THE INFLUENCE OF ANTHROPOGENIC IMPACTS ON THE WATER REGIME OF THE RIVER TOM

Olga Pasko
National Research Tomsk Polytechnic University, Institute of Natural Resources
E-mail: helgapas@mail.ru

ABSTRACT

Intensive extraction of sand-and-gravel material is often the reason for the shallowing process of rivers and seas, and the change of their hydrological regime is irreversible within several centuries. Easy profit from sand-and-gravel extraction results in great losses with regard to bottom dredging, problems with vessel’s capacity and cargo delivery.

Key words: ecosystems, river sand-and-gravel extraction, economic and social consequences

INTRODUCTION

Today in Russia there is a dynamic growth in the volume of capital and road construction. This requires an appropriate market development of the non-metallic materials - sand, gravel, granite macadam and crushed limestone (Lopatnikov, 2006; Butkevich, 2006). Market growth rates of non-metallic materials in Russia make 10-15% per year, and more than half of the volume is formed by crushed stones and gravel (Kharo, Levkova, 2005). Their cost-effective extraction is due to technical floating equipment and water transportation (Pasko, Kovyazin, 2013).

Unfortunately, intensive extraction of sand-and-gravel material is often the reason for the shallowing process of rivers and seas and changes in their hydrological regime that is irreversible within several centuries as well (Tsupikova, 2003). The ecosystems’ function is damaged, species composition of plants and animals is depleted (Litvin, Tsupikova, 1999; Tsupikova, 1999).

The object of the study was the river Tom. The aim of this work was the scientific analysis of the effects of anthropogenic impact on the river Tom. Task 1: to identify the causes and degree of reduction for the possibilities of shipping. Task 2: to consider alternative ways of gravel extraction.

MATERIALS AND METHODS

The research methods used were analytical, historical and comparative. The information for publication was obtained by the author in the archives of OAO “Tomsk shipping company” and JSC “Subrechprojectt”.

RESULTS AND DISCUSSION

This work is devoted to the investigation of sand-and-gravel extraction impact on the hydrographic features of the Tom river and the resulting economic and social consequences.

Tom – is a river in western Siberia, a large tributary of the Ob, it flows into the Ob 68 km north of the center of Tomsk city (Fig.1).

![Map of Tom river](image)
The river’s length is 827 km, the flood plain is up to 3 km, vertical drop from the source up to mouth is 185 m, the flood basin is 62 000 km², the average annual flow is:1100 m³/sec, 35.0 km³/year (Yevseyeva, 2001).

The average depth in Tomsk area is — 2.5 m, stream speed into low water is up to 1.0 m/sec. Long-time average annual water turbidity is 95 g/m³. Observations on the Tom river have been carried out since the year 1918. The water flow rate from that time had practically not changed till 1950. The water level began to decrease in 1950 when large scale gravel extraction started there.

In the Tom, in the area of Tomsk city the extraction of large volume of sand-and-gravel materials which was out of control exceeding many times the natural flow of the accumulated drift, has caused the vertical deformation of the river bed and the changes of hydraulic characteristics flow (water levels regimes, free surface slope, stream speed and etc.) (Dubrovskaya, Zemtsov, 1997; Popov, 1990; Vershinin, 2005).

The water level in the river in the area of Tomsk city has fallen by 2.1 meters (Fig.2).

Figure 2. Tom River: a) in the area of Kolarovo village; b) in the area of municipal bridge. The distance between the objects is 16 km (Source: photo from authors private archive)

According to experts’ opinion it is due to the fact that after gravel extraction the river "went" into the ground. The ground water level of the flood plain in the area of Tomsk city has accordingly fallen. Moreover, at the river bottom there was no slope from the Semilujki relief to the flat relief, crests of sand bar appeared to be removed. All these facts led to stream slowdown (Reports, 2006-2011). From the middle of the 50s up to the middle of the 80s of the 20th century approximately 70 million m³ of sand-and-gravel material had been extracted (with the maximal annual volume of extraction 6.9
Development of Tom’s river bed deposits was made for satisfying the demands for constructional of non-metallic materials of plants located in Tyumen, Omsk and Tomsk areas, where other actual sources of commercial extraction were not available. The fall in the water level required reconstruction of water intake facilities, relaying of inverted siphon and reinforcement of bridge.

![Extraction of sand-and-gravel material on the Tom river](image)

**Figure 3.** Extraction of sand-and-gravel material on the Tom river (Source: photo from authors private archive)

With the development of the West-Siberian oil and gas complex in the 80s of the 20th century the demands for sand-and-gravel material increased. The State Committee for Construction and Housing and Utility Complex (Gosstroy) of the Russian Soviet Federated Socialist Republic took the decision on rational management of natural resources of non-metallic constructional materials river bed deposits on the Tom river and maintenance of river stage. The research work on the impact of the development of river bed deposits on the state of the Tom river state was started. Alongside with the development of Verkhni (Upper) Tomsk and Nishni (Lower) Kemerovo sand-and-gravel material deposits on the Tom river with an extraction volume of about 3 million m$^3$ per year was planned. During the restructuring period in Russia (Perestroika) the construction speed and demands for sand-and-gravel material decreased sharply. According to the decision of local government authorities the sand-and-gravel material extraction on river bed deposits on the Tom river was utterly forbidden in 1993, but in 2002 the extraction was partially permitted.

Today due to multi-bucket dredger and merchant marine the processing of extracted sand-and-gravel material into valuable construction material enriched coarse-grained sand (with fineness modulus from 2.3 up to 3 mm), that is not found in natural quarries has been successfully managed. Such material is used in all kinds of construction works, in manufacturing of heavy and light aggregate concrete, precast reinforced concrete, for the forming of the filter layer by well infrastructure development of water supply, also in manufacturing of foundation blocks, floor slabs and so on. Extraction of enriched coarse-grained mortar sand and crushed stones with proven reserves of 2.086 million tons is made by OJSC “Tomsk Shipping Company” (OAO Tomskaya sudokhodnaya kompaniya). This company is dealing also with goods transport on the rivers of Ob-Irtysk basin to areas of Tomsk and Novosibirsk regions, the Khanty-Mansijsk and Yamalo-Nenets Auton-omous Districts. Now the company’s marine fleet includes more than 400 vessels, and about 270 among them were bought in the winter of 2011-2012.

Lowering of the water level as a result of excess volume extraction of sand-and-gravel material worsened by the rainless summer in 2012 has caused acute problems. Firstly, the works were performed in extreme conditions, because the water level on the sand bars (max.180 cm) was by 50 per cent less than the estimated transportation capacity of our marine vessels and shallow waters trapped the vessels capacity. Marine vessels loading by less than 50 per cent of the transportation capacity was known to be unprofitable.

Secondly, the company failed to use its own quarries on sand-and-gravel extraction and to provide road construction complexes of the Tomsk region with required materials (usually the “Tomsk Shipping Company” provided 90-95% of these industries demands for a year ahead). On the other hand, that year the company had to transport 6.3 million tons (mainly – non-metallic construction materials, reinforced concrete coal, etc.), and collect the 1.2 million tons of cargo under the contracts with the oil companies – “Surgutneftegaz”, “LUKOIL”, Rosneft”, “TNK”, “Yugansksneftegaz” and others. In the middle of summer, from 1.200 thousand t 300 thousand t were collected. The company suffered heavy losses due to force majeure because shallow waters are not specified in the contract.
Thirdly, river transport for goods delivery to the north of the region is the cheapest means of transport. The cargo which is not handled is delivered by other means of transport and for the final customer it is much more expensive.

An alternative to sand-and-gravel material extraction in the Tom river bed was the start-up of an up-to-date crushing and grading complex of Shanghai Shibang Machinery Co., Ltd (China) at the cost of 1 million USD in the territory of Kandinka sand-and-gravel deposits, on May 25th, 2012. According to the experts estimation the deposit output makes 73 million cubic meters. When extracting 1 million cubic meters per year the estimated length of time is 73 years without the damaging of river beds (Sand-and-gravel deposit, 2013). The full-flowing navigable Siberian river has been shallowed during its life of just one generation, and in the area of the municipal bridge by the end of the summer you can wade in it.

Easy profit from sand-and-gravel extraction has resulted in problems connected with bottom dredging vessels' capacity and cargo delivery. The “boomerang” carelessly started half a century ago has turned back.

**CONCLUSIONS**

1. Significant anthropogenic impact on the river Tom in the production of large quantities of gravel led to a strong deformation of the riverbed, causing the deterioration of shipping and large economic losses.
2. An alternative less hazardous options for the extraction of gravel at the moment is gravel extraction on Kandinsky Deposit of peat.

**REFERENCE**


Map of Tom river. [online] [accessed on 10.02.2013.].


Pasko O. A. Workshop on the basics of environmental management : textbook / O. A. Pasko, V. F. Kovyzinin; National research Tomsk Polytechnic University (TPU), Institute of natural resources (IPR), Department of General Geology and land (were).- Tomsk: Publishing house of TPU, 2013. - 240 p.


Sand-and-gravel deposit in Kandinka village will provide TDSK with gravel for 50-70 years [online] [accessed on 10.02.2015].Available: http://www.70rus.org/more.php?UID=18475


