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TERRITORIAL ASSESSMENT OF ENVIRONMENTAL AND ECONOMIC ASPECTS OF PLANNED CZECH HIGH-SPEED RAIL CONSTRUCTION

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Abstract
The aim of this article is to present the results of the evaluation of selected aspects of the construction of high-speed railway routes (HSR) in the Czech Republic through stimulation and sustainability criteria. The first criterion is focused on assessing potential conflicts of the proposed routes with protected areas of European importance and territorial systems of ecological stability of the landscape of supraregional importance, and the second criterion on assessing the degree of their connection to the territorial systems of centres and axes of development affecting the regional quality of the business environment. The explanatory power of these criteria is guaranteed by their theoretical framing of the original integration theory of sustainable regional development, connecting territorial systems of socio-economic development with territorial systems of ecological stability of the landscape. The acquired knowledge can be used practically for evidence-based identification of the importance of individual HSR routes and optimization of their localization.

Key words
high-speed rail, assessment, regional development, stimulation, sustainability

INTRODUCTION

It should be noted at the outset that the assessment of the potential territorial aspects of the planned high-speed rail/HSR construction is a very complicated matter and is often discussed by the public. In addition to the high construction costs, this fact reflects the political rhetoric about its extraordinary benefits for the socio-economic development of states and their regions. However, academic studies

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have shown mixed results and this conclusion is suitably complemented by the following quote: "Nevertheless, we cannot conclude whether it is the HSR connection that creates growth or whether it is the anticipated growth in these areas that attracts infrastructure investment" (see e.g. Vickerman et al., 1999; Ministry of Transport of the Czech Republic, 2013; Blanquart, Koning, 2017). In other words, neither ex-post studies do not allow a causal relation to be established between HSR and growth, especially since HSR lines have often coincided with motorway system expansions (Ministère de l'Ecologie, du Développement Durable et de l'Energie, 2015). Practical examples of non-fulfilment of the original ideas about significant positive effects of investments in transport infrastructure on regional development can be found especially in Italy and Belgium (Bray, 1992), and more recently in East Germany. This risk must therefore also be taken into account in the case of the HSR construction, which is generally expected to increase the competitiveness of "environmentally friendly" rail transport.

OBJECTIVES

The aim of this article is to assess selected aspects of the construction of HSR in the Czech Republic through stimulation and sustainability criteria, where stimulation is evaluated through business environment change on the micro-regional level while sustainability is evaluated via impact assessment on Natura 2000 network and territorial system of ecological stability.

In this context, a territorial view of the evaluation of the effectiveness of HSR construction is presented, reflecting its system anchoring in the socio-economic development of regions and focused on assessing of potential environmental and economic aspects of the planned construction of a HSR network in the Czech Republic is further discussed. The project envisages the construction of a HSR network in the form of a so-called fast connections / FC (FC in contrast to standard HSR with operation of 200 and more km / h often include modernized conventional lines with a speed of 160 to 200 km / h - in the following text is preferred HSR designation). Specifically, the following planned FC routes are analysed: Route 1 Prague – Jihlava - Brno (connection of the Route 2 →Vienna) - Přerov - Ostrava → Katowice, Route 3 Prague - Pilsen → Munich and Route 4 Prague - Ústí n. L. → Dresden (SŽDC, 2018).

THEORETICAL FRAMEWORK

In current literature there is vast research on aspects of regional development connected to construction of HSR systems. The most common subject of transport geography literature regarding construction of HSR is related to the problem of accessibility; e. g., Ureña et al. (2009) focuses on intermediate cities in Spain (Zaragoza, Cordóba) and France (Lille) and develops a multilevel analysis at national, regional, and local levels examining HSR's selective capacity to increase accessibility. The effects are not always positive; e.g. Jiao et al. (2012) shows the HSR network in China will bring about substantial improvement in accessibility and lead to national time-space convergence, but will also increase the inequality of nodal accessibility between eastern, central, and western regions, or between cities with different population sizes. In South Korea, long-term properties assessment discovered internal inequality in many regions, which got even worse than the stage before construction of the HSR (Kim, Sultana, 2015). Another criticism comes from the U.S. pointing out that HSR proposals are hub-and-spoke designs, benefitting the hubs more than spokes, and that the economic development effects of HSR are small and uncertain (Levinson, 2012). In Spain the greatest improvements in accessibility concentrate near HSR stations, whereas intermediate locations suffer from comparatively lower accessibility benefits, and furthermore negative territorial cohesion properties appear if the HSR ultimately results in a more polarized spatial distribution of accessibility levels (Ortega et al., 2012). Regarding the economic cohesion effects of the HSR network there, it seems that regional economic disparity has been decreased since the development of HSR in China and it has promoted regional economic convergence especially significantly in the East and North (Chen, Haynes, 2017). Cheng et al. (2015) examine changes in accessibility and provide evidence on changes in specialisation for both main cities and their hinterlands and confirm that the properties differ widely and that the process of convergence and divergence differs at different stages of economic development.

Broad research literature related to HSR points to a varying range of negative environmental effects or externalities, usually connected to vibration (Connoly et al., 2016), energy and CO_2 emissions (Rozycki, 2003), life cycle costs (Banar, Ozdemir, 2015), specific natural species (Clauzel et al., 2013), noise (Xiaoan, 2004), safety (Noronha et al., 2015) or comparison to air travel (Socorro, Viecens, 2013) or road transport (Barrientos et al., 2019). Few of these studies are focused on landscape or natural sites protection. The first such study is provided by De Santo and Smith (1993), who studied effects on wildlife resulting from placement and construction in the short-term, and habitat removal and fragmentation in the long-term as a consequences of transport corridor construction. Kim and Lee (2014) use a spatial decision support system to pinpoint the changes in the natural landscape as well as the physical environment, trying to solve relevant methodological limits. In China, Zhang et al. (2020) provided evidence of increasingly fragmented spatial patterns found in both urban and rural development. A strategic planning approach is presented by Carvalho et al. (2017) who conclude that a Strategic Environmental Assessment approach is, in the future, potentially most beneficial if developed before any HSR project to first determine if HSR is really necessary and strategically justifiable to the achievement of both environmental and sustainability objectives. On the other hand, there is a lack of studies filling the gap in HSR research combining strategic assessment of potential regional economic aspects together with aspects of environmental protection, aimed at landscape connectivity and fragmentation in one consistent methodological approach. There are only a few studies evaluating both regional and landscape characteristics. For Spain, the GIS based approach of TITIM (Territorial Impact of Transport Infrastructure Measuring) has been performed, harmonizing landscape and accessibility characteristics (Ortega et al., 2014). These questions represent the main research area of our paper.

DATA AND METHODS

The main priorities of the evaluation of the planned construction of the HSR presented below are environmental sustainability (focused on landscape fragmentation) and stimulation of regional development (focused on socio-economic differentiation of territories), the links between which are often considered by the public to be contradictory or even controversial. Accordingly, the basic philosophy of our article is to contribute to research on issues related to the exploitation of potential opportunities and the reduction of potential threats associated with this strategic objective. From a broader perspective, our approach is based on the original methodology of multi-criteria evaluation of the effectiveness of investment projects verified by the example of Czech motorway and expressway construction projects (Viturka, Pařil, 2015), which includes a total of five criteria: usefulness (economic aspects), relevance (technical aspects), integration (social and political aspects), stimulation (economic aspects) and sustainability (environmental aspects). Last two criteria fulfil the focus of our study and are examined deeply. The irreplaceable importance of multicriteria approaches, based on non-monetary indicators allowing a fair comparison of the production of positive and negative externalities, primarily stems from the limited possibilities of monetary expression of various effects of public projects focused, contrary to private projects, on multi-target users.

Regarding our second field of research focus based on sustainability our analysis is based on several datasets. The basic dataset includes general geographical information on Czech Republic for geographical information systems in the Czech Republic (Arc ČR, 2020). To assess potential conflicting areas for planned HSR development in the Czech Republic it was necessary to most updated plans of detailed potential HSR routing in the geographical corresponding with the most recent versions of Czech Railway Administration (SŽDC, 2018). The second data cornerstone of landscape sustainability analysis is based on data from Nature Conservation Agency of the Czech Republic as key responsible administrative body for landscape and natural protection. The data provided for analysis are of two types. First is covering all areas included in the European landscape and natural protective system of Natura 2000 ɨn the area of Czech Republic (AOPK, 2020) corresponding with analogic data from European Environmental Agency (EEA, 2020). The second landscape dataset cover Territorial System of Ecological Stability in the Czech Republic on supraregional level (AOPK, 2020). This system is highly corresponding with European ecological network system (Jongman, 2004, Jones-Walters, 2007, Jongman et al., 2011) and its main function is to provide continuous network of naturally protected elements. Based on data described above for further analysis we used a simple GIS-based topological overlay method using "line in polygon overlay" to identify conflicting points and we even used "polygon in polygon overlay" with a five-hundred-meter buffer zone for the planned high-speed line to be able to determine the range of the impact in relevant natural sites.

Quality transport infrastructure is one of the inescapable factors influencing socio-economic development, territorial division of labour and population mobility at all hierarchical levels. In this context, the results of the regional assessment of the quality of the business environment (QBE), showing strong links to GDP, were effectively used as an explanation framework for the analyses of potential developmental aspects of the planned construction of the HSR. Relevant information published in a few studies, mainly from 1998 to 2010, made it possible to draw up the first systematic model of the development potential of the regions of the Czech Republic (Viturka et al., 2010). Assessment of QBE is based on 16 factors interpreting the investment preferences of companies operating in the manufacturing industries and higher market services, defined and valued on the basis of the results of international surveys. These factors were divided into six groups, identified as business, labour, infrastructure, regional, price, and environmental factors (in order of importance). The acquired knowledge was then generalized in the original integration theory of sustainable regional development, interpreting the effect of the laws of developmental and hierarchical differentiation of socio-economic systems, the logical consequence of which is the creation of territorial systems of centres and axes of regional development. This theory follows in some respects the theory of polarized development (Boudeville, 1996; Friedmann, 1996) or the microeconomic theory of competitiveness and the endogenous theory of economic growth (Porter, 1998; Romer, 2010). From a practical point of view, it can be stated that firms realize a trade-off between agglomeration and dispersion forces and choose the location that maximizes their market potential. The application of the approach described above has made it possible to place the analysis of the effectiveness of HSR construction into a broader, relatively stable framework formed by causal dependencies between the quality of the business environment and investment attractiveness (and consequently between the quality of the social environment and residential attractiveness).

POTENTIAL IMPACTS OF THE PLANNED HSR NETWORK ON ENVIRONMENTAL DEVELOPMENT OF REGIONS

Part of the evaluation of the effectiveness of planned infrastructure projects is, of course, the assessment of their environmental aspects (with special regard to the perception of aspects on climate change and biodiversity protection), which is necessary for creating the most objective strategies for sustainable development. The intensity of aspects is amplified by metropolisation tendencies associated with the growth of population density and the necessary increase in infrastructure capacity, which leads to the emergence of conflict zones with negative aspects on the health of the population. In our case, the main attention is focused on the assessment of the construction of the HSR network in terms of the most significant direct aspects. Thus, neither GHG emissions with strong links to climate change are considered, which is more appropriate to assess compared to other modes of transport, nor are emissions from the production of energy and its transport to the point of consumption (well-to-tank). Regarding the relative importance of direct negative externalities produced by transport, in terms of their monetization, the greatest importance is attributed to accidents (European Commission, 2019). Noise pollution and air pollution are at an average level, and damage to the biotope occupies the lowest important position from this purely economic point of view.

Higher levels of meaning are clearly achieved by those externalities that have a negative impact on human life and health, or on the living environment or agriculture (climate change). These are mainly externalities related to air pollution and noise. However, the first of these is only marginally affected by the planned HSR networks, because the negative effects on air pollution are offset by shifting part of the demand from road to rail, which leads to significant emission reductions, especially in heavily urbanized regions. Conversely, the impact of the HSR on noise pollution is very significant, as in this respect a significant deterioration of the situation, and thus the quality of life, is observed for groups of the population living or working in its immediate vicinity. E.g. on the HSR section operated in Taiwan, "69% of residents highly annoyed" are within 100 meters of the railway body (Tsai et al., 2019). Despite the increased noise, which can be seen as a kind of toll on the possibility of faster transport, the speed still increases the competitiveness of HSR with individual car transport, especially in the case of transport over a distance of 200 km or more (Körner, 2013). To this end, it is worth noting that according to Czech legislation, the night-time permissible limit for outdoor noise is at the level of 50 dB, but the recommended WHO limit is only 40 dB. Depending on the nature of the relief and placement of residential buildings, the increased noise level in the vicinity of the HSR can be observed up to a distance of almost 500 meters from the centre of the railway body (Sarikavak, Boxall, 2019). In this regard, for the purpose of assessing the aspects of the planned HSR network, a buffer zone of 500 meters from the railway body was used, which reliably takes into account the most critical zone of the potentially noise affected population (in order to maintain methodological consistency, this zone was used analogously even in other analyses dealing with the aspects on nature and landscape and its fragmentation). The distribution of the population in the vicinity of the planned HSR routes was determined on the basis of the most detailed analysis from the Czech Statistical Office according to the so-called basic settlement units in combination with mapping land use according to CORINE land cover (RSO, 2020 →CORINE, 2018). The results of the analysis show that the number of inhabitants exposed to excessive noise in connection with the implementation of the HSR network is between 286 and 686 thousand, depending especially on the length and method of solving delays in the metropolitan areas of Prague, Brno and Ostrava. It is therefore very important for these sections that the noise component is considered when planning the route, because a well-thought-out technical design can significantly reduce the noise level.

Damage to natural ecosystems appears to be a less important category, which corresponds to the indirect nature of their effects on humans (human health is logically monetized more significantly than the health of natural ecosystems or plant and animal species). However, it should be noted that the health status of ecosystems (reflecting the effects of negative externalities on habitats) and their interconnectedness (reflecting the degree of their fragmentation) are a major factor influencing other externalities, such as air pollution and climate change. The mentioned problem of fragmentation of the natural environment is exemplified by The Theory of Island Biogeography (MacArthur, Wilson, 1963), which generalizes the fact that island ecosystems located closer to the mainland have more plant or animal species than isolated and remote islands. Analogously, it is generally true that larger natural units have a higher degree of biodiversity than smaller natural units, which reflect the mutual distance or the level of interconnectedness of ecosystems.

An important component of the assessment/perception of the environmental aspects of potential construction and subsequent operation of HSR is, of course, the comparison of this mode of transport with other transport alternatives. The results of this comparison are shown in Figure 1, which shows that rail transport achieves significantly lower levels of environmental impact than road transport, both in passenger transport and in freight transport. To this end, it is worth noting that, according to the available information, high-speed rail is the least onerous means of transport, even compared to standard rail transport, including diesel traction (European Commission, 2019).

The following text presents the specific results of the evaluation of the environmental aspects of the construction of HSRs in the Czech Republic with emphasis on landscape and nature protection systems of supra-regional significance and their fragmentation. For the above reasons, the following protection systems are considered in this analytical section: Natura 2000 created in the European Union, including the so-called Special Areas of Conservation (SAC, Council Directive on

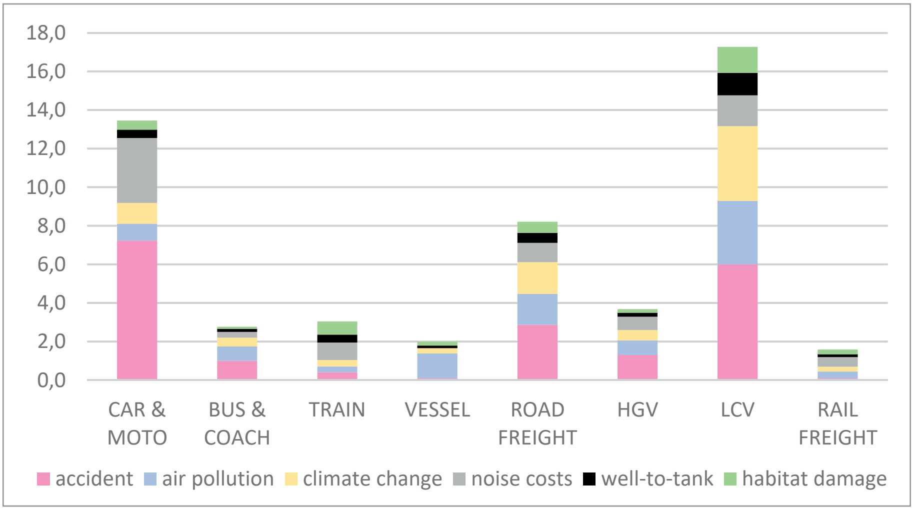

Fig. 1
Comparison of the relative importance of the environmental burden according to the nature of externalities (in Eurocent / passenger km)
Source: European Commission, 2019.
Note: HGV – heavy goods vehicle, LCV - light commercial vehicle.

habitats) and Special Protection Areas (SPA, Council Directive on the conservation of wild birds), and the hierarchically highest supra-regional component, i. e. relevant biocentres and biocorridors of the Czech territorial system of ecological stability (TSES). In accordance with the hierarchical importance of individual protection systems, the following weights were assigned to individual components: Natura 2000 – weight 2, supraregional TSES – weight 1. The identified potential conflicts, according to particular HSRs, are clearly listed in Table 1 and showed in Figures 2 (impacts on TSES and impacts on Natura 2000 areas – SPA and SAC). From an absolute point of view, the most significant environmental aspects were identified in the case of the longest Route 1, followed by routes 4, 2 and 3.

Tab. 1 Potential conflicts of the planned HSR with Natura 2000 and TSES and their weighted assessment according to the potential aspects on sustainable development/SD

HSR	SAC	SPA	TSES		final
			biocentres	biocorridorss	
HSR1	13	2	3	9	1
HSR2	4	1	1	2	3
HSR3	3	0	1	4	4
HSR4	6	1	2	4	2

Source: authors.

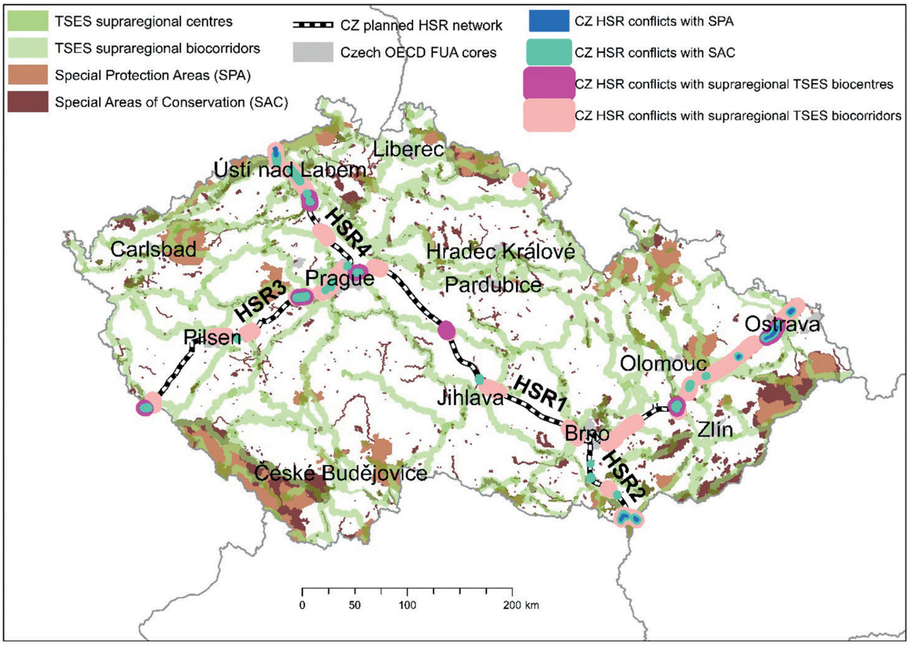

Fig. 2
Potential conflicts of the planned HSR network with Natura 2000
(SAC and SPA and supraregional TSES)
Source: Arc ČR, 2020; SŽDC, 2018; AOPK, 2020.

From the point of view of spatial complexity of delimitation of HSR routes conditioned by technical limits of longitudinal inclination and radius of curves, macro-relief of landscape and further protection of the most valuable parts of the landscape with significant direct and indirect links to overall quality of the social environment are crucial. According to the first point of view, it is possible to divide the Czech Republic into two basic parts. The first one of them consists of the "Czech Basin" bordered on all sides by mountains, where the structurally significant terrain elevation ranges from about 150 m on Route 4, to over 350 m on Route 1, to 360 m on Route 3. The second part consists of the Moravian valleys, where the total elevation of Routes 2 and 1 in the line from the border with Austria through Brno to the border with Poland reaches approximately 160 m. Routes 1 and 3 must therefore rise tens of kilometres in front of ridges. This can be overcome by tunnels, which is the most advantageous solution in terms of landscape, however this is done with the expenditure of increased construction costs (if the proposed routes cross wide alluviums, it is often necessary to build long flyovers). In addition to the problem of landscape fragmentation, it is also necessary to mention the negative aspects on the landscape, especially related to specially protected areas (diversion of HSR routes from these areas is very difficult or in some cases impossible due to the necessary size of the railway curves).

POTENTIAL IMPACTS OF THE PLANNED HSR NETWORK ON REGIONAL ECONOMIC DEVELOPMENT

In this section, in accordance with the topic, the main attention is focused on the infrastructural factor of the quality of roads and railways. Its evaluation emphasizes the achieved level of connection of regional centres at NUTS 3 level to the most functionally important segments of the road and railway network with a decisive role in long-distance transport (Viturka et al., 2010). In terms of the comparative importance of road and rail transport, based on available statistical information and technical parameters of infrastructure (especially transport performance and division of labour in freight and passenger transport, expressed in tonne-kilometres and passenger-kilometres) and taking into account current developments, a ratio is set at 5.5:1. This ratio was then used to perceive potential development aspects induced by the construction of the HSR. In this respect, the semantic position of long-distance roads was expressed, using weighting coefficients defined in accordance with their technical and operational parameters, as follows: motorway 1.0, expressway 0.9, 1st class roads of international importance according to the European Agreement on main roads with international traffic 0.5, and other 1st class roads 0.375. In the case of railways, all lines were included in the evaluation, with the exception of end routes, with preference being given to Europe-important railways or transit railway corridors (TRC) included in the Trans-European Network (TEN-T), and other lines subject to the European Agreements on international railway lines (AGC) and on the most important international combined transport (AGCT) routes, including connecting lines. The significant position of the railway lines was taken into account using weighting coefficients related primarily to double-track lines (for single-track lines the respective weights were halved) as follows: TRC 1.0, remaining lines AGC + AGCT 0.6, connecting lines 0.55, and other lines 0.5. As part of the QBE assessment, the quality factor of roads and railways was assigned a semantic weighting of 8% in accordance with the analysis of investment preferences and taking into account the achieved level of economic development of the Czech Republic (for comparison of the semantic weighting, which deal with infrastructural factors of information and communication technologies and proximity of airports, which is 6 resp. 4%).

Through the application of the methodology described above, the relevant regional centres (in the case of the Olomouc region it is a significant traffic junction Přerov, located in contrast to Olomouc on the planned HSR) were assigned corresponding point values. The original data relating to the 2010-time horizon have been converted to current data. The data in Table 2 shows that Prague, followed by

Ostrava, Brno, and Pilsen, which were included in the 1st classification group (the remaining regional capitals together with Přerov, fall into the 2nd group), occupies the best position. Thanks to the expansion of the motorway and TRC network, only Ústí n. L and Přerov with the highest share of the railway component showed a more significant improvement in position (improvement by 8% and 13%, respectively). For indicative estimates of potential aspects of HSR on the position of selected centres, a compensation coefficient of 1.35 was used, reflecting the difference between the average line speed of about 150 km/hr on TRC (taking into account the planned technical modifications of the lines) and at a real average speed of approx. 200 km/hr on the planned HSRs. With regard to speculative considerations with significantly higher speed parameters, it is worth noting that, according to a sample survey of 14 HSRs operating within the EU on only two lines, the average speed exceeded 200 km/hr (European court of auditors, 2018).

Tab. 2 The position of regional centres within the network of roads and railways and the potential impact of HSR construction

centre	original values		updated values		estimated values with HSR	
	total	share of rail in %	total	share of rail in %	total	share of rail in %
Prague	49.75	9.9	50.05	10.2	54.10	16.8
Pilsen	25.80	9.5	26.95	13.1	29.65	21.0
Ústí n. L.	19.25	22.1	20.75	20.5	23.45	29.6
Jihlava	16.65	5.1	16.65	5.1	19.35	18.3
Brno	29.55	13.4	29.90	13.2	33.95	23.6
Ostrava	30.95	9.9	31.20	9.8	33.90	17.3
Přerov	*12.75*	23.5	*14.40*	20.8	*17.10*	28.4

Source: authors.

The planned HSR network connects 6 of the 13 regional capitals, performing the function of development centres thanks to the above-average level of QBE. The analyses show that within the relevant regional capitals, the largest improvement in the quality factor of roads and railways with adequate aspects on investment attractiveness can be expected in the case of Jihlava (16%) followed by Brno (13.5%) and Ústí n. L. (13%) and the smallest improvement in the case of Pilsen (10%), Ostrava (8.5%) and Prague (8%). From the point of view of aggregate regional values of QBE, however, this improvement does not play a too significant role (Jihlava by 1.3%, Brno by 0.9%). To this end, it is worth noting that the real aspects of building the HSR network on the redistribution of transport demand will be significantly affected by road transport competition (Chmelík, Květoň, Marada, 2010). From a territorial point of view, it is clear, that the HSR will deepen the interconnections of the development centres concerned (especially between Prague as a metropolis of supranational importance (separate region NUTS 3) and Brno and Ostrava as secondary metropolises together with Pilsen). These diverse links correspond in direction to the development axes identified on the basis of positive QBE deviations from the theoretically relevant values derived from the population size of micro-regions, i.e. administrative districts of municipalities with extended powers/MEP supplemented by Prague (Viturka et al., 2010). Development axes generally function as the main channels for extending spread effects from development centres to their surroundings. The long-term effects of these links are organically linked to the establishment of development axes stimulating both quantitative and qualitative development of labour (confirmed by negative statistical links with the unemployment rate) and residential (construction of houses and flats as the most important component of investment activities) markets.

The above findings then were used to perceive the development aspects of the planned HSR routes, based on their directional correspondence with development axes of national importance - type A axes, supplemented by development axes of regional importance - type B axes (see figure 3). To this end, it should be noted that these stimuli are loose in cases where the planned sections of the HSRs pass through less urbanized MEP regions. The methodology used is based on the evaluation of the position of the affected regions through representative indicators of unemployment rate/UR and completed dwellings per 1000 inhabitants/CD - in both cases these are the borderline figures 2016 and 2020 (ČSÚ, 2020). In this respect, the best position is occupied by the Route 3 corresponding to the West Bohemian developed axis of type A Prague - Pilsen, which together with the adjoining axis type B Pilsen - Domažlice integrates Prague with a total of nine MEP regions. All these regions showed positive deviations from the national average in the case of UR. In the case of CD two regions showed negative deviations. The second place is occupied by Route 1, which can be divided into the Brno and Ostrava components. Parts of the East Bohemian developed axis of type A Prague - H. Králové in the section Prague – Kolín, supplemented by the axis of type B Kolín - Čáslav, and the Czech-Moravian developed axis of type A Prague - Brno in the section Jihlava - V. Meziříčí, correspond to the Brno component. The Ostrava component is formed by a part of the East Moravian, partially developed axis type A Brno – Zlín in the section Brno - Vyškov and a part of the declining central Moravian axis type A Brno - Ostrava in the section Lipník n. B. - N. Jičín (its declining importance is evidenced by the negative population development of Ostrava). From an overall point of view, Route 1 includes Prague together with 20 MEP regions. In the case of UR, a total of 12 regions (including Prague) showed positive deviations from the average while negative deviations were shown by 9 regions (including regional cities of Ostrava and, somewhat surprisingly, Brno). In the case of CD, 10 regions showed positive deviations from the average and 11 regions (of which 8 are part of Ostrava component) negative deviations. The Brno component shows clearly better characteristics. The third position, indicating continued deprivation, is occupied by Route 4 Prague - Ústí n. L. This route, which corresponds in direction to the only partially developed North Bohemian axis of type A, Prague - Ústí n. L., includes Prague and 4 MEP regions. In terms of the examined indicators, negative deviations in the ratio of 3 to 2 for UR and 2 to 3 for CD. The worst position of Route 2, consisting of only 4 MEP region including Brno corresponds to its primary role as a prospective connection of the Czech and Austrian HSR networks. The ratio of positive and negative deviations was 1 to 3 for UR and 3 to 1 for CD.

The results show that within the group of the most important settlement agglomerations of the Czech Republic, the capital city of Prague clearly generates the strongest development stimuli as the only established metropolis of supranational importance, followed by Pilsen. The shift of Brno to the third position is conditioned mainly by persistent imbalances on the labour market. On the other side are Ostrava together with Ústí n. L. with a long-term negative development trajectory threatening the potential benefits of HSR. From a general point of view, the constitution of systems of development centres and axis in interaction with

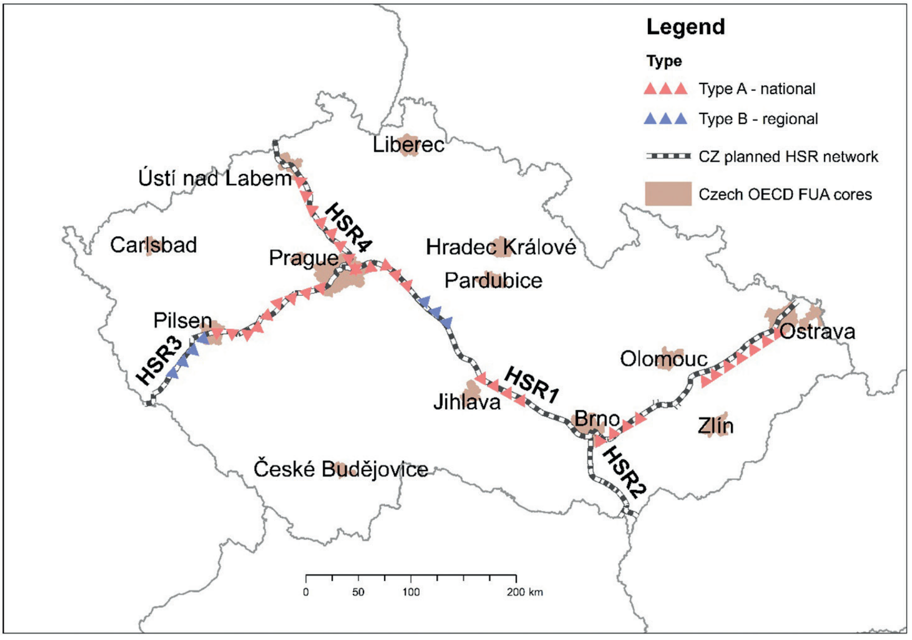

Fig. 3
Coincidence of the planned HSR construction with development axes of national and regional importance
Source: authors.

their semantic position and involvement into global production networks can be considered a conditio sine qua non of the successful activation of stimulation functions of individual HSR routes.

RESULTS AND DISCUSSION

The synthesis of the results of the performed analyses is based on the elementary method of point evaluation, based on which the order of individual HSR routes is compiled. This approach is relatively close to the practical decision-making of entities interested in the projects, or stakeholders, and from the point of view of the multicriteria evaluation method it is thus considered standard (see e. g. SUDOP et al., 2013). From a broader point of view, the significant advantage of the analyses presented above is their theoretical anchoring, which makes it possible to link the evaluation of projects with the general laws evolution of the development of social and natural systems. The final synthesis shows that the best overall position is held by HSR number 3 Prague – Pilsen → Munich, followed by HSR 1 Prague – Jihlava – Brno – Ostrava → Katowice, HSR 4 Prague – Ústí n. L. → Dresden and the "connection" HSR 2 Brno → Vienna (for more detailed information see Table3). The general importance of the planned HSR routes for regional development is demonstrated by the fact that the current share of the population within directly

Tab. 3 Evaluation of the planned HSR construction according to the criteria of stimulation and sustainability and their overall position

criterion	HSR 1	HSR 2	HSR 3	HSR 4
stimulation	2	4	1	3
sustainability	4	2	1	3
total	2	4	1	3

Source: authors.

affected regions is around 36% of the total population of the Czech Republic. From an international point of view, it is interesting to compare HSR 3 and 4 providing a prospective connection to the German HSR network. In this respect, despite difficult physical-geographical conditions generating high construction costs (planned tunnel under the mountains Krušné hory with a length of about 26 km), for political and functional reasons HSR 4 connecting Prague with the German capital Berlin is preferred. However, according to the criteria analysed above, route HSR 3 appears to be more beneficial. This fact should be carefully considered in conjunction with the evaluation of the position of the two routes under the other criteria, and only on this basis should the optimal priorities for the construction of the HSR network be definitively established. Regarding the ongoing discussion on the construction of the HSR, it should be noted that it is largely focused on political proclamations about its great economic benefits or purposeful discussions on the exact location of routes. Significantly less attention is paid to fundamental issues, such as the overall vision of HSR construction (which is documented, e.g., by non-systemic changes in the structure of main routes) or the absence of discussion on several critical issues (e.g., the use for freight transport).

CONCLUSIONS

Finally, the assessment of regional effects of the construction of express transport infrastructure is one of the important topics of regional economic research (within Central Europe, e.g., Seidenglanz et al., 2021). From the point of view of the Czech Republic, two facts can be considered essential in this context: long-term lag of motorway construction and significant delays in starting HSR construction due to the risk of gradual reduction in subsidies from European Union funds. For the evaluation of development projects, the CBA analysis is usually used, which, however, due to its reductionist nature (orientation towards monetary indicators) to a certain extent supports the preference for unilateral approaches. In our opinion, this shortcoming can be effectively addressed by means of a multi-criteria analysis of project effectiveness, the broader theoretical anchoring of which makes it possible to link project evaluation with the evolution of natural and social systems. In this context, we also consider it necessary to emphasize that inappropriate choice of an investment project cannot be counteracted by its effective implementation (an illustrative example is the construction of new motorways motivated by efforts to support economic convergence of lagging regions, which, however, has not often been achieved due to the low competitiveness of local firms). In this context, it is appropriate to recall that, precisely for the purpose of system-based prevention of the implementation of socially less beneficial or even harmful projects, standardized tools Environmental Impact Assessment and Territorial Impact Assessment have been created (European Union, 2015). These instruments emphasize a comprehensive and timeless approach that takes into account, in addition to traditionally preferred economic growth, other dimensions of social development, such as sustainability, social cohesion and the quality of territorial governance (Medeiros, 2014). By combining the assessment of two different criteria of stimulation and sustainability, we also discuss possible changes of economic and environmental relations of the capital Prague to other regions regarding the protection of transnational and supra-regional importance ecosystems. This approach creates a practical framework for applying the concept of so-called "sustainable convergence" as a tool for solving the not very convincing results of applying traditional methods. In this context, it is appropriate to state, e.g., long-term experiences from Slovakia, where significant regional disparities are not handled effectively enough (Matlovič, Matlovičová, 2011). Therefore, we ask another research question, what is the current role of the capital city or metropolitan cities in the regional system of the Czech Republic, and how will the construction of HSR change it from an economic and environmental point of view concerning the phenomenon of suburbanization and regional development. In the case of motorways and expressways, e.g., Lechowski (2021) showed an indirect effect on population redistribution in the Łodz metropolitan area). Our research indicates there can be a significant effect even in constructing the HSR system.

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