Rationale for Convergence of Institutional Arrangements Based on Individualized Approach to Cross-Border Water Pollution

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Abstract. The present research featured the level of cross-border water pollution in a resource-type region. In spite of the fact that the cross-border water pollution abatement spans more than half a century of experience, its actions rarely go beyond administrative measures, which is why the problem remains as relevant as before. Nevertheless, all stakeholders are highly interested in solving the issue, which means that the existing measures have to be tested for performance. The issue requires new recommendations on the convergence of various highly effective institutional arrangements. The article presents a rationale for assessment and analysis of the composite indicators of measures aimed at solving the problem of cross-border water pollution. The authors believe that performance should not be confused with the actual solution of the problem, not to mention reaching the goal of sustainable development on a particular territory. The research delivered some practical recommendations concerning the matter of cross-border water pollution in a resource-type region. The recommendations go beyond the scope of administrative management and focus on inter-municipal cooperation and eco-compensation trade schemes.

1. Introduction

Water resources often become a matter of shared use between several regions of one country and / or several countries. The history of natural resource sharing proves that cross-border cooperation on water resources is a norm and covers a number of issues, e.g. floods, water pollution, distribution of water resources, etc. [1-8]. However, an analysis of existing studies on cross-border water pollution in Russia showed mixed results of the work of basin authorities. Unfortunately, most institutional arrangements remain on paper.

The analysis revealed two kinds of institutional arrangements for solving the problem of cross-border water pollution. The first one is international agreements, which are implemented in 40% of all international river basins. The second presupposes development of managing organizations for river basins and occur in 60%. However, despite the significant progress achieved in trying to implement institutional arrangements for joint management of cross-border water pollution, their effectiveness remains hard to define and prove.

Current cross-border water pollution arrangements cannot ensure effective management Russia's water sector, let alone fair access to quality water resources. This situation causes a growing imbalance between neighboring regions and affects depressed and underdeveloped areas.

Therefore, the country needs a new instrumental convergence of institutional arrangements to build a "responsible" socio-economic model for solving the problem of cross-border water pollution.

An integrated approach to solving the problem demanded that the first stage of the research include an assessment of the level of cross-border water pollution. The assessment made it possible to justify the use of convergence of various institutional arrangements based on an individualized approach to managing the current state of affairs. Without knowing the level and causes of cross-border water pollution for each area, it would have been impossible to assess the efficiency of the measures taken.

An integrated approach to cross-border water pollution should be based on credible data about the geographical, environmental, organizational, technological, and economic situation in a particular water management system. Such approach makes it possible to identify bottlenecks and justify possible sollutions. However, most studies of cross-border water pollution focus on the assessment of human-induced load. They fail to assess the organizational, technological, and economic components of cross-border water pollution management, and such assessment often proves more valuable in water management complex planning.

All these facts support the methodological approach to cross-border water pollution assessment proposed by the authors on the basis of geographical, qualitative, organizational, technological, and economic criteria. The method in question is universal and can be applied to any kind of territory.

2. Materials and methods

As for the recent studies on the interregional management of cross-border river pollution, the past decades have seen a shift from the focus on administrative recommendations to the development of problem management models and schemes. Most studies focus on the implementation of institutional arrangements, e.g. international treaties and river basin management plans, or schemes. They pay much less attention to the actual results of implementing these institutional arrangements, their consequences, and effectiveness in terms of solutions for such issues as floods, water pollution, and water distribution [2]. One of the few examples is Krasner's research [9], which grouped and systematized direct and indirect principles, norms, rules, and decision-making procedures in assessing the effectiveness of measures against cross-border water pollution [10-12]. Bernauer and Siegfried [13] focused on the problem of equitable distribution of water: they developed performance indicators and described their use in assessing international, national, and regional water relations. Dombrowsky [14] concentrated on the matter of water contamination and proposed performance indicators for solving the problem of cross-border water pollution.

The present research assessed the problem solving effectiveness in the field of cross-border water pollution in a resource-type region in terms of the results of administrative, economic, and market management. It included an analysis of two main issues in solving the problem of cross-border water pollution:

1) What is the performance of traditional arrangements and tools aimed at solving the problem?

2) Which factors of this unmanageable issue, which has been observed in Russia since the early 1960s, need to be eliminated and what recommendations can be given?

It is only during the last couple of decades that the matter of assessing the performance of cross-border water pollution solutions has become focus of the global scientific attention. This interest came from realization that basin management boards and traditional management arrangements are not enough to solve problems and achieve goals in such areas as water quality, floods, and water distribution [2, 5].

The analysis of scientific sources showed a great variety of theoretical approaches, models, and tools for solving the problem of cross-border water pollution, developed and implemented by scientists and practitioners [1, 2, 5 7]. In fact, such variety provoked reasonable doubts about whether it was possible to summarize the experience and develop universal recommendations. The problem is that solutions and performance assessment are different in different river basins due to the historical differences in the geographic, economic, social, political, and territorial development of the regions

[15]. However, scientists proposed [16] a vector for developing a universal approach to performance assessment in solving this problem based on Winter's integrated model [17].

Several studies [12, 4, 1, 7, 14, 18] discuss three performance indicators for measuring and assessing the results of measures taken to solve the problem of cross-border water pollution:

1) The results of the implementation of the administrative arrangement and its compliance. Did the cross-border territories manage to develop a joint policy? Do they comply with related treaties, general rules, and norms?

2) The assessment of the implementation results of the administrative arrangements in terms of qualitative improvements in the water system.

3) Keenness to satisfy stakeholders: to what extent are stakeholders satisfied with the results of the arrangements? What has been done to increase their interest and encourage their participation in solving the problem of cross-border water pollution?

In the present research, we used a comprehensive approach to assessing the performance of arrangements taken to solve the problem of cross-border water pollution. The approach made it possible to define the level and causes of cross-border water pollution. The obtained data allowed us to develop options for the formation of a "responsible" socio-economic model for solving the problem of cross-border water pollution [19].

We selected the indicators to assess the level of cross-border pollution based on the following criteria:

- **Geographical** criterion suggests the presence or absence of a water pollution source in the administrative area;
- **Qualitative** criterion concerns the assessment of human-induced load [20];
- **Organizational and technological** criterion defines the presence and location of the engineering infrastructure of the pollution source, i.e. treatment facilities;
- **Economic** criterion states whether the polluting enterprise has any strategic plans, water management arrangements, and measures to protect the water body. It mainly concerns the amount and sources of funding needed to implement them.

The proposed criteria made it possible to shape a methodological approach to assess the level of cross-border water pollution. The approach presupposes an integrated assessment and employs several indicators. The situations were classified into four types based on the level of pollution: they ranged from "satisfactory" to "critical".

To calculate the integral indicator of the level of cross-border water pollution, we used the mean results of the score given to the situation in each area within a particular region according to four criteria groups and the lowest of these values.

The methodological approach was tested on the data obtained about 18 areas of the Kemerovo region.

We ranked and compared indicators k_{mean} and k_{min}. They summarized the score for four criteria groups. This allowed us to divide the areas according to the level of cross-border water pollution into four groups as "very high", "high", "medium", and "low". During the criteria-based assessment, we also defined the reasons behind a certain level of cross-border pollution (Fig.1).

Figure 1. Kemerovo region areas grouped by the level of cross-border water pollution and its causes.

Tyazhinskiy, Yurga, Leninsk-Kuznetskiy, Novokuznetsk, and Yaya areas made up the group with a "very high" level of cross-water pollution. These territories are home to 40.5% of the regional population. The “very high” level of cross-border water pollution in Leninsk-Kuznetskiy and Novokuznetsk areas is directly related to the local level of the total human-induced load that fuel, chemical, and metallurgical industries produce on the catchment areas (Fig.1). The largest share in the total wastewater discharge belongs to Vodokanal CJSC (Novokuznetsk), EVRAZ-ZSMK OJSC (Novokuznetsk), Joint Coal Mining Company Yuzhkuzbassugol (Novokuznetsk area), and EVRAZE LLC (Novokuznetsk). The last three enterprises are part of EVRAZ – a vertically integrated metallurgical and mining company. The annual values of the total discharge of pollutants into the local water bodies range from 10,000 to 50,000 tons for each enterprise. The water-polluting enterprises in Leninsk-Kuznetskiy area are represented by Seven-November Mine and Kirov Mine owned by SUEK-Kuzbass OJSC. The annual values of the total discharge of pollutants into the regional water bodies range from 24,000 to 35,000 tons and 12,000–20,000 tons, respectively.

Similarly, the areas where the level of cross-border pollution was marked as “high” had a high human-induced load. These are Kemerovo, Prokopyevsk, and Belovo areas. Their fuel and chemical industries produce a heavy load on the local catchment areas. As for Kemerovo area, its list of largest water polluting enterprises includes Azot OJSC, which is responsible for 67,000–70,000 tons of pollutants per year, and Coal Mining Company Kuzbassrazrezugol OJSC, which emits 16,000–19,000 tons of pollutants annually. In Belovo area, these are Listvyazhnaya Mine LLC, owned by SDS-Ugol Holding Company (5,000–7,000 tons per year), Belovo City Wastewater Treatment Plants LLC (5,000–7,000 tons per year), and Gramoteinskaya Mine, branch of Joint Coal Mining Company Yuzhkuzbassugol OJSC (5,000–7,000 tons per year). The main polluting enterprise of Prokopyevsk area is Mine Management Company Karagailinskoye LLC, branch of Zarechnaya Management Company (24,000–25,000 tons per year).

These areas still use traditional institutional arrangements to solve the problem of cross-border water pollution, namely water tax, standard and excess water use fees, and fines for environmental violations. The latter depend on the actual damage caused by the breach of water protection legislation. Unfortunately, these tools are economically effective only when it comes to the recovery of manufacturing costs or pollution-related environmental and resource costs. These measures are unlikely to improve the access to quality water resources. Therefore, the best solution for cross-border water pollution problem is market arrangements based on compensation payments and trade schemes (Table 1).

Table 1. Recommendations on the arrangements aimed at solving the cross-border water pollution problem in the region.

Level of cross-border water pollution	**Area**	**Cause of cross-border water pollution**	**Arrangements**
"very high"	Yurga, Leninsk-Kuznetskiy, Novokuznetsk	Human-induced load	Eco-compensation trade scheme, public-private partnership
	Tyazhinskiy, Yaya	Organizational and technological options; sate of economy	Intermunicipal partnership or cooperation; national and regional programs
"high"	Belovo, Kemerovo, Prokopyevsk, Topki	Human-induced load	Eco-compensation trade scheme, public-private partnership
	Izhmorka, Mariinsk, Tisul, Chebula	Organizational and technological options; sate of economy	Intermunicipal partnership or cooperation; national and regional programs
"medium"	Guryevsk, Krapivino, Promyshlennaya, Tashtagol, Yashkino	Human-induced load; geographical features	Eco-compensation trade scheme, public-private partnership
"low"	Mezhdurechensk	-	Eco-compensation trade scheme, public-private partnership

3. Results and discussion

In the Kemerovo region, Tashtagol, Mezhdurechensk, Novokuznetsk, Prokopyevsk, Krapivino, Kemerovo, Topki, Yurga, and Yashkino areas share the Tom river basin. As for the Inya river basin, it belongs to Belovo, Leninsk-Kuznetskiy, and Promyshlennaya areas. The present research identified territories with a high level of cross-border water pollution, namely Yurga, Topki, Krapivino, and Promyshlennaya areas. The situation can be explained by additional external pollution sources located in the upstream areas along the Tom river (Novokuznetsk, Prokopyevsk, and Kemerovo) and the Inya (Belovo and Leninsk-Kuznetskiy).

The implementation of an eco-compensation trade scheme in the cross-border municipalities of the Kemerovo Region will help to maintain the desired quality of the water body. This arrangement will make it possible to take into account the development of the local business. In addition, it can guarantee the necessary flexibility in achieving environmental goals and a smooth the transition to the best available technology. This, in its turn, will contribute to the development of completely new approaches to the problem of discharges to water. The trade scheme can ensure fair interaction between municipalities located upstream and downstream of the river basin, thus ensuring efficient and equitable distribution of the environmental protection funds.

According to this eco-compensation trade scheme, government bodies set a limit on the total permitted level of pollution of a particular water body for a certain period of time, e.g. one year. The limit is based on the degree of human-induced load on the hydro-ecosystems of all areas involved and schemes of integrated use and protection for a particular water body.

The limit concerns the total discharge of each enterprise in a given area. Companies that participate in the trading scheme receive a discharge quota for a certain time period, which they are free to sell. However, the total real discharge for the accounting period cannot exceed the number of available discharge permits. Companies can accumulate unused permits. Those enterprises that fail to obtain enough permits to cover their total discharge at the end of the accounting period pay financial

penalties to the Fund for the Protection and Reproduction of the water body in question. The fund is set up by the corresponding executive authorities and representatives of cross-border municipal districts. The money is then transferred as a compensation to the areas located upstream of the Tom river basin, i.e. Tashtagol and Mezhdurechensk, and those that experience external load. These include Krapivino, Topki, Yurga, and Yashkino areas in the Tom river basin and Promyshlennaya area in the Inya river basin (Fig.2).

A cost-effective adaptation of eco-compensation trade schemes demands that regional policy create an institutional infrastructure that can increase the level of access to quality water resources with minimal transaction costs. The infrastructure should also be able to achieve shared goals of economic development, thus increasing the transparency of the system and information availability. According to the scheme, the regional authorities cooperate with the cross-border municipalities of the Tom and Inya river basins to set up a regional Fund for the Protection and Reproduction of Water Bodies (Fig.2) as an institutional element. The Fund performs the following functions:

— It allocates permits according to the data on the total average discharge to a water body over the past three years. This creates fair conditions for enterprises, since the total discharge varies over time depending on the economic situation at the enterprise, weather conditions, etc.;

— It creates and maintains a unified information system of trading water pollution discharge permits. The system combines data, information technologies, and technical means that ensure the formation, processing, storage, and provision of information to trading scheme members that use the official Internet website;

— It selects and provides rational interchangeability of the discharge units for sale depending on the type of water body. For instance, the Inya has a good fishing potential, while the Tom is used as a source of drinking water and has a cultural value;

— The Fund develops a simplified system of report and control over the total discharge made by the trading scheme members;

— It ensures the availability and transparency of information as a key factor in the effective functioning of the trading scheme;

— The Fund keeps records of discharges and related decisions within the entire trading scheme;

— It identifies, analyzes, and resolves financial matters and conflicts of interests between the trading scheme members;

— The Fund keeps all members updated on the changes in the regulatory framework and trading scheme agreements;

— It collects penalties and keeps a register of unreliable trading scheme members that provide false information and fail to comply with reporting requirements;

— Finally, the Fund collects previously established sums of money from polluting enterprises located in downstream municipalities and uses the money to ensure conservation and efficient use of the water body by the enterprises of the upstream municipality.

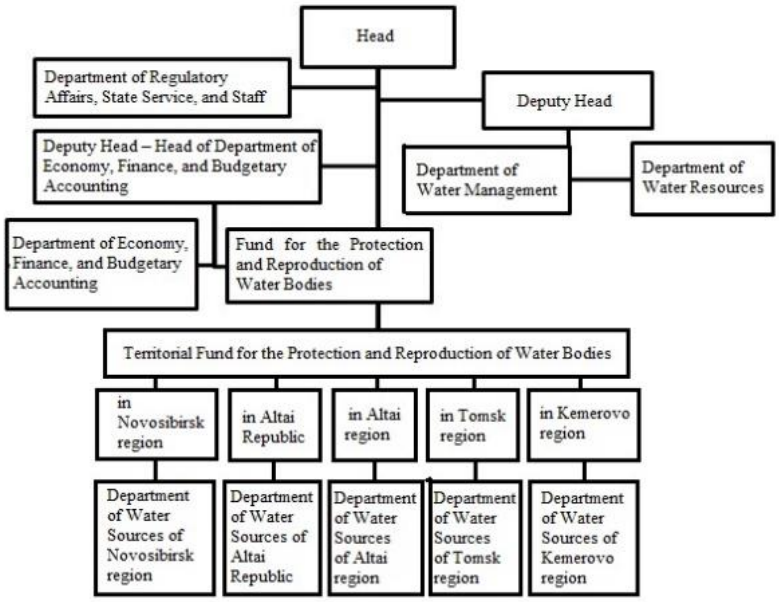

Figure 2. Improved structure of the Upper-Ob water basin management board.

We conducted a PEST analysis to assess the possibility of adapting eco-compensation trade schemes between cross-border territories along the Tom and Inya river basins to solving the problem of cross-border water pollution. The analysis revealed several key problems that demand urgent attention:

— lack of transparency of information on water resources management and water use;

— totality of payments in terms of coverage of pollution sources, i.e. enterprises, and substances. 1,356 substances are limited for water bodies used for drinking and cultural purposes; 1204 substances – for those with fishing potential. Such limitations may reduce the administrative costs of implementing the trade scheme and ensure "interchangeability" between different pollutants, which will make the trade scheme "simplified" and "broad";

— the absence of mutually beneficial municipal agreements between the cross-border territories along the Tom and Inya river basins;

— the lack of flexibility in the criteria for allocating water pollution permits between the existing sources of pollution, as well as no accounting for possible new sources that may appear in the future;

— no clear scope of impact, or a clear expression of the human-induced load intensity, acceptable for the territories of the region based on its economic activity;

— no clear definition of exchange conditions in regional and national legislation;

— the absence of an institutional infrastructure, such as a Fund for the Protection and Reproduction of Water Bodies in a particular water basin management board and its territorial divisions or a Unified Information System in emission trading, which would allow for an effective implementation of market instruments;

— the need for greater transparency in financial flows management in the water pollution permits and compensation payments.

4.Conclusion

The present research adapted a new methodological approach to assessing the level of cross-border water pollution to the situation in Kemerovo region. It revealed that 88% of the regional population suffers from “very high and high" cross-border water pollution. After the areas of Kemerovo region

were grouped according to the cross-border pollution level, it appeared that the groups with "very high" and "high" levels included both industrial and agricultural areas with totally different socio-economic indicators. Therefore, the concept of "access to water resources" differs fundamentally from accessibility of other economic benefits.

All this proves that it is high time an effective convergence of various institutional arrangements replaced the paradigm of the traditional "universal" approach. This will allow for a new "responsible" model of water sector management based on territorial features.

The modern arrangement of water resources management in Russia represents a convergence of administrative, economic, and market arrangements in the water sector regulations. It has a number of features that must be taken into account. First, the features of the administrative-command arrangement have to be preserved. Second, one should take into account the fact that human-induced and natural factors affect reproduction conditions. Third, the transition period to the market mechanism of economic managing takes time and has its own specific character.

Twenty years of administrative arrangements did not solve the problem of cross-border water pollution. The organizational and technological management component has not increased over 20 years, and although the region's economy has seen rapid advances, the region still has no sustainable water management complex. The current situation is confirmed by the high depreciation of fixed assets, the falling capacity of treatment facilities, the growing number of dilapidated networks, and a slight decrease in water transport losses.

The economic arrangement tools applied to cross-border water pollution has proved to affect only the criterion of economic affordability, the changes of which vary depending on the agents of the water management complex. As a rule, these tools increase the level of economic accessibility for the economically disadvantaged population, which reduces the level of quality, organizational, and technological components of water resources management.

According to the world's practice, cooperation, public private partnerships, and eco-compensation trade schemes are the most efficient market arrangements in solving the problem of cross-border water pollution. Unfortunately, the upgrading of the water management complex in Russia and its regions are seriously limited. First, the weak development of the institutional environment slows down the effective implementation of market mechanism. Second, Russian society lacks traditions of self-government. Third, the current voluntary institutions and forms of horizontal coordination of environmental protection remain underdeveloped. As a result, small-size and rural areas have little demand for cooperation and eco-compensation schemes, i.e. market tools aimed at a comprehensive solution of the cross-border water pollution problem that would require a wide participation of various communities.

It is cooperation and eco-compensation schemes that can solve the problem of cross-border water pollution in small and agricultural areas, as well as in those that suffer from various external factors, during economic recession and the instability.

An effective implementation of market tools is bound to increase the economic value of the region. However, the success depends on several factors. First, it is the ability to manage potential social conflicts over the shared use of the water resource. Second, the amount of compensation payments plays an important role. Third, the reforms should accompany measures to increase the welfare of local communities and economic entities, as well as positive investments in human capital, rather than physical. Fourth, the local community should participate in the implementation of "responsible" management models for such a unique economic asset as water.

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