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Ecological optimization of floodplain - channel complexes of small rivers of urbanized territories (by the example of Novosibirsk)

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Relevance of the research

The relevance of the study of floodplain - channel complexes is associated with the high demand for riverine areas at various historical stages, and especially now due to the dense development, intensive development of new territories, and environmental stress.



The purpose and objectives of the research

Purpose:

Developing environmental optimization strategy of small rivers floodplain-channel complexes in urban areas (by the example of Novosibirsk).

Tasks:

- comprehensive analysis and identification of patterns for the development of small river floodplain-channel complexes;
- determination of the aggregate problems of the floodplain-channel complexes of small rivers in modern conditions on the basis of domestic and foreign experience of their construction and reconstruction;
- development of measures for environmental optimization, based on the results of a comprehensive analysis of floodplain-channel complexes;
- application of the developed measures for environmental optimization by the example of the small river floodplain-channel complexes.

Retrospective analysis of the nature of the development of floodplain-channel complexes of small rivers.

A retrospective analysis of the nature of the floodplain-channel complexes development in the city of Novosibirsk revealed changes in urban planning priorities in the organization of floodplain-channel complexes, which reflects the nature of the interaction between the natural and anthropogenic systems. Subsequent stages of man-made and commercial expansion of the floodplain-channel complexes (entering small rivers into reservoirs, using them to discharge waste from enterprises) resulted in a significant degradation of floodplain-channel complexes resources, reducing the influence of the river on the city, the appearance in the structure of the floodplain-channel complexes of territories whose functions do not meet the context of the city at the present stage.



Analysis of environmental stress in the floodplain-channel complexes of small rivers in the city of Novosibirsk

The integrated environmental assessment of the floodplain-channel complexes of small rivers in the city of Novosibirsk was carried out on the basis of the method developed by Roman Chalov at Moscow State University named after Mihail Lomonosov.

The processes and phenomena that determine the ecological status of small rivers include anthropogenic siltation and degradation of the channels (as a result of soil erosion in catchment areas and city-industrial pollution), pollution of the channels and floodplain. In addition, the use of river channels as receivers of waste (collector) water, as well as their intersection with utilities, buildings, etc., is of great importance. Factors affecting the state of the floodplain-channel complexes of small rivers in the city of Novosibirsk are presented on the slide, taking into account weights, taking into account their role in the overall assessment of environmental tensions on small rivers.



Weights, taking into account the role of factors of changes in the channels and the floodplain in the overall assessment of environmental stress on rivers

Environmental factors of the river	Weight coefficient
Siltation	1,0
Riverbanks erosion	0,6
Clogging of floodplain	0,8
Clogging of channels	1,0
Mechanical variation of floodplain landscapes	0,6
Water pollution	1,0



Integral assessment of environmental tensions in the floodplain - channel complex of the river Yeltsovka 1.

Factors	Score	Weight coefficient	Total score
Siltation	5	1,0	5
Riverbanks erosion	2	0,6	1,2
Clogging of floodplain	3	0,8	2,4
Clogging of channels	3	1,0	3
Mechanical variation of floodplain landscapes	3	0,6	1,8
Water pollution	4	1,0	4
Total			17,4



Classification of environmental optimization measures of floodplain-channel complexes of small rivers in urban areas

0 points (lack of environmental stress) - no measures are required;

1 point (initial stage of environmental stress) - ecological rehabilitation is recommended;

2 points (weak environmental stress) - restoration;

3 points (average environmental stress) - reconstruction;

4 points (strong environmental stress) - conservation;

5 points (environmental crisis situation) - all of the above measures, as well as justification, it is possible to liquidate the object if further use of the water body is dangerous, and restoration is not advisable.



Ecological rehabilitation is a set of measures aimed at improving water quality.

Ecological rehabilitation includes the following types of work:

- deepening the bed of the water body, hydraulic structures and shore protection structures, works on clearing the bottom of the water body from sludge deposits;
- development of bioengineering measures: landscaping of the coastal zone, purification of incoming water, formation of a hydro-system of a water body.

To improve the quality of the water, a hydrobotanical site (HBS) will be constructed. Diagram of the device HBS is presented on last slide.



River restoration is a complex of engineering measures aimed at clearing and strengthening of the small river floodplain-channel complex.

River restoration includes:

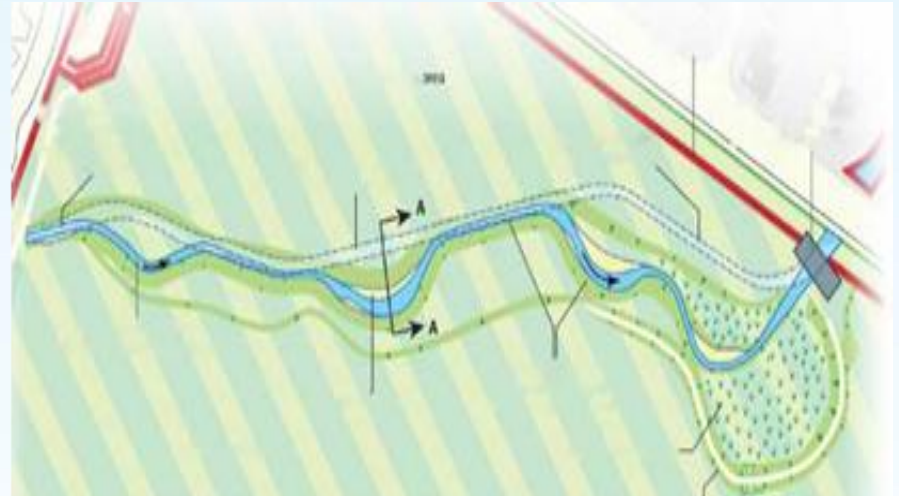
- afforestation along the small river beds and the gullies adjacent to the floodplain-channel complex;
- limiting the discharge of untreated sewage into small rivers;
- creation of a network of ponds and small reservoirs, primarily cascade ones (the upper pond serves as a nanocatcher and is periodically cleaned, sludge is used as fertilizer);
- the elimination of landfills on the banks of rivers and ravines;
- clearing springs, sources.



River reconstruction is a complex of measures aimed at restoring natural processes and biodiversity. Restoration of natural processes leads to a change in the shape of the rivers, restoration of the river ecosystem, and provides long-term restoration by eliminating the root cause of the problem.

Renovation includes:

- Reconstruction of the natural river channel.
- Creation of floodplain ponds.
- Reconstruction of the channel bottom.
- Elimination of obstacles.



River conservation is a set of measures for the complete cessation of harmful anthropogenic impact on the river.

The main problem is the purification of surface runoff (storm and melt water). The cost of introducing stormwater treatment plants is high, while river conservation programs require constant investment.

After the river has been conserved, it is possible to carry out measures for the ecological rehabilitation, restoration and reconstruction of the river.



When a crisis of environmental stress is reached, the operation of a water body becomes life-threatening, and its restoration is impractical. In such situations, a complex of measures is taken to completely or partially **liquidation a water body**. With the complete liquidation of the small river, the following measures are carried out:

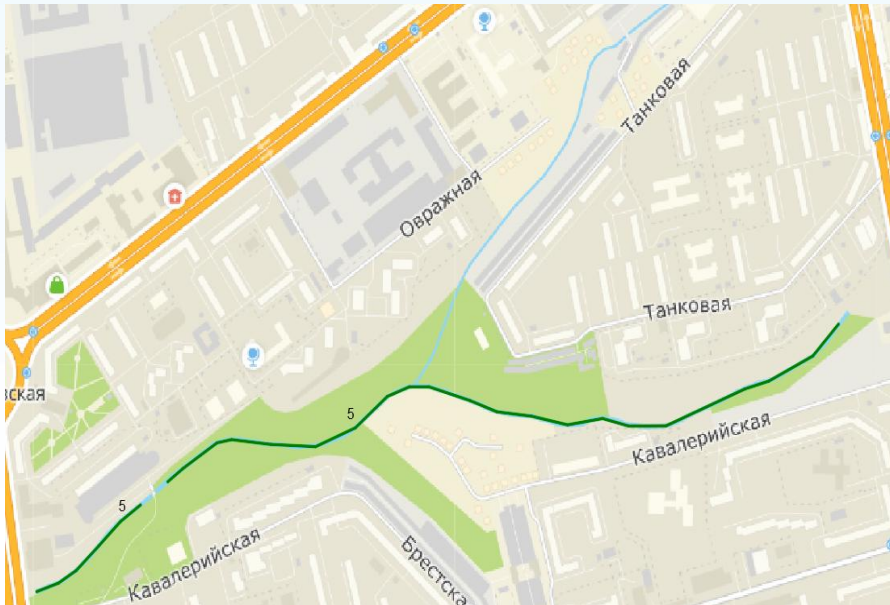
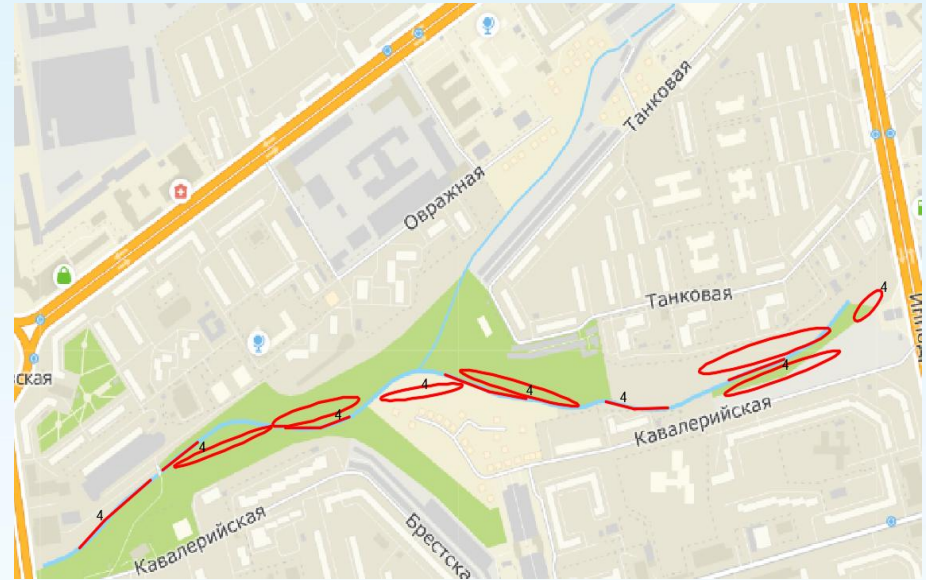
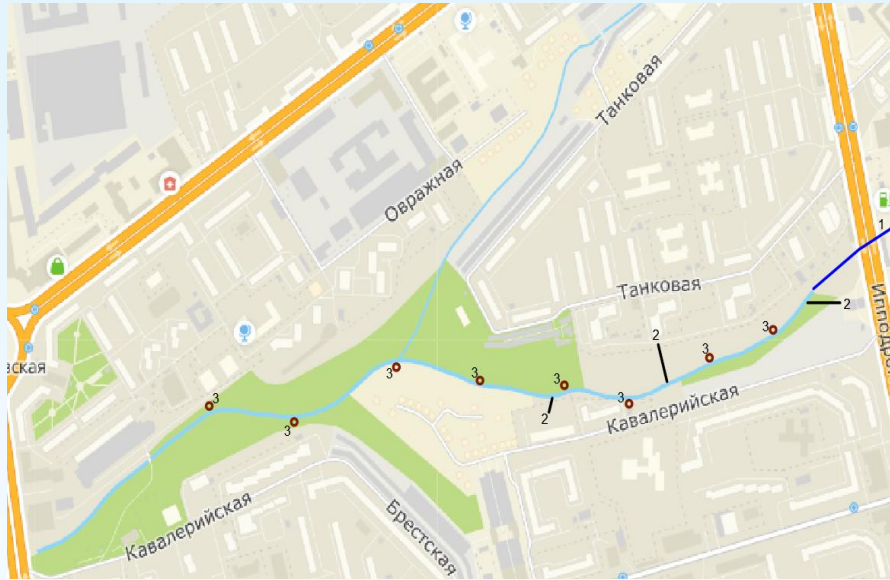
- overlap of the source;
- clearing the floodplains – channels complex from garbage, sediment, vegetation;
- backfilling of the entire river valley with soil.

With the partial liquidation of the small river, the following measures are carried out:

- Clearing the floodplain from garbage and vegetation;
- the conclusion of the river in the reservoir;
- filling of the collector with soil;
- the device of water treatment facilities at the mouth of the river, to prevent the destruction of rivers receivers.



Measures for the environmental optimization of floodplain - channel complexes of the small river Yeltsovka-1.



1 - unpurified runoff from the collector part of the river, 2 - uncleaned surface runoff, 3 - blurred banks, 4 - garbage on the floodplains and in the channels, 5 - silted areas of the channels.



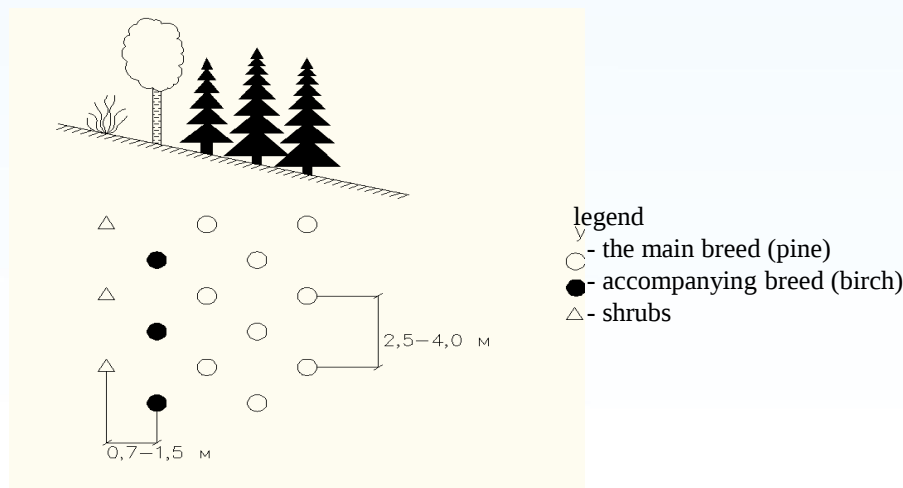
Since the river Yeltsovka - 1 has a strong environmental stress (4 points out of 5), it is necessary to take measures to conserve the river.

First, it is necessary to create water protection zone and coastal protective strip. The width of the water protection zone is taken 50 m, since the length of the river is 9 km, the width of the coastal protective strip is taken 50 m, since the slope of the banks is $> 3^\circ$. As part of the coastal protective strip, it is necessary to provide barriers to prevent ingress of untreated surface runoff into the river.

Secondly, it is necessary to eliminate all unauthorized surface runoff collectors. This will prevent harmful substances, sediments and suspended particles from entering the river.

Thirdly, mechanical clearing of the channel from garbage, sediments, fallen trees is carried out. This will expand the cross-section of the channel, increase the carrying capacity of the river, which in turn will allow the river to better self-cleaning and reduce the amount of sediment in the future.

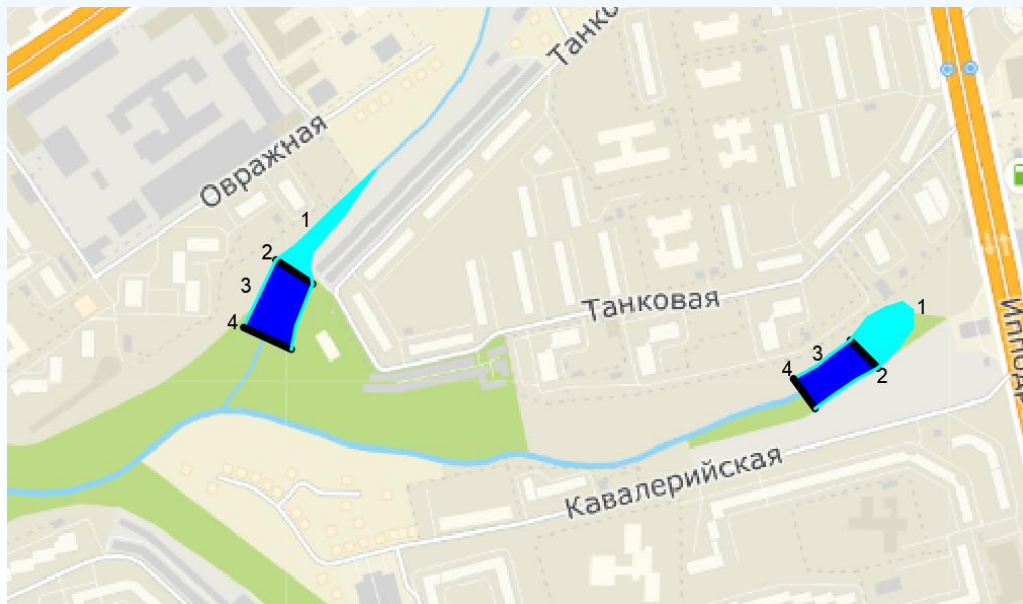
Fourthly, it is necessary to clear the floodplains from garbage, dead vegetation, fallen trees. This will save the floodplain from the harmful effects of decaying garbage. Next, you need to conduct afforestation of the coast. The forest redistributes moisture, transfers surface runoff to underground runoff, reduces evaporation and protects slopes from water erosion. Since the coast is steep, it is proposed to use a five-row waterproof forest belt.



After all the above activities, it is necessary to carry out an environmental rehabilitation of the river. For this purpose, it is necessary to arrange ponds-settlers and hydrobotanic sites (HBS).

The settling ponds are arranged at the beginning of the open area, as well as on the tributary.

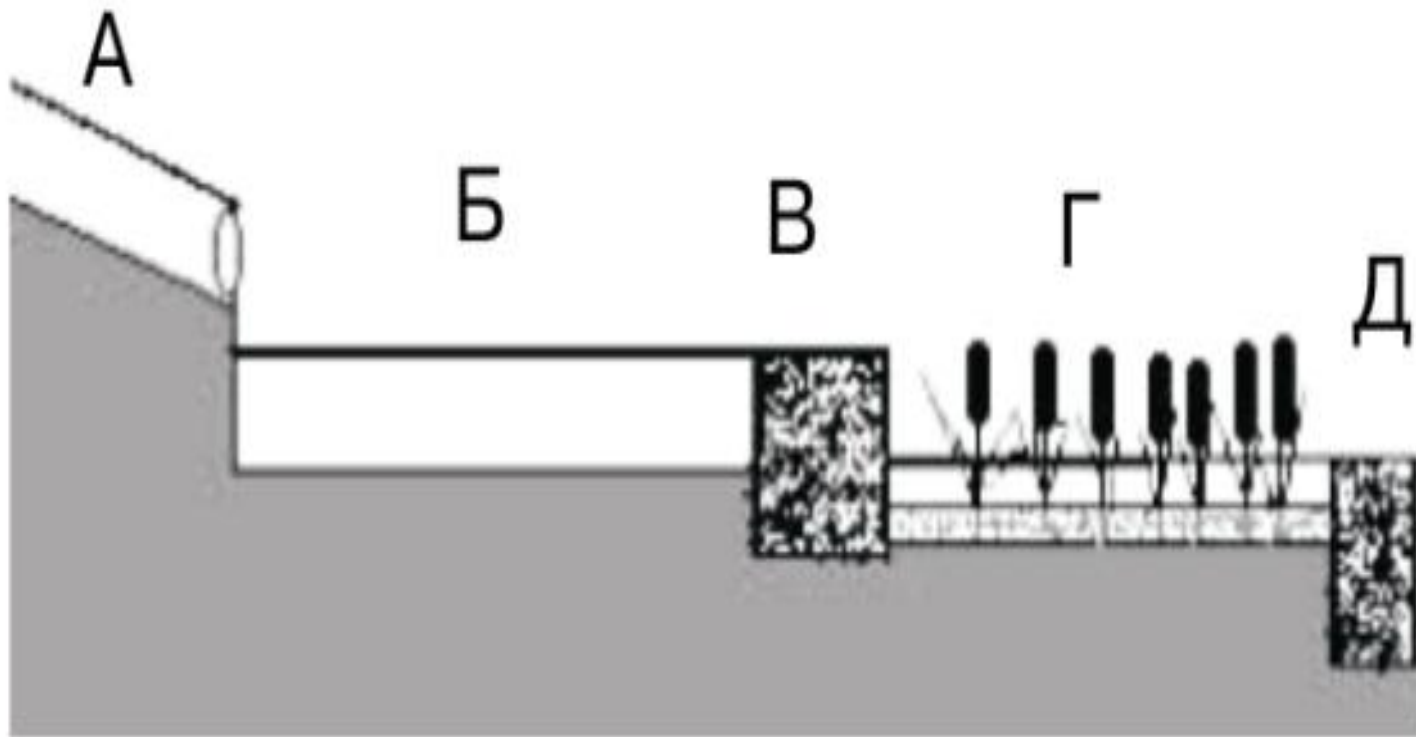
Immediately after the filtering dams, the HBS is arranged, which is populated by hydrobionts: plankton, mollusks, and higher aquatic and near-water plants. In Western Siberia, for these purposes, lake reeds, elodea, rogolistnik, the longest rdest, and ridge ridges are used. To reduce water eutrophication, the project of environmental rehabilitation provides for planting water plants with floating leaves: - nugget (nymph), varietal water lilies (nymphs), floating rdest.



HBS scheme: 1 - settling pond, 2 - filtering dam with a spillway, 3 - GBP, 4 - a spillway dam.







- * The layout of the hydrobotanical site: А - water supply tray; Б - chamber - settling tank; В - filter unit; Г - hydrobotanical site; Д - spillway dam.

