Abstract

In this paper, a novel method of computer aided VAC (Visual Absorption Capacity) estimation is presented which was applied to an investigation in Bad Muskau – Lęknica region. English style Muskauer Park, located in the vicinity, possesses a wide world known values, which a fact was confirmed by its inscribing in UNESCO list in 2004. Therefore, during the process of new investments planning in the both cities, the outstanding values of the landscape should be taken into consideration. Main steps of the method include: building a three-dimensional terrain model, visibility analyses from given vantage points, specification of the most important points, shade volume estimation and indications for the acceptable building height. Maximum dimensions of structures that can be erected in Lęknica were presented in a three dimensional diagram, which takes into account their functional requirements. It is the starting point for cubic volume of potential architecture computation.

1 Visual Absorption Capacity

Visual Absorption Capacity (VAC) of the terrain denotes its ability to absorb new elements, without any loss in its visual integrity. It indicates if given types of changes are possible within the area, regarding its configuration, covering, natural illumination and visibility. In the research, conducted in USA and Canada since late 1980-ties, three aspects of VAC have been taken into consideration: the visual effect building would make on the surroundings (perceptual factors), scale and function of the building (activity factors) and the environmental impact of the new investment (biophysical components) [SMARDON et al. 1987]. The assessment of these parameters was subjective; however basing on general guidelines, systematized in tables.

The method presented below refers to the first two issues, discarding the third one as impossible to be calculated in geometrical terms. Using a computer provides accurate results obtaining.

Regarding benefits VAC estimation can bring, it should play particularly important role for the environment that possesses extraordinary visual features.
2 Local circumstances of the research area

A region of Bad Muskau – Łęknica is located on the both sides of Nysa River. In XIX century a picturesque romantic park was founded here by Hermann von Pückler. Currently, it acts as a dominant of the area [STACHANCZYK & ZEMLA 1992]. After the World War II the terrain was crossed by the state boundary and split between Poland and Germany. The overwhelming majority of the park ground is now located on the Polish side, but the central part with a palace – on the German one.

Łęknica, situated on the right river bank, initially played the role of Bad Muskau outskirts. It maintained this character in the town planning layout, in which still detached houses are the most frequent. Postwar development, leading towards the city transformation into industrial centre, caused a mass destruction in its landscape. Town silhouette, dominated with glasshouse chimneys, is additionally interfered by large trading objects [KĘDZIORA 1997].

With respect to the Muskauer Park inscription into UNESCO list in 2004, preservation zones were marked out, embracing the major part of Łęknica [MPZPML 2005, ZSUiKZPM 2006]. Therefore, a problem of landscape protection plays significant role in the decision making, concerning future city development [KLUPSZ & ZEMLA 1995].

In recent years, cooperation of both countries involved in this process was established, in which particularly the German local government has been active. The vantage points located on the left side of the Nysa River were determined [See: Fig 1]. They relate to the views experienced by the static observer looking on the Polish side of the Park, as well as on Łęknica city lying in its neighborhood [FLÄCHENNUTZUNGSPLAN 2003].

Fig. 1: Vantage points location in the German part of Muskauer Park
3 Research method

The method of computer aided VAC estimation bases on the assumption that viewpoints can be precisely placed in 3D terrain model on their real height and visibility from them can be determined using ray-tracing algorithm of local light [APPÉL 1968, KAY 1979, WHITTED 1980, FOLEY et al. 1994, OZIMEK 2003]. The visibility diagrams allow making initial studies that will constitute basis for future decisions making about new objects localization. This approach leads toward city planning, in which visual assets of the region will be improved. The terrain configuration is the factor, which has the most permanent impact on the visibility. The rest of the scenery constituents, like trees or buildings, have more temporary character. They can be successively changed by the local policy, concerning regional planning. Therefore, building 3D model of the given terrain was the starting point of the research.

In the model mentioned above, viewpoints were positioned and point lights were located there. Fragments of the land surface lit are in view of a person standing in particular place. Graphs, obtained thanks to this method, show the areas visible nowadays, with the existing greenery (parts marked with black color), as well as areas potentially visible (obscured only by the ground convexities, without any trees on the Polish or German side of Nysa – marked with grey) [See: Fig. 2].

![Visibility diagram](image)

**Fig. 2:** Visibility diagram (for vantage point 2). Areas marked with black are obscured only by the terrain configuration. Light and dark grey fragments could be visible if there were no trees on the German or Polish side.
Regarding the fact that visibility is binary (an object has two possible states: is visible or invisible) the images, originally in grayscale, were transformed into 1-bit color depth (black and white images) [See: Fig. 3 and 4]

Fig. 3: Visibility from point 2. An image obtained as a result of terrain lighting.

Fig. 4: Visibility from point 2. The same image after binarization (with a threshold equal 1).

On the ground of visibility diagrams, valorization of points was conducted, with the major criterion of the visible area size. Situations with minimal range of sight were ignored in further analyses.

Individual diagrams were composed, in order to create collective visibility maps, in which lightness of grey color symbolizes the level of passive exposition of the analyzed part of terrain [See: Fig. 5]. All the diagrams were executed in orthogonal plan, the optimum projection for making compilations and comparisons with the other GIS data [KRÄAK & ORMELING 1998].
In this map, the edge of visibility can be found. It appears in the place where the unevenness of the terrain obscures more distant parts of land and, as a consequence, they are not visible for the observer. This line allowed constructing a boundary surface. All the objects situated below it will be hidden for a perceiver watching a scene from the vantage point and will be localized within a shadow volume, constrained with the boundary surface (above) and the ground rim (underneath).

In the next phase of analyses, the existing view curtains were taken into consideration. In this case, greeneries play significant role in the landscape perception. Therefore, green belts were introduced, taking into account the specific trees height (kinds, age, conditions) [See: Fig. 6]. As a result, shadow volume has changed, because tree tops have been taken into account in its calculation.
Fig. 6: Existing view curtains – the main greenery belts

Diagrams of visual absorption capacity were executed for all the view points with approximation of the height to 1 meter, and thus they were visualized, originally in spectrum color scale (here presented in grayscale) [See: Fig. 7].

Fig. 7: Diagram of visual absorption capacity (VAC) for the point 2. Intensiveness of gray color visualizes the buildings height, that will be invisible from the vantage point 2.

The entire terrain surface was investigated; however, some parts can be invisible from given points. Basing on the results obtained, the collective map of visual absorption was generated. Parts covered with darker color are nowadays obscured by existing greenery [See: Fig. 8].
VAC level can be enhanced by the new green belts introduction. In the process of their planning, a historical greenery layout and a river scarp underlining, should serve as the primary principles. The proposed pattern of verdure re-composition shows the solution practicable in the current city development phase, when the return to the original state is impossible [See Fig. 9]. New lines of trees have a profound effect on visual absorption capacity [See: Fig 10].

In the next step, obtained data that were intended as a starting point for planning guidelines were parameterized, regarding functional requirements for future building investments on the terrain of investigation. This gave indications for the areas where no structures can be erected, as well as for pavilion buildings (up to 9 meters high), individual and guest houses (up to 12 m), multi-storey buildings (up to 15 m) and higher edifices (with the height more than 15 m) location [See: Fig. 11].
Fig. 10: VAC diagram for the point 2 (with additional greenery). Increase in values is distinct.

Fig. 11: VAC diagram with regard to the buildings function. Ranges shown in this graph served as guidelines for town-planners in order to give precise zones of different land-use types (with: E. Szymańska).
Three dimensional diagram of visual absorption capacity creates a possibility of a new topology construction, which will show the maximum volume of the structures that can be placed on the given area [See: Fig. 12].

![3D diagram of VAC – maximum building height](image)

**Fig. 12:** 3D diagram of VAC – maximum building height

### 4 Conclusion

Analyses of visual absorption capacity for Łęknica and its surroundings provided diagrams that can be used by town-planners in order to formulate rules, according with new investments in the city should be planned. The study was restricted only to visual aspects; in consequence, complex problems concerning environmental impact of new buildings, as well as social and economic factors, were a subject of distinct investigations.

As far as visual characteristics are considered, the authors were able to generate diagrams only for points located on the German side, which had been defined in the plan as a result of former landscape studies. The same procedure should be executed for the terrain on the Polish side of the state border. Research on the moving observer sensations can constitute the next phase of this examination. Animations along scenic routes indicated in the city plan would be able to visualize a question of dynamic perception of the landscape [CULLEN 1961].

### References


