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## Estimation of Threats of the Rostov Region Economy Caused by the Collapse in the Azov-Don Water Basin

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**Abstract:**

*The article studies the implementation of a three-sided system of territorial development based on the analysis of interaction of environmental, social and economic spheres at the example of the Rostov region.*

*The chronological analysis why the collapse in the economy of the Azov-Don basin happened is presented in the article, the reasons and consequences of the ecological problem are considered in detail. It is revealed that anthropogenic intrusion in the water regime, which was justified in terms of increasing of economic potential, currently turns out to be serious risks for the economy, and for some types of economic activities - the real threats of disappearance.*

*These economic risks along with increasing economic and social challenges require a comprehensive approach to their analysis, evaluation and working out proposals for their leveling. Modern concept of sustainable development is applied as a methodological basis for this approach.*

**Keywords:** *Regional economy, sustainable development, interference in the ecosystem, negative changes in the water economy, threats to the regional economy*

**JEL classification codes:** *Q00, Q50*

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## 1. Introduction

At the current stage of rapidly changing macroeconomic conditions there is a challenge to find an optimal model of strategic development of territorial social and economic systems when the current growth of peoples' life quality does not undermine the ability to ensure that growth in the future. It is actually sustainable development, whose concept became widespread in many countries of the world and is accepted as a basis for the activity in many respected international non-governmental organizations (Akopova *et al.*, 2017; Dzhukha *et al.*, 2017; Medvedeva *et al.*, 2016 and 2015; Kovalenko *et al.*, 2016; Epifanova *et al.*, 2015; Mozyłowski and Kalinowska, 2014).

It is topical to provide sustainable development at the regional level because all three parts of this concept make a unique alloy: social, economic and environmental. These are the regional social and economic systems, where correlated links among natural resource potential, economic growth dynamics and social infrastructure are distinctively manifested. If social and economic development level in the regions can be compared with all-Russian, ecological situation is unique and definitely belongs to a certain territory. In this connection, the regional authorities are to ensure conditions for the sustainable development taking into consideration ecological risks and threats due to changes of regional ecosystem as well as complex solutions on environment protection and rational natural resources use.

The objective of this article is the assessment of economic threats which result from the collapse in the Azov-Don Basin manifested in irreversible shallowing of the Don and solemnization of the Taganrog Gulf. This environmental problem has been widely discussed in the scientific community; researches of the Southern Scientific Center RAS are devoted to it, particularly such leading scientists as Matishov (2016) and (2017), Ponomareva E.N. *et al.*, (2014), Kleshnikov A.V. *et al.*, (2014), Chikin A.L. *et al.*, (2014), Berdnikov A.T. *et al.*, (2014), Thalassinos *et al.*, (2012). Without belittling the seriousness of the situation for the entire ecological system of the Rostov region, the article focuses on the economic aspects, assessing the impact of environmental issues on the regional economy and its safe operation.

## 2. Research, information, empirical and methodological bases of research

Due to topicality of the natural and ecological problems in world and national economies, the concept of sustainable development, which appeared in the 1970-s, started to be applied everywhere. In this period such problems did not just threaten the humankind, had negative impact on the population health due to the pollution, but naturally deter high pace of growth due to the scarcity of natural resources as well. The involvement of the international community at the state level in the solution of environmental problems usually associated with the holding in 1972 in Stockholm on the UN Human Environment Conference and the creation of the

United Nations Environment Program (UNEP)<sup>5</sup>, whose ideology was the motto "environment in the interests of development". The sustainable development concept was understood as such development of the society that is based on rational, non-exhausting use of nature.

Thus, the World Commission on Environment and Development (Commission Brundland, 1987): defines the as "Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"<sup>6</sup>. According to the UN resolution <sup>7</sup> "sustainable development" – the development of the society, which allow to satisfy the need of the present generations without prejudicing the opportunities to leave a legacy to future generations to meet their own needs.

The sustainable development concept in many respects echoes the concept of the noosphere, proposed by the professor of Mathematics Leroy, E. (1927) and by the academician Vernadsky, V. (1944) in the mid-20th century. Vernadsky argued that evolution process created a new geological force – scientific thought of the social mankind whose influence bring biosphere into the new state – no-sphere. Accordingly, to preserve itself the society must assume responsibility for the development of the biosphere, which is turning into the no-sphere, and this will require a certain social organization and a new, ecological and at the same time humanistic ethics <sup>8</sup>. Modern interpretation of the sustainable development concept is a system of three components: economic, social and environmental. The sustainable development management should be performed in a systematic way to consider all three components as closely connected parts of the whole<sup>9</sup>. Therefore, today the strategic documents of the territorial development must necessarily be based on a three-sided sustainable development concept (ecological and social and economic).

The urgent need to ensure all these three parts in the documents of territorial planning was reflected in the Russian legislation regulating the town-planning process. In accordance with the Urban Development Code of the Russian Federation "sustainable development of the territories ensuring the implementation of urban

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<sup>5</sup> *Resolution of the UN General Assembly No. 2997 of December 15, 1972 (A / RES / 2997 (XXVII)) - [Electronic resource]. – URL: <http://www.un.org/ru/ga/27/docs/27res.shtml>.*

<sup>6</sup> *The Green Encyclopedia. - [Electronic resource]. – URL: <http://greenevolution.ru/enc/wiki/vsemirnaya-komissiya-po-okruzhayushhej-srede-i-razvitiyu/>.*

<sup>7</sup> *Resolution of the UN General Assembly No. 42/186 of 11 December 1987 - [Electronic resource]. – URL: <http://www.nbj.ru/publs/banki-i-mir/2008/03/11/archive-publ-13868/index.html>*

<sup>8</sup> *Vernadsky V. I. Scientific Thought as a Planetary Phenomenon / Ed. A.L. Yanshin. - Moscow: Nauka, 1991. - [Electronic resource]. – URL: <http://vernadsky.name/wp-content/uploads/2013/01/thought.pdf> c.48*

<sup>9</sup> *Johann Dréo. Sustainable development [Electronic resource]. — URL: [http://commons.wikimedia.org/wiki/File:Sustainable\\_development.svg?uselang=ru](http://commons.wikimedia.org/wiki/File:Sustainable_development.svg?uselang=ru)*

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development activities of security and favorable conditions for human life, limiting the negative impact of economic and other activities on the environment and ensuring the protection and rational use of natural resources in the interests of this and future generations"<sup>10</sup>.

However, it should be noted while speaking on the regional sustainable development, first of all, its economic component is meant - ensuring stable growth rates of the gross regional product, a steadily increasing trend of such economic indicators as the volume of investments in fixed assets, aggregate turnover of organizations, balanced financial result of enterprises and organizations. At the same time the economic growth should go without cyclical failures, without sharp or prolonged downturns, without overheating, but not necessarily on the basis of innovation, with an increase in manufacturability of production and formats of services and trade quality. With emphasis on economic component of the sustainable development the social one and especially ecological component become secondary. However the experience testifies that an unbalanced concentration of efforts at the regional level to ensure the investors' interests and business climate development, insufficient attention to environmental or social aspects in the process of competing for the mobile investment resources, turns into a "boomerang" in the form of problems for the economy itself.

These circumstances put on the agenda the problem to assess the threats to the economy, which are formed by negative processes in the regional social or environmental subsystems, which makes this article topical. The main purpose of the article is to assess the threats to the economy of the Rostov Region due to the negative changes in the water management of the Azov-Don basin.

### **3. Results**

The Rostov region hydrographic network is a key factor in its economic and social development what in many ways is defined the historic specialization of the region in the agriculture and food industry. The presence of large hydrographic objects in the region (the Taganrog Gulf, large rivers and reservoirs) partly compensates for its location within the steppe zone of the Russian Plain, providing the population and production and economic complexes with water in the required volumes. The river Don, the largest river in the South of the European part of Russia, with a length of about 2 thousand km., is the main waterway. The natural capacity of the Don within the Rostov region is sufficient for navigation only in the spring period. During the rest of the year, navigable depths (especially from the Kalach to the mouth of the Northern Donets) are insignificant, they need to be supported by additional water

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<sup>10</sup> *Urban Development Code of the Russian Federation (GRK RF) of December 29, 2004 N 190-FZ. Art. 1*

supply or by dredging and straightening works, which were practiced in the first half of the 20th century.

The construction of a complex of hydraulic structures that provide the Volga-Don waterway (VDW), which includes the Tsimlyansk hydro-power unit in the Rostov region, which controls 70% of the entire basin runoff and the Don main irrigation canal had significant positive impact on the economy and social sphere of the region. This construction was sanctioned in 1948<sup>11</sup>, and was carried out at high rates and was completed in 1953 by the introduction into permanent operation of the Tsimlyansk hydroelectric power station (Tsimlyansk HPP).

The positive economic significance of the transformation of the Don hydrography was manifested in the appearance in the region of its own river and passenger fleet due to the sufficient (not less than 3.4 m) transit navigable depths in the lower Don<sup>12</sup>. The creation of conditions for gravity irrigation of arid lands along the rivers of the Lower Don, the Sal and the Manych, and provision of water for irrigation of other lands along to the Volga-Don waterway and Tsimlyansk reservoir were important achievements<sup>13</sup>.

Irrigation has allowed creating qualitatively new conditions for agriculture, including the opportunities to produce moisture-loving crops. Especially the rice culture with flooding was grown in the irrigated lands of the Rostov Region, in 1956 more than 5000 hectares were allocated to this culture.<sup>14</sup> The obtaining of cheap renewable electricity in the Tsimlyansk hydroelectric power station (installed capacity of 209 MW) was another solved problem<sup>15</sup>.

But grounded human intrusion in the Don Water regime resulted in a number of ecological and social problems which are growing every year because there is no complex approach to solve them.

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<sup>11</sup> *Resolution of the Council of Ministers of the USSR No. 480-183c of February 27, 1948 "On the construction of the Volga-Don waterway and the integrated use of the water resources of the Lower Don."*

<sup>12</sup> *Rules for the use of the Tsimlyansk reservoir. - Moscow: Rosvodresursy, 2014. - 401 p. (Pp. 3, 149-152.)*

<sup>13</sup> *Materials of technical report on the construction of the navigable Volga-Don channel named after Lenin, Tsimlyansk hydroelectric and irrigation works. "Hydroproject" Institute. - [Electronic resource]. - URL: <http://stepnoy-sledopyt.narod.ru/vd/zgidrouzel/zgidrouzel.htm>.*

<sup>14</sup> *The general scheme of the Volga-Don complex structures and its economic importance. "Hydroproject" Institute. - [Electronic resource]. - URL: <http://stepnoy-sledopyt.narod.ru/vd/obchema/obchema.htm>.*

<sup>15</sup> *Tsimlyansk HOP. From the glorious past - for new challenges! Energo Vektor number 7 (11), July 2012. Retrieved November 30, 2014. - [Electronic resource]. <http://energovector.com/files/ev07-2012.pdf>.*

Thus, the territory in the amount of 263.6 thousand hectares, including: manors and vegetable gardens 9.6 thousand hectares; gardens and vineyards 0.7 thousand hectares; arable land of 35.7 thousand hectares; haymaking 71.1 thousand hectares; pasture 78.2 thousand hectares; forest and shrubs 30.1 thousand hectares was flooded. The sections of the Volgograd-Likhaya railway line, 164 rural settlements and partly the town of Kalach were included in the flood zone. The total number of resettled households was 13,716 units, 507 small industrial objects with 1,644 buildings.<sup>16</sup>

Currently, because of gravity irrigation, the elevated groundwater level is observed throughout the Rostov region, located the South-West of the Tsimlyansk reservoir. The construction of the Tsimlyansk hydroelectric power station led to a decrease in the height of the floods, the flood area and, accordingly, the spawning grounds, as well as the difficulty of fish passage to spawn through the HPP facilities. These changes had strong negative impact on natural fish stocks reproduction in the Don and the Azov Sea (namely anadromous and semi-anadromous fish).

Regulation of the flow of the Don and the water withdrawal for rice growing led to an increase in irreversible losses of evaporation from its mirror (estimated at 1.5 cubic kilometers per year), which contributed to the decrease in the river flow into the Azov Sea. The balance of communicating vessels was disrupted in favor of the Black Sea waters. Freshwater scarcity eventually increased the Azov Sea salinization which started in late 1960-s and continued till early 1990-s. Since 1972, the average of Azov Sea salinity, having exceeded 12 ‰ boundary, continued to increase, and reached its peak in 1976 of 13.76 ‰<sup>17</sup>.

Some effective measures, after the hydraulic works had been erected, were taken to compensate for the damage on fishery:

- discharge of unpurified industrial sewage on the Azov coast was forbidden;
- powerful complexes of biological wastewater treatment were put into operation in large cities;
- seven fish-breeding plants were established to grow whitebait<sup>18</sup>, and the sturgeon herd increased from 1.8 million heads of individuals in 1958-1960 - up to 17.6 million heads in 1988.

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<sup>16</sup> *Materials of technical report on the construction of the navigable Volga-Don channel named after Lenin, Tsimlyansk hydroelectric and irrigation works. "Hydroproject" Institute. - [Electronic resource]. - URL: <http://stepnoy-sledopyt.narod.ru/vd/zgidrouzel/zgidrouzel.htm>*

<sup>17</sup> *Getmanenko V.A. Gubanov E.P., Izergin L.V. Assessing the impact of the regulation of the rivers in the preservation and reproduction of biological resources of the Azov Sea. The main results of comprehensive researches in the Azov-Black Sea basin and the global oceans. - Kerch: YugNIRO, 2010 p.52-58.*

<sup>18</sup> *Requiem for Azov sturgeon ... Source: Azov Basin Cooperation Center - [Electronic resource].*

However in the 1990-s due to low competition almost all fish-breeding plants were closed down. The number of valuable fish species decreased greatly, and sturgeon fishes disappeared completely with the decrease in the number of whitebait produced by the fish farms as well as the deterioration of the food base of the Azov Sea.

Last decades natural and climatic changes are taking place, the amount of river flow in the Don is decreasing: such dangerous hydrological-geographical phenomena as low water levels, extreme overturns and surges in the delta of the river, Taganrog Gulf solemnization (up to 2-8%), oxygen deficiency, rapid "bloom" of microalgae began to develop actively. The Tsimlyansk reservoir practically had exhausted its resource by 2002 and its problems are to be specially mentioned: coastal abrasion, siltation, and shallowing, extreme increase in the biomass of microalgae. Nowadays the reservoir is having a negative impact on all the Lower Don system. The processes taking place in the Lower Don directly influence the Taganrog Gulf. Eutrophication, penetration of salt waters up to the town of Azov, banks destruction, sedimentation, the Don's delta deformation, extreme overtaking phenomena adversely affect the natural and economic complex of coastal areas<sup>19</sup>.

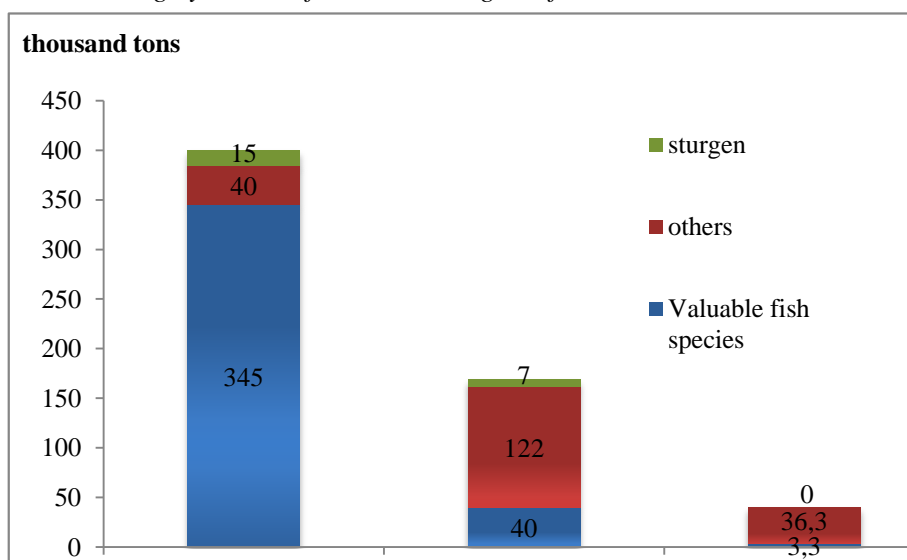
Mentioned negative consequences of human intrusion in the water regime, which had already caused a number of ecological and social problems, are more and more influencing the regional economy. The Azov-Don water resources are currently a sphere of conflict of interests of various economic sectors related to water use and water consumption, such as fisheries, water transport, energy, potable water, agriculture and industry.

The conducted analysis allowed to distinguish the following most essential threats for the Rostov region economy caused by the Don shallowing and the Taganrog Gulf solemnization.

1. Fishery and fish farming industry. The salting of the Taganrog Gulf and the decline in the fodder base has already resulted in a decline in catch of commercial fish on the Don and the Azov Sea (Figure 1).

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<sup>19</sup> *Matishov G.G. Environmental and socio-economic impact of reconstruction of hydraulic structures on the lower Don / Science of Southern Russia (Bulletin of the Southern Research Center). - Rostov-on-Don, Volume 12, №4, 2016. s.41-50.*

**Figure 1.** Fishing dynamics of the Azov Sea game fish<sup>20</sup>

The historically the fishery development can be characterized by three key phases: the period before the hydro-constructions (it is the 1860s in the figure), the period after construction of the hydro-constructions, but with active fish farming at the riverine factories (it is the 1950-1960s in the figure) and the present period where there is practically no factory whitebait production.

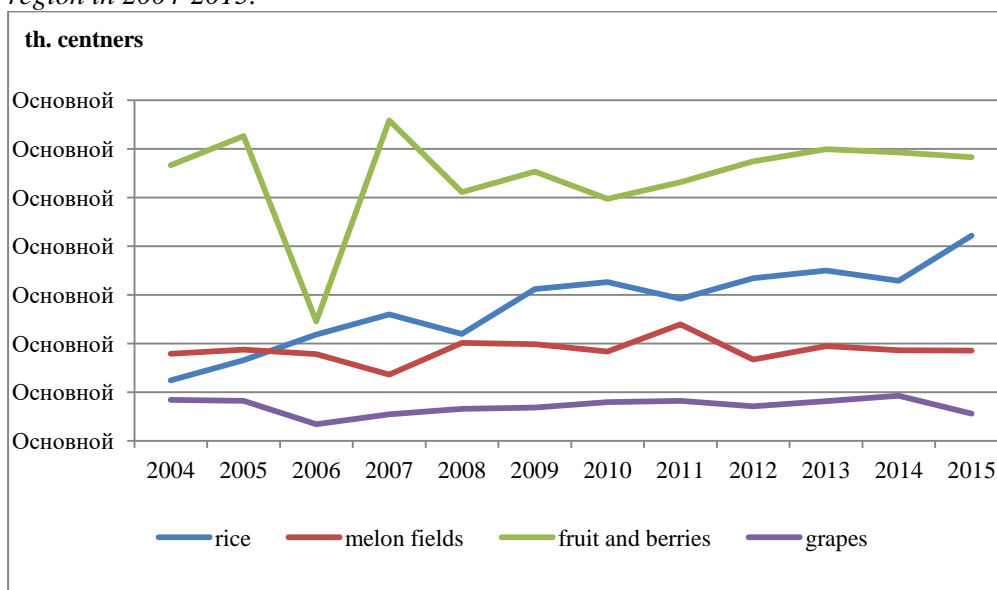
Figure 1 shows the time sturgeon species have disappeared, the catch of valuable species of fish has decreased more than 100 times compared to the 1860s, and more than 36 times compared to 1950-1960. Many valuable fish species, such as pike perch (in 2013, 0.107 tons were caught), harder (0.752 tons), silver crucian (1.733 tons) are on the verge of extinction.

2. Crop production (in terms of moisture-loving crops). Reduction of the intake of the irrigation system of the Don agriculture limits the opportunities for intensive sustainable development of such hygienic crops cultivation industries as rice cultivation, viticulture, melon growing and horticulture. Production dynamics of these crops is presented in Figure 2 and the lack of stable gross harvest it is obvious. Risks in terms of irrigation system make these agricultural sectors unattractive for investments, especially viticulture.

<sup>20</sup> Matishov G.G. The report "Irreversible Don shallowing and salinization of the Gulf of Taganrog." Expanded meeting of the Presidium of SSC RAS "The collapse in the water sector of the Azov-Don basin and anticipated consequences" - Rostov-on-Don. - February 9, 2017.



**Figure 2.** Dynamics of gross harvest of basic water-demanding crops in the Rostov region in 2004-2015.



3. Logistics. In recent years a significant drop in turnover of organizations of inland waterway transport has been observed. According to the 2015 results the volume of cargo transportation within the boundaries of the Azov-Don basin decreased by 38%. Insufficient depth in the certain areas of the Don leads to unplanned downtime of vessels. The last such case was recorded on October 22-24, 2016, when more than 45 ships from Volgodonsk to Rostov-on-Don were stopped in the lower reaches of the Don. The number of passengers transported by inland waterway transport is also decreasing: if in the peak year of 2007 566.8 thousand people were transported, then by the end of 2015 only 340,900 people used this means of transportation.

4. The Rostov region traditional exports industries. It is necessary to mention the risks due to reduction of traditional exports (grains, coal, and products of the metallurgical industry) by multi-ton tankers, which, in case of further shallowing of the Don, can cease to enter the river and sea ports of the Don.

5. Tourism. Due to the Don shallowing, tourism business has already suffered; cruise ships from Moscow, St. Petersburg, Astrakhan actually stopped visiting Rostov region. The ecological situation deterioration, manifested in coastal abrasion, siltation, shallowing of all hydrographic objects in the Azov-Don basin, an increase of extreme overturns and surges in the river Don delta, rapid "flowering" of microalgae - all these factors result in reduction of the recreational potential of the region.

6. Energy and water-intensive productions (heavy engineering, metallurgy). There is a risk of water resources shortage for many industrial and energy enterprises for their operation, including Tsimlyansk HPP, due to their significant reduction in the total volume.

#### **4. Conclusions and recommendations**

Negative consequences of the human intrusion in the Azov-Don water regime resulted in a number of ecological and social problems as well as had negative impact on the region's economy, and still remain the source of threats for many priority industries and residents of the region.

To remove all these revealed threats for the Rostov region economy resulted from the consequences of the collapse in the economy of Azov-Don basin, the integrated three-sided approach is required to remove these consequences, which takes into account ecological, economic and social aspects of this problem.

Further researches of the changes dynamics of the Azov-Don basin water balance, which allow to give an objective assessment the tendency, to forecast the biocenoses changes, to model the development scenarios, to work out further recommendations on further flow regulation are to be conducted.

The existing strategic documents provide the preservation of the navigability of the Don due to the construction of new compensating waterworks. For example, the development strategy of inland waterway transport of the Russian Federation until 2030 includes the project for the construction of the Bagaevsky hydroelectric complex worth 22 billion rubles, which will allow solving the problem of the low water level of the Don for navigation.

However, it is necessary to develop an interregional state program, including successive steps both in carrying out a set of environmental and recovery measures, and measures to ensure the interests of the main economic entities of the region: shipping business, irrigation agriculture, fisheries, industrial production and household water supply.

To avoid social problems it is necessary to preserve sufficient level of water providing for the region's population, to work regularly on leveling the threats of opening the river and flood, bank protection measures, monitoring and timely notification of emergency situations.

The main conclusion to be done after the conducted analysis of the consequences of the collapse in the Azov-Don basin is that it is necessary not just recognize and correct mistakes followed anthropogenic intrusion in the Azov-Don basin ecosystem, it is necessary to apply the sustainable development concept in practice, and any further solutions to ensure current economic interests should fully take into

account possible environmental, social, and also distant negative economic consequences

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