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REVIEW ARTICLE

FEATURES OF WOODEN DEVELOPMENT OF SETTLEMENTS BY THE RIVER

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Abstract. *This article presents the results of a study devoted to identifying the features of traditional and modern wooden construction of settlements located in the coastal zone of rivers. Traditional wooden building material gained popularity again in the early 21st century as part of a solution to environmental problems. The article presents research on wooden settlements in Russia on rivers located in the European part of Russia and in Asia - Western Siberia. The objects of the study are wooden buildings and structures built near water, in areas prone to flooding. The research methodology is based on a comprehensive approach. The following methods were used in the work on the article: analysis of scientific publications and electronic resources, chronological and comparative analysis, and generalization of results. The study showed that wooden buildings, built using traditional construction methods (log huts), as well as modern ones, built using modern construction technologies for wood processing, can be classified as temporary (not capital construction), dynamic, mobile, capable of transformation and movement. Such features of wooden architecture allow it to be effectively used in conditions created by the elements of water, in settlements on rivers that can change their course, where the water level often rises, causing flooding of the territory. Traditionally, flooding problems have been solved by building dams or dikes. Features of modern wooden construction based on quickly built, prefabricated, and movable houses can be used not only for residential settlements but also for tourist attractions, to attract investment and improve the sustainability of riverside development.*

Keywords: *architecture, wooden development, waterways, settlementt, riverside development*

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ШОЛУ МАҚАЛА

ӨЗЕН ЖАҒАЛАУЫНДАҒЫ ЕЛДІ МЕКЕНДЕРІНДЕГІ АҒАШ ҒИМАРАТТАРДЫҢ ЕРЕКШЕЛІКТЕРІ

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Аңдатпа. *Бұл мақалада өзендердің жағалау аймағында орналасқан елді мекендердің дәстүрлі және заманауи ағаш құрылысының ерекшеліктерін анықтауға арналған зерттеу нәтижелері ұсынылады. XXI ғасырдың басында ағаш архитектурасы экологиялық мәселелерді шешу аясында заманауи құрылыстың алдыңғы қатарына қайта шықты. Ресейдегі өзендер бойындағы, Ресейдің Еуропалық бөлігінде және Азиядағы аймақтарда Батыс Сібірдегі, елді мекендердің ағаш құрылысына қатысты зерттеулер берілген. Ағаш архитектурасының ерекшеліктері айқындалады. Зерттеу нысандары суға жақын жерде, су басу қаупі бар аумақтарда салынған ағаштан тұрғызылған ғимараттар мен құрылыстар болып табылады. Зерттеу әдістемесі кешенді тәсілге негізделген. Оған қоса, мақала жазу барысында ғылыми жарияланымдар мен электрондық ресурстарды талдау, хронологиялық және салыстырмалы талдау, нәтижелерді жинақтау сияқты әдістер қолданылды. Зерттеу нәтижесінде дәстүрлі құрылыс тәсілдері негізінде орындалған ағаш құрылыстар (бөренелі үйлер), сондай-ақ ағашты өңдеудің заманауи құрылыс технологияларын қолдана отырып салынған қазіргі ағаш құрылыстар екеуі уақытша (капиталдық құрылысқа жатпайтын), динамикалық, мобильді, трансформациялануға және орын ауыстыруға қабілетті деп жіктелетіні анықталды. Ағаш архитектурасының мұндай ерекшеліктері су стихиясы қалыптастыратын жағдайларда, арнасы өзгеруі мүмкін өзендер бойындағы елді мекендерде, су деңгейі жиі көтеріліп, аумақты су басатын жерлерде оны тиімді қолдануға мүмкіндік береді. Дәстүрлі түрде су басу мәселесін шешу бөгеттер немесе дамбалар салу арқылы жүзеге асырылып келді. Жинамалы-құрастырмалы, тез тұрғызылатын және орын ауыстыруға болатын үйлерге негізделген заманауи ағаш құрылысының ерекшеліктері тұрғындар елді мекендерінде де, инвестиция тарту және өзен маңы аумақтарының тұрақты дамуын арттыру мақсатында туризм нысандарында да қолданылуы мүмкін.*

Түйін сөздер: *сәулет, ағаш құрылыс, су жолдары, елді мекен, өзен жағалау аймағының құрылысы*

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ОБЗОРНАЯ СТАТЬЯ

ОСОБЕННОСТИ ДЕРЕВЯННОЙ ЗАСТРОЙКИ ПОСЕЛЕНИЙ У РЕКИ

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Аннотация. *В данной статье представлены результаты исследования, посвященного выявлению особенностей традиционной и современной деревянной застройки поселений, расположенных в прибрежной зоне рек. Деревянная архитектура в начале 21 вв. снова вышла на передний край современной застройки в рамках решения экологических проблем. Представлены исследования деревянной застройки поселений в России на реках, расположенных в Европейской части России и в Азии – Западная Сибирь. Выявляются особенности деревянной архитектуры. Объектами исследования являются здания и сооружения из дерева, выстроенные вблизи воды, на территориях, подверженных подтоплению. Методология исследования основана на комплексном подходе. В том числе, в работе над статьей использовались такие методы, как анализ научных публикаций и электронных ресурсов, хронологический и сравнительный анализ, обобщение результатов. Исследование показало, что деревянная застройка, выполненная на основе традиционных способов возведения (срубовые избы), а также современная, выполненная с применением современных строительных технологий по обработке дерева, может быть квалифицирована как временная (не относящаяся к капитальному строительству), динамичная, мобильная, способная к трансформации и перемещению. Подобные особенности деревянной архитектуры позволяют эффективно применять ее в условиях, создаваемых стихией воды, в поселениях на реках, которые способны менять русло, где часто повышается уровень воды, обеспечивающий подтопление территории. Традиционно решение проблемы подтопления выполнялось при помощи строительства плотин или дамб. Особенности современной деревянной застройки на основе быстровозводимых сборно-разборных домов, которые можно перемещать, могут быть использованы как в поселениях для жителей, так и на объектах туризма для привлечения инвестиций и повышения устойчивости развития приречных территорий.*

Ключевые слова: *архитектура, деревянная застройка, водные пути, поселение, приречная застройка*

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CONFLICT OF INTEREST

The authors state that there is no conflict of interest.

The authors declare that no generative artificial intelligence technologies or AI-based tools were used in the preparation of this article.

АЛҒЫС / ҚАРЖЫЛАНДЫРУ КӨЗІ

Зерттеу жеке қаржыландыру көздерін пайдалана отырып жүргізілді.

МҮДДЕЛЕР ҚАҚТЫҒЫСЫ

Авторлар мүдделер қақтығысы жоқ деп мәлімдейді.

Авторлар мақаланы дайындау барысында генеративті жасанды интеллект технологиялары мен жасанды интеллектке негізделген технологияларды пайдаланбағанын мәлімдейді.

БЛАГОДАРНОСТИ/ИСТОЧНИК ФИНАНСИРОВАНИЯ

Исследование проводилось с использованием частных источников финансирования.

КОНФЛИКТ ИНТЕРЕСОВ

Авторы заявляют, что конфликта интересов нет.

Авторы заявляют о том, что при подготовке статьи не использовались технологии генеративного искусственного интеллекта и технологии, основанные на искусственном интеллекте.

1 INTRODUCTION

Wood, as one of the oldest and most accessible building materials, has played a key role in the architectural development of settlements for millennia. Its use was especially significant in forested regions of the temperate zone, where this resource was readily available and widely used for the construction of residential, хозяйственных (outbuildings), and public structures. However, with the advancement of construction technologies in the 20th century, wood was gradually replaced by more durable materials such as concrete, brick, and metal. Modern construction, focused on high standards of comfort and energy efficiency, also limited the widespread use of wood in mass development.

Nevertheless, in recent decades, particularly in the context of global environmental challenges, interest in wood as a building material has significantly increased. In the 21st century, wood has become an important component of “green” construction, aimed at creating environmentally friendly, energy-efficient, and climate-resilient buildings. This trend is associated with the need to reduce carbon emissions, preserve natural resources, and adapt the built environment to climate change.

The return of wood to modern construction is closely related to the development of advanced technologies for its processing and protection, which significantly increase its durability and resistance to external factors. The environmental safety of wooden structures makes wood a promising material in the context of contemporary sustainability requirements.

Traditional wooden construction, based on accumulated empirical knowledge and craftsmanship, has always been closely linked to local natural and climatic conditions. This architectural heritage serves as a foundation for the development of modern eco-oriented and adaptive design solutions.

This study examines the features of traditional wooden construction in settlements and its modern development potential.

The problem of sustainable development of settlements with wooden buildings is particularly acute in small and very small settlements located along rivers (**Krasheninnikov, 2022**).

The architectural and planning organization of waterfront areas has been widely studied in scientific literature. Researchers propose conceptual models and design approaches for embankments, as well as recommendations for improving the quality of coastal urban environments (**Tuyakayeva & Kerimova, 2021**).

Water is a vital resource for human settlements; however, it also creates significant challenges, including flooding risks (**Mukhamejanova et al., 2025**). Therefore, rivers should be considered as dynamic natural systems with constantly changing flow regimes and riverbeds.

Studies devoted to the pre-design analysis of waterfront areas emphasize the importance of assessing spatial, functional, and environmental characteristics of territories, as well as the interaction between natural landscapes and urban fabric (**Tuyakayeva & Kerimova, 2021**).

International experience in the architectural and spatial organization of coastal areas demonstrates the effectiveness of integrated approaches based on sustainability principles, ecological balance, multifunctionality, and accessibility (**Tuyakayeva & Kerimova, 2020**).

Wooden buildings are primarily used in small settlements, where they play an important role in shaping the architectural character and spatial structure of the built environment (**Krasheninnikov & Kosenko, 2023**). The use of wood is determined by its environmental sustainability, availability of local resources, energy efficiency, and its ability to create a human-scaled and comfortable environment.

Modern studies also highlight challenges related to demographic changes, economic sustainability, and the need to modernize infrastructure while preserving the traditional appearance of settlements (**Krasheninnikov, 2024; Krasheninnikov & Kosenko, 2024**). These works emphasize the importance of integrated planning approaches combining functional efficiency, environmental considerations, and preservation of architectural heritage.

2 MATERIALS AND METHODS

The research methodology is based on a comprehensive interdisciplinary approach that integrates architectural and urban planning analysis, historical and typological research, comparative assessment, and generalisation of empirical data. This approach makes it possible to identify both the stable traditional principles of wooden construction and the contemporary trends in its development in riverine environments.

The theoretical framework of the study was formed through the analysis of scientific publications and electronic resources, including domestic and international research on wooden architecture, traditional housing construction, and riverside development. In addition, electronic cartographic materials, archival photographs, and digital databases were used to ensure a comprehensive data base.

The chronological method was applied to examine the evolution of wooden construction in settlements located near rivers, tracing the transition from traditional log structures to modern prefabricated systems. This method allowed for the identification of changes in planning solutions, structural systems, and building placement in relation to water bodies, as well as the influence of historical, socio-economic, and natural-climatic factors on the formation of riverside settlements.

The comparative method was used to determine regional and typological features of wooden architecture under different natural and climatic conditions. It enabled the comparison of traditional and modern wooden buildings, particularly in Siberian settlements, and the evaluation of differences in design solutions, spatial organization, and adaptation to flooding conditions.

Architectural and typological analysis was conducted to classify wooden buildings according to their functional purpose (residential, commercial, and tourist facilities), as well as to examine their spatial configurations, planning structures, and structural systems. This analysis made it possible to identify typical building models characteristic of riverine territories.

Urban planning and landscape analysis focused on assessing the interaction between buildings and the natural environment, including their relationship with riverbeds, terrain, and flood-prone areas. Special attention was paid to the degree of adaptation of buildings to fluctuating water levels and to the environmental and spatial feasibility of wooden construction.

Structural and technological analysis was carried out to justify the use of wooden architecture under flooding conditions. This included the study of traditional construction techniques (log cabins, pile foundations, raised floors) as well as modern wood processing technologies, prefabricated and modular systems. Particular emphasis was placed on evaluating the mobility, transformability, and temporary nature of wooden structures.

The application of this integrated set of methods ensures a comprehensive and scientifically grounded analysis of wooden construction in riverside settlements, revealing its adaptive, dynamic, and sustainable characteristics in environments influenced by water.

3 RESULTS AND DISCUSSION

Wooden construction based on traditional log structures, as illustrated in **Figure 1**, has historically not been associated with capital construction. Capital construction is characterized by a rigid connection to land and the impossibility of relocation without significant damage. According to Article 130 of the Civil Code of the Russian Federation, real estate includes land plots and all objects firmly attached to the land, i.e., objects that cannot be moved without disproportionate damage to their intended purpose (**Civil Code of the Russian Federation, 2024**). In contrast, wooden buildings may be constructed without deep foundations and can be assembled, disassembled, and transported, including in fully assembled form, which significantly increases their adaptability in unstable environmental conditions (**Figure 2**).

Figure 1 – Wooden house, manufactured in a factory and assembled on site from individual elements (**Bevzenko, 2018**)

Figure 2 – Transportation of an assembled log house (**Bevzenko, 2018**)

The problem of constructing wooden housing in settlements located near water bodies, particularly along rivers subject to seasonal flooding, has existed for centuries. Historically, this issue was addressed through the construction of dams and hydraulic structures. However, despite technological progress, this problem remains unresolved in many territories. It is particularly acute in remote and sparsely populated regions, especially in Siberia, where hydrological processes are dynamic and difficult to control.

Examples of such settlement development can be observed in Penza, located in the Volga region of European Russia within the Sura River basin, and in the settlements of the Middle Ob region in Western Siberia (**Figures 3 and 4**).

Pool Sura riva is located in the center of the European part of Russia on the left bank of the Volga River.

The pool area is 67,500 sq km. The following regions of the Russian Federation are partially located on the territory: Nizhny Novgorod, Penza and Ulyanovsk regions; Mordovia and Chuvashia; a small section of the right-bank floodplain in front of it belongs to the Republic of Mari El; the upper reaches of the Abyss River are located in Tatarstan.

The Sura basin partially includes small territories of the Saratov region (the sources of the Kalada River, Elan-Kalada, Uz, Gryazukha.

Figure 3 – The Sura River basin, a right tributary of the Volga River (**Kosaeva & Lapshina, 2025**)

Figure 4 – Ob River basin, Western Siberia, Russia (**Danilkin, 2010**)

The Sura River basin occupies a significant territory of European Russia with a total area of approximately 67,500 km² and includes parts of several administrative regions. The spatial organization of settlements within this basin has historically been closely linked to the hydrological characteristics of the river system.

The historical development of Penza clearly demonstrates the interaction between wooden construction and riverine conditions. The Penza fortress was established in 1663 using wooden structures on the elevated bank of the Penza River, which flowed into the Sura River (**Belorybkin, 2022; Kosaeva & Lapshina, 2025**). The left bank of the river was fortified, while the right bank remained low-lying and therefore more vulnerable to flooding processes (**Figure 5**).

a b

Figure 5 – The city of Penza: a) 19th-century city plan; b) 18th-century panorama of the wooden city (**Belorybkin, 2022**)

In 1850, merchant P. V. Sergeev constructed a wooden paper mill on the right bank of the Penza River (**Vishnevskiy, 2001**). The location of the factory was directly determined by the availability of water resources, which were essential for production processes. The industrial complex was integrated into the natural hydrological system through channels, trenches, and artificial canals connected to the Sura River (**Figure 6**).

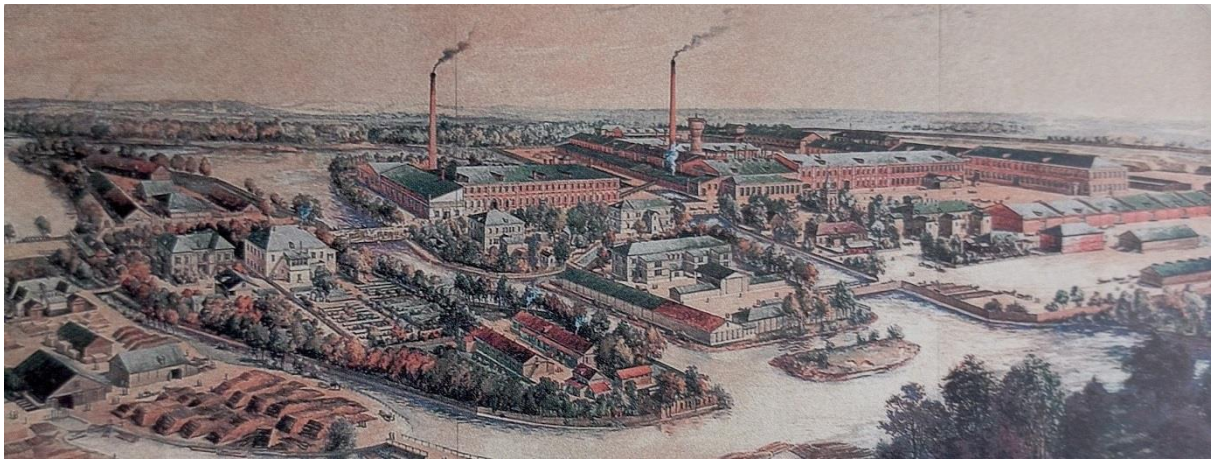


Figure 6 – Paper plant "Mayak" of merchant P. V. Sergeev in Penza (**Shishkin, 2012**)

Significant anthropogenic intervention in the hydrological system occurred in the mid-19th century, when a new channel was artificially created, which led to changes in water distribution. In response to these changes, hydraulic structures, including dams, were constructed to regulate water levels and stabilize industrial activity (**Figure 7**).

Figure 7 – Dam on the Sura River near the village of Kurilovka (**Shishkin, 2012**)

At the beginning of the 20th century, seasonal flooding became a regular phenomenon in Penza. Floodwaters periodically inundated the right bank of the river, where wooden buildings were located, demonstrating the vulnerability of such development to hydrological processes (**Figure 8**).

a

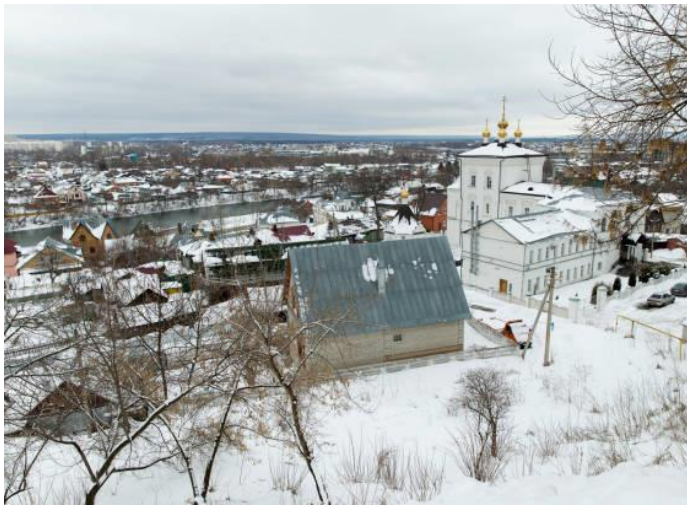
b

Figure 8 – Flooding of the Penza River:
a) near Peski Island;
b) view from Peski Island to the monastery (**Shishkin, 2012**)

Subsequently, the destruction of hydraulic structures resulted in the formation of a new river channel, while the former channel transformed into a system of backwaters and lakes (**Figure 9**). These processes illustrate the dynamic nature of river systems and their direct influence on settlement structure.

Figure 9 - Map of Penza showing the new and old channels of the Sura River (**Penza Yandex Map, 2025**)

In the 1970s, the construction of a new dam upstream of Penza allowed for partial regulation of the river regime, significantly reducing the risk of flooding in urban areas, including historically formed wooden development (**Figure 10**).



a b

Figure 10 – Peski Island in Penza:
a) view from the left bank;
b) view from the observation deck (author's material)

However, such regulation is not characteristic of all riverine territories. In many regions, particularly in Siberia, river channels remain unstable, subject to seasonal changes, erosion processes, and periodic flooding, which complicates the use of traditional capital construction methods.

This is confirmed by studies of the Middle Ob region, where settlements retain predominantly wooden construction. According to research conducted in 2018 (**History of rural settlements of the Middle Ob region in geographical maps, 2018**), settlements along the Ob River, from Parabel

to Vertikos, are characterized by the preservation of traditional log housing construction (**Figure 11**).

Figure 11 - Route of the expedition along the Ob River (**History of rural settlements…, 2018**)

In these territories, wooden buildings are often relocated due to flooding and changes in river channels. Hydrological processes such as channel migration, merging of water flows, and drying of secondary channels significantly influence the spatial organization of settlements (**Figures 12–14**).

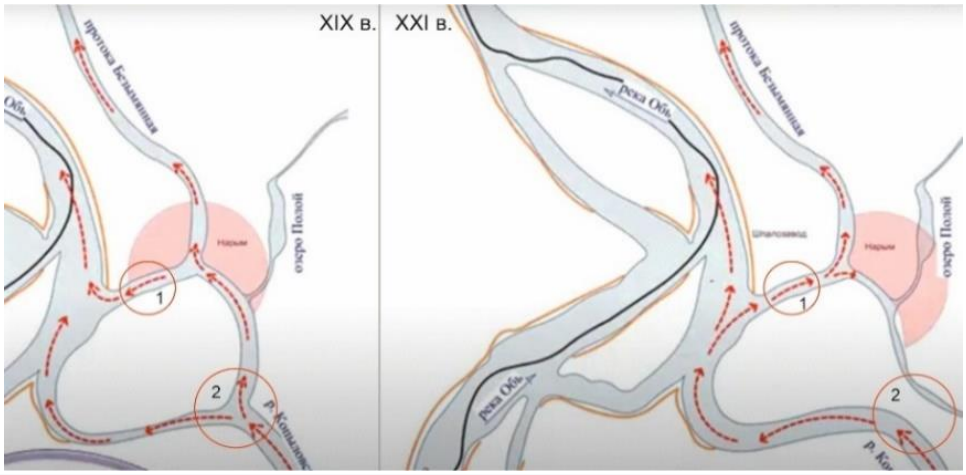


Figure 12 - Model of landscape changes near the settlement of Narym (**History of rural settlements…,2018**)

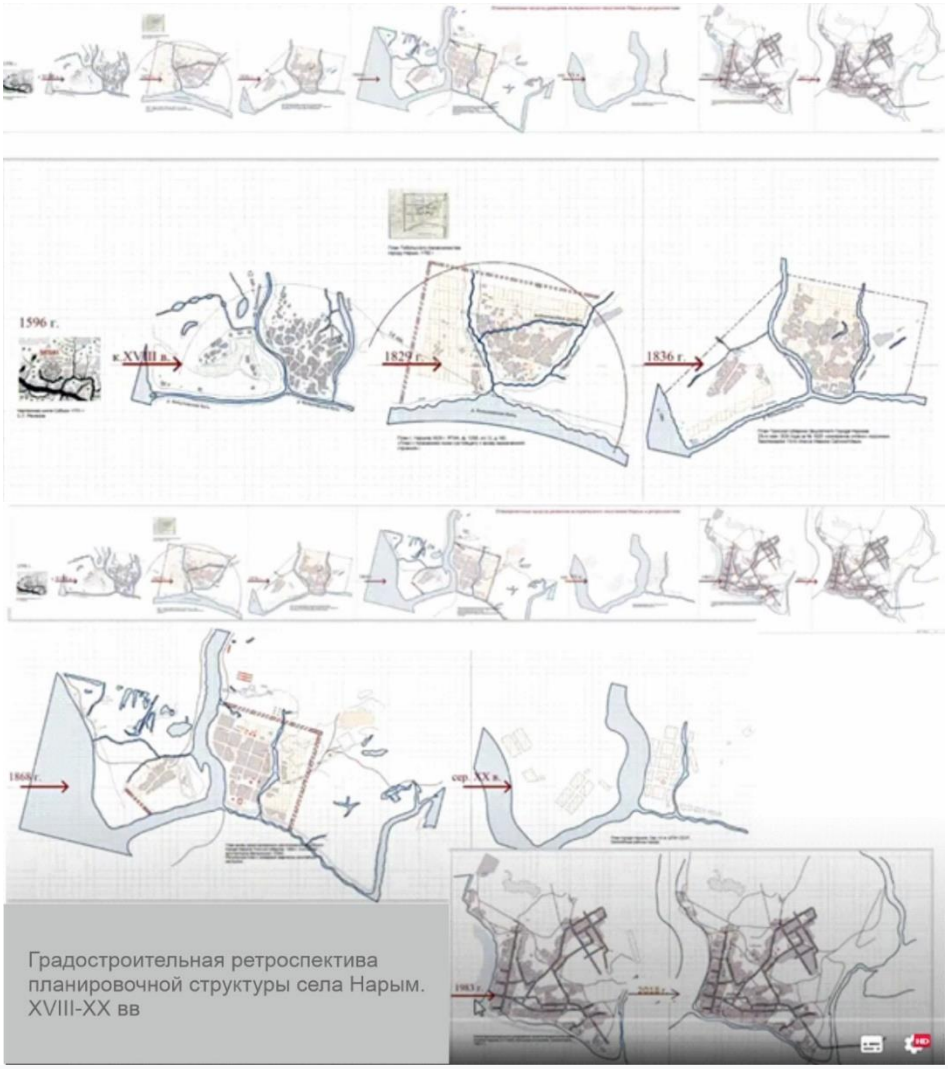


Figure 13 – Changes in the planning structure of the Narym settlement (18th–21st centuries) (**History of rural settlements…, 2018**)

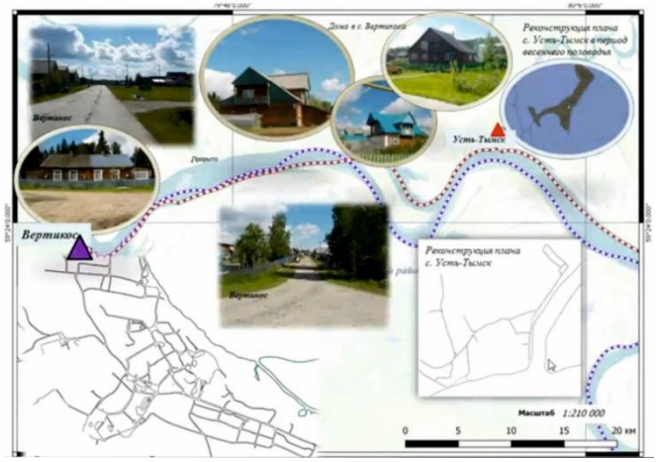


Figure 14 – Wooden houses in the village of Vertikos, Middle Ob region (**History of rural settlements…, 2018**)

Since the 1980s, the Middle Ob region has experienced degradation of inhabited territories due to complex hydrological conditions and socio-economic factors. Sustainable development in such regions requires not only retrospective analysis but also the development of new planning strategies, including the formation of tourist routes and adaptive settlement systems.

In this context, modern wooden architecture, particularly modular and prefabricated housing, represents a promising direction for development. Such buildings can be used in hard-to-reach territories, function as elements of tourist infrastructure, and provide flexible solutions adapted to changing environmental conditions (**Dimakov, 2025**).

a

b

Figure 15 – Modern modular wooden housing:
a) mini-house in operation;
b) two-module eco-house "Elbrus" (**Sitnikov, 2025**)

Thus, the analysis demonstrates that wooden construction in riverine settlements possesses a high degree of adaptability. Its mobility, lightness, and transformability allow it to respond effectively to flooding, river channel migration, and unstable natural conditions. In this regard, wooden architecture should be considered not only as a traditional form of construction but also as a promising direction for the sustainable development of riverine territories.

4 CONCLUSIONS

The study demonstrates that wooden construction in riverine settlements in Russia is characterized by a set of specific features determined by natural, historical, and socio-economic conditions.

1. Wooden buildings are predominantly temporary or semi-temporary structures that are not rigidly connected to a land plot, unlike capital construction. They can be erected without deep foundations and, due to their structural simplicity and relatively low weight, can be assembled, disas-

sembled, and relocated either as separate elements or as complete structures. This property has historically enabled settlements to adapt to changes in river channels and seasonal flooding.

2. Traditional wooden architecture has been associated with a high degree of fire hazard and susceptibility to decay, especially under conditions of high humidity and periodic flooding. However, at the present stage, these limitations are significantly mitigated by modern wood processing and protection technologies. Contemporary wood-based materials demonstrate increased fire resistance, moisture resistance, and durability, which expands their applicability in riverine environments.

3. The development of modern modular and prefabricated wooden housing has led to the formation of a new architectural typology characterized by a high level of comfort, energy efficiency, and environmental sustainability. Such buildings can be effectively used in hard-to-reach areas, including eco-settlements, rotational settlements, and temporary residential complexes intended for tourism and seasonal habitation. Their mobility and transformability are particularly important for territories with unstable hydrological regimes.

4. The analysis of settlements in the Volga region and Western Siberia confirms that wooden architecture remains one of the most adaptive forms of construction in areas prone to periodic flooding and river channel changes. In such conditions, traditional rigid solutions, including capital construction and extensive shore reinforcement, are often less effective than flexible and adaptive building systems.

5. Modern timber construction, combining traditional building principles with advanced technologies, represents a promising direction for the sustainable development of riverine territories. Its use contributes to the preservation of cultural identity, reduction of environmental impact, and formation of settlement systems capable of adapting to natural processes rather than resisting them.

Thus, wooden architecture in riverine settlements should be considered not as a relic of the past, but as a strategically important direction for the development of architecture and urban planning, particularly in regions characterized by complex natural and hydrological conditions.

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