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Possibilities of Using the Unitization Model in the Development of Transboundary Groundwater Deposits

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Abstract: Groundwater belongs to the category of strategic minerals, along with hydrocarbon resources, so the supply of drinking water will become one of the urgent problems of modern society. The management of groundwater resources and their protection is a very complicated task, especially in border areas where neighboring states jointly exploit aquifers. The problem of transboundary water resources management, in particular groundwater, has been considered at the international level for more than 30 years. However, despite the adoption of a number of conventions, agreements and programs, both at the global and in the format of interstate relations, an understanding for the approach of a universal solution to the transboundary water issue has not yet been formed. An attempt to study the possibilities of applying the principles of unitization on the example of transboundary oil and gas fields in comparison with groundwater cross-border deposits is made in the paper for the first time. As a successful example, the unitization agreement between Norway and the UK for the development of the Frigg field was chosen. It is established that unitization agreements concluded by states in the joint development of transboundary mineral deposits, actively used in regulating the activities of transboundary oil and gas fields, can be used as one of the possible models of international agreements on the extraction of groundwater in transboundary territories.

Keywords: transboundary mineral deposits; groundwater resource management; unitization agreement; oil and gas field

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1. Introduction

Currently, transboundary water problems are becoming more and more urgent. With regard to groundwater, these problems include an assessment of the mutual hydrodynamic influence during the joint operation of transboundary aquifers, that is, the problem of possible «attraction» of water resources from the territory of a neighboring state and the corresponding depletion of groundwater reserves in the territory of the latter. At the moment, there are very few examples of quantitative assessments of mutual hydrodynamic influence during the joint exploitation of aquifers in the border zone [1,2]. There is no developed methodology that would be acceptable for both sides yet.

According to V.I. Danilov-Danilyan, «water resources are one of the main limiting factors of human development». He also notes, that «for a number of countries, the shortage of fresh water has become a real constraint on economic growth, the cause of increased poverty and social tension» [3,4].

Nowadays 153 countries have at least one transboundary aquifer out of 592 (Figure 1). The problem of high-quality legal regulation of cross-border zones for the Russian Federation is particularly acute due to the possession of a vast territory bordering many countries. There is a need to create a universal methodology for joint management of transboundary waters, taking into account the peculiarities of diplomatic relations with a neighboring state and ensuring the sovereign interests of each side.

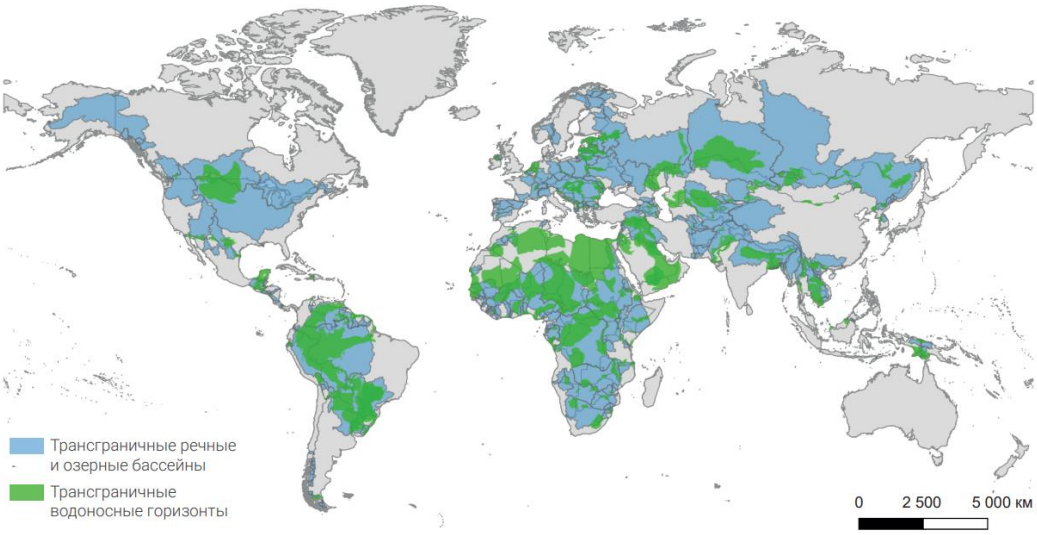


Figure 1. Transboundary river and lake basins, transboundary aquifers and international borders [5].

The history of international cooperation on joint natural resources management dates back to the middle of the last century. Initially, attention was paid only to surface waters in order to ensure navigation (for example, the Convention of 1948 on the Navigation regime on the Danube [6]).

The first universal international legal act aimed at regulating the protection and use of water as a transboundary natural resource was the Convention on the Protection and Use of Transboundary Watercourses and International Lakes, adopted in 1992 under the auspices of the United Nations Economic Commission for Europe. The Convention focused on measures to prevent, reduce, limit any transboundary impact and forms of cooperation of coastal states for the implementation of 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 water use [7].

Over the past decades, in the international legal regulation of the procedure for the use of transboundary waters, a trend towards the allocation of transboundary groundwater as an independent object of legal regulation has been forming.

A significant step in the formation of the legal framework in the field of transboundary groundwater regulation and protection was the adoption of the UN Draft Articles on the Law of Transboundary Aquifers (11 December 2008). It contains 19 articles and actually summarizes the experience gained in previous years in regulating the protection and use of groundwater. The resolution proceeds from the principle of the sovereignty of a state over its natural resources, which include groundwater, in connection with each «aquifer state» has sovereignty over a part of a transboundary aquifer or a system of aquifers located within it [8].

This Resolution is of a recommendatory nature and can serve as a guide for modern states in the field of organization of transboundary groundwater management [9].

States claiming the water resources of transboundary objects can influence the management indicators common to the entire system, in particular, the prices for water resources. Water users—sovereign states in the process of competitive harmonization of strategies for the use of a transboundary water body can be guided by any model scheme.

The development of coherent strategies for the use of transboundary water bodies requires a structure in which the management and resolution of conflict situations are centralized in the form of a non-governmental organization [4].

Unlike groundwater, the development of hydrocarbon deposits by the type of oil and gas is under various models of international management. From an organizational and legal point of view, the so-called unitization model is of the greatest interest [10].

Groundwater deposits are a complex hydrodynamically linked structure, similar in this property to hydrocarbon minerals. Oil and gas fields are also complex dynamic systems in which the spatial migration of minerals is possible.

The specific function of the development of this category of deposits is explained by the geological structure of natural reservoirs and the physical and chemical properties of the fluid contained therein—the change of certain formation conditions, for example, pressures that may cause oil or gas to move within the formation and cross the boundaries established on the surface. It is the migration of hydrocarbons within natural reservoirs divided on the surface by administrative boundaries that creates particular difficulties for the legal regulation of their use [11].

When developing hydrocarbon deposits one of the legal and, as a result, technological, economic and tax challenges is the development of transboundary deposits, i.e., deposits that intersect different types of administrative boundaries—inter-state, boundaries of subsoil sections and other types of boundaries that separate territories with legal regulation [12].

The most interesting for this study are interstate transboundary deposits (TBD), i.e., deposits whose territory is divided by an interstate border, where the subjects of rights are sovereign states [13,14].

2. Materials and Methods

The search for ways to resolve interstate disagreements on the use of water bodies located on the territory of two or more states is increasingly relevant in the international community [15]. In this regard, it is paramount to establish the concepts and definitions in the field of transboundary water resources.

This study uses a comprehensive method that includes analysis and generalization of data provided in publications of Russian and foreign authors and periodicals, industry publications and bulletins, scientific publications of leading experts in the field of economics and geological exploration, reports of government hearings, as well as annual reports and materials on the production activities of domestic and foreign exploration companies, UNESCO materials [9,15], as well as a consultative method with leading foreign experts. The method of analytical calculations in future studies will be based on numerical simulation.

As part of the study, an analysis was made of the practical experience of countries in the field of unitization of transboundary deposits. A detailed study has been made regarding the cooperation between Norway and the United Kingdom regarding the development of the Frigg field. In addition, dogmatic and comparative legal methods were used, consisting in the analysis of applicable legal norms on the use and protection of groundwater.

International experience in regulating the development of transboundary hydrocarbon deposits shows that the successful development of these assets is possible when the interests of each subsoil user are fairly achieved, which can be ensured only when the object of development is considered and mastered as a single hydrodynamically connected system [11,13]. The implementation of this initiative is possible if the following criteria are met:

1. application of unified mechanisms of legal regulation of the transboundary deposits development;
2. development of the field according to a single project 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 deposits 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 joint development of the field subject to a number of conditions (legal, technological, economic) [12,16].

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

The unitization agreement is a comprehensive document that regulates the relations of its participants.

The following concepts and terms play an essential role in the regulation of unitization relations:

1. unit area—territory described in the unitization agreement on which exploration and exploitation under the unitization agreement (unit) is being conducted; license holders pooled under the unitization agreement;
2. participating area—the part of the combined territory that, based on geological data, is considered to contain in profitable quantities the minerals for which the association was carried out, or the part that is necessary to carry out work on the combined territory and in whose favor the extracted minerals are deducted (unitization site);
3. unitized substances—oil and gas lying in the bowels of the united territory and extracted in profitable quantities in accordance with the unitization agreement;
4. unit operator—a legal entity or its subdivision that conducts the unit's activities;
5. unit owners—participants of the unitization agreement, represented by licensees;
6. working interest—rights to part of the united fossil or rights to the land in which they are deposited.

When concluding unitization agreements, each of the participating states adopts a number of provisions that define:

(1) the territory of the agreement, consisting of several plots;

The initial territory of the unitization agreement is usually established by the owners of the combined sites in order to cover the entire deposit of a transboundary deposit (unit), and is fixed in coordinates. As a rule, provisions are provided for the possibilities of expanding this territory if, according to the results of drilling, the deposit goes beyond the initial territory of the unit.

(2) the obligation of the parties to develop the field according to a single approved project and according to a single agreed estimate;

The development of the territory of the unitization agreement should be carried out according to a single well placement project and unified schemes.

If any well drilled outside the unit area by a non-unit operator proves to be profitable, the land on which it is located may also be included in the unit area. In this case, the area will be installed or enlarged in accordance with the unitization agreement, and the well will be operated by the unit operator in accordance with the terms of the unitization agreement.

(3) shares in the unitization agreement and the procedure for revaluation of equity participation;

The extracted products are distributed among the lands of the unitization site in proportion of these lands to the total area of the site. The distribution of the extracted products should be established in the unitization operating agreement or in any other way agreed by the participating parties.

(4) the procedure for the assessment and revaluation of mineral reserves for the purposes of distribution of extracted products;

Such an agreement provides that hydrocarbon reserves are systematically reviewed and clarified, since production may be less or more than expected. The unitization agreement determines how many revaluations will be made, when they will be made, by whom and by what method.

(5) the procedure for the distribution and redistribution of extracted products and costs between subsoil users;

(6) the establishment of a governing body charged with supervising operations under the agreement;
(7) the designation of the legal entity conducting the activities of the association, determination of its rights and obligations;

Upon conclusion of the unitization agreement, the exclusive rights and obligations of the parties to the unitization agreement necessary for the exploration, production, storage and distribution of minerals are delegated to the unit operator. The operator must exercise these rights and obligations only for the purpose of fulfilling the agreement. The operator of the unit becomes the company that was chosen by the parties to the agreement and expressed its consent to accept the operator's obligation to explore and produce hydrocarbons in the united territory. The operator acts as an equity owner in the unitization agreement only if he is one [17,18]. One of the main requirements for the unit operator is its compliance under the citizenship of the producing state.

(8) procedure for drawing up and approving cost estimates and development programs;
(9) information exchange procedure;
(10) features of the customs regime;
(11) taxation and accounting.

As a rule, a single tax regime is established on transboundary deposits. This is due to the fact that if there are, for example, various tax rates in different parts of a transboundary field, subsoil users will be interested in having reserves in the part of the transboundary field where taxes are higher, underestimated. Given the conditionality of dividing the territory of the field into parts, this can lead to very difficult negotiations, which will slow down the development of the facility. Therefore, uniform tax rates are used not only for domestic, but also for international unitization [19,20]. The same applies to payments for the use of mineral resources.

In the USA, for example, when merging, the owners of equity participation must pay for themselves and for the owners of the lands of the combined plots all applicable taxes calculated on the basis of the amount of minerals that can be extracted and sold from the land falling under the unitization agreement.

This paper considers the method of analogy of the law—this is the application to a legal relationship not regulated by a specific norm of the norm of the law, which regulates similar relations. The need to apply this technique is due to the fact that the decision in any case must necessarily have a legal basis. Therefore, in the absence of a rule that directly provides for a disputed case, it is required to find a rule that regulates relations as close as possible to the disputed one.

3. Results

In international terms, some experience has already been accumulated in concluding unitization agreements for the development of interstate transboundary deposits. One of the most well-known and illustrative cases of the use of unitization agreements are the agreement between Norway and the United Kingdom (UK) on the development of the Frigg field and the agreement between Indonesia and Australia on the development of deposits in the Timor Gap.

The example of the unitization agreement between Norway and the UK is considered a classic in international unitization practice and one of the most successful, since for many years it has allowed for the effective development of the Frigg gas field (Figure 2) [21].

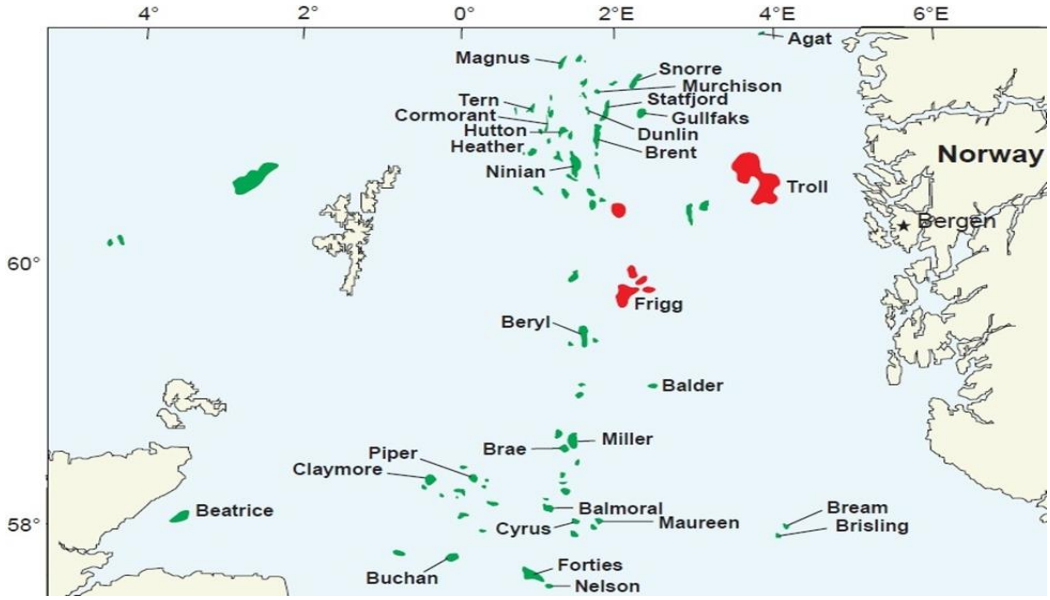


Figure 2. Transboundary Frigg deposit [21].

The exploitation of deposits in the North Sea began in 1971, and Frigg, discovered a year later, became the first transboundary gas field in the region. Its gas capacity was about 185 billion m^3, and the sea border divided it in the ratio of 39.18% of Great Britain and 60.82% of Norway. On 10 May 1976, the Frigg Reservoir Agreement was signed in London, which established the procedure for the operation of the field (AGR1976).

Under this agreement, the parties undertake to jointly develop the field, coordinate all actions in the area of operation, including installation of equipment, drilling of wells, construction of gas pipelines, distribution of licenses, safety and environmental protection measures, exchange of all information available regarding operation and safety on the unit. The parties agree on the appointment of a single unit operator and ensuring unhindered access to the territory of the opposite party. According to the idea of the drafters of the contract, the deposit should be developed as a whole, and the extracted raw materials should be distributed depending on quotas. Frigg was operated without interruption from 1976 to 2004, when gas reserves were exhausted. Two gas pipelines, British and Norwegian, were laid from Frigg, both going to the Scottish processing center St. Fergus, since Norway exported its gas to the UK [22].

Since the system in the North Sea assumed the adoption of separate decisions on unitization and separate legal registration for each specific transboundary field, in 2005 the parties signed a Framework Agreement (FAGR2005), which combined thirty years of experience in the development of transboundary resources and was an attempt to create a common legal framework obliging to conclude unitization agreements in the North Sea on the Friggian principle. The agreement is innovative and could give a new impetus to the development of bilateral cooperation, but to date it has not been ratified and has not yet entered into legal force [23].

The success of this agreement is based on its main principles and provisions, which are as follows:

- the deposit is being developed as a single operational facility (block) by the block operator on the basis of a jointly approved development plan;
- each state shall establish a legal framework for the binding conclusion of agreements both between licensees within the state and with licensees from other states;
- the states, each for its part, must necessarily agree on the territory and boundaries of the operational facility (with the possibility of subsequent border changes if necessary), determine the specifics of the procedures for calculating and reevaluating reserves,

as well as 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 they receive income and are calculated for their obligations in the process of developing an asset in accordance with approved standards, regardless of which state is producing hydrocarbons at the moment;
- each of the states determines the conditions of the tax policy and agrees not to take other measures of fiscal impact other than those provided for in the agreement, etc.

Thus, in the North Sea, the parties went from private to common. The practice of dealing with transboundary issues has always been based on the fact that there was no dispute over the delimitation of the maritime boundary, which was carried out even before the exploitation of the energy resources of the deep sea. However, this case is rather ideal and rather rare in modern practice. More often than not, the parties have to agree on the delimitation of boundaries after discovering natural resource deposits, which leads to difficulties in reaching agreements. In addition, the «ideal» North Sea is also in the fact that it is a shelf and almost 2/3 of its depth area does not exceed 100 m.

Another example of the development of hydrocarbon deposits based on the unitization agreement is the treaty between Australia and Indonesia on the Timor Gap—an agreement on cooperation in the development of deposits located in the Timor Sea zone approved by the countries.

Within the framework of this agreement, the zone is divided into three sections: north, central and south. In the northern section, Indonesia exercises control over the development of deposits (granting rights to search, exploration and exploitation of deposits), and on the basis of the agreement pays Australia 10% of the tax revenues associated with the development of these assets. The same principle is implemented in the Southern section, but in the opposite direction. In the central part, the management of field development is carried out by two collegial bodies—the Ministerial Council and the Joint Authority [24–26]. The Ministerial Council is represented by an equal number of ministers from each side and performs the functions established by each of the states, which are implemented, inter alia, by issuing directives to the Joint Authority exercising the powers and performing the functions of each of the states. The functions of the authority include the management of activities for the development of hydrocarbon deposits, including the search, exploration and exploitation of hydrocarbon resources.

Compared to the Frigg field agreement, the Timor Gap Treaty is more extensive, as it creates a new licensing system in the central section of the zone, independent of the individual licensing systems of each of the states.

The considered examples reflect useful working models of international agreements on 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 the development of transboundary deposits [27].

The agreements thus include a number of basic objectives:

1. determination of the principles of distribution of hydrocarbon reserves of the deposits between the participating states;
2. coordination of the unified operation plan and its coordination by license holders;
3. providing mechanisms for resolving disputes that may arise during the development of the field.

4. Discussion

Comparison of the Unitization Agreement with Similar Legal Acts

While making an analogy to the unity agreement in Russian civil law, then the concept of a joint activity agreement arises.

Similarities:

(1) The parties to the agreements work together to achieve a common goal.

(2) The parties to the agreements do not act in relation to each other in the role of debtor and creditor.
(3) They do not form a new legal entity.
(4) The agreements are based on the participants' shared ownership of common property.
(5) The parties to the agreements are responsible for the debts with their own property.
(6) The common property of the participants is independently accounted for on a separate balance sheet.
(7) The total profit of the participants is usually distributed in proportion to their share in the agreement.

Features of difference:

1 (a) A joint activity agreement is a civil contract based on the freedom of expression of the will of the parties; (b) A unitization agreement may be of an administrative, compulsory nature, since the participants may be required to conclude it by law.
2 (a) A joint activity agreement may be either urgent or indefinite; (b) A unitization agreement is of an urgent nature.
3 (a) Less than two participants (co-partners) may not participate in a joint activity agreement; (b) The establishment of a unit allows for the possibility of one participant's activity.
4 (a) As a general rule, the parties to the agreement on joint activities make decisions on common cases unanimously (by agreement of all participants in a simple partnership). A single management body is not created for a simple partnership;
5 (b) The participants of the unitization agreement create a joint management committee.
6 (a) The conduct of common affairs under a joint activity agreement may not be carried out by the partnership itself, nor by any of its bodies, only either jointly by all participants, or by any of the participants on the basis of a power of attorney; (b) The management of the unit's affairs under the unitization agreement is transferred to the operator.
7 (a) Members of a simple partnership are liable in solido; (b) The members of the unit bear shared responsibility for all common obligations.
8 (a) The participants of a simple partnership do not revalue their initial participation shares; (b) The participants of the unit must re-evaluate the initial shares of their participation.
9 (a) When transferring the rights of a participant leaving the partnership, the preemptive right to his share belongs to other participants of the partnership; (b) The transfer of rights under the unitization agreement can be carried out only with the consent of the state.
10 (a) The agreement on joint activities is not subject to state registration (the exception is the creation of a financial and industrial group);
11 (b) The unitization agreement must be approved by the appropriate governmental authority.

In world practice, there are many forms of interaction between state management systems for the exploitation of transboundary aquifers based on framework bilateral agreements that do not have a specific management mechanism, but are based only on the general principles of environmental safety and excessive depletion of aquifer reserves.

Currently, the Russian Federation has nine bilateral intergovernmental agreements with neighboring states on the joint use and protection of transboundary water bodies: with Abkhazia—2011, with Azerbaijan—2010, with Belarus—2002, with Kazakhstan—2010, with China—2008, with Mongolia—1995, with Ukraine—1992, with Finland—1964, with Estonia—1997, and one trilateral agreement with Finland and Norway—1959 [28].

Intergovernmental agreements concluded by the Russian Federation providing for the establishment of joint commissions include the Agreement on Transboundary Cooperation with Finland, Estonia, Belarus, China, Kazakhstan, Azerbaijan and Abkhazia; Agreements, whose implementing bodies are the Commissioners, the Russian Federation's tripartite agreement with Finland and Norway and bilateral agreements with Ukraine and Mongolia.

Both innovative and well-established mechanisms are necessary for the best joint management of transboundary waters. To date, the most appropriate policy instrument for managing transboundary groundwater is the unitization agreement discussed above.

For analysis of possibilities to use the unitization model in the development of transboundary groundwater deposits it is proposed to find similarities and differences in the field of oil and gas field development and groundwater extraction (Table 1).

Table 1. Similarities and differences of unitization models in the field of oil and gas field development and groundwater extraction.

	Similarities		Differences
1	The state of the groundwater resource is capable of dynamics (movement) during operation, including across the state border	1	The resource of an oil and gas deposit has a finite reserve, groundwater, with a competent assessment of reserves, is practically inexhaustible due to the presence of a recharge area. Groundwater dynamics differ significantly from oil and gas fields, so transboundary impact of groundwater exploitation is much greater.
2	Mining has a certain set of parameters, including quantity, quality, duration of activity—wear of producing production capacities, wells	2	The infrastructure of the oil and gas industry, which has a temporary character with a finite service life, in contrast to groundwater, where the duration of production is determined by the social factor and production necessity
3	The production condition taking into account the influence of producing wells on each other, which is determined by the assessment and revaluation of reserves	3	The valuation of the extracted oil and gas resource differs from the groundwater, the valuation of which is currently not carried out in the Russian Federation
4	Routine monitoring and control are a mandatory factor in the development of mineral deposits	4	The presence of a large number of water wells operated by legal entities and individuals in contrast to oil and gas development
5	Conservation and liquidation of production wells that have run out of time	5	The method of developing oil and gas deposits differs from the extraction of groundwater
6	The use of predictive techniques in assessing the state of the resource, including the geophysical technique	6	The source of financing for groundwater extraction, as a rule, is government programs and private capital; in the oil and gas sector, it is mainly investment capital
7	Licensing of mining and exploration	7	The development mode in the oil and gas segment is unstable, unlike the extraction of groundwater for a short period of time. The intensity of development in the oil and gas segment may vary in contrast to groundwater extraction over a short period of time.
8	Accumulation of groundwater and hydrocarbon resources is defined by the concept of "deposit". The territory of the deposit has certain boundaries	8	The aquifer is vulnerable in case of construction of mining enterprises, shale oil extraction or various drainage works
9	For groundwater deposits with a production volume of more than 100 m^3/day, an assessment of reserves is mandatory	9	A large number of unlicensed and private water intakes (this is an acute problem of today's legislation, the lack of a public administration system)
10	Taxation	10	Several independent subsurface users may be located on the territory of one groundwater deposit

Table 1. *Cont.*

	Similarities		Differences
11	The boundaries of the deposit may be located in both cases on the territory of different countries	11	Groundwater deposits require protection from the impact of polluting and anthropogenic factors. Oil extraction is a more dangerous and complex and capital-intensive technological process. The decision to develop one or another hydrocarbon field, the conditions for this development are highly dependent on the market situation and external factors (geopolitics, legal aspects, ecology). Groundwater extraction is a necessary measure to meet the needs of the population and production, which has no alternative.
12	Both resources are under the control of the state		

Proposed main functions and principles of activity of unitization companies (hereinafter referred to as the U.C.):

- The U.C. is created on the basis of an interstate agreement;
- The U.C. has access to the information base of the state monitoring system on the transboundary territory online;
- The U.C. has corrective, complementary relations with the department of licensing of subsurface use (extraction of groundwater);
- The U.C. correspond with the main organizations with production volumes over 500 m^3/day, as well as mining enterprises producing water supply (drainage) in the zone of the transboundary territory;
- The U.C. has an analytical numerical apparatus for the possibility of constructing an independent forecast;
- The U.C. has the authority to make adjustments to the amount of water intake in certain areas within the framework of the general balance scheme of groundwater extraction management;
- The U.C. has the right to assess the reliability of the initial basic information on the operating mode and measurements of the pressure state and hydrochemical composition;
- The U.C. may consist of both transboundary states; one of the transboundary states or of independent experts from third countries.

Requirements for the preparation of transboundary territory in the organization of the U.C. are:

1. Coordination of the groundwater resources management system in neighboring state territories;
2. Unified methodology and standardization of monitoring and exchange of geological information;
3. Legal aspects of the activities of water intake enterprises and mining companies in the context of the development of groundwater space;
4. The presence of a monitoring network for solving cross-border regulation, coordinated on both sides of the state border in the form of observation wells and other observation points.
5. Hydrodynamic schematization of transboundary territories taking into account the results of geological exploration, namely: filtration parameters, boundary hydrogeological conditions, assessment of the natural flow modulus, hydrochemical zonality, conditions of interaction of aquifers;
6. Establishment of limit parameters of extraction or change of hydrochemical parameters during the operation of aquifers;
7. Establish a zone of responsibility on a transboundary territory, characterize the width (strip) along the border, the size of which can be determined by the radius of influence

of R_{imp} (Equation (1)), independent of the performance of water intake, as well as internal zonality based on the calculation of the radius of formation of reserves for a single water intake

$$R_{imp} = 1.5 \times (a \times t)\hat{}0.5, \quad (1)$$

where R_{imp}—radius of impact of water intake (m), a—reservoir permeability (m^2/day); t—the reservoir life of the water intake (10^4 days);

$$R_f = (Q/(\pi \times \mu_{pr}))\hat{}0.5 \quad (2)$$

where R_f—radius of formation of operational reserves (m); Q—well output (liters/sec); μ_{pr}—module of groundwater resource potential (liters/sec per km^2) [29–31].

According to calculations, for example, for the Lomonosov aquifer on the border of Russia—Estonia, the R_{imp} value will be about 47 km, based on the filtration parameters of the main aquifer exploited for the purposes of domestic drinking water supply [28].

5. Conclusions

High-quality fresh drinking water resources are essential for quality of life, notably in water-scarce areas. Due to the rapid increase in the world's population, along with noticeable economic growth, freshwater resources have been stretched to the limit in many countries and regions of the world [32]. In many places around the globe, various pressures have threatened groundwater that calls for better management strategies for groundwater sustainability [33].

Based on the analysis of world experience in the field of unitization of transboundary hydrocarbon deposits, as well as consideration of the above-mentioned contracts and standard unitization agreements, it is possible to identify such key participants in unitization as the state (state structures), license holders (mining companies operating deposits), the unit operator appointed on the basis of an agreement of all parties, the unitization commission, investors, as well as the media and the public [34,35].

An important role in the development of transboundary deposits is assigned to the state, whose functions include, first of all, determining territorial aspects, concluding appropriate agreements between countries, deciding on the development of transboundary deposits, taking into account the strategic importance and economic feasibility at the current time, participating in the appointment of licensees and monitoring the implementation of unitization agreements.

The unit operator is also a significant element in the system of stakeholders, being a connecting element between two or more parties in legal, economic and other aspects. Coordination and control of compliance with international standards and documents on subsoil use adopted in the countries is within the competence of the unitization commission, which has the right to receive information about the state of affairs and ongoing work on the project. However, the decision to create it is not always made.

Despite the existing experience, it can be concluded that the mechanism for concluding unitization agreements has been worked out rather poorly, including in terms of interaction between the main stakeholders of this process.

Analyzing the possibility of adapting the unitization principles (models) of the oil and gas sector to the extraction of groundwater, the following should be noted:

(1) The unitization company (hereinafter referred to as the U.C.), as a coordinating structure at the interstate level, should partially assume the management functions. State models and principles of water management in different countries have a number of differences, which means that delegating part of their functions to the U.C. will help to connect at the legislative and executive international level;
(2) The field of activity of the U.C. should have restrictions based on the estimated areas of responsibility for the operation of groundwater, based on geological and hydroge-

ological calculations and assessment of the degree of development of underground water space;

(3) The activity of the U.C. should be based on highly qualified specialists who have the necessary degree of trust from both contracting parties;

(4) The U.C. is financed by both states parties to the unitization agreements with a mandatory planning and reporting model of interaction;

(5) The U.C. builds the ideology of groundwater extraction management in both adjacent border territories, including the layout of the monitoring network based on hydrogeological schemes and parameters of the main aquifers and water barriers. The analysis of the hydrogeological situation during the operation of the main aquifers will make it possible to perform the main function of the U.C.—to adjust the productivity of all water intakes on a transboundary territory, as well as their intra-territorial location;

(6) In most states where fresh and ultra-fresh groundwater is not a marketable product within the framework of the fields being developed, that is, it does not yet have a cost estimate, the formation of the U.C. budget is possible only from state earmarked funds. Nevertheless, a number of states in the Near and Middle East, Africa, and the Asian region experiencing an acute shortage of fresh water resources can and should transfer the financing of the U.C. to the principles of an investment mechanism or concession.

Unfortunately, not all interstate approaches consider groundwater as an independent type of minerals, as a result of which conflict situations arise, especially in areas with a shortage of fresh groundwater resources (the Middle East, Central Asia, the African continent, etc.). Unitization companies that have received trust and authority from neighboring states can and should, under our concept, carry out the function of managing groundwater production without involving external stakeholders.

Thus, the unitization model will help prevent the emergence of conflict situations in the development of groundwater deposits in transboundary territories, taking into account the interests of neighboring states, both in terms of ecology and the economics of subsoil use. The delegation of rights and obligations to unitization companies should be based on unconditional trust, transparency, and high qualification of employees (specialists) appointed by the parties (neighboring states). An important factor in this is the legal adaptation of the activities of such companies to local rules of law, but in the end, international law is dominant.

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