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Dynamics of Erosive Processes in the Nizhnayaya-Volga Prikaspiy Region

DYNAMICS OF EROSIVE PROCESSES IN THE NIZHNYAYA-VOLGA PRIKASPIY REGION

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The valley of Volga river is located within the Northern Prikaspiy region, that include areas of the Russian Federation and the Republic of Kazakhstan. This valley forms the extensive Volgo-Akhtubinskaya flood-plain at the underset current. This region is characterized by active growth of the erosive processes all along the river valley from Volgograd city to Astrakhan city. The most intensive erosive processes are on the right-bank of Volga river, where we can notice simultaneous landslide on some areas.

Key Words : *Erosive process, Volga and Akhtuba rivers, slope, sandy-clay deposits, landslide deformation.*

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We can mark the following reasons that influence on the marginal erosion of Volga banks. There are morphology, geological structure of slopes, ice and level modes of the river, as well as flowing currents, that define accumulation and deposits moving. Because of the small length of dispersal the wind excitement does not develop and does not render an essential influence on processes of formation of coast owing.

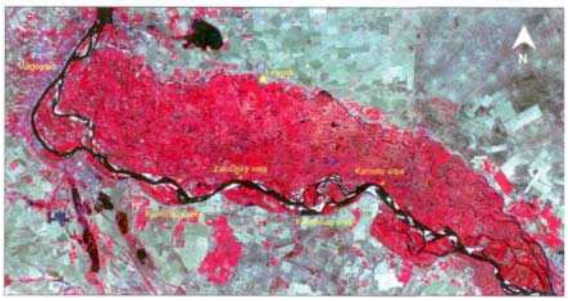
Changes of water level on the Nizhnyaya Volga occur during all over the year. These changes are

in direct dependence on a mode of water dump through the dam of the Volga HPS.

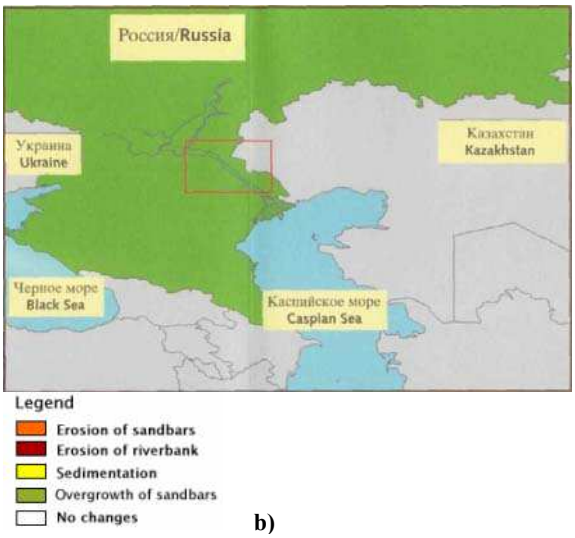
River bank slopes of the rivers of Volga and Akhtuba are consisting of erosive breeds: friable sandy-clay deposits of khvalynsky terrace and modern alluvial sand, loams and sandy loams. Periodic saturation by water and drainage of such soils at passage of high waters and daily fluctuations of a level substantially promote bank destruction. Influence of current is shown intensively on sites of abrupt turns of a channel of the river where the washout size of alluvial sand can reach 50-60 meters a year.

Dike currents make active processes of erosion due to a river bank slope cutting on various marks at changes of height of a water level, washing out and moving of the fallen breeds. Also an ice mode influences to processes of river erosion. Influence of a water stream on a river bank slope is absent during freeze-up, however the cutting of the bottom part of a slope, its collapsing and an edge recession of a riverside ledge with the following washout of the fallen material by freshet waters occur during an ice drift.

Monitoring of river banks erosion was done for a number of years (1975-1990) on the sites differing by the maximal intensity of process for an estimation of adverse hydro meteorological and technogenical factors and the engineering-geological processes causing significant damage to territories, industrial and economic objects. In 1999-2003 morpho-dynamic researches of Volga-Akhtuba floodplain (Fig.1) were carried out by scientists from Moscow State Universities together with the RIZA Institute (Netherlands) in order to decide a problem of restoration of the rivers of the Europe [1; 2].



a)



b)

Fig.1 Morphological changes of Volga-Akhtuba floodplain in 1986-1996 (a) and scheme of geographical location (b).

The analysis of satellite pictures of the floodplain territory for the period 1985-2001 and field observations of key sites of the floodplain were conducted to perform this work.

In 2007-2008 stationary research of erosive processes was continued, in particular, on Svetly Yar site on the right bank of Volga River and on a number of sites of the left bank of Akhtuba River.

Riverside ledge on Svetly Yar site is steep, in the top it is vertical and more flat only in the south part of the area. The slope altitude is from 25 up to 30 m above the low-water level in Volga River. Edge is plain, sandy-clay, with a bias to a channel under a corner 7-10°, width is 15-20 m (Fig. 2).

Fig.2 Erosion of a slope on a Svetly Yar site

Tetradic loams, layered clay and clay fine-grained sand (Fig. 3) take part in a geological structure of a riverside ledge. Structures of comparison of a relief for the period of supervision from 1972 to 2007 show an average slope erosion speed at a rate of 0,7 - 1,1 meters a year.

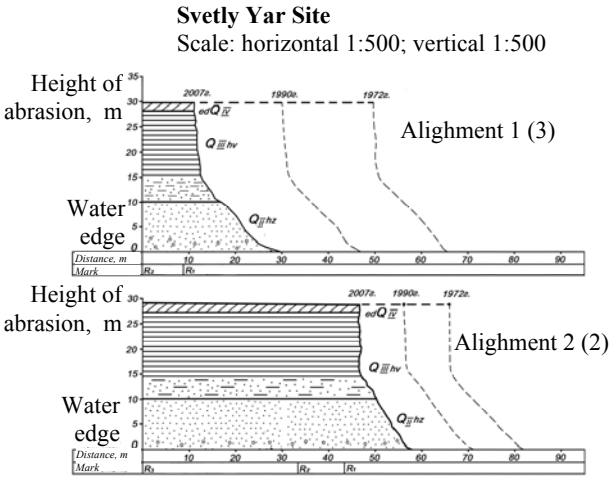


Fig.3 Structures of a riverside slope of a Svetly Yar site

Erosion of river bank occurs as a result of undermining a riverside ledge to formation of collapses and taluses. Soils saturation by water at high levels of the river reduces stability of a slope and leads to occurrence of landslips. Increase and downturn of a level of subsoil waters leads to cracks and times increasing in soils that creates the best conditions for a filtration of waters. Outputs of subsoil waters on river bank slopes are observed on a site, due to chemical and mechanical suffosion are developing.

Here two types of processing of river bank are marked: erosion-falling and erosive landslide-crumbling.

Erosion-falling type

Sites of a riverside slope of this type are incurred to influence of simultaneously two and more processes. At the top of the riverside ledge the landslide phenomena is observed, at the bottom - erosion-falling deformations are observed too. This type of processing is widespread on sites by the general extent up to 40 km.

The most part of Volga River banks concern to this type (120 km of the right and about 100 km of the left bank). For banks of this type it is typical the presence of the high (15-30) abrupt erosive ledges, combined by loams, sandy loam, sand and clay inundated adjournment. Sometimes sandy towpath and sandy-argillaceous in the width 5-20 m are covered by a grass. Outputs of grey clay are noticed on towpath in many places, subsoil waters filter on its housetop.

Erosive landslidely- crumbling type

The maximal intensity of erosive cutting of the riverside ledge is observed on sites with abrupt bends of the river channel due to increase of a role of current, that has greater speed here in a riverside part of the channel than on the rectilinear sites.

Stationary observation of erosion on a riverside slope was conducted here in 1972 – 1990. Total edge indention of the riverside ledge was from 3,1 m up to 11,90 m, and the mid-annual size of processing of bank was within the limits of 0,5-1,7 m for this period.

Survey of the erosive processes dynamics on the sites of Akhtuba River was fulfilled in 1982 - 1990 in order to make special recommendations delivery of recommendations for necessities of protection of economic objects from destruction.

Intensity of erosive processes on Akhtuba River is defined by the same hydro meteorological factors, as on Nizhnyaya Volga including the rise of a water level during the freshet period due to the miss of water of the Volga HPS; cutting of a riverside ledge by ice drift with the subsequent formation of collapses, taluses and sliding deformations; a drain of superficial waters during spring snowmelt and atmospheric precipitation losses.

Levels mode of Akhtuba River depends on an operating mode of the Volga HPS. The schedule of a level change repeats the schedule of water dump through a dam of power station with reduction of amplitude of fluctuation depending on remoteness of a water-measured post from Volgograd City. So seasonal amplitudes of fluctuation of a water level in Akhtuba River in 1988 changed from 7, 34 m up to 5, 91 m, and duration of the freshet period has made 56 days with peak on May, 1-7st.

Observant sites on Akhtuba River are located on the left bank of the marine khvalynskaya plain. The Volzhsky site (Metallurgist settlement) is the most representative, it is chosen for carrying out of erosion monitoring of Akhtuba River bank in 2007-2008.

Fig.4 An erosive slope of Akhtuba River valley

Within the limits the Akhtuba River valley has a sharp turn, this causes an activity of erosion on this site. The valley is asymmetric: its left bank is abrupt, and right is flat (Fig. 4). The width of a channel at horizon of water minus 9-10 m makes about 125-130 m. Depth of the river varies from 0,5 up to 2,5 m, and the greatest depths are dated for the left bank.

Loams, sandy loam, sand (Fig. 5) take part in the geological structure of the riverside ledge. The riverside slope is flat, the ledge is abrupt, steep, and it has height up to 20 m. At a sole of the ledge taluses and collapses, large columnar chars of breeds, traces of falls deformations are noted. The beach is narrow and sandy, its width makes 1-2 m. Washout of bank is connected basically with passage of the high water cutting landslide-crumbling accumulations and directly riverside ledge that defines high activity of erosive processes.

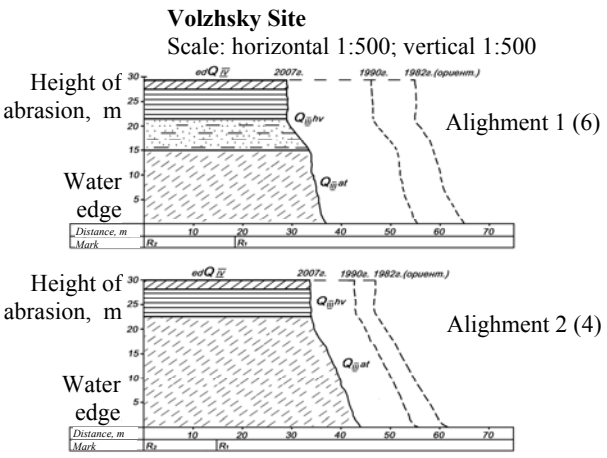


Fig.5 Structures of a riverside slope on Volzhsky site

Mid-annual speed of the riverside slope processing combined by khvalynsky clays, makes about 3, 0 m, and the coast recedes on the average on 1,3 m a year in sand.

On the Figures 3 and 5 are shown following conventional signs: edQ_{IV} – recent eluvial-dealluvial deposits – loamy soil; $Q_{III}hv$ – highquaternary khvalynsky deposits – clay, in there is clay sand in the bases; $Q_{II}hz$ – middlequaternary hazarsky deposits – silica sand, there is gravel in the bases.

Now erosion of the slope represents the greatest danger for some cottages located on distance of 40-50 m from the coast. Besides it is necessary to note, that absence of regulation of a superficial drain leads to khvalynsky clays humidifying and to possible development of fall slope deformations.

The further activization of erosion-falling processes on this site will demand performance of protective actions.

CONCLUSIONS

Thus, at the present time the erosive processes of the banks of Volga and Akhtuba Rivers are very active both on the right and on the left banks. On the right bank these processes are inseparably linked with landslide deformations. According to the observations an average speed of indent on the right coast is 0,3-0,5 m/year, on some sites reaches the level of 2,5 m/years as a result of erosive cutting.

The erosive processes on the left bank of Volga river are incomparably more intensive (on the left bank there are rest zones, very important agricultural lands and various constructions). Studying of the topographical plans of the left bank of different years has shown that speed of washout can reach 50-60 m/year. The washed away material collects below on the current, forming bars and causing growth of islands in a local part of the valley. Clay bank are washed much more slightly.

Keeping in mind these results it is very important to make the further stationary researches of the characteristics and the intensity of these erosive processes during a development of any construction project and exploitation of the current objects within the riverside zone of Volga and Akhtuba rivers. Moreover it is required to make a forecast of the further development of these erosive processes in order to realize early protection actions.

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