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Methods of geodiversity assessment and theirs application

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The concept of geodiversity has rapidly gained the approval of scientists around the world (Wiedenbein 1993, Sharples 1993, Kiernan 1995, 1996, Dixon 1996, Eberhard 1997, Kostrzewski 1998, 2011, Gray 2004, 2008, 2013, Zwoliński 2004, Serrano, Ruiz- Flano 2007, Gordon et al. 2012). However, the problem recognition is still at an early stage, and in effect not explicitly understood and defined (Najwer, Zwoliński 2014). Nevertheless, despite widespread use of the concept, little progress has been made in its assessment and mapping. Less than the last decade can be observing investigation of methods for geodiversity assessment and its visualisation. Though, many have acknowledged the importance of geodiversity evaluation (Kozłowski 2004, Gray 2004, Reynard, Panizza 2005, Zouros 2007, Pereira et al. 2007, Hjort et al. 2015). Hitherto, only a few authors have undertaken that kind of methodological issues.

Geodiversity maps are being created for a variety of purposes and therefore their methods are quite manifold. In the literature exists some examples of the geodiversity maps applications for the geotourism purpose, basing mainly on the geological diversity, in order to point the scale of the area's tourist attractiveness (Zwoliński 2010, Serrano and Gonzalez Trueba 2011, Zwoliński and Stachowiak 2012). In some studies, geodiversity maps were created and applied to investigate the spatial or genetic relationships with the richness of particular natural environmental components (Burnett et al. 1998, Silva 2004, Jačková, Romportl 2008, Hjort et al. 2012, 2015, Mazurek et al. 2015, Najwer et al. 2014). There are also a few examples of geodiversity assessment in order to geoconservation and efficient management and planning of the natural protected areas (Serrano and Gonzalez Trueba 2011, Pellitero et al. 2011, 2014, Jaskulska et al. 2013, Melelli 2014, Martinez-Grana et al. 2015).

The most popular method of assessing the diversity of abiotic components of the natural environment is based on geodiversity indexes. Burnett et al. (1998) and Nichols et al. (1998) used Shanon-Weaver diversity index but without success. Most studies that use geodiversity indexes are based on a concept originally published by Serrano, Ruiz-Flaño (2007), later developed by others, e.g. Serrano et al. (2009), Hjort, Luoto (2010), Pellitero et al. (2010, 2014), Comanescu, Nedelea (2012), Kot (2012), Silva et al. (2013), Martinez-Grana et al. 2015). Geodiversity value can also be assessed using techniques of quantitative and qualitative point bonitation method and its modifications (Kot 2005 a, b, c, 2006 a, b, 2014, Jačková, Romportl 2008, Kot, Smidt 2010, Zwoliński, Stachowiak 2012, Pereira et al. 2013). Highly promising results of the geodiversity assessments may also provide statistical modeling, more precisely generalized additive models (GAM) (Hjort, Luoto 2012, Hjort et al. 2012).

Methods of geodiversity assessment may be recognised as direct and indirect (Pellitero et al. 2014). Direct methods are used to geodiversity value computation of soils, rocks, types of landforms, etc. Their application allows to obtain more accurate results and the same calculation is much simpler, although their usage is much more labor intensive (Pellitero et al. 2014), and often considerably more expensive. The use of these indicators for the assessment of broad scale areas is quite breakneck and their universality due to the fact limited. Indirect methods are not identifying features internally different, but some favorable conditions for the occurrence and intensification of the processes that usually generate diversity of the abiotic components and consequently the landforms. The biggest advantage of using indirect methods is time and money saving, resulting from the reduction to the minimum of field work. Usually source data acquisition (satellite imagery, digital elevation models or point clouds) is as well much cheaper, but unfortunately their correct preprocessing and analysis is not as simple as in the case of direct methods. Indirect methods offer the possibility to assessment and mapping of geodiversity of large and not easy accessible research areas.

The foregoing examples mainly tend to refer to areas at the local or regional scale. These analyses are although possible for the implementation of large spatial units, such as territories of the country or state (Zwoliński 2007, Benito-Calvo et al. 2009, Pereira et al. 2013, 2015). A fundamental difference lies in the appropriate, corresponding to the spatial scale and the specification of the study areas, selection of the assessing criterion, and above all, the input geodata.

In the geodiversity assessments, access to the data in the adequate resolution and accuracy is especially important. Acquisition and integration of the geodata often requires considerable financial and temporal outlay and not

infrequently could be a serious limitation to perform some analyzes. The proposal of geomorphometry based landform geodiversity indirect assessment method and single, in addition, easy to obtain source data - digital elevation model, might create new opportunities for its broad implementation across numerous disciplines.

The research on the assessment of geodiversity must be regarded to be at an initial stage at present. While the conception of geodiversity itself has a reliable theoretical foundation, no universal method of its assessment has been developed yet. It is only the adoption of a generally accepted and clear methodology of geodiversity evaluation that will make it possible to implement it widely in many fields of science, administration and the management of geospace. Then geodiversity can become as important an indicator as biodiversity is today.