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# Linear Transport Infrastructure Development Processes as the Objects of Harmonisation with Wildlife

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**Abstract.** The most efficient way, how to avoid or to minimise the conflicts and negative effects of the transport on the wildlife is reflection of the needs to protect the wildlife in the processes of the development of the transport infrastructure. The effects and potentials for their minimizing differ depending on transport mode (car transport, pedestrian transport, bicycle transport, railways, air transport, cable lines, pipelines, waterways and channels), geographical contexts (landscape features, modes of use of the territory) and element of transport infrastructure (static and dynamic). This paper is focused on linear infrastructure represented predominantly by different categories of roads and railway lines (including supportive and complementary infrastructural elements like crossings, stops, stations, bridges, tunnels etc.) as they are most common among transport infrastructure in the countryside and to big extent representative in dealing with the conflicts between transport infrastructure and wildlife. The process of the development of the roads and railway lines is very similar and includes the logic of steps starting with the scoping, via planning, designing, construction and use/maintenance and monitoring. The paper is discussing these five steps in three types of processes - development of new roads and railway lines or their parts, update of existing roads and railways (modernising, extension in former corridors, increase of capacities, speed ...) and improving ecological status of existing routes and railways. Individual steps within these processes are described and discussed with objective to illustrate the contents of the phase (identification/definition of qualitative and quantitative demand on transport performance, analyses of technical, technological, economic and other framework precondition for the respond on the demand), the main challenges and problems to be dealt with (realistic identification of current and estimation of future demand on transport performance mirroring the development of the society and its economy), the advised approaches, tools and measures to be used in reflection to the identified challenges and, lastly, the stakeholders relevant for engagement within the phase are listed together with scheme of appropriate participation to help to guide the players in the development.

## 1. Introduction

Economic and social development is largely dependent in Carpathian countries on development of so-called grey infrastructure (roads, railways, bridges and related hard infrastructure) for connecting urban and rural areas, centres and peripheries and countries and ensuring exchange of materials, people and information. Although these constructions are of crucial importance for functioning of the modern society, their impact on the nature and biodiversity is considerable and is impacting the natural world in many ways (lack of connectivity, road kills etc.). The following paper is discussing the processes of development of new infrastructure, extension of the existing infrastructure and improving the ecological status of existing infrastructure, [1, 2]]. Detailed look at the content of these phases shows differences



depending of the kick-of situation. Based on this we can distinguish basically 3 modes of development processes.

## 2. Development of new roads and railway lines or their parts

The overall flow of logically interlinked steps is represented by the phases shown in figure 1.



**Figure 1.** Diagram of development of new roads and railway lines

### 2.1 Demand definition and framework preconditions

#### a) The content of the steps/phase

In the development process of new roads and railway lines the phase of scoping is focused on the identification/definition of qualitative and quantitative demand on transport performance and analyses of technical, technological, economic and other framework precondition for the respond on the demand. This phase is crucial for the decision to build transport infrastructure and for the definition of its qualitative and quantitative parameters of the infrastructure.

#### b) Problems/challenges to be solved

The scoping phase is crucial for realistic identification of current and estimation of future demand on transport performance mirroring the development of the society and its economy. The problem can lead to not efficient (economically and societally) investments or to problems resulting from underestimation of the demand and need of additional solutions.

#### c) Advised approaches, tools and measures to be used in reflection of identified problems/challenges

In many cases the decision about the construction of the linear infrastructure have been taken before clear strategy for social and economic development. In optimal case the scoping phase is integrated into analytical part of the comprehensive strategy development at the national and regional level allowing to take into account synergy effects of different projects as well as better estimation of their effects and interlinked risks.

#### d) Stakeholders relevant for engagement

The scoping, although basically professional activity, has to include relevant key holder of the transport performance demand and players at the market of transport services.

### 2.2 Strategic planning – routing of the corridor and the process of Strategic Environmental Assessment

#### a. The content of the steps/phase

The phase of strategic planning is crucial decision-making phase the outputs of which are the decisions about:

- What? Mode of transport covering the transport demand (e.g. whether to build road or railway);
- How? The category of the transport infrastructure and transport capacity and basic features/parameters of the linear transport infrastructure;
- Where? The definition of the transport corridor.

b. *Problems/challenges to be solved*

This phase is the most important for avoiding and minimising threats and negative effects of the transport infrastructure and wild life as in this phase are two confronted elements for the process of harmonisation defined:

A. The intervention

- construction of the linear infrastructure with defined parameters deriving the effects on wild life in the phase of construction;
- use of the transport infrastructure/ performance.

B. The ecosystem of the countryside which is going to be affected by the intervention with its specific features including the resilience (by localisation/definition of the corridor of the road or railway).

Typical feature of the phase of strategy development and strategic decision making is the work with alternatives. The comparison of the alternatives allows better understanding of possibilities, limits and optimal solutions.

c. *Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

Rather complex range of the aspects of the interaction between transport infrastructure to be build and ecosystems of the countryside have to be assessed in the process of strategic environmental assessment (SEA). The output from the SEA process, which includes first phase of public participation in the decision-making process are:

- Transparent identification of positive and negative effects, threats, risks, benefits, beneficiaries and looser to be expected in the context of the proposed activities (construction and use of the road/railway);
- Advice/decision about acceptability of the activities, choice of alternatives of the activities (obligation of the SEA process to assess alternatives);
- Definition of the preconditions of acceptability of the activities under chosen alternative e.g. required parameters or changes of the parameters of the road/railway and technologies and algorithm of the construction (incl. timing), location, measures eliminating or lowering negative effects of the construction and use of the road/railway, mitigation measures, parameters for monitoring etc. framing strategic decision.

In most cases the strategic decision on linear transport infrastructure is inherent part of the strategic documents of social and economic development e.g. regional development plans and land-use plans or similar strategic planning documentation. Especially the land-use plans with their supporting documents and parts (e.g. landscape plans, plans of terrestrial system of ecologic stability...) use to be the instruments for first optimisation of the transport infrastructure development plans with other interest in the landscape including the protection of ecosystems and wild life. Based on the EU directive these strategic development documents are the object of strategic environmental assessment on strategic documents. Location and construction of the linear transport infrastructure is not possible without its inclusion into the land-use plan or similar document of territorial/spatial planning, [3].

Based on outputs of SEA and the land-use planning process, the corridor for the construction of the road/railway is approved and framework preconditions for the projecting of particular parts/elements/construction elements are defined. Inclusion of the parameters reflecting the wild life protection reflection already in this phase is crucial as the inputs for the phase of projecting and construction design.

Among the measures in this phase dominate:

- Legal, institutional and financial measures
  - roadless and low traffic areas
  - institutionalisation of the concept of ecological compensation
  - definition of legal obligations

- special taxes
- motivating allowances
- Technical and ecological measures
  - solving problems on existing roads and railway lines
- Planning and design measures
  - innovative technical solutions
  - innovative transport modes
- plans of terrestrial systems of ecological stability
- land-use plans
- strategic socio-economic plans and programs
- Managerial and monitoring measures
  - redistribution of transport performance demand
  - monitoring of the animal movement.

The phase of strategic planning use to be closed by strategic decision about constructing new linear transport infrastructure including its basic location. This has got different positions and forms starting with the approval of the land-use planning documentation and ending with decision about location (e.g. territorial decision) as a part of the decision-making process of integrative land-use planning including binding precondition for projecting and construction design

*d. Stakeholders relevant for engagement*

This phase is crucial for the engagement of the whole spectrum of stakeholders starting with the inhabitants and their representatives from the self-government, owners, entrepreneurs, NGOs, professionals, relevant public sector representatives and bodies.

### **2.3 Projecting – construction design and the process of Environmental Impact Assessment**

*a. The content of the steps/phase*

The phase of projecting and construction design is focused on detailed elaboration of the project for the particular elements of the road/railway line in given corridor.

*b. Problems/challenges to be solved*

This phase built on strategic phase including the analyses and strategic assessment and basic requirements resulting from the strategic phase of decision making and on detailed data about the technologies and resources available and about environment of implementation. Based on defined and in detail identified problems, threats and challenges the proper solutions at the level of projecting and construction designing are proposed and elaborated into the implementation documentation. This phase is crucial for identification of optimal solutions of the problems which could not be solved or identified at the strategic level of planning. The existence of strategic decision done, is basically limiting the scale of available instruments and dominant measures are focused on lowering and mitigating the negative effects of the construction and use of linear transport infrastructure.

Inherent part of the phase of projecting and construction design is the process of environmental impact assessment (EIA). The EIA process focuses on detailed assessment of the proposed technical and technological proposal for construction and use of particular elements of the linear transport infrastructure. The whole lines use to be divided to smaller segments and assessed with special focus on detailed parameters of the segments and parts of infrastructure as well as on detailed parameters of the measures lowering or mitigating connected impacts in the phase of construction and in the phase of use. The output use to be legally binding statement of responsible body, relevant for construction permission and in-use setting the infrastructure including additional preconditions for further designing, construction and use of infrastructure. EIA processes include as inherent part public participation.

The phase of projecting and construction design ends with the process of construction permission. In this process the coherence of the projects and designs with the preconditions defined in the strategic phase has to be assessed including the coherence with current legal requirements, technical requirements and other requirements of the relevant public body and public interest. Among them the requirements resulting from the EIA process play important role. This process includes the public participation. The

problem used to be multiplied addressing the public on the same topic in different processes, which are not properly harmonised.

The decision of responsible body – construction permission, in accordance with the building code or similar law act or specific law (e.g. on railways), includes detailed preconditions for the construction of the infrastructure and unifies the statements of all responsible sectoral bodies inclusive the nature protection, water protection and management etc.

*c. Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

In this phase the detailed measures and solutions are developed and proposed. The dominant measures include:

- Technical and ecological measures
  - Fauna passages as part of a general landscape permeability concept
  - Adapting engineering Works for use by animals
  - Solving problems on existing roads and railway lines
  - Mitigation measures
  - Overpasses
  - Wildlife overpasses and landscape bridges
  - Modified bridges over infrastructure: multi-functional overpasses
  - Tree-top and other special overpasses
  - Underpasses
  - Viaducts and river crossings
  - Underpasses for large and medium-sized animals
  - Modified and joint-use underpasses
  - Underpasses for small animals
  - Culverts modified for use by terrestrial animals
  - Passages for fish and other aquatic organisms
  - Amphibian tunnels
  - Fences
  - Artificial deterrents
  - Warning signs
  - Wildlife warning systems with sensors
  - Adaptation of the habitat alongside the infrastructure
  - Adaptation of infrastructure
  - Other measures for reducing barrier effect and mortality
  - Adapting road width and reducing traffic intensity
  - Decommissioning of infrastructure
- Managerial and monitoring measures
  - Monitoring of the animal movement technologies and instruments
  - Monitoring of distribution and movement in the area
  - Monitoring along the roads

*d. Stakeholders relevant for engagement*

Similarly to the strategic planning phase this phase includes the engagement of the whole spectrum of stakeholders starting with the inhabitants and their representatives from the self-government, owners, entrepreneurs, NGOs, professionals, relevant public sector representatives and bodies... The process of participation is framed by the EIA as well as by the process of construction permission. The limit for their participation is in many cases capacity to understand the technical data and the danger of preferences of subjective motivations and interest against the public interests. As the process use to effect rather large number of stakeholders, proper management of participation process is crucial for its efficiency.

## **2.4 Construction of linear infrastructure**

*a. The content of the steps/phase*

The phase of construction is the implementation process in which the approved projects and construction designs are implemented. This phase ends with the in-use taking decision.

b. *Problems/challenges to be solved*

Implementation can affect much broader area than the area of the road or railway line itself. It can discover unexpected features of the environment requested the modification of the technologies used event the changes in the location of the road or railway line. That because the monitoring is important part already in this phase.

c. *Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

Dominant tools and approaches in this phase are linked to two field as follows:

- Managerial and monitoring measures
  - Monitoring of the animal movement
  - Monitoring of distribution and movement in the area
  - Monitoring along the roads
  - Monitoring of effectiveness of realised measures
- Organisational measures
  - restriction during the construction phase
  - timing
  - protective temporal measures.

d. *Stakeholders relevant for engagement*

The broad spectrum of stakeholders can take active part in the monitoring of the progress of the construction and discipline in following the preconditions defined in the construction permission for the phase of construction

## 2.5 Monitoring

a. *The content of the steps/phase*

The phase of monitoring is important part of the linear transport infrastructure development focused on identification and assessment of the real effects of the construction and use of infrastructure.

b. *Problems/challenges to be solved*

Although the focus of monitoring should be on crucial critical aspects, the comprehensive monitoring and assessment is the precondition for objective assessment of the effects including unpredictable effects and flexible reaction on these effect by proposing and implementing proper measures. The question of efficiency can be discussed. The involvement of broad public can contribute to this. Important is the use of monitoring outputs not only I relation of assessment and optimisation of given road/railway line, but as a source of knowledge and experience for planning, projecting and designing of other infrastructure.

c. *Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

- Crucial approaches and tools are lined to collection and evaluations of gained data
  - Monitoring of the animal movement
  - Monitoring of distribution and movement in the area
  - Monitoring along the roads
  - Monitoring of traffic mortality
  - Monitoring of effectiveness of realised measures

d. *Stakeholders relevant for engagement*

Involvement of broad public can contribute to higher efficiency of monitoring processes. The participation of the professionals seems to be crucial.

### 3. Update of existing roads and railways (modernising, extension in former corridors, increase of capacities, speed ...)

The processes of the development of linear transport infrastructure via update of existing roads and railways have following specifics in the comparison with the new infrastructure development (figure 2). The logic scheme of the process of the roads and railways development focused on update of existing infrastructure is specific by the integration of the phases of planning and projecting as the strategic dimension of those phases is limited by absence of the localisation decisions, [4].



**Figure 2.** Diagram of updating the existing roads and railways

#### 3.1 Demand definition – Threats, analyses

##### a. The content of the steps/phase

In the process of update of existing roads and railways lines is predominantly motivated by the demand to improve their transport performance via changing their parameters determining the speed of transport flows, capacity of flows, resilience of the infrastructure, safety. In this context the phase of scoping is focused on the identification/definition of qualitative and quantitative demand on improved transport performance in given transport corridor and analyses of technical, technological, economic and other framework precondition for the respond on the up-date demand. This phase is crucial for the decision to update transport infrastructure and for the definition of its qualitative and quantitative parameters of updated infrastructure.

The motivation resulting from the societal demand on greening the transport is specific and covered by special processes described in separate scheme for improving the ecological status of existing routes and railways.

##### b. Problems/challenges to be solved

The scoping phase is crucial not only for realistic identification of current and estimation of future demand on transport performance mirroring the development of the society and its economy, but for the strategic choice of proper reaction to this demand. Crucial decision is about to invest into the up-date of existing infrastructure in the confrontation with the possibility to develop new road/railway line. The leading aspects influencing the decision use to be economic aspects and the environmental aspects are often marginalised.

##### c. Advised approaches, tools and measures to be used in reflection of identified problems/challenges

In addition to the approaches and tools addressed in the description of the new infrastructure development processes are the monitoring and assessment tools of special importance. They provide relevant information about the development of the transport load on the road/railway line, about the side effects including environmental effects, can be valuable sources identifying critical points and limits for use and future up-date of the roads/railway lines.

##### d. Stakeholders relevant for engagement

The scoping, although basically professional activity, has to include relevant key holder of the transport performance demand and players at the market providing transport services. In addition to those



stakeholders addressed in the description of the new infrastructure development processes the role of user of existing infrastructure going to be updated has to be underlined.

### **3.2 Projecting – Construction design and the process of Environmental Impact Assessment**

#### *a. The content of the steps/phase*

The phase of projecting and construction design is integrated with the phase of planning. As the strategic decision about the localisation of the road is in regard of up-date of existing roads not relevant, the strategic planning decision is about the mode and way how to achieve requested new parameters of existing roads and railways. The crucial modes are modernisation (e.g. change of surface layers, introduction of intelligent traffic control systems, competition by communication tools, lowering the angles of the curves, extension of the road belts brightness), extension focused on growth of capacities (e.g. additional road belts, special belts for traks), change of road/railway category, improvement of safety. This is closely linked with the scoping on available detailed technical and technological solutions, potential and limits given by the locality of existing road/railway line.

The projecting and construction design is than focused on detailed elaboration of the project for update of the particular elements of the road/railway line in given corridor.

#### *b. Problems/challenges to be solved*

The specifics of this phase in comparison with the development of new linear infrastructures is in the absence of the possibility to decide about the principal localisation and with this of the possibility to lover the negative effects via optimising the localisation of the road/railway line. The challenge is to respond to the request to harmonise the up-date demand with the given environment of existing road/railway line. Based on the extend and character of the up-date intervention the strategic environmental assessment takes or not takes place, but the dominant instrument for safeguarding the environmental dimension of the decision making is the process of EIA linked to the phase of projecting and construction designing. The EIA process focuses on detailed assessment of the proposed technical and technological proposal for construction and new mode of use of particular elements of the linear transport infrastructure. The output use to be binding statement of responsible body, relevant for construction permission and in-use setting the infrastructure including additional preconditions for further designing, construction and use of infrastructure. EIA processes include as inherent part public participation.

The phase of projecting and construction design ends with the process of construction permission. In this process the coherence of the projects and designs with current legal requirements, technical requirements and other requirements of the relevant public body and public interest, with the requirements resulting from EIA and, in case of realised SEA, with the preconditions defined in the SEA process. This process includes the public participation as well

The decision of responsible body – construction permission, in accordance with the building code or similar law act or specific law (e.g. on railways), includes detailed preconditions for the construction of the infrastructure and unifies the statements of all responsible sectoral bodies inclusive the nature protection, water protection and management etc.

#### *c. Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

In this phase the detailed measures and solutions are developed and proposed. The dominant measures and solutions are identical to measures in section 2.3.

#### *d. Stakeholders relevant for engagement*

Similarly, with the stakeholders addressed in the description of the new infrastructure development processes, engagement of the whole spectrum pf stakeholders starting with the inhabitants and their representatives from the self-government, owners, users, entrepreneurs, NGOs, professionals, relevant

public sector representatives and bodies has to be taken into account. In the comparison with the development of new infrastructure with included SEA processes, the process of participation in many cases of the up-date of transport infrastructure is limited on the EIA process and the process of construction permission. Important for the process of public participation is availability of tacis knowledge and direct experience of the public linked to the use of existing road/railway line going to be up-dated determining very efficient involvement of the public not only in the decision making, but in the preparatory phase as well. The limit for their participation is in many cases capacity to understand the technical data and the danger of preferences of subjective motivations and interest against the public interests.

### **3.3 Refurbishment of linear infrastructure**

#### *a. The content of the steps/phase*

The phase of construction is the implementation process in which the approved projects and construction designs are implemented. This phase ends with the in-use taking decision.

#### *b. Problems/challenges to be solved*

The specifics of this process is that in majority of cases the up-date process is realised on parallel with the use of infrastructure which means restriction in the use, limitation of the refurbishment processes in time, space and used technologies and can bring additional threats with the wild life as well. The limits of the use of existing up-dated infrastructure can lead to redirecting of the transport performance to other roads/railways connected with not wished additional environmental loads on those transport corridors. Temporal interventions connected with the phase of construction (e.g. demolition of the fences, penetration of the movement barriers) can cause lowering of environmental standards of existing roads/railways lines. This has to be mirrored in the careful definition of adequate temporal measures during the construction processes.

#### *c. Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

Dominant tools and approaches in this phase are linked to two field as follows:

- Technical and ecological measures
  - Temporal bio-bridges
- Managerial and monitoring measures
  - Monitoring of the animal movement
  - Monitoring of distribution and movement in the area
  - Monitoring along the roads
  - Monitoring of effectiveness of realised measures
- Organisational measures
  - Restrictions for transport use during the construction phase
  - timing
  - protective temporal measures.

#### *d. Stakeholders relevant for engagement*

The broad spectrum of stakeholders can take active part in the monitoring of the progress of the construction and the discipline in following the preconditions defined in the construction permission for the phase of construction. Special position of the stakeholders can be seen in the context of temporal measures connected with the construction work parallel with use of road/railway line.

### 3.4 Monitoring

#### a. *The content of the steps/phase*

The phase of monitoring is important part of the linear transport infrastructure development focused on identification and assessment of the real effects of the up-date measures and use of infrastructure.

#### b. *Problems/challenges to be solved*

Although the focus of monitoring should be on crucial critical aspects, the comprehensive monitoring and assessment is the precondition for objective assessment of the effects including unpredictable effects and flexible reaction on these effect by proposing and implementing proper measures. Monitoring focused on phase of implementation of up-date measures parallel with the continual use of the infrastructure is specific feature of monitoring linked to up-date of linear transport infrastructure

#### c. *Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

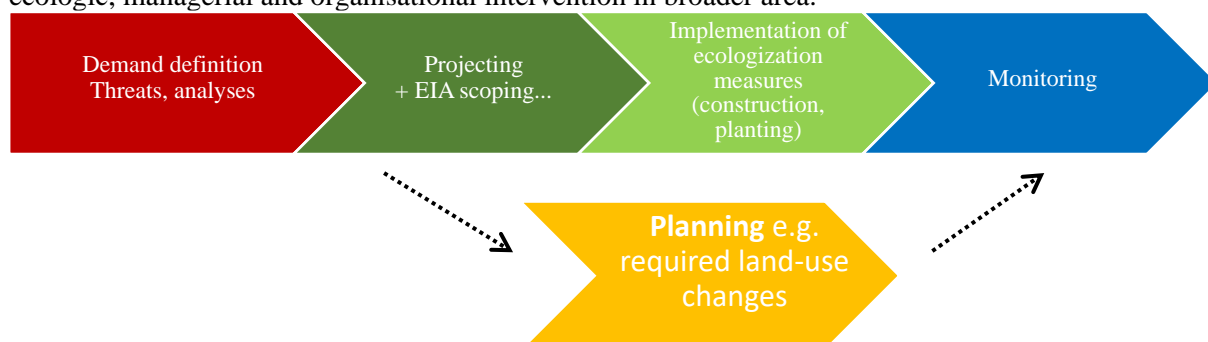
- Crucial approaches and tools are lined to collection and evaluations of gained data
  - Monitoring of the animal movement
  - Monitoring along the roads
  - Monitoring of traffic mortality
  - Monitoring of effectiveness of realised measures

#### d. *Stakeholders relevant for engagement*

Involvement of broad public can contribute to higher efficiency of monitoring processes. The participation of the professionals seems to be crucial.

### 4. Improving ecological status of existing routes and railways

Development of the linear transport infrastructure via improving its ecological status of existing routes and railways is a specific case of up-date of the infrastructure (figure 3). As in some cases the efficiency of the particular technical interventions implemented directly on the road/railway line depends on supportive interventions in broader area, the process has to include the planning and implementing ecologic, managerial and organisational intervention in broader area.



**Figure 3.** Diagram of improving ecological status of existing routes and railways

#### a. *The content of the steps/phase*

In the process of update of existing roads and railways lines via improving ecological status of existing routes and railways is framed by changes in the societal priorities in the direction towards environmental values and motivated by the necessity to safeguard sustainability via protecting the wild life and living environment.

*b. Problems/challenges to be solved*

The scoping phase has to be concentrated on identifying crucial threats and negative effects as well as improvement potentials linked directly to the existing roads and their broader environment.

*c. Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

In addition to the approaches and tools addressed in the description of the new infrastructure and the infrastructure up-date development processes have absolutely dominant role of monitoring and assessment tools. The measures have to be neaten on specific needs of existing roads in given environment. Special position in the scoping phase has the transfer of best practice solutions and know how allowing to propose, design and implement effective and efficient interventions.

*d. Stakeholders relevant for engagement*

In comparison to the stakeholders addressed in the description of the development process of new infrastructure development the engagement of local public in the definition of stress points, problems and conflicts between wild life and given transport infrastructure is more important. The local public can bring very valuable tacit knowledge and immediate experience into the scoping phase. Moreover, in many cases the public represents the driving force for decision to start the projects on ecological improvements of existing linear transport infrastructure. The public awareness about the negative effects plays important in deriving public pressure on the decision makers to mobilise the sources for ecological improvements.

#### **4.1 Projecting – construction design and the process of EIA scoping**

*a. The content of the steps/phase*

The phase of projecting the measures for ecological improvement of existing transport linear infrastructure is integrated with the phase of planning. Based on results from the scoping the projecting is focused on the mode and way how to achieve requested environmental parameters of existing roads and railways. The crucial modes, ways and technical solutions use to be lined to modernisation and improvement of safety. This is closely linked with the scoping on available detailed technical and technological solutions of ecologic oriented improvements.

*b. Problems/challenges to be solved*

The specifics of this phase in comparison with the development of new linear infrastructures or their up-date is special focus on ecological improvements and solutions of the conflicts with the wild life protection lined to the use of existing roads/railway lines. Their efficiency is mostly determined by synergy effects of a set of implemented measures realised directly on the infrastructural objects and organisational measures in their surroundings. That because the logic scheme of the processes includes as an alternative branch the step of planning.

The character of the interventions has to be assessed in the EIA scoping and based on its outputs particular interventions have or have not to be assessed in the EIA standard processes.

*c. Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

In this phase the detailed measures and solutions are developed and proposed. The dominant measures and solutions are identical to measures in section 2.3.

*d. Stakeholders relevant for engagement*

The EIA process and the process of construction permission includes participation processes opened for broad public. As the object of the environmental assessment and of construction permission process are environmentally targeted measures mostly requested by the public the involvement of the professional public in the discussion on particular solutions of special importance.

**4.2 Planning (e.g. required land-use changes)**

*a. The content of the steps/phase*

The phase of planning is focus on supportive measures in broader surroundings in open or urbanised landscape complementary to technical, ecological and technological measures implemented direct on the road/railway line.

*b. Problems/challenges to be solved*

The specifics of this phase are its orientation on synergy effects between the set of implemented measures realised directly on the infrastructural objects and organisational, technical and ecological measures in their surroundings. They can contribute e.g. to better connectivity of the ecosystems and eco ducts, to the lowering of spatial dispersion of negative effects etc.

The character of the interventions has to be assessed in the SEA scoping and based on its outputs particular interventions have or have not to be assessed in the SEA or/and EIA standard processes.

*c. Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

In this phase the detailed measures and solutions are developed and proposed. The dominant are listed in section 3.4.

*d. Stakeholders relevant for engagement*

The SEA process and the process of land-use plan approval includes participation processes opened for broad public.

**4.3 Monitoring**

*a. The content of the steps/phase*

The specific of the phase of monitoring as a part of the development of the linear transport infrastructure via improving its ecological status of existing routes and railways is its division in 3 parts.

The first part is focused on the monitoring as the part of scoping providing the data for the decision about realisation of improvement of the ecological status and for planning, projecting and designing of particular interventions.

The second part is focuses on the phase of implementation of improvement measures parallel with the continual use of the infrastructure as specific feature of monitoring linked to up-date and eco-improvement of linear transport infrastructure

The third part typical post-implementation monitoring as addressed in the description of the new infrastructure development and its up-date.

*b. Problems/challenges to be solved*

Although the focus of monitoring should be on crucial critical aspects, the comprehensive monitoring and assessment is the precondition for objective identification of the problems and assessment of the effects including unpredictable effects and flexible reaction on these effect by proposing and implementing proper measures.

*c. Advised approaches, tools and measures to be used in reflection of identified problems/challenges*

In this phase the detailed measures and solutions are developed and proposed. The dominant ones are listed in section 3.4.

*d. Stakeholders relevant for engagement*

Involvement of broad public can contribute to higher efficiency of monitoring processes. The participation of the professionals seems to be crucial.

## 5. Conclusions

The paper was discussing the importance of considering the ecological impacts of each stage of the processes of building new infrastructure, extending the existing constructions and improving the ecological condition of the existing infrastructure. Another objective was to raise awareness of the importance of green infrastructure for protection and preserving the biodiversity and putting emphasis on the whole set of processes linked to construction and updating the infrastructure.

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