Urban planning analysis of the city of Tulun

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Abstract. In June 2019, an environmental and humanitarian disaster occurred in the city of Tulun in the Irkutsk region. The water in the Iya river, on which the city stands, rose 14 meters and flooded 1/3 of the city territory. These were floodplains and low floodplain terraces. More than 15 thousand residents lost their homes. Tulun is a small depressive city. There is no work here, starting with “Perestroika”. However, there are natural resources on the basis of which the enterprises of Soviet history successfully developed. And in the current revival of the city's economy, nature could also help. If cities are designed in accordance with it. After the flooding, a new master plan was developed. Its main provisions include: employment development, urban zoning, and the placement of new residential areas. The problem of the city's planning framework has not yet been solved. Connections within the city are not well organized.

1. Introduction
Urban planning policy in post-Soviet Russia leads to the depopulation of provincial territories. Small and medium-sized cities are getting smaller. And several megacities concentrate a multi-million population, financial, labor, and production resources. Another trend is the development of urban areas by completely replacing the natural landscape. Such landscape properties as ecological value, stability, and dynamics of the state of natural ecosystems [1,2] are practically ignored. Both trends give rise to the problem of small depressive cities. The number of cities where the population, jobs and the level of security of life are reduced is growing. Such cities include Tulun in the Irkutsk region. After the 1990s, all the city-forming enterprises were ruined here. The population has declined by more than 20% in 20 years. The attitude to the landscape in Tulun is negligent. More than 1/3 of the territory is located in the floodplain of the Iya river. This river has flooded the city many times, with a frequency of about once every 10 years. On June 29, 2019, there was a strong flood, the water level in the city rose by 14 meters, all floodplains and low floodplain terraces went under water, along with residential buildings [3]. Major transport infrastructure facilities were also affected. Traffic on the Moscow-Vladivostok federal highway stopped for two weeks. The disaster showed the need to develop the basics of urban planning policy for small depressive cities [4], located on rivers.

2. Urban planning assessment
The city is located at the intersection of the transport corridor (the Moscow highway and the TRANS-Siberian railway) with the Iya river. The Iya is a left tributary of the Angara river, draining from the eastern Sayan mountains. The river is fed both by the melting snow of the peaks and by rain. The city originated as a yamsh gomba station (a post station for horse-drawn transport) on the Moscow highway, created in the 18th century. Historians note that the road was built next to the river, due to the fact that in winter it turned into a road.
At the end of the 19th century, a railway ran parallel to the horse-drawn highway – the TRANS-Siberian railway, the steel belt of Russia, which pulled together all the regions of the country at the turn of the 19th and 20th centuries. From Tulun to the north is the highway “Viluy” to Yakutsk, which became a federal highway in 2007. In Soviet times, regional coal mining enterprises operated in Tulun. Logging and woodworking industries developed on the basis of raw wood resources, in particular, a large hydrolysis plant that produced forest chemistry products. There was a glass factory at the local quartz sand deposit. There are favorable conditions for agriculture around. By 1990, the city had more than 50,000 inhabitants. Before the flood, the population was 41 thd. people.

3. Topography
The city is located on both banks of the Iya river, which flows from south to north. In the Tulun alignment, the river makes a wide bend, retreating from the main channel to the right to the east for three kilometers. On both banks there are ridges of hills, the tops of which rise above the water mirror up to 100 meters. The water mirror in the center has a mark of 450 meters. Within the city limits, the ridges consist of two hills on each bank, forming a high protective rampart. However, these protective levees have closure channel. It consists of two broad logs. They cross the valley in the latitudinal direction and their bottom flowing left tributary of the Iya – Tulunchik stream and a tributary – river Azey. Into the right wing of this gap, the Iya river itself rushes, where it makes a loop, the main bend. This is the lowest tract of Tulun, it rises less than 10 meters above the water. In the left (western) log, the TRANS-Siberian railway is laid along its very bottom. On the right (eastern) bank, the TRANS-Siberian railway bypasses the log and presses against the slope of the northern hill. Half of the TRANS-Siberian railway is above the critical flood level. But the Moscow highway in the right-bank part of the city was flooded along its entire length from the riverbed to the upper edge of the Eastern log. Since the entire eastern log is below flood level.

4. Layout
Tulun consists of more than 2/3 of the estate development. Block-sectional development in three blocks. The city has three districts: central, northern (railway), and southern (coal and hydrolysis) across the river. Figure 1. along the long axis across the river, the city stretches for 11 km. In the central district, the main street network consists of the following axes. 1. The main Lenin street runs along the left bank of the river along the meridian. To the south, it is directed to the village of Ikey, to the north – to the city of Bratsk. 2. Volodarsky street, also known as Moscow tract, runs perpendicular to the river, along the Tulunchik stream. 3) The district streets of the latitudinal stretch also include the streets of the commune and Sovetskaya. Thus, the layout of the central district is combed. This means that the city highway has a frontal location with respect to the river, and the rokad streets that are perpendicular to it (Volodarsky, Sovetskaya, and Kommuny) depart from it. The citywide linear center stretches along Lenin street. Part of the central district is located in the river basin. This part is completely submerged. The border of the floodplain and upland parts runs along Lenin street. The Moscow highway is laid through the bend. They intersect in the gap zone between the central and northern regions.

The northern district is located partly on the territory of the western log, and partly on the slope of the northern hill of the left bank ridge. There is still a gap between the central and northern regions. The TRANS-Siberian railway passes through it. Districts are connected by ring roads. Three points: the entrance to the northern district, the exit from the central district, and the bridge over the railway - connect along a complex trajectory, due to the functional interlacing. The area's spot has the shape of an ellipse. Blucher's main street is the long axis of the ellipse. From the west along the perimeter of the ellipse runs a railway and along it four streets, randomly linked in a polyline configuration. Tulun railway station is located at the intersection of the short axis of the ellipse and the western perimeter. A regular orthogonal grid is built inside the ellipse. Its cells form blocks with dimensions of 80X350 meters. The blocks are divided into homestead plots.
The southern district lies above the river bend, on a hill beyond the river. At the foot of the hill lies the eastern log, drained by the river Azeys. Hydrolytic street runs along the sole – this is the city name of the Moscow highway. The planning structure of the southern district generally corresponds to the shape of the terrain. In log there is an area of estate development with a small parcel. It was flooded to the bottom of the hill. Parallel to the street Hydrolytic higher up the slope is the street of resurrection. Two cluster-type microdistricts are connected to it. These are the block-section coal miner's microdistrict and the estate-type Sosnovy bor microdistrict. An undeveloped landscape has been preserved between the two clusters. Hydrolytic street bridge to cross the river Iya closer to the base of the main bend. Being the border of the eastern log, this street was flooded. Figure 2.

The city's planning framework is assessed as vulnerable and poorly ordered.

5. City-forming base of the Soviet period

The greatest development of the city was in Soviet times. Figure 1. Tulunsk and Azeysk coal deposits were developed. Mining was carried out in quarries. After working off the coal seams, recultivation of quarries and dumps was performed. There were two types of reclamation – forestation of dumps and flooding of quarries. The “Vostsibugol” company in the south hill neighborhood was built from the model houses mid-rise. At the foot of the hill is a hydrolysis plant that produces wood chips from wood chemistry products. The plant and its sludge lagoons located between the shore and the streets Hydrolytic. During Perestroika, it was devastated, and in 2019 it was completely flooded. In the area between the central and northern districts, until 1990, there was a glass factory that produced flat glass, glassware, and other products. The plant was moved from the village of Taltsy on the Baikal tract in 1955, when the bed of the Irkutsk reservoir was filled. In Tulun, he worked on the basis of a quartz sand deposit located nearby. Woodworking enterprises are located to the east and west of the railway worker's district. Tulun station is located in the northern district, as part of the passenger station, track management workshops and rolling stock maintenance. There was a breeding station where seeds of crops zoned to the conditions of eastern Siberia were bred. By 1990, 19,000 people were employed at Tulun enterprises. [6]

6. Catastrophic flooding

On June 29, 2019, the water of the Iya river rose 14 meters. The entire floodplain of the central bend and the bottoms of the eastern and western lairs were flooded. Based on the satellite image of the Google Earth program from July 1, 2019 [7], Figure 2, we calculated the damage from flooding. The calculation method is as follows. 1) the satellite image outlines the area of development that was flooded. 2) within these boundaries, objects that existed in the period preceding the flooding are marked. 3) the number of individual houses and apartments in block-section houses that were flooded is multiplied by 3, i.e. the average number of people living in one apartment. The results of the calculation are given in values showing the order of the damage figures.

A) Housing. Number of people who lost their homes.
   3500 individual residential buildings;
   1500 apartments in medium-rise apartment buildings,
   5000 apartments X 3 people = 15000 people.
B) Number of social infrastructure objects.
   1) secondary school № 20; 2) secondary school № 6; a total of 1,100 students; 3) kindergarten “Alyonushka”; 4) kindergarten “Rodnichok”; 5) kindergarten “Luchik”. 280 seats.
C) Transport infrastructure. The roadbed and road surface of federal roads and main streets of urban significance were destroyed.
   1) Moscow tract – 8 km; 2) Lenin street – 6 km. A total of 14 km.
D) Industrial and municipal facilities,
   1) Repair and construction department; 2) Meat processing plant; 3) Confectionery factory; 4) Agro-industrial enterprise; 5) Fruit processing plant; 6) Animal farm; 7) Food and clothing market; 8) Gas station; 9) Hydrolysis plant.
The damage amounted to 29 billion rubles and 26 dead [3]. More than 1/3 of citizens lost their homes.

7. **Small depressive city**
The criteria for depressiveness of the city are as follows: poor population; low housing standards; low employment; low diversity of places of employment; lack of quantity and quality of social infrastructure; low security; environmental problems; population decline as a result of the outflow of citizens. The negative dynamics of the population of the city of Tulun is shown in table 1. The outflow of population from the city over the past 10 years has led to a decrease in the population by 6.5 thd. inhabit-
ants [8]. Report of the city administration: “5718 houses and apartments in the flood zone, where 17154 people lived, were declared uninhabitable. 3 thd. 458 residential premises belonging to 10374 owners are subject to major repairs”. [9]

Figure 2. Satellite image of the flooding of Tulun on June 29, 2019”. Google Earth, 2019.

Table 1. Population dynamics of Tulun over the past 10 years.

| Years | 2008 | 2009 | 2011 | 2013 | 2015 | 2017 | 2019 |
|-------|------|------|------|------|------|------|------|
| Population | 47800 | 47266 | 44497 | 42961 | 42029 | 41671 | 41279 |

The total number of families in need of new housing after the flood is 5,718. Table 2 shows a decrease in the level of employment in the city-forming industries.

Table 2. Structure of the city-forming personnel of Tulun [6].

| | 1986 г | Reference year | 2019 г | Billing period (2025) |
|---|---|---|---|---|
The table shows that in the post-Soviet period, the number of jobs in industry decreased by 3.3 times. In construction, their number decreased by 8.6 times. And only at the railway station and on external road transport, the number of labor personnel fell not so much: by 1.4 times. Mining and forestry provide the main contribution to the economy, and bring the largest share of tax revenues to the city budget.

8. New general plan
The Tulun transport hub of federal significance. Periodic flooding of this node makes it unreliable. In 2019, the Institute of JSC “Transproekt” proposed a scheme for the northern bypass of the city by the Moscow highway. The bypass intersects with the “Viluy” federal highway less than 10 km north of the existing intersection in the central district of the city. The master plan of Tulun, completed by LLC “PPM Master plan” at the end of 2019 [6] is based on the correct decision to remove residential development from the flooded floodplain and to place new construction on the two southern hills of the left and right banks.

9. Conclusion
- **Topography.** Tulun is a section of the Iya river valley. On each bank stretches a ridge of two hills, 100 meters above the mirror of the river. In the riverbed hills there is a proran in the form of western and eastern logs, which are drained by left and right tributaries. The bottoms of the logs rise above the mirror of the river by 1 - 20 meters and represent a floodplain. The central bend of the main channel juts into the floodplain of the eastern log.
- **Damage.** High floods on the Iya river occur at 10-year intervals. In the summer of 2019, there was a high (14 meters) flood that flooded the eastern log and part of the western – 1/3 of the city. 17 thd residents lost their homes. 26 people were killed. The economic damage is estimated at 29 billion rubles.
- **Population and activities.** Tulun is a transport hub at the intersection of the meridian route “Viluy” to Yakutsk (to the Arctic) and the latitudinal Moscow highway and the TRANS – Siberian railway. During the Soviet Union, the main enterprises were: a coal mine, a hydrolysis plant, and a glass factory. The region has favorable conditions for agriculture and animal husbandry. Enterprises were ruined during the collapse of the USSR. The small business of the service economy remained. Since the beginning of the 2000s, the population has decreased by 20% (10 thd. people) and amounted to 41 thd. inhabitants at the time of flooding. After flooding, 6 thd. people left, 35 thd. remained.
- **Layout.** The urban planning organization of the territory is characterized by the dominance of the sublatitudinal axis, to which three districts adjoin. Each district has mountainous and submountainous parts. In the foothill part along the axis of the Moscow highway, the districts were in the flood zone. The Moscow highway itself on the floodplain in the bend of the river including. The planning framework is characterized by incompactness and poor organization.
- **New general plan.** Provides for changes in urban zoning – construction is not allowed in the floodplain. New construction is being moved to the hilltops: birch grove on the left bank and coal miners on the right bank. Two microdistricts for 7 thd. residents compensate for half of the damage caused to housing.

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