# THE CUMULATIVE EFFECTS OF ASSESSED DEVELOPMENT PROJECTS ON THE MALACKY LANDSCAPE

## KUMULATÍVNE VPLYVY POSÚDENÝCH PROJEKTOV NA KRAJINU MESTA MALACKY

**Vyskupová M.**

Department of Landscape Ecology, Faculty of Natural Sciences, Comenius University Mlynská dolina B2, 842 15 Bratislava, Slovak Republic

E-mail: vyskupova@fns.uniba.sk

## ABSTRACT

Our objective in this research was to outline the need of cumulative impact assessment in the EIA process and the possibility to assess cumulative impacts taking into account also the carrying capacity of landscape components. On the model area in Slovakia we predicted the impacts of individual development projects, specified their potential accumulation and determined their significance according the set of vulnerability of each affected environmental component. We came to the conclusion that this possibly could be a method for practical use in maintaining sustainable development of concrete area.

**Key words:** cumulative impact assessment, impact, landscape

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# INTRODUCTION

Cumulative environmental impact assessment as a part of environmental impact assessment process (EIA) is a pre-decision tool for avoiding adverse anthropogenic effects on the environment. This process focuses on those effects which can occur when impacts on the natural and social environments take place so frequently in time or so densely in space that the effects of individual projects cannot be assimilated (Ramachandra, 2007). In practice, the most difficult part of this process is to identify related impacts of various development projects in terms of a potential occurrence of cumulative effect and to consider their significance for the affected environment as a base for specifying appropriate mitigation measures.

The important part of our environment which is affected by development projects almost every time is a landscape itself. We can notice the basic landscape changes as changes of landscape structure. Although we can see fragmentation or conversion of land structure elements, these processes are more extensive and are usually connected with decreasing of landscape stability and subsequently with reduction in quality of human life because the state of landscape is a fragile expression of natural conditions, regional culture and local identity (Lipský, Romportl, 2007). To avoid the oncoming problems we can operate with landscape carrying capacity. It is a landscape characteristic which expresses how many changes caused by exogenous factor the landscape sustains. It determines the range of feasible human land use activities, while the natural characteristics, the basic processes and interactions between landscape elements and the quality of the environment will not be disrupted or destroyed (Drdoš, Hrnčiarová, 2003).

Otherwise the carrying capacity can be expressed as a vulnerability of landscape elements which represents an extent of acceptable volume of landscape changes while respecting its thresholds (Wilson et al., 2005). So the potential solution to maintain the quality of the landscape at the suitable level is to determine the carrying capacity of each affected component and subsequently select activities whose impacts will not exceed it and for the other ones suggest appropriate mitigation.

Practically we can say that the vulnerability of geological substrate and rock base is linked to its thickness, nature, integrity, and lithology, hydrological and hydrogeological conditions. The vulnerability of soil is connected with its types, granularity, and structure, position of the soil layers and also the way how the contaminants can penetrate into them. The vulnerability of water surface is given by the presence of sources of pollution, the character of water flow, if it is widely open and its self-cleaning ability. For the groundwater is important the collector position, the quality of infiltration and the aquifer level. The air condition is influenced by discharging emissions so the vulnerability of this environmental component depends on the amount of emissions and the type and multiplicity of sources. Important factors for the carrying capacity of this element are also the amount of precipitation that falls in the locality, strength and direction of wind and also types of filtration in the sources. The vulnerability of biota is predominantly based on the type of plant cover, their origin and current state and also on its distance from urban settlement and other human-influenced territories. For animal species their abundance on the locality is important, also the authenticity to that place, the state of their habitats and representation of their food options. Regarding the structure of landscape we can mainly talk about its sensitivity to land use conversion and the vulnerability of the landscape view is linked with the architectural trends of urban settlement, typical rural character of marginal places, eventual inappropriate landscape features or possible vertical distortion of today´s components.

## MATERIALS AND METHODS

In our research we outline a possible method how to identify impacts with eventual cumulative occurrence, how to evaluate their significance and how to predict potential landscape changes in terms of its carrying capacity. For this investigation we have chosen a model area Malacky situated near the western border of the Slovak Republic (map 1). The exact time frame for our research was determined from 1st of September 1994 when the first Slovak law on EIA was effective to 1st September 2012. During this time 30 different development projects were proposed. All of these projects met the limit values prescribed by actual law on EIA (Act No. 127/1994 Coll., Act No. 391/2000 Coll., Act No. 24/2006 Coll. as amended) so they were individually assessed.

For cumulative assessment it is necessary to consider not only time frame of construction and operation of activities but also their spatial context (Smit, Spaling, 1995). So in addition we checked other projects near this selected area proposed on set time. We found other 5 industrial projects near the eastern border of Malacky, which potentially have considerable impacts on the affected environment. So we had to set a new southeast border of our model area (see map 2) and while assessing took into account also these five activities. Then we detected the technical and technological construction and main features of operation of proposed activities using the documentation from the EIA process. The realization of all of them was in final statements and decision from screening step recommended although for some of them with necessary mitigation measures. For verifying this written information we predicted the potential impacts on the environment including landscape of each action individually during their construction, operation and after operation. Finally we identified the potential accumulation of them as you can see in table 1.

To consider the effects of proposed projects on the landscape structure we created a map of current landscape structure using the tourist map of this region, aerial photos and additional field survey. We further identified 21 basic structural elements of current land use (see map 2). The map was created as an extension of previous simple map in the geographic information system ArcGis 9.3. in the Cartesian coordinate system S-JTSK.

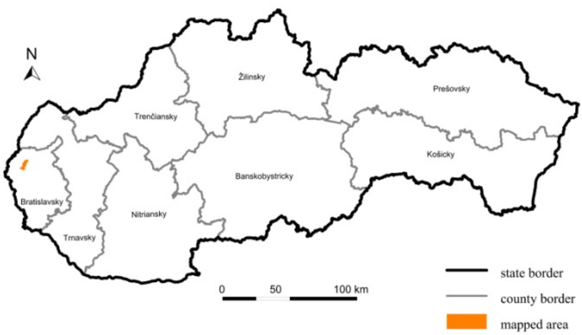
The carrying capacity of affected parts of environment was specified for determining the significance of the identified impacts (table 2). For the detection of changes of affected landscape we first carried out some basic literature search about the environment of model area such as information about local climate, geology of locality, occurring soil types, hydrological conditions, potential vegetation etc. Using the literature review about the environment of selected locality, the obtained information about their originality, their current state of pollution and from EIA documentation we subjectively characterize the vulnerability of each environmental component verbally and also by numeric values (table 2). We assigned the numeric values to the components according this evaluation scale developed by Roberts (1991): 5 – critically vulnerable, 4 – high vulnerable, 3 – slightly vulnerable, 2 – softly vulnerable and 1 – little vulnerable.

With the weighted matrix method (table 2) we evaluated the impact significance. For this evaluation we used the vulnerability of each affected environmental component multiplied by the assigned weight of impact strength using the following range suggested by Pavličková (2009): value 0 (without impact – the proposed activity will not affect landscape components in any way), value 1 (insignificant impact – mainly impact with character of risk or coincidence), value 2 (small significant impact – impact with low quantitative influence, local impact), value 3 (significant impact – the impact on the wider environment with high reception) and value 4 (very significant impact (reception is very high).

## RESULTS AND DISCUSSION

The model area of presented research is situated in the western part of the Slovak Republic in the Bratislava region and Malacky district (see map 1). This zone covers an area of 2618.92 hectares and according to urban and municipal statistics (Statistical Office, 2012) has in the year 2010 18 132 inhabitants.

*Map 1 A placement of model area within the Slovak Republic*



According to Mazúr and Lukniš (2002) the relief there consists of plains and floodplains on the west and of undulated plains on the southeast. The whole area extends on the Bor lowland which is a part of Záhorská lowland, Vienna basin, Pannonia basin and the Alpine-Himalayan system. Lapin et al. (2002) ranked this territory to the warm moderately dry region with 50 or more summer days annually in average with daily maximum air temperature min. 25 °C and with mild winter. The geological structure of this zone is formed with Pannonian and Pontian gray, mostly calcareous clays. silts, sands, gravels, lignite seams and freshwater limestone horizons. The quaternary deposits consist of fluvial sediments (mainly floodplains humic loam or loam and sandy loam, partly with gravel-sandy loams of river valley floodplains) and calcareous and noncalcareous wind-blown sand (Maglay, Pristaš, 2002). According to Slovak soil map (1993) for the southern part of this locality are typical arenosols, on the southwest we can find mollic fluvisols and mollic gleysols and on the northeast cambic arenosols. Maglocký (2002) described the potential natural vegetation in the river basin as hardwood alluvial forests, in lowlands as hygrophilous oak-hornbeam forests and on the south pine forests on sand and sand-dune grasslands.

During the last 18 years 35 various development projects were planned in this locality. Specifically, the majority of these intentions were connected with industrial development of this region, such as modernization and increasing of production, reconstruction of existing halls and enlargement of storages. Also three shopping centres, three larger groceries and two residential zones were planned. The realization of all of them was in final statements and decision from screening step recommended although for some of them with necessary mitigation measures. For verifying this written information we predicted the potential impacts of each action individually as you can see in table 1 below. Basically almost all of proposed activities will cause during their construction more temporary impacts such as the building mechanisms will produce more emissions into air, their mobility and service will cause more dust, animals living near the site will be disturbed and so on. One of the permanent effect that we carried out is that more proposed industrial plants will have negative effect on the local air due to discharge of emissions of $CO_2$, particulate matter an $NO_X$. When we also consider obtained information from noise studies done by the EIA, intensive are also the noise values of seven proposed industrial plants. The larger activities such as golf park near pinewoods and residential zones with 62 and 80 detached houses on former arable land will radically change the landscape view. Landscape structure will be affected by some of these activities which will change the current land use to a new one. The other activities will be constructed on the paved surfaces in built-up areas of settlement or industrial use so the land structure elements there will not be changed.

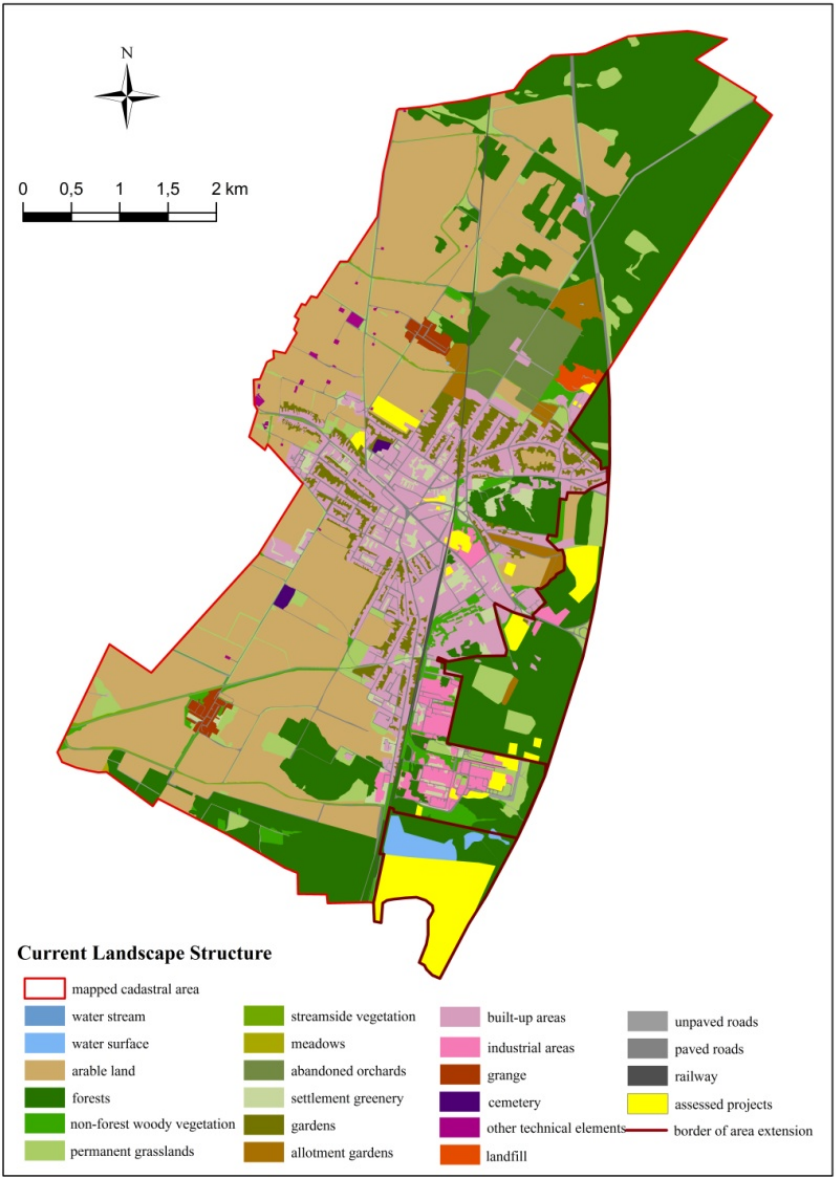
*Tab. 1 The model of a simple matrix used for identifying permanent potential impacts*

| Receptor | Project 1 | Project 2 | Project 3 | ... | Project 34 | Project 35 | Cumulative impacts |
|---|---|---|---|---|---|---|---|
| geology and rock base | | x | | ... | | | |
| soils | | x | x | ... | x | | |
| water areas | | x | | ... | | | |
| air | x | x | x | ... | x | x | x |
| biota | | x | x | ... | x | | x |
| protected areas | | x | | ... | | | |
| noise | | x | x | | x | | x |
| landscape structure | x | x | x | ... | x | | x |
| landscape view | x | x | | ... | | x | x |

In almost all related final statements and decisions from the screening step the impacts of proposed projects were evaluated as little significant. However when we put the related impacts together and consider also the carrying capacity of affected environmental components, the potential impact is more extensive and could cause effects which are more important because could endanger the environment.

As we mentioned before, people can notice the basic landscape changes as changes of landscape structure. So both dimensions, the time and the spatial, were taken into account while considering the adverse effects on the Malacky landscape. From these points of view we detected that the size of industrial area is getting bigger in recent years mostly on the eastern part of Malacky (see map 2). We tried to review the importance of this potential cumulative impact setting the impact significance and the vulnerability of each affected environmental component in the weighted matrix below. We found out that the overall effect of this landscape has really strong influence on landscape ability to cope with adverse effects.

*Map 2 Current landscape structure of mapped area and the placement of assessed projects*



The rock base and geological structure of affected area will not be markedly influenced neither the quaternary cover. The proposed projects can little increase the evaporation because the cover layer can be removed due to construction activities. Also if there is detected some eolic erosion on sandy soils, these activities can accelerate this current geodynamic process. These effects are not so likely so we marked the vulnerability of this environmental component with value 1.

The affected soil we also marked with value of vulnerability 1. The reason is that even these soils are sandy and little resistant, the concrete projects are situated into areas where these are already fixated or the other activities are not so expansive. But there is still some possibility of contamination risk or eolic erosion.

The water areas are also marked with the value of vulnerability 2. This is due to the distance of water surface from development projects and the depth intervention of mentioned projects. The final recipient for sewage of all of these projects is Malina stream which means that the there will be greater load and potentially the stream quality can be worse.

The air condition in this area is given the vulnerability of value 5 because according the available materials which we had, the current quality of air in this locality, mostly in the southeast part, is considerably worse. To not exceed the permissible limits for pollution the local air quality various kinds of mitigation measures have been set as conditions for implementation of some projects. The air is influenced also by the movement of car traffic on roads and by the close railway.

The vulnerability of local biota we marked with value 3, because the animal and plant species were significantly important during the construction phase of projects by increased noise, local higher production of air pollutants by movement of building mechanisms, then by the local conversion of soils, local deforestation, by the reduction of plant cover etc. During the operation phase of activities there will be other potential threats such as spreading of synanthropic species, potential introduction or permanent occupation of habitats.

For the close protected areas we selected the degree of vulnerability 2 because near the majority of proposed activities there is no concrete locality valuable in terms of biodiversity conservation. Only on the eastern part of the area we can find Marhecke ponds which are special area of conservation labelled as SKUEV0121, a part of the European net NATURA 2000 and according the territorial system of ecological stability one local biocoridor Mlaka stream.

The sensitivity value of noise we marked with value 4 because in this locality there are a lot of sources which currently influenced the limits permitted by actual Slovak law. The actual noise level in this locality is due to close first class road, railway and industrial activities high enough so even small increases can cause crossing these limits.

Also the structural components of this area are given the value of sensitivity 4. The reason is contingent by very frequent change of recent land features to new ones which means total conversion of land use. With this is partly connected also the landscape view which we gave the vulnerability values 3 because half of projects is proposed into the urban settlement with appropriate architectonical proposals and other are nominated as a fluent contiguity of it to the rural parts.

*Tab.2 The model of a weighted matrix used for evaluating the significance of potential permanent impacts*

| Receptor | Vulnerability A | Project 1 | | Project 2 | | Project 3 | | Project 34 | | Project 35 | | CI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | a | A.a | b | A.b | c | A.c | d | A.d | e | A.E | (A.a)+(A.b)..+(A.e) |
| **geology and rock base** | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **1** |
| **soils** | 1 | 0 | 0 | 2 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | **5** |
| **water areas** | 2 | 2 | 4 | 3 | 6 | 0 | 0 | 1 | 2 | 1 | 2 | **14** |
| **air** | 5 | 4 | 20 | 4 | 20 | 3 | 15 | 3 | 15 | 4 | 20 | **90** |
| **biota** | 3 | 3 | 9 | 4 | 12 | 3 | 9 | 3 | 9 | 0 | 0 | **39** |
| **protected areas** | 2 | 2 | 4 | 2 | 4 | 0 | 0 | 1 | 2 | 0 | 0 | **10** |
| **noise** | 4 | 1 | 4 | 3 | 12 | 4 | 16 | 3 | 12 | 2 | 8 | **52** |
| **landscape structure** | 4 | 4 | 16 | 4 | 16 | 4 | 16 | 3 | 12 | 1 | 4 | **64** |
| **landscape view** | 3 | 3 | 9 | 4 | 12 | 2 | 6 | 2 | 6 | 4 | 12 | **45** |
| **together** | - | - | 66 | - | 85 | - | 64 | - | 59 | - | 46 | **320** |

**CI – cumulative impacts, a,b,c,d,e – degree of impact significance*

The most significant impact according our outcomes (with total value 324) is impact on landscape structure of the model area. As we mentioned before, the proposed actions mean a great modification of land use and conversion of actual land use elements to other ones. For example the intention suggesting to build a new shopping centre will change the current abandoned arable land to paved area full of amenity objects.

The second most significant impact with total value 315 from these activities is an effect on local air quality. According to seven noise studies made as a part of environmental impact statements and intentions in the EIA process, air quality in the southeast part of model area is due to industrial use currently very low. If we start more activities discharging a bigger amount of emissions into air without properly mitigation measures, the quality of air will get worse and it will negatively affect local inhabitants, home biota and also the macroclimatic conditions.

Also important is that the deforestation on the eastern part will cause smaller mitigation of air flow. Very important impact is also overcoming the noise limits (reached the total value 240). The most liable parts of the model area are in the industrial southeast and the eastern part with urban settlement near that. There are planned a lot of noisy activities such as furniture production, mill for car bodies or waste shredders. There will be also an increase in car traffic and in carriage. All of these actions are situated near the railway and first class road which are very frequent. For these reasons and because of the proximity of urban settlement it is essential to use special technologies or to built there some noise barriers.

Not least significant are also impacts on landscape view (the total value 201) which will be supplemented in the industrial part by more storage, parking places, roads and produce halls. In the northern part it will be supplemented by waste storages and in the urban area by more shopping places. More visible will be the changes in the peripheral rural parts where the residues of pine and alder forests will be changed to built-up areas or golf course.

Due to all this mentioned changes will be large affected also local biota (the total value 168), ie. there will be made a little deforestation in the eastern part, many plant species will be destroyed and replaced by new landscaping activities as creating urban greenery. Subsequently this will change also the representation of animal species, which will have destroyed or drastically changed habitats.

## CONCLUSION

Landscape carrying capacity is always related to the anthropogenic activity. In one area more various thresholds can exist so the basic problem there is to determine these critical thresholds which point out on the intervention which can cause irreversible changes in landscape. It means the quality of landscape will get worse which will affect also the quality of human life. As one solution we have to consider the actual state of the environmental components locally and take into account every potential disruption not only these which are located immediately into rated landscape element.

As we know, all of development activities can have various adverse impacts on the environment and not only on the exact parts where these projects are proposed. Cumulative impact assessment can help to predict that kinds of impacts which can supposedly multiplied and can cause worse effects than they could cause individually. The great advantage of this process is that we can assess the predicted impacts thinking of the actual carrying capacity of each affected environmental component. With our research we confirmed our conviction that this preventive process is one of the suitable tools which can show us how to use our landscape sustainable and how to harmonize human requirements for land use with the options which are offered by the landscape itself.

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