

VOLGA-AKHTUBA PLAIN. ORIGIN, STATE OF NATURAL COMPLEXES, GEO-ENVIRONMENTAL PROBLEMS

Viktor Andreevich Brylev and Olga Vasilievna Kozina

Received: 20.05.2012 / Accepted: 21.09.2012

Abstract: The floodplain of Volga-Akhtuba is a unique area which was formed about 10-12 thousand years ago. In the 20th century, scientists had begun to study the vegetation and fauna of Volga-Akhtuba floodplain, but complex research studies were made only during the second half of the last century.. After building the power plant and associated reservoir creation, the hydrological regime of the river Volga in the Volga-Akhtuba floodplain was severely affected. From that moment began the degradation of the natural environment of this unique area. This article describes all the negative aspects that affect the natural Volga-Akhtuba floodplain.

Keywords: floodplain, human impacts, hydrological regime, Volga-Akhtuba plain

The Volga-Akhtuba Plain is a unique natural entity, which finds itself in a critical state at present. Its natural resources have been exhausted, the landscapes are degrading, and the use of natural resources in the plain is poorly controlled. To reveal the reasons of crisis and to determine the ways it is necessary to get acquainted with the history of this unique entity and with the anthropogenic load for the last one hundred years, when the regular monitoring of hydrologic regime started.

In the 1930s A.D. Fursaev conducted the vegetation research, I.P. Plyusnin ran the soil research and V.N. Kuzin conducted the

research of ground waters of the Volga-Akhtuba Plain.

In the 1940s in connection with the projects for the construction of the Volga hydro-electric power plant (HEPP) in the plain some fault lines (G.A. Brazhnikova) were revealed and the laboratories of Geological and Geographical Institutes of the Academy of Sciences of the USSR (S.K. Gorelov, Yu.A. Meshcheryakov) took part in the assessment of this faulty regime and activity. Thus, due to the construction of the Volga HEPP the plain found itself in the special regime of the Volga River.

The study of the plain nature was made as a part of the large Caspian Expedition in 1948-1955. As a result hereof the climatic, hydrologic, geomorphologic conditions of the plain were determined as main natural peculiarities. The issues of floodplain forests drying were studied. The meadows of the three levels were distinguished. The results of the Caspian Expedition work were presented in a report consisting of some books, one of which was entitled "The Nature and Agriculture of the Volga-

**Viktor Andreevich Brylev and
Olga Vasilievna Kozina:**
Faculty of Geography and Natural Sciences
Department of Physical Geography and
Geocology
Volgograd State Pedagogical University
Lenin Boulevard no. 27, Volgograd
Russian Federation
e-mail (same for both authors):
pogoda1@rambler.ru

Akhtuba Plain and Volga Estuary” (1962). This work is also a decisive survey, which fixed the state of the natural complexes and the components of the plain before the regulation of the hydrologic regime of the Lower Volga. However, the water regime of Upper and mid-Volga Regions has started to change due to the construction of such water-storage reservoirs as Rybinsk Reservoir, Gorky Reservoir, Kuybyshev Reservoir.

Our hydro-electric power plant named after Congress XXII created the Volgograd Reservoir and its working regime began influencing upon the environmental conditions of the Volga-Akhtuba Plain after the first decade of its operation. A team of scientists from the Faculty of Natural Sciences and Geography of the Volgograd Pedagogical University under the supervision of Professor B.I. Kubantsev undertook an independent budget research. Unfortunately, the negative forecast of the degrading environmental conditions and the scientific findings made by us have proved fully true to date.

The possible human impacts upon the plain's nature can be divided into direct (including goal-directed impacts) and indirect, and often uncontrolled afterwards (Brylev 1976). The effects, which influence practically upon the whole landscape and the separate environmental components, can be distinguished in the first group. The first effects are as follows:

- allocation of some lots of plain as building areas;
- construction of trenches for pipelines, gas pipelines;
- embankment when laying highways and large damming;
- planning the fields of irrigated farming;
- light earthwork, including bomb and shell craters formed during the war.

As concerns the anthropogenic effects upon the nature of the Volga-Akhtuba Plain, which influence upon the separate landscape components, it is worth mentioning:

- trampling of grass layer by holidaymakers, who rest in the plain

every day. In summer, this flow increases up to 150-200 thousand people per day at weekends (Bobrov 1973). It is enough to give the example of Bakalda country forest-park, whose grass layer has been practically destroyed;

- unreasonable cattle grazing at one and the same pastures;
- fires, forest cutting, when the micro-fauna is also partly destroyed. There were many fires especially in the summer and autumn of the dry years of 1971-1972-1975-2006;
- arrangement of dumps polluting the plain, the decomposition products which, including the hazardous ones, get into soil, underground waters and surface waters;
- chemical pollution of water by industrial and domestic wastes;
- forest planting and creation of artificial soils;
- consolidating separate plots of bank line.

The majority of direct effects upon the plain nature listed above are negative and only a part of them is positive, mitigating the negative influence upon the environmental components or improving their condition.

The group of indirect, often uncontrolled effects of urbanization of the considered territory includes the following main processes and phenomena:

1. Reduction of duration and height of spring floods as a result of Volga River regulation by the dams of the Volga hydroelectric power plants. The level of plain flooding, which included 60 % to 80 % of the area in the natural conditions, does not exceed 50 % and even 20-30 % nowadays. The following phenomena can be regarded as a consequence of the abovementioned process and also as a result of damming of many plain plots:

- reduction of underground water level, especially perched ground water and outlined tendency to increase the underground water mineralization;

- separation and isolation of upper underground aquifers;
- dieback of some ducts and shallow channels, which have stopped running even during flooding;
- drying of tree vegetation, disease and death of 20 % of forestland of the plain since 1961;
- steppification of plain hill-sites and increase of the role of sand plants in the grass layer;
- reduction and termination of accumulation of plain silt deposit at many land plots due to reduced bottomland;
- reduction of silt content in the main water arteries - Volga River, Kuropatka River, Akhtuba River as a result of stand age of silt load in the Volga water reservoirs;
- slight reduction of eroding force of riverbeds due to the process described above.

2. Blowing away of sand deposits of river-borne sediments, which results from depauperization of grass layer and poor plain flooding.

3. Change of summer and winter low-flow period of the Volga River towards the level increase. As a result hereof the low-flow levels became higher to 0.5-1.0 m, the lowland watersides of the plain have been therefore subject to submergence.

4. Soil water-logging at some plots due to unreasonable fields watering during the wet years and years with relatively high flood flow, when the phreatic high level joins underground aquifers or capillary fringe, as a result of which the wetting of roots of horticultural crops and natural vegetation takes place (But 1975).

5. The chemical pollution of soils, water surfaces and underground waters from the irrigation systems as many herbicides and chemical compounds circulate in the irrigation systems during many years (Kovda 1974) being sources of pollution of underground water and soil.

6. The micro-climatic changes caused by the thermal effect of the city and its

enterprises, by the mitigating effect of water reservoir and the Volga River artery.

7. Smoke and gas pollution of the plain adjoining the Volgograd agglomeration. The north-western winds dominate in summer, and the plain vegetation is influenced by the industrial wastes of the Volgograd enterprises in this season.

When evaluating different factors according to the degree of their negative influence upon the plain nature it is worth distinguishing the most significant ones. First of all, it is the process of Volga River regulation by dams and numerous hydroelectric power plants built on the Volga and Kama Rivers.

Secondly, such negative factors as construction and road works can be mentioned. They influence directly upon many nature components and destroy them.

Thirdly, it is necessary to distinguish the group of phenomena, which have a significant effect upon separate nature components, such as chemical and mechanical pollution of soil, under-soil, water surfaces and underground water, fires, cutting down and trampling down of vegetation.

No positive measures for improving the situation have been made up to now. In the 1990s after the adoption of the Federal Law on Specially Protected Natural Reservations and foundation of the Russian Ecological Academy the Volgograd ecologists commenced the elaboration of the local Law on Protection of Environment of the Volga-Akhtuba Plain. The working group (V.A. Brylev, V.I. Korinets, V.V. Revebtsov) for elaborating the documentation for creation the Volga-Akhtuba Natural Park was formed in 1998 in the Regional Ecological Committee.

The ecological and geomorphologic conditions of the Volga-Akhtuba Plain have been actively examined by the scientists of the laboratory of erosive and channel processes of the MGU (Moscow State University) under the supervision of Professor R.S. Chalov during the last decade. The main findings of examination of the

nature components of the Volga-Akhtuba Plain are given below.

The plain was formed during the Holocene age, for example 10-12 thousand years ago. The geomorphologic data also do not contradict this fact as the terraces above the flood-plain are not associated with the plain and the Volga-Akhtuba valley in general is not cut into the Nizhnekhvalynsk lowland. There are no traces of settlement of the ancient people in the Volga-Akhtuba Plain, it proves the plain regular flooding by high water.

The reason of the sharp bend of the Volga valley near Volgograd is explained by crossing the fault system, by the newest tectonic deflection. Thus, the Caspian Depression has played a major role in changing the direction of the Volga River near Volgograd, it has pulled the Volga River to itself and has given it the south-eastern direction.

Below Volgograd the Volga riverbanks are formed by easily eroding sandy and clay rocks, the right bank is only 20-25 m high instead of 200-250 m near Volgograd. It means that the Volga River went to the right in compliance with the global law of Coriolis effect.

The development of the Akhtuba River (branch) is less clear. It is situated 20-30 km away from the Volga River. It is not clear why it developed to the left. Maybe it just fell behind the Volga River, which went to the right more energetically due to bigger water mass.

The segmental structure of the plain is clearly seen in the aerial and satellite images. It speaks of its alluvial-erosive character of formation besides the geological data.

The low ridge micro-relief, inner lakes and shallow channels, and quite evident natural levees of the Volga River are distinguished in the plain at the background of the general flatland, for instance the relative amplitude of the relief inside the plain is of 5-8 m. It explains why the plain has easily submerged at high levels of seasonal floods. The highest level was observed in 1926, when the level of flood

exceeded the low-water stage for 9.3 m, it was the maximum flow volume during the whole history of observations and constituted 52 thousands m³/sec. The area submerged reached 90 %.

The plain vegetation and its finery, for example oak woods have got further development due to this flooding. The flood plain landscape has been finally formed as intrazonal forest-meadow landscape with wetlands at the background of Caspian semi-deserts. The economic set-up of the plain has been also formed: vegetable growing, animal breeding (bovine cattle, pig breeding), fishing. However, we can learn about the former fish wealth only from the folk tales now.

Everything started changing. At first everything was changing gradually in the 1960s and then more sharply in the 1970s. When analyzing the chart of flow volume and water discharge during the seasonal floods for the last forty years, it is possible to distinguish the high-water cycles, which have a 4-5-year regularity – 1966, 1970, 1974, 1979, 1985, 1990, 1994, 1999, when 5 % of the plain or so was submerged and the scouring soil regime was stated. The years 1967, 1975, 1984, 1996, 2006 are considered critically low-water, they have a 9-11-year regularity.

The government decrees concerning reconstruction of agriculture and fishing industry have been adopted as a compensation for new conditions created. It has been decided to give water release from the dam of Volga HEPP every year, in the second quarter of flood. It provides for submergence of plain its water reservoirs, and shallow channels, for spawning of sturgeons and other valuable fishes. This water release has been performed irregularly, every year new restrictions in the tail ponds of the hydroelectric installations occurred. It was also influenced by plain development, restrictions on reservoir drawdown before a seasonal flood, conditions of operation of water intake facilities.

The difficulty of precise forecasts of flood volume and spring water pass can be

also added. The problems in the tail ponds have become evident – there is a lack of water during the warm seasons and there is plenty of water in the cold seasons. The Volga River is seldom frozen near Volgograd nowadays. However, it is a combination of hydrologic regime and frost-free winters, which have become more frequent for the last decade.

The whole nature complex has changed in the tail pond of the Volgograd Reservoir. This change has been caused by the reduction of floods level and their duration. The process of plain drying has become more apparent during the last decade, as in the to-date economic conditions the sufficient volume of water, which is released more equal during the year, does not reach the plain. Only 30 % of plain area is flooded nowadays, and in the crisis years of 1996 and 2006 it constituted only 30 %. The plain natural complex reached the critical condition in 2006. The meadows suffer from steppification, the fish resources and their yield has been ten times reduced for the last ten years.

The conditions of water lack in the Volga River basin in 2006 started to form even in winter 2005/2006. The probability of 15-20 % reduction of spring water release in 2006 as compared to the mean values, which amounted to 120 km³ for the last 15 years, was indicated at the meetings of Interagency Operative Group for regulating the regime of operation of Volga-Kama Cascade reservoirs. According to the forecast for 2006-2020 the water release will be 15-25 less and will amount to 100 km³ (A.A. Bykov). Actually it has amounted to 76 km³.

The flooding of Volga-Akhtuba Plain in 2006 included only one-third of its area. The Lower Volga basin authority (city of Volgograd) states that the water release in the tail pond of the Volga River increased in July and the autumn 2006 after the main flood phase and constituted up to 6 thousands m³/sec as compared to usual 4 thousands m³/sec.

The growth of cumulative water inflow in the Volga-Kama Cascade reservoirs

started in October 2006 and reached the maximum volume for the whole period of cascade reservoirs operation at the beginning of 2007. The premature release of water from the Volgograd Reservoir into the tail pond and the Volga River started. Thus, the Volga River had the water flow 1.5-2.0 times higher than the average annual flow near Volgograd in winter. Will it be enough water for spring release or will it be used only for electric power generation? It sets the conflict between the economic entities of the Lower Volga. The electric power or impoverishment of natural resources of the plain, that is the plain drying is at the edge of admissible level, finally it may cause the destruction of its unique ecosystem.

The adverse ecologic situation, which was created in 2006 in the Volga-Akhtuba Plain, is a result of the process, which has been developed for the last 25 years. After 1979, which was the year with the biggest abundance of water, when the flow constituted up to 38 thousands m³/sec, the self-regeneration of natural complex had been being observed for some years. This situation was maintained until 1994. In 1996 the lowest volume of release during the seasonal flood was observed. However, the adverse effect upon the nature was again compensated by relatively large releases from 1997 to 1999.

Starting from 2000, the reduction of flow volume during the seasonal flood has been progressing. It was especially obvious in 2004-2006. At the same time, the privatization of land plots, separate water bodies took place in the Volga-Akhtuba Plain in the 2000s together with creation of the natural park having the same name as the plain. It caused local negative consequences, deterioration of the environmental situation of the Volga-Akhtuba Plain in general.

Conclusions:

The chain of negative processes and phenomena, traced 30 years ago can be supplemented by the figures of the last years:

1. The average volume of discharged high water as compared to the natural flood has been reduced to 20 %, the level has been reduced to 1.5 m, and the total area of flooding has reduced to 1/3. The minimum flood discharge amounted to:

- 1980-1983: 26 thousand m³/sec;
- 1996: 24 thousand m³/sec

During the period from 1996 to 1999, the maximum flood discharge did not exceed 26 thousand m³/sec. The plain submergence constituted 40 % at such discharges and levels. The hydraulic connection between the Volga River and inner plain parts has been interrupted. As a result hereof the plain area covered with forest has been reduced to 15 % for four decades. The drying of oak woods and appearance of leaf-eating insects are impossible to compensate by the chemical operations. The poaching capture of herring until its practically complete disappearance as well as poaching capture of sturgeons and other valuable fishes has taken place during these years, too.

2. The presence of feather grass, which is often met at the plain highlands, is a sign of steppification of the Volga-Akhtuba Plain. At the beginning of 1990s, when the problem of the construction of a bridge across the Volga River was discussed, the Volgograd dwellers voted against the bridge as they thought that the construction of new transportation branch would destroy the plain nature. The actual situation is the following: there is still no bridge and there is already no plain. Therefore the main reason of the degradation of natural complexes of the Volga-Akhtuba Plain is its drying. No pumps can make good the deficit of flood water.

When realizing that the way out from the situation created is not difficult, the region's authorities have demanded to establish the ecologic regime of the operation of the Volga HEPP, to give the peak at the beginning of seasonal flood and then the flood shelf for three-four weeks with the discharge of 26-28 thousand m³/sec or more and the flooding area occupying 2/3 of plain area or more. The power engineers indifferent to nature can again fail to respond

to the opinion of Volgograd dwellers, not only of certain scientists but of legislative and executive authorities.

Besides preserving the natural complex of the Volga-Akhtuba Plain, the economic entities are also concerned with the operation of water intake, which is possible on smoother water discharge into the Volga River during a year. The population is concerned with the operation of Volga river crossing facilities within the city. By the way, the last problem can be solved by the bridge built near Volgograd. It is quite evident, that we have come to the effect of emergency at present due to the functioning of natural and man-triggered geosystem, for instance to the impossibility to forecast its operation as an increasingly higher number of natural and man-triggered factors are involved in the operation within the area of influence of Volgograd agglomeration.

At the second half of April 2007, the flood peak reached 26 thousand m³/sec, however it lasted only one week. It is not enough, but there is some progress as the flood shelf during May has been provided. Though the flood regime improved a little bit in 2008-2009, it still remained minimal taking into account the ecologic requirements.

Rezumat:

LUNCA INUNDABILĂ VOLGA- AKHTUBA. ORIGINE, STAREA COMPLEXELOR NATURALE, PROBLEME GEOGRAFICE DE MEDIU

Lunca inundabilă Volga-Akhtuba este o zonă unică ce s-a format cu aproximativ 10-12 mii de ani în urmă. În secolul al 20-lea, oamenii de știință au început să studieze vegetația și fauna zonei inundabile Volga-Akhtuba, însă studii de cercetare complexe s-au realizat după a doua jumătate a secolului trecut. După construirea centralei electrice și crearea lacului de acumulare aferent, regimul hidrologic al râului Volga, în sectorul luncii inundabile Volga-Akhtuba, a fost grav

afectat. Din acel moment a început degradarea mediului natural al acestui teritoriu unic. Acest articol descrie toate aspectele negative care afectează sistemul natural din lunca inundabilă Volga-Akhtuba.