THE EFFECT OF RAILWAY NETWORK EVOLUTION ON THE KALININGRAD REGION'S LANDSCAPE ENVIRONMENT

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This article addresses methodology of modern landscape studies from the perspective of natural and man-made components of a territory. Railway infrastructure is not only an important system-building element of economic and settlement patterns; it also affects cultural landscapes. The study of cartographic materials and historiography made it possible to identify the main stages of the development of the Kaliningrad railway network in terms of its territorial scope and to describe causes of the observed changes. Historically, changes in the political, economic, and military environment were key factors behind the development of the Kaliningrad railway network. Nature was less important. The existing Kaliningrad railway network is to a great degree the legacy of the earlier, pre-war times. Today, its primary function is to provide international cargo and passenger transportation. Two types of railway infrastructure are identified in the Kaliningrad region — modern (functioning) and relic (abandoned) ones. In the Kaliningrad region, the process of land reclamation of the railway system starts when the maintenance of railroads is discontinued, which is followed by the formation of primitive soils and emerging biocenoses enhanced by fill soils and artificial relief.

Key words: landscape environment, railway network evolution, settlement system, relic and modern anthropogenic landscapes

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Today's landscapes of the Kaliningrad region are an elaborate system of territorial complexes at different stages of development. These complexes show a varying degree of transformation of natural components. Growth points are characterised by expanding human occupation, i. e. continuing restructuring of the cultural landscape. Depressed districts are dominated by abandoned and reclaimed-by-nature landscapes (in the terms proposed by V. P. Semyonov-Tyanshansky) [25, p. 128]. Abandoned and reclaimed-by-nature landscapes correspond to different stages of secondary succession. Without denying the fact that modern landscapes of any territory are based on natural components, we believe that a modern researcher cannot limit his or her focus only to these components (in view of the extent of human transformations, it would rather be reconstruction than research) [18, p. 202]. Over the last century, the landscape environment of the Kaliningrad region developed under the influence of both socioeconomic and military-political factors affecting the current appearance and state of landscapes. One of such factors that changed the landscape over a rather short period — less than two centuries — was the development of rail transport.

This study aims to track changes in the landscape environment of the territory brought about by the construction and alter transformations of the railway network. Maps dating back to three periods — the mid-19th century (1834—1860), first half of the 20th century (1926—1939), and 2010—2012 — as well as materials on military and geographical history of East Prussia were used in analysing the appearance of landscape environment affected by the railway network development. The opportunity to compare cartographical and historical materials arose in the framework of a project of the Russian Geographical Society entitled ‘Post-war changes in the Kaliningrad region based on topographic maps’.

The impact of railway network on the landscape environment

The development of a transport system always affects the territory’s appearance. This impact can be either direct or indirect. The direct impact of a transport system on the landscape is the emergence of a special anthropogenic landscape. F. N. Milkov and F. V. Stolberg describe the linear road-based category of landscapes associated with using and transforming lands for supporting communications [15, p. 73; 16, p. 123]. Alongside traffic connections, this category includes engineering structures — bridges, viaducts, and buildings (stations, warehouses, etc.). A. Yu. Skopin and P. Haggett define the transport structure landscape as a variety of the industrial landscape [27, p. 207]. Since it concerns a road structure, it is worth stressing that road landscapes are not identified as an individual type but are considered as part of settlement and industrial facility landscapes [4]. However, the origin, structure, and influence of roads on surrounding systems distinguish them from any other anthropogenic landscape. In particular, railway construction requires moving large volumes of soil for building embankments and cuts using gravel, sand, and other materials. Embankments and cuts trigger the development of special microclimates (especially within large railway objects), regulated water flows (internal and external drainage), vegetation, and primitive soils. The railway is supplemented with forest areas, overhead lines, waysides, and ditches, which significantly increase its area. The direct impact of railway construction on the landscape is not limited to augmenting the existing landscape structure with new elements. Embankments create a local network of watersheds and thalwegs facilitating the redistribution of existing water flows. This results in the formation of small fens. Embankments are affected by erosion to a much higher degree than the initial landscape. The railway infrastructure includes not only the elements of transport economy — crossings, viaducts, and bridges — but also the railway junction system with marshalling yards, railway depots, and passenger stations. Therefore, the railway system of a territory is a network structure, where railways create networks with different configurations and network concentrations create nodal districts, where the proportion of artificial landscape components dramatically increases.

The indirect — but equally important — impact of the transport network on the appearance and structure of the landscape network is associated with the changes in the settlement system. At the early stage of railway construction, the road network is of major significance for further development of the settlement system. The recent history of the European part of Russia proves this thesis. For instance, the construction of strategic railways from Saint Petersburg to Murmansk, Vologda, and Vyatka required a significant number of non-qualified workers. Moreover, it required construction materials, which could be excavated at the construction site in order to cut costs. This led to the disappearance of many small villages, whose population were moving to workers' villages and towns. Another consequence was the emergence of new villages at railway stations [11, p. 231].

The development of a railway network changes the economic and geographical position of settlements leading to the economic prosperity and growth in some settlements and decline in others. It also contributes to the polarisation of space. B. B. Rodoman distinguishes between continual and discrete communications and means of transport. Continual ones suggest the possibility of making a stop and performing any transport operations at any place throughout the transport network. These are motor vehicles (earlier, animal-powered transport) [17, p. 77]. The discrete type includes railway, water, and air modes of transport, which require certain infrastructure for vehicles to make a stop. Since any transport point serves as a crystallisation centre for settlements, in an anisotropic environment, settlements take on the shape of a stripe stretching along the traffic artery in the case of continual transport and the shape of circles with stations, airports, and marinas serving as the centre in the case of discrete transport. The increasing speeds of discrete transport contribute to the polarisation of occupied space, since the intervals between stopping points become less accessible alongside the areas beyond the densely inhabited 'circles'. Polarisation of space and settlement systems is also caused by the development of continual transport. However, it results in the emergence of isolated stripes, whereas gaps characterised by decreased human activity are disconnected and they have less opportunities for preserving biodiversity [ibid].

Railway network development is associated with a long-term process of primarily unidirectional transformation of the network's spatial structure [29, p. 131]. The process can be both upward (resulting in the gradual complication of the transport structure) and downward (resulting in its simplification).

Configurations of transport networks can either be supported by the system of administrative division (as is the case in most European regions of Russia) or contradict it, which happens when state (and more rarely, administrative) borders are changed. Based on the direction of network development, the railway history of the Kaliningrad region's territory can be divided into the following periods:

- beginning of railway network development (main artery stage);
- development of the narrow-gauge railway network (filling in inter-artery intervals and creating looped networks) [ibid];
- simplification of railway network following the destruction of most narrow-gauge railways;
- current stage (extant and relict railway landscapes).

Landscape environment prior to railway network construction

Natural landscapes of today's Kaliningrad region assumed their current character approximately two and a half thousand years ago, when soils and vegetation became harmonised with the climate. The underlying rock was formed more than 10 ka by the motion of the Valdai glacier. The following landscapes can be observed in the Kaliningrad region — ground moraine plains, terminal moraine uplands, glaciolacustrine plains, coastal landscapes, ancient delta lowlands, valley landscapes, and aeolian ancient alluvial landscapes. The interaction between the natural landscape genesis factors and the region's location in the glacier ablation area accounts for the complexity of the landscape structure, which also affects human occupation [20, p. 26; 21, p. 35; 22, p. 30].

At the beginning of railway construction, East Prussia had highly developed agriculture. It is sufficient to mention that croplands accounted for two thirds of agricultural lands [6, p. 8]. The amelioration system, which started to develop in the 14th/15th centuries, included lands with open and closed drainage, forced (polder) and gravity structures. The main settlement framework had already developed by that time. Numerous towns, villages, and farms were interconnected by a dense network of primarily paved roads meant for animal-powered transport [18, p. 202; 19, p. 47].

By the mid-19th century, almost the whole territory of East Prussia was under human occupation. The area of cultural landscapes significantly exceeded that of intact ecosystems. The landscape environment of this period can be characterised as complex and mosaic [21, p. 37; 23, p. 30; 24, p. 145].

Overview of railway development on the Kaliningrad region's territory

The emergence of a railway network

Development of East Prussia's railway network was affected by several factors. The first one is civilizational. In the middle and especially second half of the 19th century, mass railway construction was launched across Europe. East Prussia was no exception. As early as 1847, the construction of the Berlin — Königsberg railway commenced. It was completed in 1853. In 1860, the Königsberg — Insterburg — Eydtkuhnen line started to operate. In the 1860s, Königsberg, Pillau, and Lyck were also connected by a railway [10, p. 348; 2, p. 192, 195].

However, Germany — which was rapidly transforming into an empire, — paid special attention to the military aspect of railway network development. One of the 'blitzkrieg' ideologists, Moltke the Elder, considered railways the key to war. Once he ordered, 'Build no more fortresses, build railways' [28, p. 129].

East Prussian railways were built in accordance with Moltke's ideas. Of course, railways affected the development of economy, but their primary purpose was military. Therefore, the construction was supervised by the military. Each line was supervised by an officer of the German General Staff. Not a single track could have been constructed without the approval from military authorities [10, p. 348].

East Prussia's railway network had been largely completed by the end of the 19th century. It was designed to serve military needs. In strategic terms, railways had to deliver troops and military cargoes to the German border with Russia's Northwestern provinces. To the east from the Vistula towards the Neman, there were two major lines — Marienburg (Malbork, Poland) — Elbing (Elblag) — Braunsberg (Braniewo) — Königsberg and Thorn (Toruń) — Allenstein (Olsztyn) — Insterburg. A continuation to the second line was the Insterburg — Tilsit — Memel railway with branch lines running from Tilist to Stallupönen via Pillkallen and to Königsberg via Labiau. The first line was double-track throughout its length; the second was single-track within East Prussia. Both lines were interconnected by six lateral railways leading to the Russian border. Two lateral railways situated in today's Kaliningrad region are of special interest: Königsberg — Preußisch Eylau — Bartenstein (Bartoszyce) — Lyck (Giżycko) and Königsberg — Insterburg — Eydtkuhnen with the Inserburg — Gołdap — Lyck branch. The Königsberg — Eydtkuhnen line was double-track and its branch single-track [3, p. 71—72, 80—87].

The railway network development continued throughout the second half of the 19th century. A connection between Insterburg, Darkehmen, and Gołdap was established. Insterburg and Thorn were connected in 1894. In 1890, the construction of a large loading platform was completed in Eydtkuhnen. Similar platforms were constructed at other stations (300 m long at Tapiau, 250 m in Wehlau, 260 m in Norkitten, two platforms in Insterburg, 200 m in Gumbinnen, and 200 m in Trakehnen). By 1895, the total length of railways in East Prussia reached 1891 km and their density 51.1 km per 1000 sq km [31, S. 66.].

Since the railways of the westernmost German province were constructed to suit strategic needs and designed for transporting troops to the east and back, the lack of additional and linking railways soon became evident. This significantly slowed down the dispersal and regrouping of troops along the border and complicated supply. Moreover, by the time, the military had modified the plans and ideas of Moltke the Elder. They started to pay more attention to fortifications and field engineering. However, this also required local railways. Railways leading to Ragnit and the Tilsit — Stallupönen section were constructed for primarily military purposes. The local railway network was developing along the lines of Tapiau — Friedland — Bartenstein and Friedland — Domnau — Preußisch Eylau. In 1913, the railway density reached 78.3 km per 1000 sq km [ibid].

In general, East Prussia's military need for railways had a positive effect on the province's economic development, especially, trade. Railways were necessary to support trade with Russia and — via the seaport — with European countries.

Increasing popularity of resorts stimulated the development of suburban railways. The first line connected Cranz (Zelenogradsk) and Cranzebeek — a marina on a canal, from where vessels sailed to Memel (Klaipeda) and Nidden (Nida) via the Curonian Lagoon. The connection between Königsberg and Cranz was established in 1885. The Königsberg — Rauschen (Svetlogorsk) — Georgenswalde (Otradnoye) — Warnicken (Lesnoye) line started to operate in 1900.

In the 1920—30s, the railway network was developing despite the economic crisis. The second track of the Tilsit (Sovetsk) — Insterburg (Chernyakhovsk) — Gerdauen (Zheleznodorozhny) line was constructed in this period. The last pre-war decade saw the construction of the line running from Heiligenbeil (Mamonovo) to Preußisch Eylau (Bagrationovsk). Moreover, the ring road on the Sambia peninsula was completed and the Königsberg railway junction reconstructed [13; 14].

The development of a railway network has a profound effect on changes in the region landscape. These changes are especially pronounced at the intersections between railways and water bodies, where bridges and supplementary structures are erected. The region's most famous bridge is the 270 m long structure over the River Neman. Bridges were also constructed over the Rivers Alle, Inster, and Pregel. Königsberg boasted several railway stations. The first one, called the Eastern station, was opened in 1853 (it did not survive to this day). Today, there are two operating stations — the Southern (*Yuzhny*) and Northern (*Severny*) stations [1]. The Southern station was opened in 1929. It had a platform covered by a three-span riveted metal structure with glass panels [9, p. 448—449]. The North railway station was built the same year to replace its predecessors — the Cranz and Samland stations offering connections to the resorts [9, p. 450]. In the North of East Prussia, large railway junctions were built in Tilsit, Insterburg, and Pillau.

Development of the narrow-gauge network

Alongside main and secondary railways with a regular gauge (1435 mm), East Prussia had numerous narrow-gauge (750 mm) railways filling the gaps between standard-width railways. They were first built in East Prussia at the turn of the 19th century. In 1917, their total length reached 215 km. Vehicles running the narrow-gauge railways stopped at almost every village, at rural road intersections, and at major clearings in forest areas. Alongside agricultural companies, its services were used by numerous dairy and brick plants, mills, sawmills, and other small firms. Moreover mixed passenger and cargo trains were bringing workforce from adjacent suburbs and villages to Königsberg (the Königsberg — Neuhausen (Guryevsk) narrow-gauge railway). The first narrow-gauge railway connecting Königsberg and the Curonian Lagoon up to the village of Schaakswitte (Kashirskoye) was built in 1899—1900. Its primary purpose was servicing the agricultural industry. However, it also generated passenger traffic and supported recreational routes in the Curonian Lagoon area [9, p. 423; 14].

Therefore, until World War II, the region's territory boasted a dense railway network (fig. 1) of a total length of 1823 km (including 442 km of narrow-gauge railways). There were 184 railway stations and 240 platforms [13; 14]

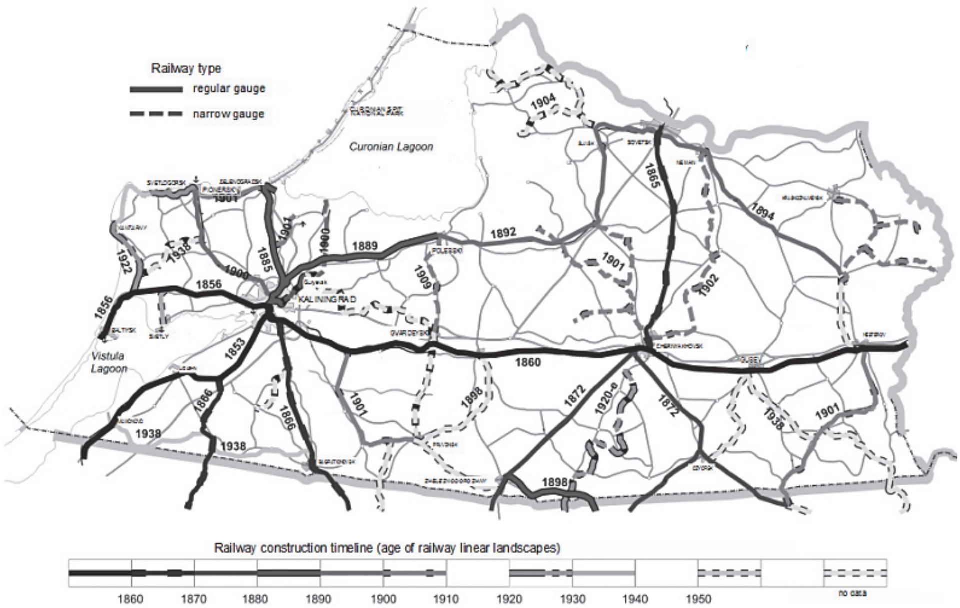

Fig.1. Development of the railway network on the territory of the Kaliningrad region (from the mid-19th century to the present).

Post-war changes in the railway network

The post-war period raised the question of restoring passenger and cargo traffic using regional and local railways of the newly established region. In April 1945-October 1946, 1500 km of railways were restored and the narrow European gauge was replaced with the wide Russian one (1520 mm) [7]. In spring 1948, daily trains were launched on the Kaliningrad — Polessk — Bolshakovo — Slavsk — Sovetsk line. The autumn of the same year witnessed the arrival of the first direct train, whereas the Kaliningrad — Sovetsk line was extended to Klaipeda. In 1949, local passenger traffic was restored on the Neman — Sovetsk line. In 1945, the newly established Soviet-Polish border severed the province's railway network and most of local wide-gauge lines, especially those in the southern and eastern districts, were dismantled. By the 1960s, all narrow-gauge railways were either dismantled or remodelled into wide-gauge lines. The latter do not function anymore, being in the best case mothballed.

Modern stage of railway network development in the Kaliningrad region

In 2010, the length of operating railways reached 963 km; part of the network went out of operation (the branch to Nesterov, Svetlogorks — Baltiysk, between Chernyakhovsk and Zheleznodorozhny). Since 2009, trains from Kaliningrad to Bagrationovsk have operated on a reduced schedule [30].

Most regional railways are single-track and non-electrified (only 14 % of the railways are electrified, including those running to resort towns). The tracks have the Russian gauge (1520 mm). The only exceptions are the branch running from the Southern station to Poland and further to Berlin (via Mamonovo) and the Zheleznodorozhny — Chernyakhvosk line, which have the European gauge (1435 mm). The European gauge is also found at the station of Bagrationovsk. Cargo is reloaded from the European to the Russian gauge at the stations of Chernyakhovsk and Dzerzhinskaya Novaya (Kaliningrad). The largest railway junction in the Kaliningrad region is the regional centre, where six routes converge. The junction also caters for the needs of the seaport. The region's largest marshalling yard is the Southern station. The city boasts two railway station the Southern (passenger long-distance and local traffic) and the local Northern stations, three local traffic stations (Dzerzhinskaya, Chkalovsk, and Kutuzovo), and several platforms. In the post-Soviet period, the intensity of local traffic decreased, although the resort lines trains are overcrowded in summer. Most international cargoes are handed by the seaport border crossing points at the stations of Kaliningrad, Baltiysk, and Baltiyski Les (Svetly). The village of Mamonovo has a busy railway station. The major cargoes forwarded by railways are oil and petroleum products (50 %), ferrous metals (16 %), chemical and mineral fertilisers (6 %), timber (5 %), construction materials, and coal. Despite the considerable post-war reduction in the railway network (fig. 2), the situation in the region is satisfactory in comparison to other Russian territories, since the density of its general-purpose railway network is 48.3 km per a 1000 sq km, which is 9.5 times the national average [30].

Prior to the railway construction, the territory of today's Kaliningrad region had a developed transport network. Roads designed for animal-powered transport, which were lined by trees and ditches (the latter used to drain the roads surface), connected numerous local settlements. The density of roads reached 1.46 km/1000 sq km (including field and forest roads) on the Sambia Peninsula. The established settlement framework ensured sufficient support for agricultural production and population. The emergence of railway transport marked the industrial stage of the territory's economic development [26, p. 62]. Railways are constructed at minimum gradients and curve radii require space, therefore railways were designed to bypass natural and artificial obstacles due to financial reasons. As a result, railways emphasised the key features of local relief and environment. However, railways were also affected by the economic and geographical significance of adjacent settlements [5, p. 256]. The high density of railway network in this part of East Prussia was a result of not only the territory's industrial development but also the significance of its agricultural sector and the need to transport agricultural produce. The highest density and length of the railway network was observed in 1939. After the war, it started to shrink, which was also the case in other European countries [12, p. 430].

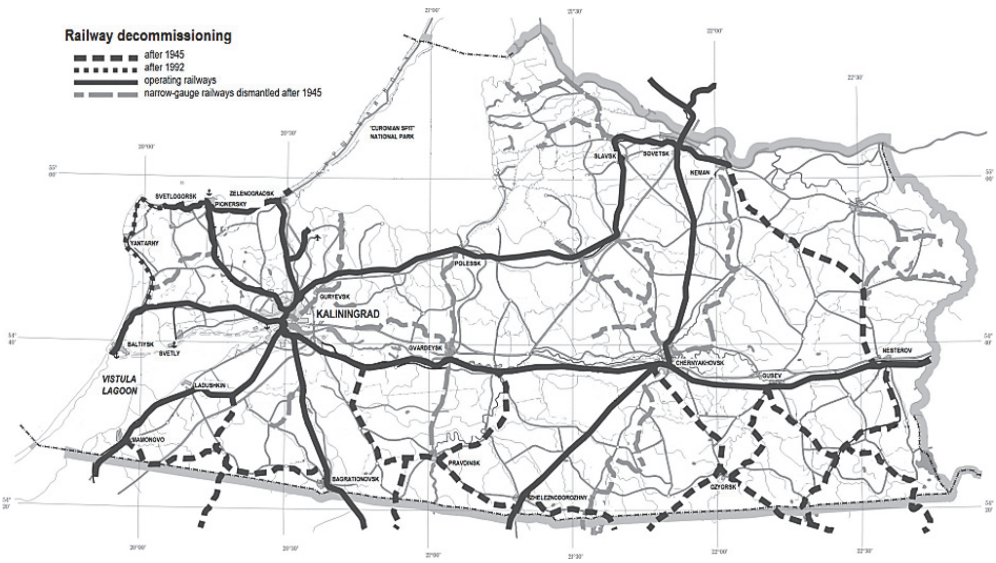

Fig. 2. Changes in the railway network of the Kaliningrad region

Impact of the railway network evolution on the Kaliningrad region's landscapes

Today's railway network is almost completely inherited from the pre-war period, although in a reduced form. It was upgraded to meet modern technological and economic requirements, which makes it possible to distinguish between two types of railway landscapes — modern (one third of the total length) and relict (approximately two thirds of the total length).

Relict railway landscapes and their characteristics

The appearance of relict railway landscapes is shaped by the processes of their rewilding. After decommissioning, the process of landscape rewilding begins. Without supportive measures, landslide and sheetwash processes begin; embankments are overgrown by psammophytic and petrophytic vegetation. Mesoxerophilic grasses — *Agrostis alba, Festuca rubra, Poa pratensis, Hólcus, Anthoxānthum odorātum, Nárdus strícta* form a distinctive biocoenosis, sometimes supplemented by *Plantago minuta* and *Plantago lance-*

olata, Leontódon autumnális, and *Trifólium campéstre* and *arvense.* Overgrowing is often accompanied by the spread of the blackberry on slopes and the birch and hawthorn on tracks. Trees planted along the railway grow to form closed corridors with the height and age of undergrowth gradually decreasing from the planting line to the periphery. The railways that disappeared in the post-war years form a special landscape, which, despite the 'natural appearance' of vegetation, retains traces of human occupation.

However, there are forms of relief that are less affected by changes. For instance, embankments are clearly distinguishable 60 years after the dismantling of the railway branch. The vegetation of former embankments (sometimes up to 4 m tall structures) is similar to that of dams (since embankments are made of gravel materials). Mesophilic vegetation is characteristic of slopes and sparse xerophilic pasommophytic grasses of tops. Embankments are also overgrown by the hawthorn, sweetbriar, and blackberry. Former railway cuts remain distinguishable relief forms overgrown by the elderberry, willow, and less often, aspen. Over time, they become almost unpassable. Relict railway landscapes develop corridors of vegetation traditional for this area, which contributes to the preservation of biodiversity and makes the landscape structure mosaic and more stable.

Secondly, some plots retain the infrastructure of the dismantled railway. As a rule, it is viaducts. On the Kaliningrad peninsula, the dismantled narrow-gauge railway running from Marienhof (Pereslavskoye-Zapadnoye) to Gaffken (Parusnoye) survives in the form of a stone viaduct over the river valley (used today as a country road) and deep (up to 15 m) cuts at the site, where the railway crossed the western spur of the terminal moraine upland. Until the 1990s, towns of the peninsula's coast were connected by a railway running from Svetlogorsk 1 to Primorks via Yantarny. It was decommissioned, but its infrastructure — numerous viaducts and bridges over streams and rivers — survives. Some sections of narrow-gauge tracks' embankments are used as country motorways (for instance, the road between the villages of Krasnoye and Bukhovo).

Thirdly, special components of the cultural landscape are platforms and station buildings preserved after the war. Buildings are often used as residential houses, storage facilities as maintenance buildings. Due to their age and architectural features, they often have historical and cultural significance.

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Therefore, the history of railway network development of the territory of today's Kaliningrad region can be divided into several periods:

− main artery construction (1847—1939);

− filling in inter-artery intervals and creating looped networks) (1899—1945);

− destruction of railways during World War II and their restoration to match the new economic system of the region (1945—1946);

− simplification of railway network following dismantling of most narrow-gauge railways (1946—1960);

− development of the railway network to meet the needs of the region's population and economy (1960-the present day).

An analysis of the stages of railway network development shows that the formation of landscape environment can take place either directly through the creation of linear road-based landscapes or indirectly through changing the settlement system. Moreover, today's landscape environment of the Kaliningrad region 'reconciles' developing and relict railway landscapes.

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