a special testing ground for the hydrogeological monitoring of the environment, which is relevant for almost each of the 15 transboundary aquifers of Kazakhstan [7].

Transboundary aquifers of Kazakhstan on the map (Figure 2) are distributed as follows:

1. North Kazakhstan; 2. Priirtyshsky; 3. Zaysansky; 4. Alakolsky; 5. Zharkent; 6. Tekesky; 7. Shuisky; 8. North-Talas; 9. South Talas; 10. Pritashkent; 11. Syrdarya; 12. Amudarya; 13. Caspian; 14. Syrtovsky; 15. South-Pre-Ural.

Figure 2. Map of transboundary aquifers of the Republic of Kazakhstan. Source: [10].

Summarizing the above, it should be emphasized that there is an acute lack of cooperation in the regulation of the development and monitoring of transboundary aquifers in the post-Soviet space. At the same time, the agreements reached are largely outdated and require revision of some provisions and their revision with a focus on the UN recommendations that appeared later.

In the final summaries of the agreements reached by countries, groundwater is not separated from surface water, and the countries themselves are divided into a number of drainage basins or water bodies that receive runoff, to which these countries are geographically confined. That is, it is not obviously implied that the aquifer may not have an active hydraulic connection with surface waters and carry out its feeding or discharge outside the river or sea basin, but if it overlaps a particular drainage basin in the plan, then it automatically refers to it [31,32].

This approach, which makes an identification between a catchment basin and an aquifer, is valid but should not be applied to all cases. In the aforementioned thesis, A.G. Kuchin reasonably uses this approach to schematize and typify filtration conditions in transboundary aquifers in Kazakhstan, which is caused by the geological and hydrogeological features of their structure, near-surface occurrence, and active hydraulic connection with intermountain rivers [7].

It is also necessary to include in the zone of responsibility of those aquifers that are not currently exploited but have a certain potential for future generations [28]. An account and an observation system are needed. Aquifers that are currently unpromising, can be used as:

- collectors for storing natural gas;
- the disposal of toxic and radioactive waste;
- industrial waters, that is, the extraction of micro- and macrocomponents from water.

Nevertheless, the issues of sustainable groundwater resources management in the transboundary territory have rather blurred boundaries of the defined tasks. It is necessary to introduce the concept of the so-called zone of responsibility in the transboundary territory, within which it is possible to organize a methodology for groundwater resources management. The fact is that the monitoring system and knowledge exchange itself have no meaning if there is no concept of regional subsoil use. It is this methodology at the interstate level that should be applied within the framework of the concept of water industry development as a whole, that is, in the presence of planning institutions. Tasks of this level are not able to be solved by private companies, since tasks are not associated with economic benefits and profit.

4. Discussion

The main task of public administration is to solve a set of forecasting tasks [33]. The monitoring system is a tool for solving scientific problems in the field of subsoil use. Scientific bases, institutions, and coordination are needed.

The unitization approach used for the coordinated development of oil and gas fields can, to some extent, be used as a model for managing common fields located on the border of neighboring states. In the world practice of the joint exploitation of oil and gas fields, a model of unitization has been developed and successfully applied in transboundary fields [34]. The main types of management tasks are based on the functions of state control from neighboring countries, but the unit models themselves have a number of differences.

Nevertheless, there is a common aspect—the definition of the boundaries of the exploited field—and hence the boundaries of responsibility and interests. Each mining company within a unitization zone is subject to a unitization agreement. This is a significant difference from the development of groundwater deposits since, until now, the area of responsibility at the interstate level for the transboundary territory has not been determined in world practice, there are no uniform mechanisms for its assessment [35]. The second difference is that an unlimited number of subsoil users (legal entities and individuals) can be located on a cross-border territory, whose activities cannot be united by a unitization agreement.

However, the state remains in charge of the principle of licensing of subsoil use, i.e., the functions of managing the development of groundwater deposits are assumed by the state apparatus that issues the license. Today, when issuing and registering licenses for the extraction of groundwater, the impact of water intake on water-use facilities located outside the state border is not at all taken into account. In this regard, clearly fixed conditions for the development of transboundary groundwater deposits are needed.

The purpose of the unitization agreement is to ensure equal opportunities and advantages in the development of transboundary deposits for all its participants, while preserving natural resources and the existing environmental situation.

Similar features with the unitization model in the development of hydrocarbon transboundary deposits are in the role of vertical regulation—regulation at the interstate, state (national), and regional (subjective) levels, as well as in a clear definition of the boundaries of unitization. However, unlike oil and gas deposits, which, as a rule, have a limited territory for which raw material reserves are estimated, groundwater deposits generally have much larger areal sizes, sometimes reaching tens and even the first hundreds of kilometers.

Each transboundary territory has its own set of characteristics associated with the geological structure of aquifers, the degree of their knowledge, as well as the administration model. The size of the area of responsibility may vary. Nevertheless, at any scale of the area of responsibility, it is necessary to account for all enterprises producing groundwater and subsoil users using groundwater in their activities, regardless of the volume of exploitation and the degree of development in the transboundary territory. Only in this case is it possible to develop a methodology for state sustainable management of subsoil use on the territory of both neighboring states. In the case that one of the states is unable to organize such an approach, to solve such a managerial task, these functions should inevitably fall on the neighboring state within the framework of the international strategy [36].

International experience in regulating the development of transboundary hydrocarbon deposits shows that the successful development of these assets is possible and achieved when the interests of each subsoil user are justly achieved, which can be ensured only in one case: when the development object is considered and developed as a single hydrodynamic coupled system [37]. The implementation of this initiative is possible if the following criteria are met:

(1) the application of unified mechanisms of legal regulation of transboundary deposits development;
(2) the development of the field in accordance with a development project that is common for all parties and a single estimate.

The application of such an approach in international practice is reflected in the currently prevailing method of developing transboundary deposits called unitization. Unitization is understood as the unification of all users of a transboundary field in order to ensure a single coordinated activity for its development. This process is implemented through the conclusion of a unitization agreement, according to which the parties undertake obligations to carry out the joint development of the field subject to a number of conditions (legal, technological, economic) [38].

The species diversity of unitization agreements is based on the specific features of transboundary fields, which, as a rule, are characterized by two key criteria:

(1) the subject of rights to transboundary deposits;
(2) the norms governing the use of transboundary deposits.

Interstate transboundary deposits are of the greatest interest for this study. In the case of interstate transboundary deposits, i.e., fields, the territory of which is divided by an interstate border, the subjects of rights are sovereign states. The source of legal norms on the use of transboundary deposits in this case is the international unitization agreement, in which the participating states determine the general procedure and features of the development of a transboundary field, and also under which they undertake to take coordinated measures of regulation and control in order to ensure the most efficient use of transboundary deposits.

When concluding unitization agreements, each of the participating states has a number of obligations [39]:

- the determination and coordination with other member states of the territorial boundaries of the field;
- the development and approval of a regulatory framework on the issue of unitization based on international and national legislation;
- the determination of the main parameters of unitization (approval of a single development project, calculation of geological and recoverable reserves of the field, determination of the shares of participants, within which the income and expenses of each of them are determined);
- the interaction with subsoil users (issuance of licenses, permits for the use of the field, determination of principles and requirements for use (recommendation of technology for the development of the field, consolidation of standards for the safety of operations and environmental requirements));
- control over the implementation of the unitization agreement by both subsoil users and other parties to the agreement;
- the provision of mechanisms for resolving disputes that may arise in the process of using the deposit.

Internationally, a certain experience has already been accumulated in concluding unitization agreements on the development of interstate transboundary deposits. Some of the most famous and illustrative cases of the application of unitization agreements are the agreement between Norway and the UK on the development of the Frigg field, the agreement between Indonesia and Australia on the development of fields in the Timor Basin, etc. The example of a unitization agreement between Norway and the UK for the development of the Frigg field is considered a classic in international unitization practice. This agreement is considered to be one of the most successful international unitization agreements since, for more than 18 years, it has allowed the efficient development of the Frigg field.

The success of this agreement was based on its basic principles and provisions, which boil down to the following [40,41]:

- the field is developed as a single operational object (unit) by the unit operator on the basis of a jointly approved development plan;
- each state creates a legal basis for the mandatory conclusion of agreements both between license holders within the state and with license holders from other states;

- states, each for their part, must agree on the territory and boundaries of the operational facility (with the possibility of subsequent changes in the boundaries if necessary), determine the features of the procedures for calculating and recalculating reserves, and also determine the corresponding shares of reserves attributable to each of the parties to the agreement;
- each of the states agrees with the approved estimate of income and expenses commensurate with their share in the agreement, in connection with which it receives income and calculates its obligations in the process of developing the asset in accordance with the approved standards, regardless of the territory of which of the states the production of hydrocarbons is carried out in at the moment.
- each country determines the terms of tax policy and agrees not to take any other fiscal measures other than those provided for in the agreement [42,43], etc.

Thus, this agreement provides for a number of main objectives:

(1) determining the principles of distribution of hydrocarbon reserves of the field between the participating states;
(2) the approval of a single operation plan and its coordination by license holders;
(3) providing mechanisms for resolving disputes that may arise during the development of the field.

Another successful example of the development of hydrocarbon fields on the basis of a unitization agreement is the Timor Basin Agreement—an agreement between Australia and Indonesia on the cooperation in the development of fields located in the zone of the Timor Sea approved by the countries.

Under this agreement, the zone is divided into three sections: northern, central, and southern. In the northern block, Indonesia exercises control over the development of deposits (granting rights for prospecting, exploration, and the exploitation of deposits) and on the basis of the agreement pays Australia 10% of the tax revenues related to the development of these assets. In the southern section, the same principle is implemented, but in the opposite direction. In the central part, the management of field development is carried out by two collegial bodies—the Council of Ministers and the joint authorized body. The Council of Ministers is represented by a certain equal number of ministers from each side and performs the functions determined by each of the states, including by issuing directives to the Joint Authorized Body. The Joint Authorized Body exercises the powers and functions of each of the states. The functions of the Joint Authorized Body include the management of activities for the development of hydrocarbon deposits, including prospecting, exploration, and the exploitation of hydrocarbon resources [44].

Compared to the Frigg agreement, the Timor Basin agreement is broader in that it creates a new licensing system in the central section of the zone, independent of the individual licensing systems of each state.

The examples reviewed reflect useful working models of international agreements for the development of transboundary hydrocarbon deposits. The criterion for the success of each of them is contained in their common goal—the creation of mechanisms for the peaceful regulation of cross-border deposits' development.

5. Conclusions

In the literature [45,46], it is indicated that the priority direction in the activities of the working bodies is the integrated sustainable management of transboundary watercourses and reservoirs. In this case, the following measures should be made:

- joint monitoring of transboundary water bodies;
- the exchange of hydrogeological and hydrochemical information;
- the coordination of regimes for the use of water resources of transboundary water management systems;
- the coordination of measures and actions in emergency situations (since it is groundwater that can be the only source of water supply in case of emergency);

- joint research.

As recommendations for improving the system of sustainable state management of groundwater resources at the global level, the following are proposed:

(1) to conduct a geological audit of all aquifers and complexes that are jointly operated now and in the distant future. This means, first of all, their hydrogeological characteristics in terms of chemical composition, hydrodynamic properties, the determination of the recharge area and discharge area, interaction with adjacent aquifers and surface watercourses, as well as boundary conditions of various types, including those associated with the tectonic structures of the region;
(2) to align the monitoring system techniques and basic concepts in the structure of hydrogeological research (measurement system);
(3) to differentiate aquifers by reference to basin structures in border areas exclusively for the aquifers of the active water exchange zone (for groundwater);
(4) to determine the areas of responsibility on the territory of the transboundary aquifer based on geological information and hydrogeological parameters of the main aquifers;
(5) to choose a methodology for managing groundwater resources, which is based on the maximum permissible values of lowering the level of groundwater during the exploitation of aquifers not only in the area of responsibility but also on adjacent border areas. This is especially important for areas with active mining activities;
(6) to consider the possibility of choosing one of the models for regulating subsoil use, based on the principles of unitization used for cross-border oil and gas fields, from a legal point of view;
(7) on the example of the use of unitization agreements in world practice, if a field is actively developed by one of the parties, controversial issues arise and the effectiveness of unitization becomes unlikely. In order to avoid future conflicts in joint development of groundwater deposits, it is necessary to stipulate in advance the rules for joint subsoil use long before the dominant regional water intakes reach their design capacity.

It is important to note that the COVID-19 pandemic is an alarming signal for the pace of solving transboundary problems [47], especially in the context of a lack of groundwater resources, which is typical for Asian and African states and the countries of the Middle East. At the same time, it is groundwater that can protect the world's population from the sudden contamination of surface water supply sources, therefore, the role of groundwater resources management in the zones of joint subsoil use of neighboring states is extremely important. Resilient water governance needs an enabling environment that can deal with existing water management problems as well as has the flexibility to deal with future, uncertain situations [48].

Author Contributions: Conceptualization, E.G.; methodology, E.G.; software, N.T. and P.T.; validation, S.P.; formal analysis, E.G., S.P.; investigation, N.T. and P.T.; resources, E.G., S.P. and N.T. and P.T.; data curation, E.G.; writing—original draft preparation, E.G., S.P., N.T. and P.T.; writing—review and editing, E.G., S.P. and P.T.; visualization, E.G. and T.P; supervision, E.G.; project administration, E.G.; funding acquisition, E.G. All authors have read and agreed to the published version of the manuscript.

Funding: The study was carried out at the expense of the subsidy for the state assignment in the field of scientific activity for 2021 No FSRW-2020-0014.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data supporting reported results can be found, https://www.un.org/,https://unece.org/; https://www.un-igrac.org/ru; https://en.unesco.org/themes/water-security/hydrology/groundwater/transboundary-cooperation (accessed on 7 July 2021).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Karlov, G.A. *Water Resources Management in Russia. Collection "International Aspects of Water Legislation"*; Russian State Duma Publ.: Moscow, Russia, 2015; pp. 3–6. Available online: http://duma.gov.ru/media/files/ZAv7xBiAFyPtU4gCsKtTZW796VN28ggn.pdf (accessed on 7 July 2021).
2. Yazvin, A.L. Once again about "underground waters and minerals". *Explor. Prot. Miner. Resour.* **2020**, *5*, 7–12.
3. Berezko, O.A.; Vasneva, O.V. *Management of Groundwater and Transboundary Groundwater in the Republic of Belarus*; Republican unitary enterprise "Belarusian Research Geological Prospecting Institute": Almaty, Kazakhstan, 2012; p. 27. Available online: https://unece.org/fileadmin/DAM/env/water/cwc/groundwater/%D0%A3%D0%BF%D1%80%D0%B0%D0%B2%D0%BB%D0%B5%D0%BD%D0%B8%D0%B5_%D0%BF%D0%BE%D0%B4%D0%B7%D0%B5%D0%BC%D0%BD%D1%8B%D0%BC%D0%B8_%D0%B2%D0%BE%D0%B4%D0%B0%D0%BC%D0%B8_%D0%B8_%D1%82%D1%80%D0%B0%D0%BD%D1%81%D0%B3%D1%80%D0%B0%D0%BD%D0%B8%D1%87%D0%BD%D1%8B%D0%BC%D0%B8_%D0%BF%D0%BE%D0%B4%D0%B7%D0%B5%D0%BC%D0%BD%D1%8B%D0%BC%D0%B8_%D0%B2%D0%BE%D0%B4%D0%B0%D0%BC%D0%B8_%D0%B2_%D0%A0%D0%B5%D1%81%D0%BF%D1%83%D0%B1%D0%BB%D0%B8%D0%BA%D0%B5_%D0%91%D0%B5%D0%BB%D0%B0%D1%80%D1%83%D1%81%D1%8C_%D0%91%D0%B5%D1%80%D0%B5%D0%B6%D0%BA%D0%BE_%D0%B8_%D0%92%D0%B0%D1%81%D0%BD%D0%B5%D0%B2%D0%B0.pdf (accessed on 9 July 2021).
4. Bolgov, M.V.; Demin, A.P.; Shatalova, K.Y. *Russian International Cooperation in the Use and Protection of Transboundary Water Objects: Experience and Problems. Collection "International Aspects of Water Legislation"*; Russian State Duma Publ.: Moscow, Russia, 2015; pp. 32–46. Available online: http://duma.gov.ru/media/files/ZAv7xBiAFyPtU4gCsKtTZW796VN28ggn.pdf (accessed on 7 July 2021).
5. Danilov-Danilyan, V.I.; Khranovich, I.L. Water Resources Management. Harmonizing Water Use Strategies. 2010. Available online: http://www.prometeus.nsc.ru/contents/books/danilov1.ssi (accessed on 1 September 2021).
6. Frumin, G.T.; Timofeeva, L.A. Transboundary waters and basins in Russia: Problems and approaches to their solution. *Biosfera* **2014**, *6*, 118–133. Available online: https://elibrary.ru/item.asp?id=21723871 (accessed on 10 July 2021).
7. Kuchin, A.G. *Transboundary Aquifers of Kazakhstan*; Institute of Water Problems of the National Academy of Sciences of the Kyrgyz Republic: Bishkek, Kyrgyzstan, 2012; p. 21. Available online: https://e-catalog.nlb.by/Record/BY-NLB-br0000811268 (accessed on 11 August 2021).
8. Mironova, A.V.; Molsky, E.V.; Rumanin, V.G. Transboundary problems in the exploitation of groundwater in the region of the state border of Russia–Estonia (on the example of the Lomonosov—Voronkovsky aquifer). *Water Resour.* **2006**, *33*, 423–432. [CrossRef]
9. Nikanorova, A.D.; Egorov, S.A. Formation of principles and norms regulating the use of transboundary water resources by states. *Water Resour.* **2019**, *46*, 114–120. [CrossRef]
10. Podolny, O.V. Cross-Border Aquifers of Kazakhstan 2010. Available online: https://unece.org/fileadmin/DAM/env/water/meetings/Assessment/Almaty%20workshop/pdf/breakout_session/groundwater/Podolny-13-15.10.10.pdf (accessed on 1 August 2021).
11. Zektser, I.S. Investigation of transboundary aquifers in Russia: Modern state and main tasks. *NATO Sci. Peace Secur. Ser. C. Environ. Secur.* **2012**, *129*, 79–85.
12. Law of the Russian Federation on Subsoil. 21 February 1992. N 2395-1. Available online: http://www.consultant.ru/document/cons_doc_LAW_343/ (accessed on 13 June 2021).
13. Alimov, A.A. *Sustainable Development and Use of Water Resources: Global, Regional and Local (National) Scale. Collection "International Aspects of Water Legislation"*; Russian State Duma Publ.: Moscow, Russia, 2015; pp. 104–109. Available online: http://duma.gov.ru/media/files/ZAv7xBiAFyPtU4gCsKtTZW796VN28ggn.pdf (accessed on 7 July 2021).
14. Model Provisions for Transboundary Groundwaters. UN, New York and Geneva. 2014. Available online: https://unece.org/DAM/env/water/publications/WAT_model_provisions/ece_mp.wat_40_eng.pdf (accessed on 15 June 2021).
15. Kashirin, V.V. *The Right to Water. Water Resources Management in Russia. Collection "International Aspects of Water Legislation"*; Russian State Duma Publ.: Moscow, Russia, 2015; pp. 14–32. Available online: http://duma.gov.ru/media/files/ZAv7xBiAFyPtU4gCsKtTZW796VN28ggn.pdf (accessed on 7 July 2021).
16. UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes, Helsinki. 1992. Available online: https://treaties.un.org/doc/Treaties/1992/03/19920317%2005-46%20AM/Ch_XXVII_05p.pdf (accessed on 8 July 2021).
17. UN Convention "On the Law of the Non-Navigational Uses of International Watercourses", New York. 1997. Available online: https://www.un.org/ru/documents/decl_conv/conventions/watercrs.shtml (accessed on 8 July 2021).
18. Convention on the Regime of Navigation on the Danube. 1948. Available online: https://www.danubecommission.org/uploads/doc/convention-ru.pdf (accessed on 10 July 2021).
19. Collection of Existing Treaties, Agreements and Conventions Concluded by the USSR with Foreign States. XIV. Moscow. 1957. Available online: https://mgimo.ru/files/210139/8-mchp4.pdf (accessed on 7 July 2021).
20. Helsinki Rules for the Use of Waters of International Rivers. 1966. Available online: https://www.internationalwaterlaw.org/documents/intldocs/ILA/Helsinki_Rules-original_with_comments.pdf (accessed on 10 July 2021).
21. *Materials on the Law of the Sea and International Trade Navigation*; Soyuzmorniiproekt: Moscow, Russia, 1979; 19p.
22. Bulletin of International Treaties. *Collection of Legislation of the Russian Federation*; Bulletin of International Treaties: Moscow, Russia, 1999; 10p.

23. Water Framework Directive 2000/60/EU. 23 October 2000. Available online: http://caresd.net/iwrm/new/doc/direct.pdf (accessed on 11 July 2021).
24. *Our Waters: Joining Hands, bypassing Borders: A First Aassessment of the State of Transboundary Rivers, Lakes and Groundwater*; UNECE: New York, NY, USA; Geneva, Switzerland, 2007; Available online: https://unece.org/fileadmin/DAM/env/water/blanks/assessment/1st-Assessment-Rus.pdf (accessed on 12 July 2021).
25. Second Assessment of the State of Transboundary Rivers, Lakes and Groundwaters. UNECE, 2011. Available online: https://unece.org/ru/environment-policy/publications/vtoraya-ocenka-transgranichnykh-rek-ozer-i-podzemnykh-vod (accessed on 15 July 2021).
26. Model Groundwater Provisions. UNECE, 2014. Available online: https://unece.org/ru/environment-policy/publications/tipovye-polozheniya-po-transgranichnym-podzemnym-vodam (accessed on 7 July 2021).
27. UN General Assembly Resolution 63/124 on the Law of Transboundary Aquifers. Report of the International Law Commission Sixtieth Session. 2008. Available online: https://www.un.org/ru/documents/decl_conv/conventions/pdf/intorg_responsibility.pdf (accessed on 10 July 2021).
28. Sustainable Development Goals, Goal No. 6. Available online: https://sdgs.un.org/ru/goals/goal6 (accessed on 2 June 2021).
29. Agreement between the Government of the Republic of Belarus and the Russian Federation "On Cooperation in the Field of Protection and Rational Use of Transboundary Water Bodies"; Minsk, Belarus. 2002. Available online: https://old.voda.gov.ru/regulatory/detail.php?ID=3280 (accessed on 8 July 2021).
30. Redko, A.; Golovina, E.I. Analysis of the problems of groundwater extraction in the transboundary territories of the Republic of Kazakhstan. In Proceedings of the XII Scientific and Practical Conference "Sustainability Development of the Digital Economy, Industry and Innovation System (ECOPROM-2020)", St. Petersburg, Russia, 19–21 November 2020; pp. 192–196. [CrossRef]
31. Ustyugov, D.L.; Mironchuk, D.P. Express pumping as a way to identify the interaction of the watered strata with the external environment. *J. Min. Inst.* **2015**, *212*, 84–88.
32. Norvatov, Y.A.; Sergutin, M.V. Prediction of water inflows into mine workings in the process of combined open-underground ore mining operations. *J. Min. Inst.* **2015**, *212*, 89–94.
33. Luebeck, J.V. Integrated stakeholder analysis in investment project implementation under concession agreements in the region of Russia with mineral and raw material orientation. *Rev. Espac.* **2019**, *40*, 22–37.
34. Katysheva, E.G. Economic Problems of Oil and Gas Complex Development in the Northern Territories of Russia. *Int. J. Adv. Manag. Econ.* **2016**, *5*, 78–83.
35. Kurilenko, V.V.; Zhdanov, S.V. Problems of water use of the Izhorsky groundwater deposit. *J. Min. Inst.* **2013**, *200*, 216–221.
36. Mareeva, S.Y. Legal Regulation of the Use of Cross-Border Mineral Deposits; Ph.D. Thesis, The Institute of State and Law of The Russian Academy of Sciences, Moscow, Russia, 2004.
37. Mareeva, S.Y.; Dyachkova, E.A. Features of development of transboundary hydrocarbon deposits. *Miner. Resour. Russ.* **2002**, *1–2*, 26–31.
38. Cherepovitsyn, A.E.; Arild, M.; Smirnova, N.V. Development of Transboundary Hydrocarbon Fields: Legal and Economic Aspects. *Indian J. Sci. Technol.* **2016**, *9*, 1–10. [CrossRef]
39. Cherepovitsyn, A.E.; Ilinova, A.A.; Romasheva, N.V. Key stakeholders in the development of transboundary hydrocarbon deposits: The interaction potential and the degree of influence. *Acad. Strateg. Manag. J.* **2017**, *16*, 1–12.
40. Ulyanov, V.S.; Dyachkova, E.A. Analysis of World Experience in Regulating Field Development, Crossed by State, Administrative and License Areas. Moscow. 1998. Available online: http://www.yabloko.ru/Publ/Unit/unit.html (accessed on 14 September 2021).
41. Ponomarenko, T.V.; Nevskaya, M.A.; Jonek-Kowalska, I. Mineral resource depletion assessment: Alternatives, problems, results. *Sustainability* **2021**, *13*, 862. [CrossRef]
42. Jonek-Kowalska, I.; Ponomarenko, T.V.; Marinina, O.A. Problems of Interaction with Stakeholders during Implementation of Long-Term Mining Projects. *J. Min. Inst.* **2018**, *232*, 428–437. [CrossRef]
43. Ponomarenko, T.V.; Nevskaya, M.A.; Marinina, O.A. An Assessment of the Applicability of Sustainability Measurement Tools to Resource-Based Economies of the Commonwealth of Independent States. *Sustainability* **2020**, *12*, 5582. [CrossRef]
44. Dmitrieva, D.M.; Romasheva, N.V. Sustainable development of oil and gas potential of the Arctic and its shelf zone: The role of innovations. *J. Mar. Sci. Eng.* **2020**, *8*, 1003. [CrossRef]
45. Seliverstova, M.V. Report by the Head of the Federal Agency for Water Resources, Transboundary Water Cooperation of the Russian Federation. 2015. Available online: https://unece.org/fileadmin/DAM/env/documents/2015/WAT/11Nov_17-19_MOP7_Budapest/High-level_segment/Russian_Federation_Ms._c_RUS.pdf (accessed on 1 August 2021).
46. ISARM—Internationally Shared Aquifer Resources Management. Available online: https://isarm.org/isarm-internationally-shared-aquifer-resources-management (accessed on 1 August 2021).
47. Marian, J. Neal. COVID-19 and water resources management: Reframing our priorities as a water sector. *Water Int.* **2020**, *45*, 435–440.
48. Timmerman, J.G. Building Resilience through Transboundary Water Resources Management. In *The Palgrave Handbook of Climate Resilient Societies*; Springer: London, UK, 2020; pp. 1–19.