TRANSGREEN. Integrated Transport and Green Infrastructure Planning in the Danube-Carpathian Region for the Benefit of People and Nature
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Integration of linear transport infrastructure into the surrounding landscape

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www.interreg-danube.eu/transgreen
Alignment – recommendations for different types of landscape

- Responding to ridges and valleys

  - Hilly landscape: well incorporated into the surroundings and allow for free movement of animals. Pb: the two requirements unfortunately often contradict each other → Solution: leading a road at the bottom of a valley

  - Brings difficulties searching for suitable places for effective fauna passage

  - Barrier effect of a new road planned with this alignment cumulates with the effect of already existing barriers

These can be first of all dense linear housing development along a watercourse in length of several kilometres and also roads or railways already passing through the area. Such accumulation of old and new barriers often leads to complete impermeability of long stretches of the infrastructure and to prevention of animal movement perpendicular to the axis of the valley.
Greatest danger: impermeable housing development and infrastructure

Only tool: spatial planning → fundamental task for migration studies to recognize critical points in time and to propose protection of available passages.

From the viewpoint of road planning/preparation it is necessary to consider the following aspects:

• Leading the route away from the valley bottom more to the slopes: immediate cumulative effect of barriers limited; more demanding technically and economically, but advantageous with regard to impacts on human inhabitants (disadvantage: more extensive interventions to natural habitats often needed)

• Linkage of passages in the housing development and fauna passages on the road: mapping of all potential passages through the housing development in the valley and making effort to connect them to fauna passages on the road
• Crossing points of the infrastructure with small creeks or small vertical valley: creating a system of functional wildlife underpasses instead of small culverts only for hydrological purposes.

- Following a valley bottom = satisfactory alignment only if the severance of watercourses and other linear features is avoided or minimised and connectivity between both sides of the valley is maintained

- Alignment that follows the foot of a major ridge: good option, enables the infrastructure to remain hidden from view + benefits to wildlife (lower noise levels, reduction of disturbance from vehicle light) + avoiding the valley bottom where it can have a major impact on sensitive wetland habitats
Alignment in flat landscapes

Many different habitats can be present in flat landscapes. Alignment should be sensitive to landscape scale and context and consider needed connectivity of habitats for the species that inhabit them. Some of the main general principles to be followed are:

Leading a route at ground level with local terrain for good incorporation into the surrounding landscape. At the same time, existing topographical features should be used as much as possible, since alignments respecting local drainage or vegetation are often the best.
• Steep, intrusive embankments should be avoided

• Viaducts should be preferred as they maintain connectivity for species.

Habitat fragmentation should be minimized by integrating crossing points for target species → smaller but well designed passages, for example culverts with dry ledges or badger or amphibian tunnels in low-level embankments.
• Flat landscapes (particularly wetlands): high nature conservation value. In case crossing such an area is unavoidable, viaduct should be the proper solution, as it minimizes land occupation and soil disturbance and allows passage for animals.
• In case a new alignment will cross a known migration corridor of large mammals, the situation can be solved by a properly designed green bridge.
- **Crossing valleys**
  - Viaducts:
    - Environmental advantages subject to the choice of the appropriate crossing point
    - Narrow, steep-sided valleys as they minimise landtake and fragmentation and enable species movement
  - Embankments:
    - Wide shallow valleys as they can maintain some degrees of connectivity through the use of appropriately sited and dimensioned culverts and underpasses and offer more scope for green planting.
Crossing watercourses

- Conveying a road over a watercourse: maintain in maximum possible extent the natural state of the stream bed, stream flow and of the bank vegetation.
- Means of conveying watercourses: radically influences the possibility to use the object for animal movement as well.

In line with the requirement to safely manage the passage of extreme flood waters.

- Local materials within a site-specific design: important to ensure that animals can climb out of rivers, streams and ditches → steep banksides and concrete elements should be avoided.
- Nature conservation opportunities include planting of particular species associated with the water environment, e.g. willow species, or creation of special features such as nesting opportunities for birds, dry ledges and other bankside elements for small mammals.
Crossing natural sensitive areas

- Infrastructure planned near sensitive areas of high natural value: avoidance or comprehensive evaluation of wider area of interest, compare several variants and select the one with minimal negative impacts

- Lot of input information and looks at habitat quality from many different viewpoints

- Assessment: provide a map of habitats in the area, including their categorization based on quality. This map then forms the basis for deciding about final alignment. In this decision, again several criteria besides habitat quality need to be considered:
  - Size of land occupation and its proportion to the entire area of interest
  - Potential fragmentation and its effects (means of separating the locality – e.g. leading the route on the side or in the middle)
  - Impact on core areas (in case the locality is not homogeneous in its quality)

Protection of habitats = only one viewpoint in the selection of possible variants → necessary to always search optimal solution in relation to all environmental elements
Alignment in urban and suburban landscapes

- Urban and suburban landscapes: strongly anthropogenic character with elements of industrial, transport and housing infrastructure dominating natural elements

  • Basic criterion for route optimization: lowering the impacts on human inhabitants (first of all minimization of noise and air pollution). That however does not mean ignoring the impacts on nature.

  • Minimize interventions into smaller and less preserved natural elements, which would in other landscape types remain unnoticed, but have their relevance. These are smaller forest patches, minor streams, trees and shrubs and all other elements belonging to so-called green infrastructure.

  • Not to increase the probability of entering towns by large and medium-size mammals and adjust the solutions of migration objects.
➢ Design solutions of particular technical components

- Earthworks: cuttings and embankments

Cuttings and embankments: components that help with route alignment. Can also be used to better integrate the infrastructure with natural landforms or even provide opportunities for various habitats to be created.

The following aspects should be considered:

- **Integration into the landscape**: grading out of earthworks to suitable slopes, which also ensures efficient use of materials. In certain areas, irregular cuttings (e.g. in woodland changing with rough pasture) or false cuttings (especially in gently undulating ground) could be good solutions, in others rock outcrops can be created as most appropriate. It is also beneficial to round off the tops of cuttings to a gentle profile or to use terracing to break up the sides of deep cuttings to overcome their visual dominance (which brings structural stability and facilitates the establishment of vegetation as well).
• **Elimination of disturbing effects:** together with good integration into the landscape → reduction of noise, light, pollution and other negative effects of transport infrastructure on fauna

• **Traffic safety:** several safety issues to consider for proper design of cuttings and embankments
  ✓ always contain escape routes for people in case of emergency
  ✓ should effectively stop especially larger animals from crossing the infrastructure
  ✓ needs to secure potential falling stones or other material on steeper cuttings

• **Maintenance:** keeping all elements of an infrastructure functional and in good state → regular maintenance

• **Ecological importance:** earthworks and other infrastructure edges can become interesting habitats and host various plant and animal species. Examples include rock exposures in upland areas, rich xerothermic communities or habitats with native grasses or bushes. Respecting local natural character and appropriate management and maintenance are all very important.
- **Junctions and roundabouts**

Highway junctions and roundabouts:

- Can be wildlife traps or islands

- Very intrusive unless well sited and designed with earthworks at a scale appropriate to minimise the impact of any signs, gantries, lighting and overhead crossings

- Should be designed to avoid fragmentation with good connections above or below the carriageways as is appropriate for the species native to the area

- Connectivity between the segments of a major interchange: important for the movement of fauna and can be achieved using culverts or tunnels. These passages have to be combined with fencing with exits for large mammals.
- **Tunnels**

  - Expensive but may be the best design solution to protect high-value landscapes + desirable solution from engineering point of view compared to extensive excavations

- Two basic methods of tunnel construction:
  - **Bored tunnels**: allow sites of high nature conservation value to remain undisturbed and are least damaging environmentally
  - **Cut-and-cover tunnels**: more appropriate for sites of lower conservation interest, but where maintaining connectivity between habitats is desirable

The reuse of the original soils should be considered if they can be stripped and stored in such a way as to minimise compaction and loss of structure. The soil profile should be constructed to match the adjoining profile in order to reproduce the hydrological characteristics as well as the physical structure and chemical properties of the original substrates.

Where the cut-and-cover tunnel is to be used by a range of fauna, the natural vegetation type for the species’ habitat should be planted over the tunnel and on the approaches.
Water management (Drainage)

The main goals of water management are:

- To safely drain precipitation water from a road.
- To control integration of this water into the surrounding environment, so that no damage to property, nature or water resources is caused.
- To create conditions for the capture of polluted water in case of accidents.
- Associated water management features (drainages, ditches, retention reservoirs) have to be built in a way that ensures suitable integration into the landscape, no formation of barriers or traps for animals and if possible also improved conditions for fauna in the surroundings.
Fences and walls may have serious barrier effects as well as a significant effect on the appearance of the road in the landscape. Their use should be restricted to locations where they are absolutely necessary (effective reduction of fauna mortality and improvement of traffic safety is expected).
Vegetation adjustments

Common part of road/railway project preparation

Vegetation adjustments = new ecological element in the landscape → effect of vegetation adjustments can be both positive and negative. Proposing such adjustments has to be based on local conditions and should optimize their functions.

- **Biotechnical function**: stabilization of slopes to prevent sliding, protection of soil on slopes from water erosion. Technical solutions needed especially for anti-erosion protection on longer slopes of embankments and cuttings.

- **Influence on conditions of operation**: changes in microclimatic conditions (increase in humidity, limiting climatic extremes), improvement of health conditions (reduction of dust, noise, etc.), increasing traffic safety (optical leading, capturing vehicles out of control, protection from glares from oncoming vehicles, limiting undesirable climatic effects, etc.).

- **Landscaping (aesthetic) function**: integration into the landscape, improving road appearance, positive effect on landscape character, etc.

- **Biological and ecological function**: increasing landscape stability, creating optimal volume of biologically active matter, incorporation into the ecological network of the landscape, support of biodiversity, compensation of negative effects of transportation, etc.
The last point is crucial from the viewpoint of biodiversity conservation so several comments are added here:

- **Suitability** of certain type of vegetation adjustments depends mostly on surrounding habitats. Cuttings and embankments: more sun-exposed and drier than surrounding habitats and often host xerothermic vegetation of high ecological value → advisable to prefer natural succession over artificial planting.

- **Steppic character** of embankments and cuttings: migration routes for thermophilic species along the road/railway. Road verges can also pose environmental threats.

- Create corridors for **spreading of non-native species**: if vegetation along roads is attractive for some species, the high concentration of animals can bring increased mortality.

- Keeping an **empty verge near the road**: advisable regarding the risk of collisions of vehicles with animals → increases lookout conditions and makes it easier for both drivers and animals to react better.
• The slopes of embankments and cuttings = rocks or stony rubbles → **suitable habitats** for reptiles and invertebrates. Should remain untouched to maximum possible extent.

• **Traffic safety**: not recommended to plant trees that could in adulthood fall on the road after a wind gust.

• When leaving space for natural succession of xerothermic vegetation, it is necessary to continuously **implement suitable maintenance** (cutting of shrubs and trees).

• Proposal of vegetation adjustments has to be solved also in relation to **road fencing**. It is not recommended to plant trees and bushes (hiding sports for animals) in the fenced area (between the road and the fence) → strong motivation to break the fence and to get dangerously close to traffic.

• Proposal of vegetation adjustments should be based on using of **original tree and shrub species** corresponding to given pedological and climatic conditions. Where possible, natural tree and shrub regeneration can be an optimal way to achieve the ecological functions of verges.

+ necessary to avoid planting of invasive alien species
Thank you!