

A modern approach to improve the effectiveness of logistics management of water flows of transboundary areas of Russia

Un enfoque moderno para mejorar la efectividad de la gestión logística de flujos de agua de áreas transfronterizas de Rusia

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ABSTRACT:

The article deals with the problem of increasing the effectiveness of water flow management in the transboundary areas of Russia. The authors present the results of the analysis of the current status and trends in the development of the water flow infrastructure in transboundary areas of the Russian Federation and the Republic of Azerbaijan. Based on the conducted analysis, the authors offer ways to improve the effectiveness of water flow management.

Keywords: logistics infrastructure, transboundary area, water flows, logistics processes, water flow management.

RESUMEN:

El artículo aborda el problema de aumentar la efectividad de la gestión del flujo de agua en las áreas transfronterizas de Rusia. Los autores presentan los resultados del análisis del estado actual y las tendencias en el desarrollo de la infraestructura de flujo de agua en las áreas transfronterizas de la Federación de Rusia y la República de Azerbaiyán. Sobre la base del análisis realizado, los autores ofrecen formas de mejorar la eficacia de la gestión del flujo de agua.

Palabras clave: infraestructura logística, área transfronteriza, flujos de agua, procesos logísticos, gestión del flujo de agua

1. Introduction

The global financial crisis caused by changes in the oil market, the reassessment of credit risk, as well as the uncertainty in the development of the main economies of the world, the glut of commodity markets, pose the most difficult tasks for modern economic

science, such as ensuring the growth of business investment and real income, optimizing customs and logistics systems, and developing business partnership in the transboundary space. One of the main points of the country's economic development strategy is the transition from a closed economic system, isolated from the world, to an economy incorporated into the global world economy (Bryntsev *et al.*, 2018).

The creation of a logistics infrastructure for flow business processes, which should be focused on innovation and investment, including the development of logistics methods for regulating flow processes in the transboundary water sector economy, is of great importance for the economic recovery of a number of transboundary areas (Izmaylova *et al.*, 2018a).

In world practice, there are a number of transboundary areas, where integration processes related to the logistics infrastructure of WFM have been or are now being implemented with varying degrees of success. The transboundary situation between the Russian Federation and the Republic of Azerbaijan was studied most deeply by Russian scientists (Dukhovny, 2007; Suleymanov, 2016). The presence of transboundary water flows necessitates the existence of a common strategy to meet the water needs of each state in accordance with its economic needs. Azerbaijan is a traditional trade partner of the Republic of Dagestan, of the Russian Federation. These republics are united by historically developed economic interests. One of the main problems of transboundary cooperation between the Republic of Azerbaijan and the Republic of Dagestan is that related to the distribution of water flows of the Samur River, which flows along the border between these republics. The issue of sharing the waters of the Samur River today is relevant for both regions. The main water consumers are agriculture, industry, and water supply in the cities located in the river basin.

An urgent need for a final solution to the issue of water withdrawal by countries, for the rational use of water flows, emerged quite a long time ago. An important step may be a new bilateral agreement between the Republic of Azerbaijan and the Russian Federation, which would ensure the rational use of water resources and guarantee optimal environmental drainage in the river estuary area because in the long term water consumption will be much greater. This increase in water consumption is related to the development of ports, the Caspian shelf, and agriculture, as well as the formation of recreational complexes (Saypulaev *et al.*, 2005).

At the same time, a number of problems related to the logistics management of water flows remain insufficiently studied and require additional theoretical and practical research. The development of theoretical and applied approaches to solving the problems of water infrastructure deterioration, the lack of a scientifically grounded mechanism of logistics support for the organization of water delivery and distribution still does not lose its relevance. In many countries, the formation and development of the water flow logistics infrastructure in transboundary areas have shown their high economic, social, and political effectiveness. However, in Russia, the experience of these countries is not generalized. There are practically no recommendations for the creation of a mechanism of logistics support of water flows (Saypulaev *et al.*, 2005).

The purpose of the present article is to scientifically substantiate the ways to improve the efficiency of water flow logistics management based on the analysis of conceptual approaches to water flow management (WFM), as well as taking into account the current status of water flow infrastructure in Russia, and identifying developmental trends of water flows in its transboundary areas.

The relevance of the present work consists on developing theoretical and methodological approaches to solve the problem about how to organize the logistics management process of transboundary business processes on the example of transboundary water flow logistics, which meets the concept of sustainable development and contributes to the achievement of socially significant results. In the modern world, water resources are included in the category of strategic resources that ensure the economic security of the state, and, as a consequence, various organizational and economic measures are developed and implemented in almost all countries to build an effective system of water management depending on the goals of the state and specific water consumers

2. Methodology

The theoretical concept of the study is based on the works of diverse scientists, whose research interests are devoted to issues related to solving organizational and logistical problems, arising from the flow process management (Adamov, 2011; Adamov and Ellaryan, 2013; Bryntsev *et al.*, 2018), WFM theory and practice (Ellaryan *et al.*, 2013), and transboundary interaction in the water sector economy (Dukhovny, 2007; Saypulaev *et al.*, 2005; Suleymanov, 2016).

The study was carried out using general scientific methods of cognition, which include a dialectical method, method of analysis and synthesis, as well as special methods of empirical cognition, such as methods of scientific modeling, analysis of economic and statistical indicators, comparative analysis, and expert assessments. General scientific methods of cognition were used in the process of theoretical analysis of scientific works of foreign (A. Barone, D.J. Bowersox, D.J. Closs, P. Murphy, D.L. Wardlow, D.F. Wood) and Russian (G.M. Alimusaev, M.A. Izmaylova, E.A. Kameneva, V.I. Morgunov) scientists, which made it possible to identify a number of unresolved problems in the field of logistics management of natural resources of transboundary territories of a supranational nature. Our scientific interest to the study of the problem of logistics management of water resources is determined by its high relevance for Russia, reliably substantiated empirical data presented in publications of Russian scholars (V.A. Dukhovny, I.M. Saipulaev) and personally obtained by members of the authors' team (N.A. Adamov, Z.E. Suleymanov). The systematization of existing scientific knowledge and original contribution to its growth, as well as the use of a systematic approach and comparative analysis, allowed us to formulate conceptual approaches to managing water flows in relation to the transboundary territories of Russia – to generalize tools for integrated WFM, to identify key principles for managing water flows in the logistics sphere, to develop a logistic mechanism for managing water flows and to give an interpretation of this phenomenon in relation to modern business conditions. To assess the applicability of the proposed approaches to improving the existing infrastructure of water flows of Russian transboundary territories, it seemed necessary, based on an analysis of economic and statistical indicators and expert assessments, to evaluate the current state of logistic-oriented management of water flows using the example of the Samur basin and identify its negative trends. The generalization and comprehension of the theoretical and empirical results of the analysis allowed us to formulate the main directions of effective management of water flows and give them a detailed description.

3. Results

3.1. Conceptual approaches to WFM

The WFM system includes logistical support of water flows, while the integrated management of water flows is treated in a broader sense as a management system based on the consideration of all possible water sources, links between sectoral interests, broad involvement of all water consumers, and rational use of water flow that provides water supply of population and environmental safety.

In Russia, numerous Russian scientists were engaged in the development and implementation of the concept of integrated natural resources management (Dukhovny, 2007; Adamov, 2011; Ellaryan *et al.*, 2013; Suleymanov, 2016; Gerasimov *et al.*, 2018; Kuzmin *et al.*, 2019; Dudin *et al.*, 2019a,b). The studies revealed that the principles of integrated natural resources management should be implemented in stages, while the implementation dates and their fulfillment have depended on the financial and economic situation of the country, as well as a number of other factors, such as government support. The main focus of the concept is to create a regulatory framework for individuals and legal entities, and state (municipal) authorities to assess water use conditions, total costs, and methods of improving the effectiveness of water use and

water protection measures.

In order to coordinate the actions of the executors, it is necessary to have a legal framework, organizational structure, and general tools in the WFM system (table 1).

Table 1
Tools for the integrated management of water flows.

Tools	Indicators
Management tools	– water use effectiveness – assessment – planning
Regulatory tools	– key indicators – method – criteria
Information exchange	– database – complex of mathematical and logical models
Social tools	– staff training system to obtain the necessary profile qualification of managers
Demand management	– water flow utilization effectiveness

Source: (Suleymanov, 2016)

The planning process should take into account economic, environmental and social factors, as well as methodological tools for their assessment (Troshina *et al.*, 2013). After carrying out organizational and economic activities, taking into account the necessary amount of investment, important water management results can be achieved, the main ones being:

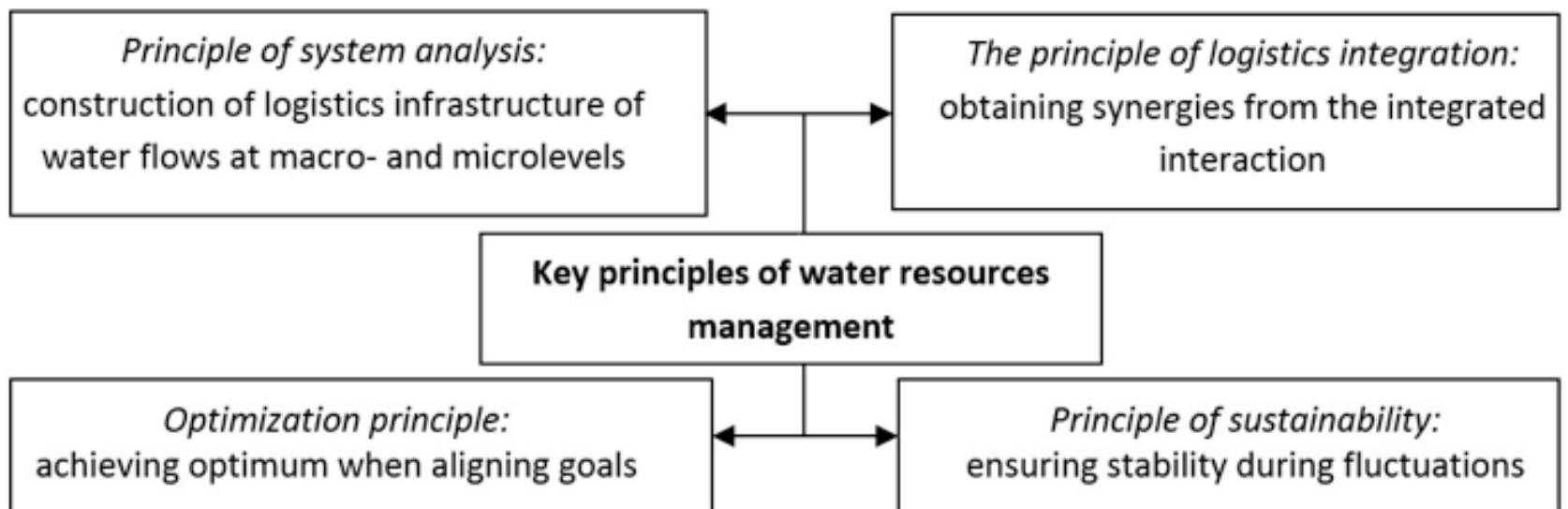
- equitable distribution of water flows
- stable water supply to consumers
- reduction of unproductive water losses
- solving environmental problems
- improving the productivity of water flow use

The WFM concept is based on the logistics principles (fig. 1), which allow regulating the functions of each level of the water management logistics system, as well as is based on the following understanding of the essence of WFM (Adamov and Ellaryan, 2013):

1. Large-scale use of different types of water flows is quite possible if taking into account the climatic features of the territory.
2. Management is carried out among sectors and all levels of water management, namely, executive authorities, water users association as well as legal entities and individuals.
3. Information support of WFM logistics system should be necessarily created and implemented.
4. Observation of the priority of the water environment protection is the primary approach to the activities of water management bodies.

5. Ensuring strict liability, primarily financial, for maintaining the water saving regime and the absence of unjustified water losses by water management organizations and water users.

Figure 1
Key principles of WFM
in the logistics sector



Source: (Suleymanov, 2016)

WFM can be considered complete if all the above principles are observed and implemented. The partial implementation of one or more principles cannot serve as a basis for its recognition as being complete. It should be noted that the forms and methods of implementing the WFM principles differ from each other, though this does not prevent to achieve the main goal.

The studies from Ponis and Koronis (2012) and Cardoso *et al.* (2018) have revealed that the logistics mechanism of WFM, applied at the level of the state or a particular region, is the starting point for the construction of the logistics infrastructure of the area under study, as well as it helps to adequately assess the demand for water, using all available water flows, regardless of water quality. In parallel, it monitors the environmental issues that are critical to all aquatic ecosystems.

The essence of the mechanism consists in determining the logistics methods of management of all water flows. The basic principle of WFM is the application of an integrated policy within the framework of legislation through the construction of a logistics structure.

The principles of WFM directly imply the implementation of changes synchronously related to technical innovations. This means that, within the country, major changes will affect the distribution and management of surface and ground waters. Certainly, the regulatory framework is also subject to change. The WFM principles implicitly imply that the existing economic entities responsible for water use will need to be reformed that may lead to resistance, rejection, or alienation. In the event of such situations, the creation of new institutions for achieving effective and responsible use of water may be demanded (Johnson *et al.*, 1999). Water reform is inextricably linked to social issues, though the main focus of reforms should be directed on the competence of decision-makers.

The WFM establishes also the organization for the use of water flows, taking into account logistics principles starting from the hydro units and ending with the water basin, in general. If the development of the logistics principles of WFM is carried out within a specific basin, then the planning is carried out taking into account the implementation and evaluation of the effectiveness of logistics processes in all sectors of water management. But, as is obvious from the above, only the creation of single management of the entire logistics process can provide effective and logistic-oriented management of water flows, taking into account the environmental component.

It should be noted that the considered principles are implemented at both the upper and lower hierarchical levels of WFM. At the upper level, the changes concern strategy,

regulatory framework, and administration related issues. At the same time, a number of existing methods and procedures are subject not only to change, but also to replacement. At the lower level, WFM is implemented into operational activities, whose main objectives are the effective operation and technical maintenance of various water facilities, as well as the fight against climate change. The lower level includes all parties concerned in the water systems operation and management, both individuals and legal entities (Ellaryan *et al.*, 2013). Water distribution and water use will be more effectively planned and monitored at the availability of WFM logistics system. There is a need to create and maintain a unified information base of the water environment in the region. This will allow for the coordinated use and accounting of all water sources.

The result of comparing the implementation of the WFM principles with the existing system is presented in table 2.

Table 2
Implementation of the logistics management principles in comparison with the existing system.

Existing system of WFM	Implementation of the WFM based on logistics principles
Disjunct executive bodies of water management	Availability of coordination mechanism and involvement of all economic entities of the water industry in the coordinated process of logistics management
Administrative barriers preventing effective management	Assurance of stable and equitable water supply regardless of the location of the water consumer
Water loss due to the inconsistency of managerial actions at different levels of management	Minimizing water losses by creating hierarchy levels and coordinating actions at these levels
Conservative laws	Uniform policy and legislation
Rigid managerial procedures imposed by authorities	Flexible regulations to meet dynamic conditions
Bureaucratic multilevel structures	Commercial societies with or without partial support of the state, including those based on the public-private partnership
The incorrectness of the true financial costs of water management services	Financial planning and payment based on real logistics costs. Transition to the self-sufficiency of operations and industry sector, in general
Lack of incentives for water conservation (an increase in water productivity)	Implementation of incentives to improve water productivity and water conservation
Incorrect data on water consumption, its volumes, and losses	Development of hydrometric studies, standard accounting of water, when supplying and draining
Lack of qualified and/or parties concerned decision-making on water management	Training of personnel with specialized competencies to be involved in WFM
Lack of accountability to consumers for the rates	Provided services based on contracts, joint participation in the definition of norms and tariffs

Poor legal and economic literacy of water consumers	Establishment of water consumer associations
Insufficient attention to environmental problems	Water distribution according to the requirements of environmental protection
Lack of unified accounting of surface and groundwater use, as well as utilization of return flow	Unified planning and universal implementation of WFM based on logistics principles
Source: (Suleymanov, 2016)	

Thus, it can be concluded that WFM should be considered as a triune phenomenon, which:

- is a process that allows supplying the required amount of water with the required quality to the required place and at the required time, based on logistics principles using various resources to provide water management services (Prokofieva and Sergeev, 2012);
- is a phenomenon requiring minimal impact on the management to improve the indicators of economic, environmental, and social living standards, without endangering the sustainability of water systems (Ponmaarov and Holcomb, 2009);
- is a process which allows centralized use of water flows from all possible sources, with monitoring of surface and groundwater depletion and other environmental measures, including waterlogging and salinization; the main purpose of this process is to meet the water needs of various sectors of the economy (Bryntsev *et al.*, 2018).

3.2. Current status and development trends of water flow infrastructure in the transboundary areas of Russia

The main factors affecting the water flows of the Samur River are irrational water intake and losses in the course of waterworks operation. Construction of housing and social facilities, irrigation of fields, development of industry, hydropower, etc. require the growth of water consumption. Therefore, WFM should be focused on the needs of the economy. At the same time, the constant task of logistics-oriented WFM is to reduce the loss of water resources and increase the rationality of their use. In this regard, it is important to make a forecast of the perspective situation with water consumption for the Russian Federation (Republic of Dagestan) and Azerbaijan based on statistics of previous years from Rosstat of the Republic of Dagestan and the State Agency for Land Reclamation and Water Management under the Ministry of Agriculture of the Republic of Azerbaijan (table 3).

Table 3
Statistical data on water consumption
in transboundary areas (mln m³).

Years	2000	2005	2008	2009	2010	2011	2012	2013	2014
Water consumption in the Republic of Dagestan	4.397	4.464	4.010	3.824	4.151	3.621	3.315	3.254	3.968
Water consumption in the Republic of Azerbaijan	6.588	8.607	7.886	7.639	7.715	8.012	8.248	8.229	8.115

Table 3 shows that over the past 15 years, the water consumption in the Samur basin by

both countries had a multidirectional character. The first years of the 21st century, both states widely used the power of hydraulic structures built in the USSR. However, the reduction of funding for maintenance and modernization of equipment led to the deterioration of its operation, and consequently, reduction of water withdrawal (Adamov, 2011). Azerbaijan has drawn the appropriate conclusions, and launched a broad program for the construction of new hydraulic structures, as well as the implementation of elements of water flow logistics management, thereby breaking the negative trend, and achieved an increase in water consumption in the transboundary areas under consideration. According to the forecast (table 4, figs. 2 and 3), water consumption will continue growing, and most importantly, there are technical possibilities for this (Suleymanov, 2016). Unfortunately, the Republic of Dagestan did not pay due attention to this problem, and the construction of new hydraulic structures began 10 years later. Besides to date, there is no evidence-based development of water flow logistics infrastructure. Therefore, in case of need to meet the growing demand for water consumption, it will be necessary to use other sources.

Table 4
Estimated forecast of water consumption
in transboundary areas (mln m³).

Years	2016	2017	2018	2019	2020	2022	2024	2025
Water consumption in the Republic of Dagestan	3.388,8	3.316,3	3.243,9	3.171,5	3.099,1	2.954,5	2.810,0	2.737,8
Water consumption in the Republic of Azerbaijan	8.464,9	8.546,8	8.628,6	8.710,3	8.792,0	8.955,3	9.118,5	9.200,0

Figure 2
Forecast of water consumption in the
Republic of Dagestan (mln m³)

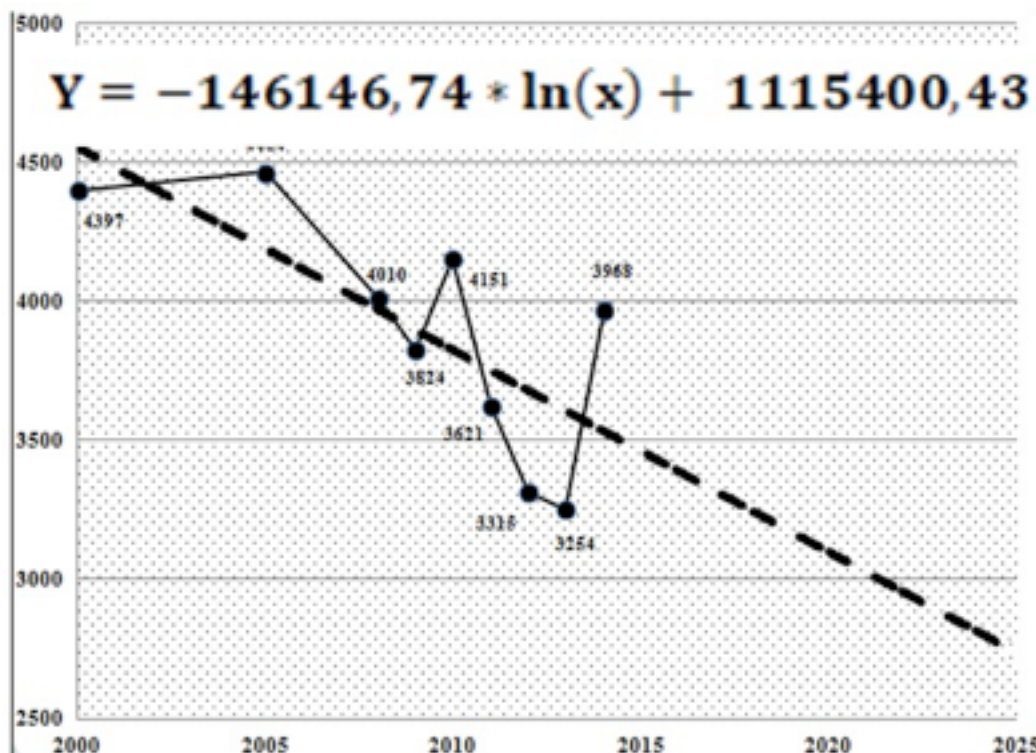
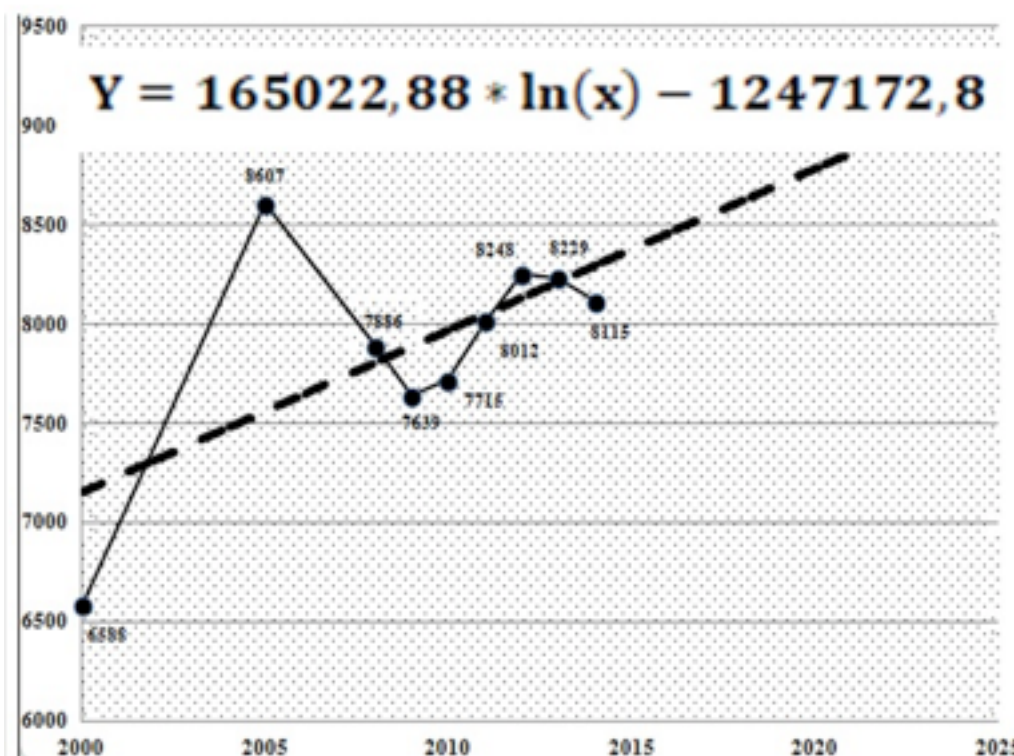


Figure 3



According to the forecast (table 4), without solving the urgent technical, organizational, and economic problems, the water consumption of the Republic of Dagestan from transboundary areas of the Samur River can inevitably decrease, constraining the development of this region. The analysis of the above facts suggests the need to revise the agreement on water withdrawal from the Samur River, to organize close cooperation on the creation of joint investment programs for the construction of logistics water infrastructure to meet the needs of its parties, while reducing irrational water abstractions and losses in the course of water delivery to its consumers.

3.3. Ways to improve WFM

It is noted by the researchers (Suleymanov, 2016; Adamov and Ellaryan, 2013) that one of the significant drawbacks of the WFM system is its centralization. At that, the upper level of management is loaded with routine decision-making details, while the lower level does not have sufficient powers and means for operational work and implementation of activities in the water management.

The main directions of modern effective WFM are as follows:

- reform of the legal and regulatory framework
- implementation and development of logistics management mechanism
- development of water body monitoring system based on databases

The reform of the regulatory framework of water utilization is supervised at the top hierarchical level of water management structures and involves the development of new and improvement of existing rules and regulations. The purpose of the development of logistics support for WFM is to meet the demand for water and its availability, including reducing the load on the water system, ensuring sustainable water utilization, and adherence to exposure limit on the aquatic environment. The key objectives to improve the WFM (Gnezdova *et al.*, 2017) include the following measures: developing water flow base; creating a system of operational monitoring in major cities based on the automated systems of data surveillance, control, processing, storage, and transmission; ensuring evolution of an analytical measurement base; and developing monitoring system over the condition and changes in catchment and coastal areas. The main difficulties in reforming the water management system are related to the low investment attractiveness of water management projects. Reform of the water management system should be divided into three phases (table 5).

Table 5
Phases of the WFM reform

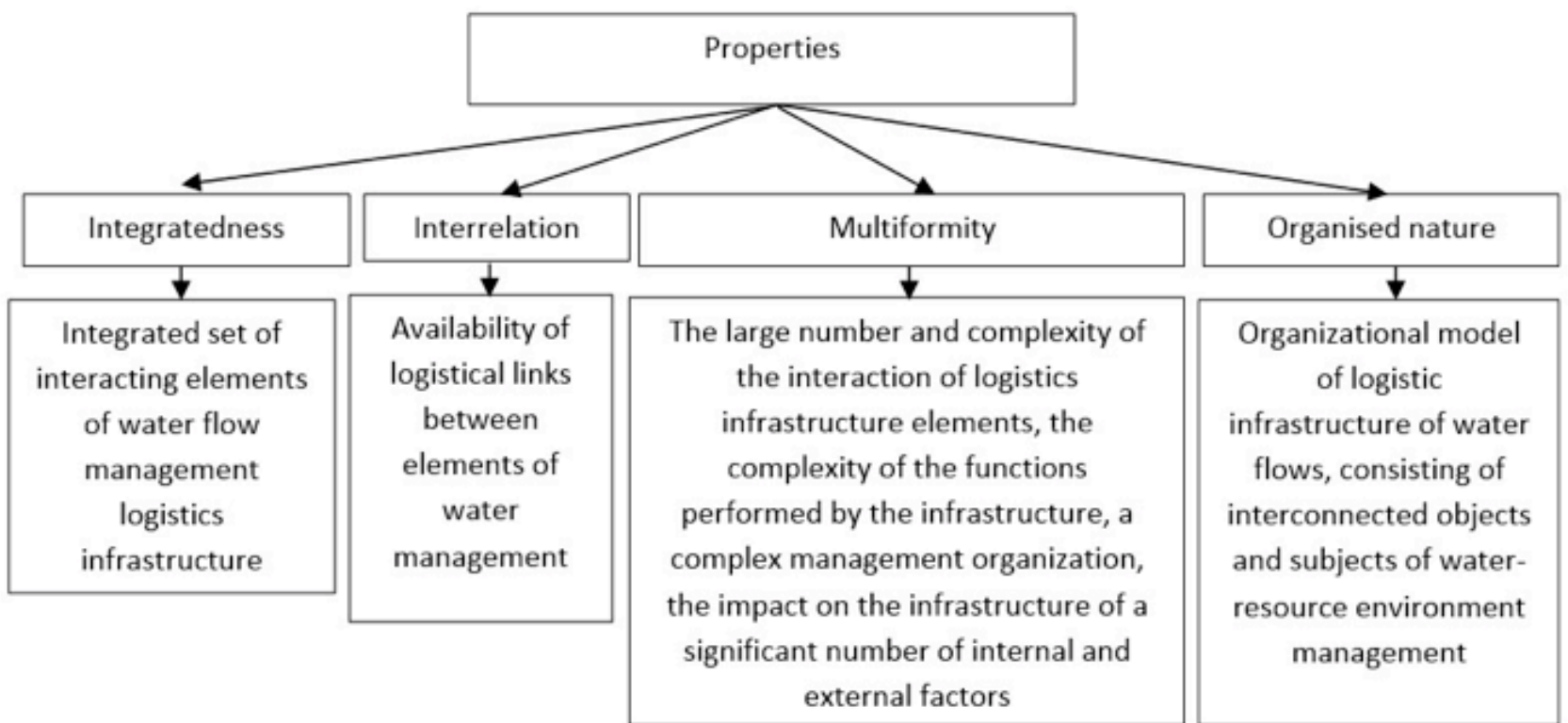
Phases	Tasks	Actions
1. Creating the legal, institutional, and economic framework	<ul style="list-style-type: none"> - to reform the management system - to improve the organizational and economic mechanism - to develop a regulatory framework 	<ul style="list-style-type: none"> - development of legal documents and technical regulations for water utilization - development of water standards taking into account permissible loads on water bodies
2. Developing measures for rational water utilization in all sectors of the economy	<ul style="list-style-type: none"> - to reduce the load on water bodies - to reduce the level of pollution of the aquatic environment - to reduce damage from natural disasters - to prevent damage - to eliminate the consequences of harmful effects 	<ul style="list-style-type: none"> - transition to self-financing in the water management industry; - restoration of biological resources - establishment of water bodies' regular monitoring system - development of mathematical and logical models of rational management and use of water flows.
3. Implementing logistics support for WFM	<ul style="list-style-type: none"> - to develop and implement logistics support for WFM - to develop the program-target activity 	<ul style="list-style-type: none"> - development and implementation of logistics support for WFM - providing the evolvement of program-target activity

Implementation of all phases of WFM reform involves the coordination of all federal and local authorities, whose activities are related to the development of water management and WFM.

The water environment of the region is considered in studies as a logistics infrastructure (Wood *et al.*, 2002). The use of logistics support for WFM makes it possible to effectively use the water potential of the region by building infrastructure links on the logistics chain, linking water sources and end users. Logistics infrastructure of water flows is a set of enterprises, which are included in the infrastructure of water flows, and are in certain organizational relationships with each other so as to obtain the maximum effect of joint activities.

Logistic infrastructures of water flows are characterized by the fact that the set goal can be achieved only by the whole system, rather than by its individual elements (Stock and Lambert, 2001). These elements can be water intake, drainage, irrigation, and other facilities, but they are always interrelated, although, in fact, each of them is isolated. The properties of the water flow logistics infrastructure are shown in fig. 4.

Figure 4
Properties of water flow logistics infrastructure



Source: Suleymanov, 2016

Thus, the study of the water flow logistics infrastructure is necessary to understand the external conditions in which the logistics infrastructure operates, as well as to clarify the real objectives of the logistics infrastructure, alternative ways to achieve them, the limitations, and consequences of the choice of alternatives.

4. Discussion

As is evidenced by the conducted study, transboundary business processes, including water processes, are an important element of both national economies and interstate economic relations. Effective management of transboundary water flows based on logistics principles will allow meeting increasing water needs and improving the quality of water bodies and the environment in general (Seth *et al.*, 2005).

The focus of scientific research of both Russian (Izmaylova *et al.*, 2018a) and foreign scientists (Bowersox and Closs, 1999) is aimed at solving a whole set of problems. First of all, this concerns the search for logistic-based theoretical solutions of the problems in the field of transboundary WFM, the development of theoretical and methodological approaches to the formation of a developed system of logistics infrastructure of transboundary areas with appropriate risk assessment. Important is also obtaining practical solution to the problem of logistic support of water flows of specific transboundary areas, identifying its specificity, which can be used to make optimal decisions in the field of transboundary WFM, as well as identifying promising ways of joint solution of problems related to the organization of transboundary flow processes (Alimusaev, 2014). And finally, the problem of development strategy generation of the logistics infrastructure of transboundary areas, which allows increasing the investment attractiveness of logistics-oriented projects in the water sector, requires urgent solution (Izmaylova *et al.*, 2018b).

5. Conclusion

It is impossible to solve the problems of effective construction of the water flow logistics infrastructure without the creation of a scientific methodological apparatus that would allow giving professional justification to managerial decisions at all levels of WFM in the country, as well as forming a modern logistics system of water utilization. From this viewpoint, the presence of transboundary areas has put forward a range of completely new socio-economic problems, previously unknown to the economy of the country, to a number of entities of the Russian Federation. They are due to a number of objective reasons that accompany the new situation in the country's economy at the present development stage, namely, gap of economic relations with other entities of the world market, caused by the sanctions, a sharp complication of transport communications, and

a higher level of manifestation of crisis phenomena at the area under study.

In this context, the systematization of theoretical concepts in the field of logistics infrastructure development, the clarification of the role and place of WFM processes as a tool for water resources management, and the improvement of the efficiency of economic activity of enterprises in this sphere, are quite demanded. The solution to these problems will allow building a scientifically grounded mechanism of WFM based on logistics principles, taking into account the sustainable development concept, specific natural and climatic conditions, established water management system, national traditions, and cultural specifics.

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