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USING THE 3D COMPUTER SCANNING METHOD IN THE ENVIRONMENTAL IMPACT ASSESSMENT

Summary

This article presents the possibilities of using computer scanning to design a location for a sewage treatment plan taking into account its impact on the landscape. The activities undertaken could constitute a part of the proceedings carried out in performing environmental impact assessments. Completion of the goal requires literary studies and the analysis of interdisciplinary studies, including planning, land and academic research. The research has been divided into several parts, of which the first one concerns, among other things, the analysis of the value of the natural environment in a given area and analysis of the planning documents in place. The land research consists of scanning the area for the sewage treatment plant using the 3D method. The collected data will constitute the basis for the possibility of using computer scanning to visualise the development in an area of high landscape value.

Key words: spatial policy, environmental impact assessment, 3D visualization, Białka Tatrzańska

INTRODUCTION

One of the mechanisms, which may impact on the decisions taken in the area, and at the same time the basic tool for managing environmental protection in the development processes, is a procedure regarding issuing decisions about environmental conditions and environmental impact assessment in the Nature 2000 areas. Environmental assessment provides comprehensive and synthetic knowledge about potential consequences of the planned activities and about the possibilities of avoiding or relieving them. It constitutes, next to the local spatial development plans, the basic tool for regulating the rules of spatial management. It allows for introducing issues connected with environmental protection to the decision making process, providing a valuable tool which assists in the planning

process [Sas-Bojarska 2007]. The environmental impact assessment is a procedure incorporated in the rules of sustainable development, and most of all, it is a tool which supports sustainable development of a given commune. Trying to determine the sustainable development "as a process which aims to achieve the same goals for the next generations" [Our Common Future 1987] and particularly important seems to be the role of decisions taken by the local authorities with regards to the environmental impact assessment. ... these are in fact the planning and location instruments which constitute the basic tools determining the shape of the space filled with anthropogenic buildings" [Kistowski 2003, Hełdak 2009, Hełdak Raszka 2011]. Prieur [2006], discussing the preamble to the European Landscape Convention, refers to its promotion of: ''all four ingredients of sustainable development (social, ecological economic and cultural improvement)'' [Owen & Sarlöv 2009].

The procedure of environmental impact assessment is supposed to provide the decision-making public administration body information, whether a development's interference in the natural environment has been planned in the optimum way, ensuring restricted interference in the environment and compensating the losses sustained be the environment, which are usually impossible to avoid.

Landscape and visual impact assessments are important parts of the iterative effects of the development and, where appropriate, can also help in seeking opportunities for landscape enhancement. During site selection and the initial design of the layout for the development, the landscape architect may produce:

– land use/landscape strategies to evaluate and address constraints, taking advantage of environmental opportunities for each of options available;
– comparative appraisals of alternative options, to identify those with least overall adverse environmental effects on the landscape and visual amenity [Guidelines for Landscape … 2002].

In Poland, basic regulations concerning the environmental impact assessment have been included in the act of law from 3rd October 2008 regarding information about the environment and its protection actions in environmental protection and about assessment of the environmental impact (Journal of Law No. 199, item 1227). Instigation of a procedure regarding environmental impact assessment takes place when a development may significantly or potentially impact the environment, which has been determined in separate regulations. As part of the proceedings, verification of the report concerning the development's impact on the environment, including opinions and agreements required by law, also ensures that the public is entitled to take part in the proceedings.

Currently, the proceedings are instigated in certain circumstances, e.g. regarding intention to complete a development in the area of Nature 2000. An application for issuing a decision regarding location for a public purpose development is accompanied by an environmental impact assessment which constitutes part of proceedings with respect to issuing a decision about environmental

conditions. Hence, the proceedings are carried out before the decision regarding building permit is granted.

Within the administrative proceedings, which are completed when the decision on environmental conditions is issued, direct and indirect impact of the planned development is determined on natural environment, social environment which includes health, living conditions, material goods and on culture monuments and mutual links between these elements. The assessment also determines possibilities and ways of preventing or relieving the negative effects of environmental impact and the required scope of monitoring. In the case of more bothersome developments it will allow for determining realistic impact on natural and social environment during operation and for potential correction of undertaken remedial actions.

The essence of the discussed procedure of environmental impact assessment is therefore to forecast potential threats – at the stage of development planning (issue of the planning decision) – which may exert significant impact on the environment and then counteracting or restricting them.

In many Western countries within the EIA a method of landscape and visual assessment is used and is integrated within the planning and designing processes. A link between planning procedures, design and completion of an investment and EIA enables, in further stages of decision making, taking into account environmental conditions and development possibilities. Current forecasting practice is based on the division of the environment into components and on independent testing of effects in each of them by a separate expert. As a result, an incoherent picture of the environment and changes taking place within the environment arises…[Sas-Bojarska 2007]. A method of forecasting impact of the development on environment proposed by Sas-Bojarska assumes testing the effects in a division into function, form and significance. Its foundation is an assumption that the only element of the environment which fully reflects the aspect of function, form and significance is the landscape.

The research carried out of forecasting landscape changes refers to a chosen area of Białka Tatrzańska village in the commune of Bukowina Tatrzańska. The work's aim is to analyse possibilities of using computer scanning in the process of designing a sewage treatment plant, taking into consideration its impact on the landscape and searching possibilities of the most advantageous solutions in the scope of scale and building's dimensions. The work undertaken could constitute part of the proceedings regarding environmental impact assessment.

To achieve the goal of the work literary studies, interdisciplinary studies - including planning – analysis, land studies are required. The work consist in integrating knowledge and research, coming from different fields, concentrated around the issue of shaping environment in rural areas. The research has been divided into a few parts of which first concerns analysis of natural environment

values in a chosen area and analysis of planning documents. The field research consist in scanning the area for location of the sewage treatment plant with 3D methods. Collected data will constitute the basis for the possibilities of using computer scanning in visualisation of the development in the area of high landscape values.

Among the used materials are current *Change of a study of land use conditions and directions of Białka Tatrzańska* [2006], application for building permission for location of public purpose development, photographic documentation and three-dimensional area map (3D method).

NATURAL VALUES OF THE RESEARCHED AREA

Geographically, Białka Tatrzańska is situated in the area of the Orawsko-Nowotarskie Depression. The northern part, where the planned sewage treatment plant is located, is part of the Nowotarska Basin. The eastern part of Białka Tatrzańska with its existing buildings is situated in a V-shaped basin of the Białka River. With regards to the tectonics, the village is located in Podhalańska basin. The village is placed at the 670-750 m above sea level, in a valley, on the left bank of the Białka River [Wolanin et al. 2005].

The area of the planned sewage treatment plant is situated in the Basin of Białka River which is a right-bank tributary of the Dunajec River. The Białka River starts in the area of Tatry Wysokie and its water is very clean. The Białka flows through the village along its eastern border. The river bank is quite steep, rocky and partly regulated, and in some parts the river has preserved its natural character. The area of analysis is situated between Białka river and local road Białka Tatrzańska – Nowa Biała, in the floodland area.

In the area of the Białka valley there is a riparian forest, there are some small parts of pine forest and spruce-fir forest. The forestation of Białka valley plays a significant part of a local ecologic corridor – creating spatial structures which enable spreading of different species between crucial areas and the adjacent land. Together with its flora they form an ecotonic area on the border of different habitats – on the junction of water and land and constitute biological river casing [Hełdak 2009]. Creation of "Białka River" nature reserve has been planned for years, covering in part areas within Białka Tatrzańska and Jurgów.

The area of the river at the mouth of the Leśnicki stream to the Czorsztyński reservoir, in the neighbourhood of the analysed area is covered by Natura 2000 program within Special Protected Area – "Białka Valley" PLH120024, type B. The protected area covers the stream basin together with riverside riparian forests, willow thickets and alder groves. 10 natural habitats have been found there of the 1st Attachment of the Council Directive 92/43/EWG, including a very rare natural habitat connected with Mountain Rivers, which means thickets on river rocks.

PLANNING DOCUMENTS IN PLACE

In the existing *Change of study of land use conditions and directions for Białka Tatrzańska of Bukowina Tatrzańska commune* [2006], the area of analysis is located in the area marked as R/L and L – areas of forest and water flows biological protection – area of ecologic system for protection of natural environment – earmarked for forestation and forest areas.

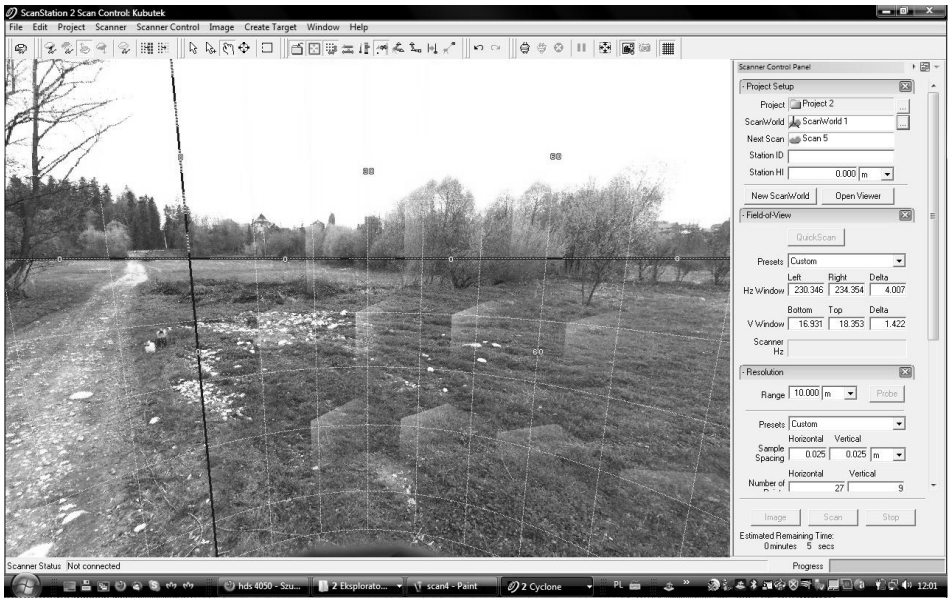
For the area of planned sewage system plant there is no local development plan. This is not an area which requires preparation of such plan. The location of the area in the analysed area not covered by the development plan creates an opportunity of development completion on the basis of decision regarding localisation of public purpose development. During the administrative proceedings regarding establishing the conditions for building public purpose development a procedure has to be carried out within procedure of environmental impact assessment.

COMPUTER SCANNING

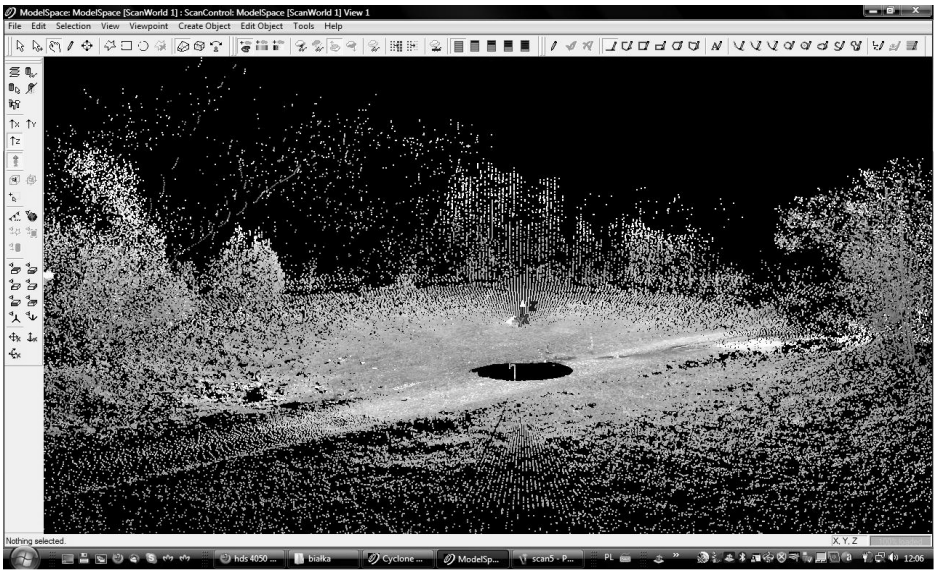
To assess a development's impact on the landscape, mainly in the scope of form, field laser scanning may be used. The laser scanner allows for a mobile area scanning enabling inventorying large-surface measurements creating spatial pictures. 3D scanning is considered one of the fastest methods of collecting data pseudo-pictorial, enabling faithful reflection of the space. Scanner outlines spatial coordinates X, Y, Z in field points determining distance and angle. Moreover, it registers the reflection force of the returning signal sent by the scanner which allows it to obtain additional information, e.g. moisture of scanned spatial elements, diversity of building material, and so on. This is a result of refraction of light (reflection intensity) depended to a large extent on a building's colour, including discolorations [Van Genechten 2008, Vosselman & Maas 2010].

3D surface properties are largely excluded from the information extraction and knowledge creation process of geo-visualization despite their potential for being an effective tool in many such tasks [Lorenz & Döllner 2010].

Space inventorying measurements were carried out using the Leica ScanStation 2 HDS 4050 scanner. This scanner enables area measurement to be made with geodetic precision with full field of vision with geodetic biaxial compensator. The scanner ensures a scanning speed of 50000 points per second and a large scope of measurements (max. up to 300 m) and also high density (even to 1mm/1mm) and efficiency of scanning. The Sewage treatment plant localisation measurements were carried out in May 2010 (Pictures 1-3).



Picture 1. View of the localisation for sewage treatment plant in the direction of the Białka River and the area of Nature 2000 with the "eye of the scanner" (image from the scanner). Source: own study



Picture 2. View of the measured area with a Leica ScanStation scanner – cloud of points in processing program. Source: own study

The received spatial image renders the character and geometry of the inventoried building much better than flat image, especially when it concerns complicated structures. The used laser technology allowed, in short time, to obtain dense model points of the measured structure. The method of laser scanning provides only a half-finished product in the form of point model covering the area of measured structure. As a result of the measurements an image in the form of point cloud was received, which later requires professional processing with available tools in order to gather useful information for final study, e.g. "spatial model" [Van Genechten 2008, Gawałkiewicz 2008] .

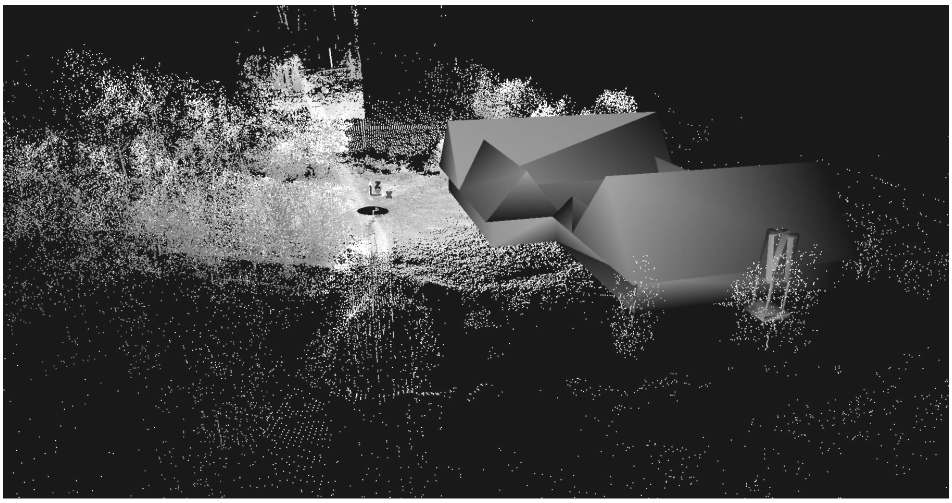
Further work consists of creating an area model and adding texture. Such spatial image can be used for design work and structure visualisation in the field.

TECHNICAL DESCRIPTION OF DESIGNER DEVELOPMENT

Construction of the sewage treatment plan will be carried out on the basis of decisions regarding the localisation of public purpose development. An application for issuing the above mentioned decision concerns construction of local sewage treatment plant in Białka Tatrzańska in Bukowina Tatrzańska commune, county Tatrzański in the Małopolskie region, was made on 26th October 2009. The development will cover construction of a local sewage treatment plant of average capacity of 2100 m^3/d with all necessary outbuildings and technical and personnel facilities, water/mains sewage system, manually and automatically controlled ventilation, and all the necessary infrastructure, including: entry drive, ground water intake, water mains/sewage connection, electricity connection, fire protection container, raw sewage canal, processed sewage canal and its point of disposal together with bank reinforcement for the point of disposal – river Białka branch.

The architectural form of the building refers to characteristic, local mountain style. A plan of the building must be subject to its purpose and function. Keeping the regional character of the structure, including layout of roof slope and inclination angle, will result in excessive building development.

Outside of the building there will be equipment and outbuildings connected with the technological process, including container decantation station for delivered sewage measuring 2.50 x 3.50m, underground decantation container measuring 6.90 x 5.05m, fire protection water container measuring 8.0 x 10.0m of 200 m^3 capacity, silos for slaked lime, air deodorization station in the form of container measuring 11.0 x 11.0 x 2.20me placed on foundation plate from clinker brick measuring 16.6 x 12.0m.



Picture 3. Visualisation of the sewage treatment plant in the field. Source: own study

POSSIBILITIES FOR USING SCANNING

The construction of sewage treatment plant, preceded by the issuing of the decision regarding the location of the public purpose development, requires the undertaking of a procedure of environmental impact assessment which constitutes an element of strategic environmental impact assessment. Installations for sewage treatment, used to service no less than 400 residents, are part of a group of developments which can significantly impact the environment. Moreover, the area for the sewage treatment plant is located on the border of Nature 2000 area, as a part of the Special Area of Conservation "Dolina Białka" PLH120024, refugium type B.

The body authorised to issue a decision decided that construction of the planned undertaking requires carrying out an assessment on the treatment plant's impact on the neighbouring area Nature 2000. The construction of the sewage treatment plant, preceded by EIA should take into account long and short term goals.

According to Sas-Bojarska [2007], short term goals involve: improvement of pro-environmental design, checking environmental correctness of the design and environmental resistance, assuring adequate usage of resources, identification of remedial means and facilitation of the decision making process by determining conditions for completion of investment.

Long term goals involve: avoidance of irreparable changes and serious environmental damages, protection of valuable resources, including nature areas and natural elements, strengthening social aspects of the development and protection of people's health and safety.

3D computer scanning is a modern method of mapping the area which can be useful in determining the impact, as a part of the EIA procedure, on the visual aspect of landscape (in literature: impact on visual aspect is different than impact on the landscape). The spatial area model can be used to minimize the effects of including new development in the landscape. Using a fully measurable area scan allows for variant inclusion of designed development in its natural surroundings, which is very helpful when choosing the best design solution and is part of the pro-environmental design. Modelling allows for assuring the appropriate use of resources which also include visual values, such as: a panorama, a certain view and so on. In social discussions visualisation of the sewage treatment plant together with all buildings and equipment in their natural environment would allow for convincing the local community to its location. It has already been shown by research undertaken. The residents living in the neighbourhood of the planned location for the sewage treatment planned are against the development claiming that its construction will influence the reduction in the values of their properties and in the future, loss of opportunities for building recreational facilities. Thus, visualisation would be helpful in social discussions and consultations.

Area scanning and then development visualisation can also be useful in completing the long term goals of EIA procedure by avoiding irreversible changes and serious environmental damages especially in conservation areas of high cultural and visual values.

The role Environmental Impact Assessment (EIA) in the development process is recognised as an integral part of the planning and decision - making process. Its strength lies in its potential for analysing the associated environmental issues and for improving the siting, layout and design of a particular scheme. The assessments of landscape and visual effects are essential part of this process. Environmental assessment can thus be appropriate for all forms and scales of development, not just for those for which an EIA is mandatory [Guidelines for Landscape …].

Fully measurable area model can be used in monitoring and in post-completion analysis. Observation of changes in the river basin as a result of the discharge of treated sewage to the point of disposal - river Białka function – can be undertaken by comparing the area measurements (scans) performed at certain times. It would enable the determination of the scale and scope of real effects of the development. Relevant units in the system of impact control (operator, controlling institutions) require data regarding developments' impact enabling a decision to be taken on whether a certain means for restricting one or some impacts need to be applied. Such means can be used additionally, together with existing or planned remedial actions [Bisset & Clark 1999].

A river is a particularly ungrateful object of geodetic measurements due to fluctuation of water levels and difficult access. Computer scanning performs well in difficult terrain which is found in the overflow area of Białka river.

SUMMARY AND CONCLUSIONS

In Poland, taking measurements using a ground-based scanner for spatial and development planning has not actually been used. The above deliberations showed that mapping an area in the 3D technique can be used in the procedure of environmental impact assessment carried out within strategic environmental impact assessment.

The main tasks which need to be performed before implementing new technology of data gathering about an evaluated area include visualisation of designed development in its natural surroundings. The possibility of modelling and "a free walk" on the area with an introduced virtual project enables the ability to choose the best option of its development taking into account its visual aspect.

Photo-realistic computer visual simulations are a very valuable tool in the design and planning of surface mining or landfill operations. When used ethically and with care, they can result in representative, realistic, bias-free and credible representations of future conditions. They can be effective communication tools for explaining the operator's intentions, and indispensable analysis tools for assessing the visual impacts of operations on public and private lands [Ellsworth, Medina, Hamud 2005].

Variant integration of the sewage treatment plant in the natural surroundings can be a valuable element assisting social dialogue. Such visual simulations can convince the local community to choose the best option, and the residents themselves can choose one of the options. Engaging the local community in the decision making process regarding a new development is part of the requirements of the New Athens Charter which stresses the increase of participation of local communities in the decision-making processes [Sas- Bojarska 2007]. Area measurements in the 3D technique can be used in monitoring and post-development analysis, including observations of changes in the lie of the land or the river basis and so on.

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