Principles of reconstruction of a small depressive city on the example of Tulun

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Abstract. Three principles of reconstruction of a small depressive city are considered. The principle of landscape conformity is the order of urban zoning of landscape locations. And in particular, the direction of engineering flood protection. Compares the two cities: Tulun and Lensk and two floods that they experienced. The second principle is to use the advantages of economic and geographical location to identify areas for the revival of a small depressive city. The third principle is a targeted approach to the development of morphotypes of residential development that are adequate for a small depressive city.

1. Introduction
Three lessons should be learned in urban planning policy from the history of the small depressive city of Tulun, which was subjected to catastrophic flooding in the summer of 2019. 1. Urban planning should finally become landscape-like. About the proper relation of the city to landscape the author wrote works in 1991, 2003, 2009, 2019 [1, 2]. Landscape conformity will prevent huge damages from flooding. In Tulun alone, the damage amounted to 29 billion rubles. 2. In order to avoid mass outflow of population from small depressive cities, residential development should be targeted, according to the criteria of attractiveness and with a full-fledged social infrastructure. 3. Revive small cities based on the advantages of economic and geographical location, taking into account available resources, by modernizing and diversifying jobs.

2. The principle of landscape conformity
The principle of landscape conformity is formulated as follows [1]. Of the three elements of the microrelief, facies and tracts, which include the top, slope and lowland (floodplain, in particular), the maximum urbanization is allowed on a flat top; the minimum urbanization, recreation, and natural frame formation are shown in the floodplain or valley; slopes, depending on the steepness, should occupy an intermediate position according to the intensity of development. The principle is explained by the ecological properties of locations. The top surface is characterized by an eluvial regime, landscape material is blown out and washed away from it, and it is more resistant to contamination than other locations. Material accumulates in the lowlands, and the valley floor is an alluvial landscape that is the richest in biological productivity. At the same time, the valley (lowland) is most vulnerable to the threat of pollution. The floodplain is a place with a high risk of flooding. The ecological regime of the slope is deluvial, transit. The slope is less stable than the top and less productive than the bottom. Therefore, you can build more intensively on the slope than in the lowlands, but more moderately than on the top.
On the example of Tulun, practice has shown that it is vital to conduct urban planning policy according to the principle of landscape conformity. In the new Tulun master plan [3] urban zoning is closer to this principle. The general plan does not allow construction in the floodplain. It is transferred to flat hilltops. Note that even in the 19th century, Tulun was planned more correctly. Below the current Lenin street, in the bend of the Iya river, the building did not descend. In Figure 1. [4]. Lenin street was then called Bolshaya [5]. The fact that the main street is oriented to Bratsk suggests that the Tulun-Bratsk connection initially worked as one of the main ones. The Moscow tract within the borders of Tulun in the 19th century passes in a different way. At its intersection with high street is the church of the intercession. Pokrovskaya street is a continuation of the tract. Then the street was renamed in the Soviet. The intercession church served as an important urban planning landmark on the Moscow tract. The road from the floodplain to the church rose 18 meters. And the church, thus, separated the safe place from the flooded one.

![Figure 1](image.jpg)

**Figure 1.** Plan of Tulun- the parish center in the late 19th century [4].

In addition to the methods of urban planning, which are fundamental, the Tulun reconstruction project also offers engineering methods of flood protection. JSC “Institute Gidroproekt” has developed a scheme of two dams [6].
Flooding of small towns in Siberia is not uncommon. So, in 2001, a catastrophic flood occurred in the city of Lensk. Due to the ice blockage during the spring ice drift, the water of the Lena river rose by 21 meters and flooded the entire city. The Institute “Sibrechproekt” [7] designed the embankment dam with a length of 19 km and a height of 18 m. This dam has a sloping cross-section, made of soil, and the slope reinforced concrete. Figure 2. A protective dam in Lensk is on the floodplain and a section of the river channel shrink.

The flood and properties of both cities are similar. Lensk is also a small city, with 27,000 inhabitants, and it is experiencing a population decline, as is Tulun. But the landscape and urban development situation in Lensk is different. The difference is that its entire territory is in the zone of catastrophic flooding. The water rise of 18 meters covers the entire city. In Tulun, the landscape and hydrological situation is more favorable. Because the share of the floodplain in the city area does not exceed 30%. Close to the river are the hills where most of the city is already located and it is easier to move the floodplain development to the top.

The 15-meter-high Tulun dams will be located: north on the left bank and south on the right. Figure 3. The northern dam is placed mainly on the floodplain of the main bend. This dam is parallel to Lenin street and runs along the edge of the Zhukov microdistrict, built up with five-story houses, along the interface of the floodplain and the above-floodplain terrace. It stretches from north to south. In the north, the dam is adjacent to the railway bridge. Here it goes more than half a kilometer along the water's edge to the south and then rises to the floodplain. After passing the floodplain, the dam again comes to the water's edge in the South and stands on the edge of the left bank, upstream from the main bend. This section of the dam supports the shore with a length of 300 meters. The extremities of the northern dam raise questions.

Figure 2. Embankment on the protective dam and the church of St. Innokentij.
The southern dam is located on the right bank. It separates the development of the coal Miner's district and the hydrolysis plant from the eastern log and the right-bank floodplain of the Iya. It stretches from west to east. Contrary to the principle of landscape conformity, the city authorities want to preserve the development on the floodplain – on the eastern wing of the dam. In the middle part, the dam returns to the rear of the floodplain and protects the Moscow tract (Hydrolyznaya street). At the western end, the dam bends around a second bend. And it comes out here at the water's edge.

There is an objection to sections at the water's edge. When they compress the cross-section of the riverbed and do not allow it to overflow into a flood, they enter into an unreasonable confrontation with it. Due to the increase in pressure and speed, the compressed river stream will carry out from under the heavy dam base, composed of its own alluvium. And the wall will collapse. Landscape conformity is such a dam structure as a rock-throwing beach, with a sloping slope. The sloping slope of the bank protection allows the river to flood without forcing pressure. In the body of the stone outline, the jet's speed is extinguished, and it begins to build a coastal protection for itself, depositing its solid runoff in the voids between the boulders.

It is impractical to keep the village on a floodplain that has already been flooded several times. Since in the event of an inevitable re-rise of water, it will, at least, be heated. In other words, the housing stock should be removed from here and placed on the tops of hills.

3. Economic geographical position and the principle of investment attractiveness
The values of economic and geographical location are: availability of mineral and fuel and energy resources; location on main roads: relative to markets, labor, agricultural land and forest resources. Coal, timber, electricity from the Bratsk HPS, and the possibility of crossing two federal tracts, latitudinal and meridional-these factors are prerequisites for the revival of Tulun. Regional centers are located at a distance of: Krasnoyarsk-600 km; Irkutsk-400 km; Bratsk-200 km. The meridian connection is relevant as a vector of movement to the Arctic via Bratsk and Yakutsk. The northern sea route and other Arctic programs are related to this. The famous Soviet and Russian urban scientist Lezhava I.G. [8] considered the TRANS-Siberian railway latitudinal connection as a linear framework for settlement in the east of Russia. In other words, there are economic and spatial prerequisites for the development of Tulun on the TRANS-Siberian railway and the Moscow tract. It is a point on the Irkutsk-Krasnoyarsk line. There are 10 cities on this line. The TRANS-Siberian railway is seen as a conveyor belt on which
there is an exchange of activities, products and services. Using their local potential, each city contributes to the regional market. The borders of the market will go beyond the outlined band, but it is important that the general revival will start from places. For Tulun, there is a program of the following items. 1. Production of glass composite. The implementation period is 2020-2028. The estimated amount of investment is 1000 million rubles; it is planned to create 1,100 jobs. 2. Production of birch veneer. Increasing the volume of existing production. The implementation period is 2021-2027. The estimated investment volume is 10.5 million rubles, and 240 jobs are planned. There is a program of advanced socio-economic development, with preferential taxation, to encourage investment in the city's economy. In addition to the spatial position relative to the resources of the activity, the potential of the locality itself is important. Tulun's competitive advantage is that part of the landscape that is little changed. River, taiga, fields. Low-density low-rise estate development. A leisurely pace of life. This raises the question of the morphotype of the residential environment that would be adequate and attractive for city residents.

4. Morphotypes of residential development that are adequate for a small city

In Lensk, after the catastrophic flooding in 2001, a survey of residents was conducted and found that the concept of home security for the population is not uniform. There are 4 categories of the population that have their own requirements for housing types, in terms of flooding risks [9]. For example, the old-timers prefer to live in individual single-family houses on their land plots. Employees of the “Alrosa” corporation preferred compact living in blocks blocked by 2-4-storey buildings and were determined to organize themselves in the aspect of flood rescue. Wealthy citizens preferred to build a cottage village outside the city with an autonomous infrastructure. Finally, residents who temporarily came to Yakutia in the hope of short money, preferred to live in apartments in multi-storey buildings.

Two morphotypes of housing were proposed for Tulun: manor houses with plots of 10-20 acres and apartments in block-section houses. The estate district “Birch grove” is located on the top of the southern hill on the left bank. 370 hectares have been allocated for development, and the territory is divided into 1200 plots by the planning project. The planning connection of the new district with the existing center is proposed along the Commune street. Due to its location, it connects the central Lenin street and the periphery of the district and goes beyond its borders. A new district was connected to this street. It should be noted that the physical parameters of the Commune street do not correspond to the status of the district highway. Its width in a narrow place is only seven meters. It should be 40 meters. This raises the question of reconstruction of buildings in the central district due to the need to expand the street.

The layout of the estate district is derived from the grid of existing streets in the part of Tulun that it adjoins. The new grid consists of edges that are either parallel or perpendicular to those streets. Figure 4. New streets are oriented from north-northwest to south-southeast. This applies to streets perpendicular to the river. The second family of streets in the grid is laid parallel to the river and oriented from west-southwest to east-northeast. As a result, blocks of 100X400 meters were formed – 44 units. Of these, 20 units are oriented sublatitudinal, and 24 units are oriented submeridionally, approximately equally. Street facades of meridian blocks look at the favorable sides of the horizon, and with the latitudinal orientation of blocks, 50% of street facades look to the north (north-northeast, to be more precise). This orientation is compensated by modifying the layout of the house itself. Large parcels-from 18 to 20 acres. This allows each family to run a subsidiary farm. If you calculate the net density, take into account only the area of residential blocks, you will get 15 people/ha. This is a very low density for the city, and it does not allow you to rely on a central engineering infrastructure. But if each household is equipped with autonomous engineering life support, this problem can be removed. The district offers three planning fragments, each united around its own social zone. The project also includes a universal sports hall. Three pedestrian green boulevards.

The second morphotype – blocked two-story and block-section five-story buildings proposed in the microdistrict “Coal miners”. Figure 5. Area of 4 ha. It houses ten five-story two-section houses with 480 apartments and three two-story block houses with 66 apartments. A group of medium-rise build-
ings is arranged in 4 courtyards with dimensions of about 50 meters across. That is, when the ratio of the height of the building to the distance between buildings is about 1:2. A fairly spacious morphotype. Blocked two-story houses are built in three lines. The ends of the lines face north-north-west. the main longitudinal facades face the favorable sides of the horizon. The plot configuration looks like a trapezoid made up of a square and a triangle. The layout of residential buildings is solved in a square, and a kindergarten for 140 children is located in a triangle. We found a place for a square in the square. A total of 546 apartments, or about 2000 residents. The density is high, up to 400 people/ha. However, it is quite acceptable for landscaping and even for gardening.

Figure 4. Planning of the estate development of the “Birch grove” district project LLC “PPM Master plan”, 2019.

Thus, Tulun is offered two different, polar morphotypes, low-density manor and block-section dense development. City, if residents have a city job, city apartment in a dense block-provides adequate living conditions. If there is a shortage or part-time employment, the estate development with its own garden, of course, is an ideal place to live. As a result, we have a variable solution to the problem of creating an attractive residential environment in the city of Tulun. Life will show which type of housing will be more in demand [10].

Figure 5. A development project in the area of “Coal miners”. CC “Vostsibstrojproekt”, 2019
5. Conclusion

- The principle of landscape conformity is the order of urban zoning of locations: peaks, slopes, floodplains. At the top – intensive development, in the floodplain - a natural frame, recreation, on the slope – moderate urbanization. The history of Tulun has shown that it is criminal to neglect the principle of landscape conformity. This entails huge damages and casualties. In the case of Tulun, this means that housing, social facilities, and federal tracts for engineering and transport infrastructure should be removed from the floodplain and placed on flat peaks.

- The principle of engineering protection. Construction of dams is an extreme measure when urban planning measures are exhausted. It is especially important to take into account in the design of the dam that the placement of walls directly along the water's edge, with compression of the cross-section of the riverbed and with the restriction of river flooding on the floodplain, will cause the consequences that the river will take out its own alluvium from under this wall and the wall will lose its foundation. For reliable shore protection, it is preferable to use a sloping rock-throwing beach.

- The principle of revival based on economic and geographical location. Based on the available resources and experience, it is necessary to continuously develop and modernize abandoned activities – the coal industry; deep woodworking, including wood chemistry; production of glass and advanced glass composites; the agro-industrial complex and its selection component, as well as animal husbandry. It is necessary to improve Tulun as a hub at the intersection of latitudinal and meridional federal transport infrastructure routes. In the transformation of the TRANS-Siberian railway from the dotted line to the settlement channel of the Irkutsk region, the role of Tulun is among the primary ones.

- The principle of the popular morphotype of residential development. Two morphotypes of residential development for Tulun are considered: homestead and multi-apartment block-sectional. These types of buildings have their own advantages and disadvantages. Depending on which way the city will go – to urbanize or develop as a suburb with a quiet rhythm of life, it will be seen which of these polar morphotypes will be more in demand. If there is work and employment in the city, then the multi-apartment morphotype is more suitable. If there is no employment, and residents need to feed from the garden, the estate morphotype will be in demand.

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