Methodology of Visual Pollution Assessment for Natural Landscapes

Jūratė Kamičaitytė-Virbašienė

Kaunas University of Technology, Faculty of Civil Engineering and Architecture
Studentu st. 48, LT-51367 Kaunas, Lithuania

Giedrė Godienė

A. Baranausko st. 8, LT-04224 Vilnius, Lithuania

Gintas Kavoliūnas

Vilnius College of Design, Kauno st. 34, LT-03202 Vilnius, Lithuania

Corresponding author: **jurate.kamicaityte@ktu.lt**

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In 2014 the Ministry of Environment of the Republic of Lithuania initiated creation of Methodology of the Assessment of Visual Pollution to Natural Landscape Complexes and Objects. In order to prepare the Methodology legal (international and national level) and theoretical framework (world-wide and Lithuanian experience in the field of visual impact assessment (VIA) and assessment of landscape visual-aesthetic potential) was analysed and evaluated. Using the method of logical analogy and considering the results of analysis of legal and theoretical framework of VIA, and peculiarities of Lithuanian landscape, the concept of visual pollution and the main methodological stages of visual pollution assessment (VPA) for natural landscapes were proposed. The authors of the methodology state that the assessment of visual pollution should be based on: the establishment of the overall landscape character, visual character, visual capacity, and other aspects as the starting point for the evaluation of visual pollution; assessment of visibility of a pollution object; description of physical, visual and other characteristics of the pollution object; evaluation of negative visual impact (visual pollution) according the level of contrast of physical, visual and other characteristics of landscape and the pollution object.

KEYWORDS: natural landscape, visual pollution, visual impact assessment, methodology.

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Introduction

In 2014 the Ministry of Environment of the Republic of Lithuania initiated creation of Methodology of the Assessment of Visual Pollution to Natural Landscape Complexes and Objects.

Developing the Methodology the legal framework (international and national legislation) of the assessment of visual pollution (negative visual impact) to landscape was analysed. The statements of EU Directives (85/337/EEC (amendment 2014/52/EU); 2001/42/EC), European Landscape Convention (2002), the Recommendation CM/Rec(2008)3 of the Committee of Ministers to Member States on the guidelines for the Implementation of the European Landscape Convention, national political documents (National Landscape policy (2004)), studies (National Landscape Study (2013)), laws (Law on Environment Protection (1996), Law on Protected Areas (2001), Law

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on Immovable Cultural Heritage Protection (2004), Law on the Assessment of Environmental Impact of the Planned Economic Activity (2005), etc.) plans (National Landscape Management Plan (2015)), and other documents were reviewed. The analysis showed that international legal documents create all preconditions for the visual impact assessment (VIA) at the national level. The national legislation requires the avoidance of visual pollution, but there are no recommendations how to assess visual impact (Kamičaitytė-Virbašienė *et al*, 2015).

The analysed theoretical framework consisted of Lithuanian and world-wide experience in the fields of the assessment of landscape visual-aesthetic potential and visual impact assessment. We analysed theoretical issues of VIA in United Kingdom, United States, Germany, Spain, New Zealand, South African Republic, and Australia (Environmental impact..., 2008; Turner, 2003; Visual Resource... 2001; Manual 8431..., 2012; Morris and Therivel, 2001; Guidelines for Landscape..., 2002; Evaluation of Methodologies..., 2012; Böhm, 1996; Guidelines for..., 2005); reviewed Lithuanian experience (scientific works of M. Purvinas (1975, 1983a, 1983b, 1990), P. Kavaliauskas (2011), R. Skorupskas and V. Vasilevskaja (2014), J. Abromas (2014), etc.). Lithuanian and world-wide experience was compared and evaluated considering the concept of visual pollution (negative visual impact) and the necessity of its assessment for natural landscapes. The analysis of experience of foreign countries in the field of VIA, showed that these countries have validated concepts of landscape visual quality and planned activity or object visual impact assessment; systemic and objective methodological recommendations of visual impact assessment, which are used in practical activities of planning and design. Methodologies used by Lithuanian authors are well developed theoretically and intended for the overall evaluation of landscape visual quality or VIA, designation of landscape visual quality classes, evaluation of indicators of visual spaces, establishment of visual resistance and sensitivity of visual spaces (Kamičaitytė-Virbašienė *et al*, 2015). Though parts of some works can be used for the assessment of visual pollution (negative visual impact), there are no created specific methods suitable for visual pollution assessment (VPA) for natural landscapes.

The aim of the paper is to present the concept of visual pollution and the main methodological stages of visual pollution assessment for natural landscapes.

Methods

After the analysis of legal and theoretical framework in the field of visual impact assessment and assessment of landscape visual-aesthetic potential (Kamičaitytė-Virbašienė *et al*, 2015), using the method of logical analogy and considering the results of the analysis and peculiarities of Lithuanian landscape, we proposed the main methodological stages of visual pollution assessment (VPA) for natural landscapes.

Logical analogy has enabled us to formulate scientifically valid notion of visual pollution (negative visual impact), describe the comparative indicators (physical and visual characteristics) of landscape and the object of visual pollution, clarify of the main stages of VPA, and determine the content of each stage of VPA.

Considering the peculiarities of Lithuanian landscape (such as: big variety of landscape types and separate elements, human scale of landscape visual spaces, high degree of fragmentation and quite high level of anthropogenization) we elaborated the content of each stage of VPA.

Results

Visual pollution in the proposed VPA methodology is understood as negative visual impact of *visual pollution object* (VPO) on landscape, i.e. the changes of landscape physical components (relief, water bodies, vegetation, and structures and/or installations) and their visual characteristics that determine the change of landscape character and decrease of landscape visual quality and/or obstruct overview of the valuable natural complexes or objects, diminish visual significance of valuable landscape objects.

Already existing or designed new landscape elements and their modifications (land surface mounds, excavations, structures and/or installations, greene ry, water bodies, movable objects and so on, or significant increase of the existing buildings volume after reconstruction and maintenance works, changes of architectural forms, colours, lines and textures, etc.) can be assessed as a potential VPO if from the particular observation place they:

- are observed by bigger than 1° vertical viewing angle and bigger than 2,5° horizontal viewing angle;
- obstruct 5 percent or more of the visible image;
- has the potential to:
  - change the landscape character;
  - reduce landscape visual quality;
  - obstruct overview of valuable natural landscape complexes or objects, reduce visual significance of the valuable objects on the landscape.

We state that VPA should be mandatory in the protected areas established for the purpose of the protection of landscape or its components, i.e. in all state parks, relevant state and municipal reserves; areas of natural and cultural heritage objects; visual protection zones of state parks and heritage objects; recreational areas; in areas of expressive aesthetic potential designated in the National Landscape Management Plan (2015); in the landscape areas of particularly expressive and medium-sized vertical and horizontal fragmentation with open and semi-open spaces designated in the National Landscape Study (2013). VPA is recommended in the areas which the municipal authorities have designated as the identity-shaping and/or having significant recreational and/or aesthetic potential; from the observation places in the corridors of national tourism routes.

The main proposed methodological stages of VPA for natural landscapes are the following:

1 **Preparatory stage:** description of the observation place, landscape visibility analysis, photo-fixation, general evaluation of natural landscape complex or object (common landscape character, valuable characteristics, rarity (exclusivity), protection status, immanent, ecological, historical-cultural, economic, scientific-cognitive, recreational values and meaning to local identity, function, and regulations), detailed assessment of landscape character, visual nature, values, and capacity (objective indicators of landscape components, indicators of visual spaces, visual dominants, accents, landmarks, landscape visual characteristics (scale, lines, visual plans, forms, colours, textures), landscape visual capacity and possible level of visual constrast, evaluation of overal impression).

2 **Identification of the potential visual pollution:** repeated visualization or photo-fixation, visibility evaluation of the potential VPO: designation of VPO visual impact zone, identification of its horizontal and vertical viewing angle, description of physical and visual features of VPO, its function and style, evaluation of the contrast level and comparison of it with the possible level of visual contrast (Table 1).

Preparatory stage. Describing the observation place, it is necessary to indicate address and name of the place, shooting point coordinates, the absolute height above the sea level, to describe briefly the analyzed landscape, the main landmarks, to specify direction of the observed view, horizontal and vertical viewing angle, recreational and touristic importance of the observation place.

Landscape visibility analysis could be performed using GIS intervisibility function and designating visual influence zone of the observation place. The area seen from the observation place is our landscape analysis and evaluation unit.

Performing photo-fixation attention should be paid to atmospheric conditions, time, photo-fixation height, direction, photographic technique, how many shots are done, if shots have to be

Table 1

Possible levels of visual contrast in areas with different levels of landscape protection

Areas with different levels of landscape protection	Possible levels of visual contrast			
	Considerable	Moderate	Weak	Insignificant
Natural and cultural heritage objects	impossible	impossible	impossible	impossible
State parks, except zones of economic functional priority	impossible	impossible	impossible	possible
State and municipal landscape reserves and reserves in which visually perceived landscape components are protected (geological, geomorphological, hydrographical, urban/architectural, etc.)	impossible	impossible	impossible	possible
Visual protection zones of state parks and heritage objects	impossible	impossible	impossible	possible
Recreational areas	impossible	impossible	impossible	possible
Areas of expressive aesthetic potential designated in the National Landscape Management Plan; the landscape areas of particularly expressive and medium-sized vertical and horizontal fragmentation with open and semi-open spaces designated in the National Landscape Study	impossible	impossible	impossible	possible
Other not protected aesthetically valuable areas	impossible	impossible	possible	possible
Zones of economic functional priority in state parks	impossible	impossible	possible	possible
Other areas	possible *	possible *	possible	possible

* possible if changing of landscape visual type is permited by the territory planning documents

joined, what computer program is used, and other technical data. In the scheme the shooting point, angle and direction should be marked.

General evaluation of landscape character should be performed referring to the National Landscape Study (2013) and using the scheme of physio-morphotops and describing the main landscape elements which are observed. Describing function, regulations, and protection status information from State Service for Protected Areas database should be used; referring to the legislation and spatial planning documents properties of protected landscape complexes, restricted and prohibited activities should be specified.

Elaborating the assessment of landscape character, objective indicators of landscape components have to be established: physiognomic characteristics, height, angle of inclination, specific formations of *relief*; scale and nature, size, abundance of formations of *water bodies*; spatial structure, the dominant species, height, size of habitats, abundance of formations of *vegetation cover* (forests, meadows, wetlands/agricultural land, water plant communities); spatial structure, types, size, abundance of formations, materials used, constructions, historical-cultural significance of *structures and installations*; ratio of open and planted/built-up area (Table 2).

The main analyzed quantitative and qualitative indicators of landscape spatial structure that condition landscape visual character are the following (Kamičaitytė – Virbašienė, 2003, 2011; Purvinas, 1975): size, plan configuration, vertical and horizontal closure, the number of ranks of visual spaces (VS) (hierarchy); integrity, naturalness and variety of VS; degree of dominance of VS components (Table 3). There is also analyzed the existing material of the research of landscape aesthetic potential: scheme of location of emotio-tops (Kavaliauskas, 2011), the scheme of visual structure from the National Landscape Study (2013), material of the National Landscape Management Plan (2015), the data of territorial planning documents, etc.

Table 2

The proposed set of landscape components objective indicators

Landscape components	Objective indicators						
Relief	scale and nature	height	specific formations	angle of inclination	-	-	-
Water bodies	scale and nature	size	abundance of formations	-	-	-	-
Vegetation	-	height and size of habitats	abundance of formations	spatial structure	species	-	ratio of open and planted/ built-up area
Structures and installations	-	size	abundance of formations	spatial structure, types of structures	mate-rials, cons-tructions	historical-cultural significance	ratio of open and planted/ built-up area

Table 3.

Indicators of VS and their characterization acording M. Purvinas and P. Kavaliauskas

Indicators of spatial structure	Characterization of indicators			
VS size (according viewing radius R, m)	R = 50 – 100 m – small VS	R = 100 – 500 m – average size VS	R = 500 – 2000 m – large VS	
VS rank	Place of VS in the hierarchical spatial structure of landscape			
VS plan configuration	Simple VS	Complex VS	Continuous VS	
VS horizontal closure (perimeter of VS occupied by visual obstacles)	Absolute – 90 – 100%	Big – 85%, average – 65%	Minimal – 30%	
VS vertical closure (viewing angle)	Absolute – 45° (details of the object can be seen)	Partial closure – 27° (proportions of the object are perceived)	Partial closure – 18° (object relation with contextual environment and its shape is perceived)	
Expressivity of spatial structure (height of relief and the number of ranks of VS conditions this indicator)	Big expressivity (hilly with deep valleys landscape with 4-5 ranks of VS)	Average expressivity (hilly with vallleys landscape with 3 ranks of VS)	Small expressivity (undulating landscape with 2 ranks of VS)	Unexpressive structure (plain landscape with 1 rank of VS)
VS integrity	integral VS		Fragmented by visual obstacles VS	
VS naturalness	Quantity of natural, athropogenizied and anthropogenic components of VS		Dominance of natural, athropogenizied and anthropogenic components of VS	
VE variety	Quantity of VS components		Location of VS components	
Degree of dominance of VS components	Dominant components of VS according size, form, colour and texture		Background components of VS according size, form, colour and texture	

Landscape visual character is also conditioned by *landscape visual characteristics*: scale, forms, lines, colours and textures of landscape components. There are assessed complexity, expressivity, orientation, and regularity of forms; complexity, curvature, orientation, and intensity of lines; hue, intensity, and brightness of colours; degree of fragmentation, density, regularity, and inner contrast of texture. Scale is described as the proportionate size relationship between an object and the surroundings in which it is placed.

Landscape visual capacity is understood as ability of landscape to integrate new objects without changing its visual character and quality. The main indicators of visual capacity are the following: degree of variety, landscape expressivity, size, horizontal closure, plan configuration, and integrity of VS. The bigger variety and expressivity of landscape, more complex configuration of VS, the bigger closure and fragmentation of VS, the bigger visual capacity of landscape is.

There is also proposed expert evaluation of *overal impression* which helps to identify protected individual features and values of the analyzed area.

Identification of the potential visual pollution. Repeated visualization or photo-fixation has to repeat the conditions of the *status quo* view (colours, lighting, etc.). Anlyzing visibility of the potential VPO, its coordinates, the absolute height above the sea level, distance to the observation place, its width, height, vertical and horizontal viewing angle have to be established. Using GIS intervisibility function VPO zone of visual influence is designated. The nearer VPO to the viewer, the bigger its vertical and horizontal viewing angle is. The table 4 shows the relationship between the viewing angle and the size of the visual impact.

Table 4

The relationship between the viewing angle and the size of the visual impact of VPO

Visual impact levels according to the size of the viewing angle	Maximum vertical viewing angle of VPO height measured from the line of the horizon	Maximum horizontal viewing angle of VPO width
Discernible	5` - 0,5°	5` - 1°
Visible but insignificant	0,5° – 1°	1° – 2,5°
Visually significant	1° – 5°	2,5° – 30°
Clearly dominant	5° – 45°	30° – 120°

The next step is description of physical and visual features of VPO, its function and style. There are specified VPO scale, forms, lines, colours, textures; object size, spatial structure, abundance of formations, species (if VPO is vegetation), materials, constructions, etc.

The overall visual contrast level (level of visual polution) is derivative of contrast levels of protected landscape and VPO visual properties and materials. It is determined by comparing visual features and materials characteristic to the individual components of the landscape with potential VPO visual characteristics and materials and determining their contrast (Table 5).

Table 5

Visual contrast rating by visual charcteristics and materials

Landscape components	Relief				Water bodies				Vegetation				Structures			
Degree of visual contrast (comparative indicator)	Considerable	Moderate	Weak	Insignificant	Considerable	Moderate	Weak	Insignificant	Considerable	Moderate	Weak	Insignificant	Considerable	Moderate	Weak	Insignificant
Scale (weight coefficient 2)*																
Forms																
Lines																
Colours (weight coefficient 2)*																
Textures																
Materials																
Overall visual contrast level	Considerable				Moderate				Weak				Insignificant			

***** scale and colour are the most important factors of visual contrast

The overall visual contrast level is influenced by the *style* and *function* of the new object (potential VPO) as well. For ex.: if a modern building will be built near the historic buildings, their style will create high contrast; if a residential building will emerge in the protected forested landscape, their functions will be fully incompatible (high contrast). It is also necessary to assess what proportion of observed panoramas/protected complex or object potential VPO obstructs.

The overall visual contrast can be considerable, moderate, weak or insignificant. Depending on the status of landscape protection different level of contrast is permitted (Table 1).

Considerable contrast means that VPO dominates in the landscape, changes the landscape character and strongly reduces visual quality and/or obstructs overview of the valuable natural landscape complexes or objects (covers more than 12% of the visible image) and decreases visual significance of valuable landscape objects. Landscape visual pollution is high.

Moderate contrast means that VPO draws attention, but does not dominate in the landscape (the landscape accents level), results in some changes of the landscape character and reduces the visual quality and/or obstructs overview of the valuable natural landscape complexes or objects (covers 5% - 12% of the visible image), decreases visual significance of valuable landscape objects. Landscape visual pollution is average.

Weak contrast means that VPO is visible, but little changes the landscape character and only slightly reduces the visual quality (in some cases it may not reduce if the area is not protected) and/or obstructs overview of the valuable natural landscape complexes or objects (covers up to 5% of the visible image), decreases visual significance of valuable landscape objects. Landscape visual pollution is low.

Insignificant contrast means that the landscape changes are minor, do not draw attention and do not alter the landscape character or reduce visual quality; VPO does not obstruct the view. There is no visual pollution.

Conclusions

Methodolgical propopsals of VPA are based on the analysis of world-wide and national legal and theoretical framework of VIA which helped to specify: the main stages in the VPA process and their content, levels of visual contrast, notions of landscape visual capacity, description of the visual characteristics, quantitative and qualitative indicators of visual impact, criteria and indicators of landscape aesthetic potential and visual resistance of VS, etc.

The authors of the methodology state that the assessment of visual pollution should be based on: the establishment of the overall landscape character, visual nature, visual capacity, and other aspects as the starting point for the evaluation of visual pollution; assessment of visibility of VPO (designation of VPO visual influence zone, identification of its horizontal and vertical viewing angle); description of physical and visual characteristics of VPO, its function and style; evaluation of negative visual impact (visual pollution) according the level of contrast of physical, visual and other characteristics of landscape and the pollution object.

The proposed methodological framework of VPA can be used not only assessing visual pollution for natural landscapes but also assessing possible visual contrast of a new object in a townscape, suburban landscape, etc. It is a good starting point for the preparation of the broader methodological work – guidelines for the visual impact assessment that could be used while preparing spatial plans, projects of urban complexes or even designing separate buildings.

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About the authors

JŪRATĖ KAMIČAITYTĖ-VIRBAŠIENĖ

Professor

Kaunas University of Technology, Faculty of Civil Engineering and Architecture, Department of Architecture and Urbanism

Main research area

Landscape visual quality analysis, evaluation and regulation, methods of planned activity or object visual impact assessment, analysis of social preferences evaluating landscape visual quality and use of the analysis results in territory planning, evaluation of the potential of urban structures, expression of sustainable development conception in architecture, landscape architecture, town and territory planning

Address

Studentu st. 48, LT-51367 Kaunas, Lithuania
Tel. +37061477082
E-mail: jurate.kamicaityte@ktu.lt

GIEDRĖ GODIENĖ

Doctor, freelanced landscape expert

Lithuanian Geographical Society, Board Member

Main research area

Landscape impact assessment, visual impact assessment, studies on landscape legislative system regarding the implementation of European Landscape convention, methods and techniques of the public participation, involvement into decision making regarding the landscape issues

Address

A. Baranausko st. 8, LT-04224 Vilnius, Lithuania
Tel. +37068563451
E-mail: g.godiene@gmail.com

GINTAS KAVOLIŪNAS

Lecturer

Vilnius College of Design, Department of Photography

Main research area

Photographic apparatus and equipment, special technologies

Address

Kauno st. 34, LT-03202 Vilnius, Lithuania
Tel. +37068444076
E-mail: gintas@afd.lt