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GEOGRAPHICAL INFORMATION SYSTEMS, OPEN SOURCE PHILOSOPHY AND TECHNOLOGY TRANSFER. OPPORTUNITIES AND PERSPECTIVES

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Abstract:
In the presented paper we dedicate opportunities and perspectives of connection among geographical information systems (GIS), open source philosophy and technology transfer in context of triple helix. In the first part of article we focus on the main theoretical principles of GIS, open source philosophy and we try to conceptualize the term of open source GIS technology transfer, which we understand as the process of transferring skills, knowledge, technologies and their methods to ensure that scientific and technological developments are accessible to a wider range of users who can then further develop and exploit the technology into new products, processes, applications, materials or services. Further we see the term as cooperation of university, private sector and government towards to the concept of triple helix. Therefore using this concept we try to suggest a theoretical framework of triple helix geographical space with an emphasis on open source. The last part of article looks more closely at one of the possible application of the proposed framework in practice.

Key words:
geographical information systems, open source, technology transfer, triple helix, THOS, GIS.lab

INTRODUCTION

Geographical Information Systems (GIS) have already completed more than half a century of their existence, during which they have gone through significant changes in technological progress realm as well as changes in target group of users. As states Hofierka (2003, p. 6), formation of GIS and geoinformatics origins go back to the age of so-called quantitative revolution in geography in 1960s, and are closely related to the onset and greater use of information technologies. In the history of GIS development we can distinguish four main stages (edited by Hrubý, 2006). The first stage (beginning of the 1960s to 1975) is characterized by spontaneous development, mainly by influence of important personalities of science and government with an emphasis on digital cartography. In the next second stage (ending early 1980s) it commutes to the gradual unification of intentions of local research centers with central administration (formation of the first local information system – LIS). The third stage (ending early 1990s) is marked by the onset of commercialization

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entailing rapid development oriented to the enforcement of GIS in market. Creating market competition in this sector are beginning to form the first software systems for GIS (ESRI, Intergraph, and others) and systems based on CAD (Computer Aided Drawing/Design), which are still used today. The last (current) period is characterized by orientation on the user (desktop GIS) as well as open systems (open source GIS), where developers are trying to introduce standards and interoperability of solutions. Typical for this period is the development of object-oriented systems, massive linking to databases, different solutions via internet (WebGIS) as well as different network technologies, which drive space-time compression, in which absolute space ceases to play an important role. In the last two stages of the GIS development are manifested impacts of so-called *spatial turn*, which is characterized by a gradual change in man´s perception of space. Pavlovskaya (2009, p. 37) perceives that turn in the growing use of spatial and cartographic expressions, what Lünen (2013, p.vi) sees as a huge potential for development of GIS: *"Geographic information systems welcome the spatial turn with open arms"*. Described turn is constituted serious society-wide shift to the democratization of society known as *cultural turn* leading to actual change of the values of individuals. In this context, we can observe also a change in the target group of users who do not form only experts, but GIS solutions are becoming available also for different users who use at their job the spatial information. With the development of GIS technologies, individuals can be more aware of the space presence. They can perceive, understand, use the space in their favor and especially they learn to represent it, thus the multidimensional ontological view of the world is creating in their minds. From this point of view representation reality via maps becomes an important tool for different user groups from medics (e.g. map of malaria occurrence in the world) through economists (e.g. map of economical dependency in developed countries) to historians (e.g. map of freemason lodges in Austro-Hungarian Empire).

In the indicated context, it is therefore important to find the most effective ways for creating and visualization this kind of data. Since the spatialisation penetrates into all areas of life, we can also consider the fact that tools that allow viewing and creating spatial data can be understood also as the tools for connection of these areas. In the present paper we will try to identify possibilities and perspectives of GIS through the open source philosophy in order to create space for the possible technology transfer based on the triple helix context.

OPEN SOURCE AS BASIS FOR GIS

The idea of open source software as freely available software exists, from which develops the software itself (Neteler and Mitasova, 2004). Stallman (2013) defined the concept of free software with the four freedoms:

0. The freedom to run program as you wish, for whatever purpose.
1. The freedom to study the program's "source code", and change it, so the program does your computing as you wish.
2. The freedom to make and distribute exact copies when you wish.
3. The freedom to make and distribute copies of your modified versions, when you wish.

Open source philosophy is thus based on the principle of teamwork on the given solution with condition, which allows the sharing and use of that solution by whole community based on open license (e.g. various versions of the General Public License, BSD License, etc.). Nowadays we have got a personal/physical freedom, which should be reflected in current cyberspace in the form of software freedom (Michalko, 2013). Although it is now significantly dominant proprietary software, they are exactly the open source solutions, which are increasingly developing their stable position among ordinary users. It is also seen in the field of geospatial technology, in which the open source solutions find wide application (Neteler and Mitasova, 2004, Hofierka, 2003, 2010, Hofierka and Mičaník, 2011). Users are able to directly use software tools – operation systems, database solutions or specialized applications such as QGIS, GRASS etc. (Hofierka and Mičaník, 2011). To support these open solutions was founded in 2006 a non-profit organization Open Source Geospatial Foundation (OSGeo), which goal is to support and promote cooperation in the development of open source geospatial technology and data (OSGEO, 2013). Formation of this initiative preceded the establishment of the Open Geospatial Consortium (OGC), which participated in the development and implementation of open standards for geospatial data and services, GIS, processing data and their exchange (OGC, 2013). The latest idea to legitimize open source GIS solutions is the "Geo for All" concept, which is under the auspices of OSGeo and ICA (International Cartographic Association). In 2011 the two organizations signed a memorandum, which aim is the development of cooperation possibilities at global level among academic environment, private and public sector in the field of open source GIS software and data. Memorandum further declares providing expertise and supporting the development of the open source geospatial laboratories and research centers worldwide. At present there are 50 laboratories, while is assumed that number of laboratories double to September 2014 (GFA, 2013). In Slovakia, such a laboratory does not yet exist, and therefore it is our ambition to join into this initiative by our designed concept of open source GIS technology. In recent years there is considerable emphasis on transfer of these technologies into various realms of life, where trend is the efficiency of "production" and cost reduction in general. This transfer can be realized by several ways. For one of the possible mediators of this transfer we consider the concept of triple helix. Due to the above mentioned trends of behavior in socio-economic environment we can see appropriate deployment of triple helix model based on open source.

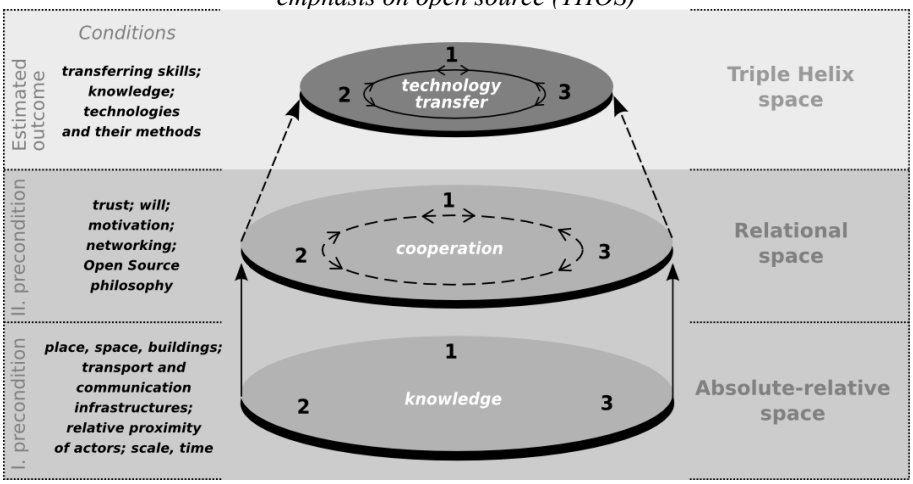
OPEN SOURCE GIS TECHNOLOGY TRANSFER AND TRIPLE HELIX

According to general definition of technology transfer (Grosse, 1996) we understand the term of open source GIS technology transfer as the process of transferring skills, knowledge, technologies and their methods to ensure that scientific and technological developments are accessible to a wider range of users who can then further develop and exploit the technology into new products, processes, applications, materials or services. Further we see the term as cooperation of university, public sector and private sector towards to the concept of triple helix.

In recent decades we have observed a shift from an earlier focus on innovation sources limited to a single institutional sphere (such to new product development in industry, policy making in government or the creation and dissemination of knowledge in academia environment), towards the interaction among these three institutional spheres as the source of new and innovative organizational designs and social interactions. This shift entails not only different mechanisms of institutional restructuring of the sources and development path of innovation, but also a rethinking of our main models for conceptualizing innovation, including innovation systems (national, regional, sectoral, technological, etc.) and the triple helix (Ranga, Etzkowitz, 2013).

The concept of the Triple Helix concernig university - private sector (e.g. industry) - public sector (e.g. government) relationships was initiated in the 1990s by Henry Etzkowitz (1993) and Etzkowitz and Loet Leydesdorff (1995) and it encompassed elements of precursor works by Lowe (1982) and Sábato and Mackenzi (1982) (Ranga, Etzkowitz, 2013). Its developmnet has endeavored Henry Etzkowitz' long-term interest in the study of university-industry relations (e.g. Etzkowitz, 2002) and Leydesdorff's interest in an evolutionary model in which there is an overlay of communications between various and independent spheres of activity (Leydesdorff, 1995 in Leydesdorff, 2012; Smith, Leydesdorff, 2012). The first paper, Etzkowitz a Leydesdorff, (1995), The Triple Helix - University-Industry-Government Relations: A Laboratory for Knowledge-Based Economic Development came about after Etzkowitz' (1994) participation in a workshop in Amsterdam and the metaphor of a triple helix emerged thereafter in discussions about organizing a follow-up conference under this title in Amsterdam in 1996 (Smith, Leydesdorff, 2012). Since then, Hnery Etzkowitz a Loet Leydesdorff further elaborated this concept into a model for studying both knowledge-based and developing economies. Over time the model has evolved, been re-interpreted and critiqued (e.g., Carayannis, Campbell, 2009; Cooke, Leydesdorff, 2006; Lawton Smith, Ho, 2006; Shinn, 2002 in Smith, Leydesdorff, 2012). However it is possible to state that concept of triple helix represents the shift from a dominating industry (private sector)-government (public sector) dyad in the industrial society to a growing triadic relationship between university, industry and government in the knowledge society (Ranga, Etzkowitz, 2013). Main thesis of triple helix is that the potential for innovation and economic development in a knowledge society lies in a more prominent role for the university and in the hybridization of elements from university, private and public sector to generate new institutional and social formats for the production, transfer and application of knowledge (Ranga, Etzkowitz, 2013).

Figure 1: *Theoretical framework of triple helix geographical space with an emphasis on open source (THOS)*



Notes: 1 – Public sector; 2 – Private sector; 3 – University

By definitions of the open source GIS technology transfer and concept of triple helix we aim to their complementary connection in order to create an triple helix theoretical framework embedded into the Harvey´s geographical space conception (Harvey, 2005, 2006; Michalko, 2012) (Figure 1). In the given framework we emphasize a principle of the open source functionality, which becomes the main precondition for fulfillment of our framework (Triple Helix with emphasis on open source – THOS). On the basic of Harvey´s conception of geographical space organization we have divided the mentioned framework into the two main levels of space. The first level represents an absolute-relative space, which is formed by the absolute as well as relative space. The first one is conditional by the Euclid geometry such a container of physical objects in space and the second one represents variable, relative space formed by interpretations, approximations existing in various time and space *(I. precondition)*. At this level are the triple helix actors (university, public sector, private sector) relatively unconnected. The second level represents a relational space, which is conditional by the relations based on trust, will and motivation and networking among universities, public and private sector *(II. precondition)*. In this context, we consider a very important aspect of the functioning of these relations open source approach, which we see in the two views. The first one represents a technological line based on the deployment of open source software and the second one, the more important view, represents a line of the thinking and behavior of involved actors, who start to use a way of thinking community, that contains the main attributes such as trust in common goals, willingness in participation and sharing knowledge. In order to the framework is able to good working, the mentioned preconditions should be fulfilled *(I. and II. precondition)* (Figure 1). At the same time these preconditions respond to qualities of the individual levels of space organization. The expected outcome of the outlined theoretical conception should be a conceptualization of space

for triple helix, by which is possible to achieve the transfer of skills, knowledge, technologies and their methods through building of knowledge base (absolute-relative space) and cooperation of mentioned actors (relational space) based on open source.

Thus proposed theoretical framework of THOS can be applied in the field of open source GIS technologies, while the open source philosophy becomes a base for the technology transfer process. In the next part we will look more closely at one of the possible application of the framework in practice.

CASE STUDY OF GIS.LAB

We have created the theoretical framework by an inductive method of scientific procedure, which initiative was a beginning of cooperation between our academic workplace and the private open source GIS company acting in Prešov city. This cooperation was based on a motivation for the development of open source GIS technologies. Although so far public sector wasn´t involved into the cooperation, we would argue that mentioned cooperation between actors has a potential to achieve the expected outcome of the theoretical framework of THOS.

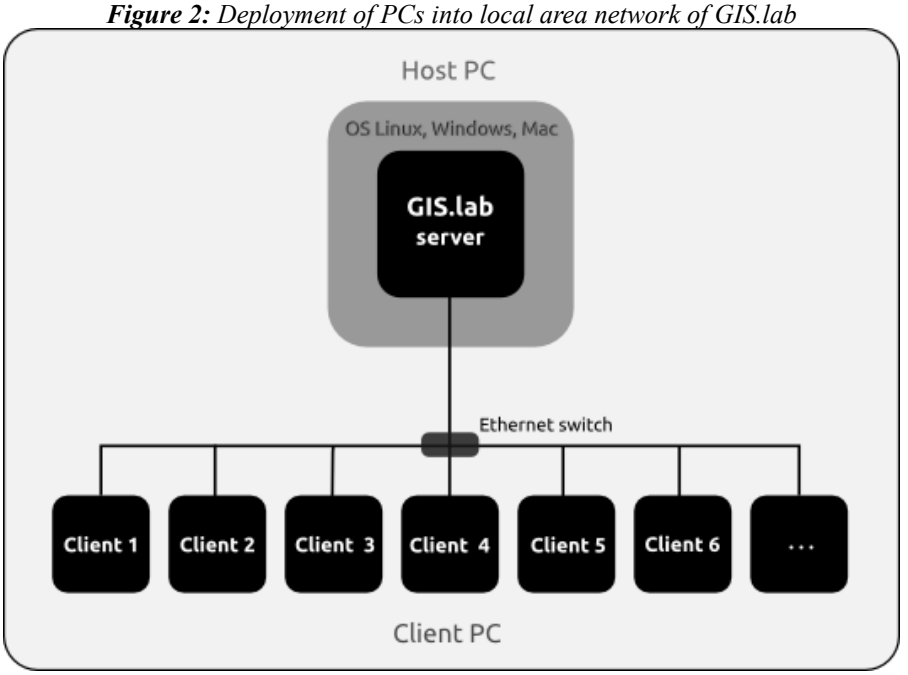
If we look more closely at the first precondition of THOS, we can see that conditions in absolute-relative space were accomplished thus. Knowledge base was built through the relative proximity of actors and through connection on one hand of company´s practical experiences from open source GIS realm and through support of this knowledge by potential of academic environment (open source GIS knowledge, human resources, technical infrastructure) on second hand. The main condition for cooperation of both actors in meaning of relational space was firstly the motivation. For the university it was mainly the sharing information in modern open source technologies realm ranging from Linux and various systemic services, to specialized software aimed at work with open source GIS software (QGIS, GRASS, etc.). In case of the company was motivation especially the university´s support in the development of open source GIS technologies. This bilateral cooperation aims to the main principles of open source philosophy, where the thinking community of actors will contribute to achieve their common goals, from which will rise benefits for the both sides. For "healthy" cooperation working is important the trust between actors, as one of the main conditions of relational space, what aims to the building and strengthening of networking.

The result of cooperation was creation of a GIS.lab project at the end of the year 2013. The project is developed under the license GNU GPL version 3 and is located on the GitHub server[3]. The GIS.lab stands for unique technological solution on the basis of open source which allows automatic creation of completely equipped working environment with geographic information system (GIS), regardless of the location (interior, exterior), and in a very short time (approximately 20-60 minutes). Its advantage, in comparison with standard solutions, is its mobility, indestructibility and especially, a usage without need of maintenance. It is designed for immediate work without the necessity of any set up or more detailed knowledge on the matter, what enables users to focus solely on their work with GIS. The described solution

[3] *https://github.com/imincik/gis-lab*

minimalizes overall expenses for establishment of complex GIS infrastructure, but does not degrade the quality of GIS work and its outputs. Its architecture is based on automatically created and portable GIS.lab server and unlimited number of client computers which can be connected to the server without any required installation (Figure 2).

Figure 2: *Deployment of PCs into local area network of GIS.lab*

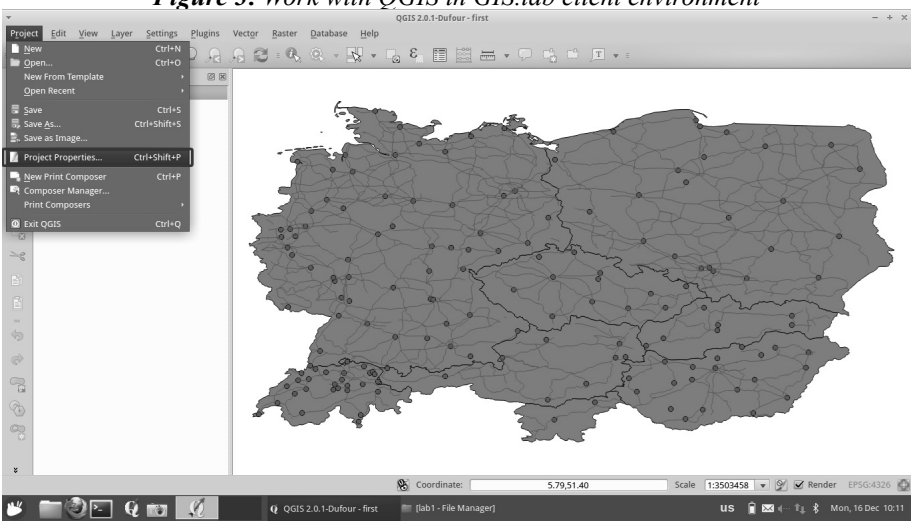


GIS.lab is designed to be used mainly by a target group of users who utilize spatial information in their work. Those may include GIS experts, professional operators using GIS software for analyses and also experts from other areas (ranging from medics – e.g. map of malaria occurrence in the world, economists – e.g. map of economical dependency in developed countries, to historians – e.g. map of freemason lodges in Austro-Hungarian Empire) who will find the presented solution to decrease the technological and financial demands of obtaining and operation of GIS software. However, the target group may also comprise persons who do not require any GIS software, since the GIS.lab is also outfitted for general office work (Figure 3).

GIS.lab offers great possibilities of implementation in private (intradepartmental network, small GIS company, ...), as well as in public sector (local governments, state administration, ...). Above mentioned properties of GIS.lab can be rightly integrated into structure of non-profit organizations because of minimal expanses and unnecessary maintenance. GIS.lab can be also applied in the conditions of crisis management, providing for effective data acquisition and their processing. (e.g. crowdmapping). Proposed solution is particularly appropriate for application in experimental and educational settings, e.g. in the form of effective research

laboratory which can be installed and used in the classroom, as well as directly in the field. Applicative utilization of mentioned technology also includes education of individuals, students of university, employees of different organizations, as well as education and edification in public sector.

Figure 3: *Work with QGIS in GIS.lab client environment*



As indicate the possible scenarios of using the open source technology of GIS. lab in various realms, it can be just the open source philosophy, which has a potential to be an mediator (a bridge) for creation of the right working triple helix space (Figure 1), which is "the living soil" for technology transfer process.

DISCUSSION

In introduction to the paper we have outlined, that spatial turn has changed people´s perception on space therefore has occurred change of understanding and perception of our world. The last years are characterized by the growing number of popular map software as well as the increasing "difficult" technology owned by the ordinary user (smart phones, tablets, GPS) using these programs. This boom reflects also in a slogan of the commercial company ESRI: *"Understanding our world"* (ESRI, 2013). The relatively high performance of IT has become a routine matter of nowadays. All mentioned aspects imply the increased interest in representation reality through software working with spatial information. Demand on this kind of data constantly rises mainly in environment of professional public acting in various realms. In this context, we have indicated in our paper using the open source GIS technologies as well as principles of the very open source philosophy, which has significant advantages in the contemporary information world, in which dominates a monopoly of proprietary software. But on the other hand has open source also few disadvantages, which relate especially with the technical side (still low compatibility of formats, weak service support, lack of awareness). The philosophical side of open source appears in turn idealistically with elements of humanism, altruism

and philosophy of permaculture. These attributes are not valuably very popular in current neoliberal discourse, which is more oriented on profit maximization, what is confirmed by Noam Chomsky´s words (in Fiala, 2014): *"The whole capitalist system is strongly monopolized nowadays. If you buy a computer, you have got there operation system Windows. But not because, that Windows are good operation systems, but that Microsoft has in market a monopoly. Despite this media constantly yell talks about free markets. It is pure propaganda."* Also for this reason is the open source philosophy still "out of game".

The current socio-economic environment vastly emphasizes the inevitability of implementation of acquired knowledge into practice. The frequented notion which constitute the basis of modern economic system and which we have outlined in our paper belongs the technology transfer into practice. In the indicated context, the described GIS.lab technology presents a process of transfer of experience, knowledge, technologies and their methods for securing a widely available scientific and technological development for various users who can further develop and use the technology in their new products, processes, applications or services. Apart from constituting a basis for specific open source GIS laboratory, introduced solution might also create or substitute present info-communicational background in different institutions, organizations and business not using GIS software.

The open source GIS seems as one of the possible tools for creating space for the triple helix aiming to the technology transfer, which could be based on education, testing and development of modern open source GIS technologies with following application using for students of university, organizations as well as for public sector environment. These options of cooperation scheme among individual components of the geographical organization of space is in the present age of significant disparities among regions, their cores and peripheries a challenge for regions and their internal structures.

REFERENCES

ESRI (2013). Oficiálna stránka organizácie Esri [online]. [cit. 2013-10-26]. Dostupné na: <http://www.esri.com/>

GFA (2013). Oficiálna stránka iniciatívy Geo For All [online]. [cit. 2013-10-26]. Dostupné na: <http://www.geoforall.org>

GROSSE, R. (1996). *International Technology Transfer in Services.* Journal of International Business Studies 27: 782.

ETZKOWITZ, H., LEYDESDORFF, L. (1995). *The Triple Helix - University-Industry-Government Relations: A Laboratory for Knowledge-Based Economic Development.* EASST Review 14, 14-19.

FIALA, J. (2014). Noam Chomsky: Václav Havel byl statečný muž.[online]. [cit. 2014-06-06]. Dostupné na: <http://a2larm.cz/2014/06/noam-chomsky-vaclav-havel-byl-statecny-muz/>

HARVEY, D. (2005). Spaces of Neoliberalization.Towards a Theory of Uneven Geographical Development. Franz Steiner Verlag, ISBN 3-515-08746-X, 131 s.

HARVEY, D. (2006). Critical reader. Blackwell Publishing Ltd, ISBN: 978–0–631–23510–1, 340 s.

HOFIERKA, J. (2003). Geografické informačné systémy a diaľkový prieskum Zeme. Vysokoškolské učebné texty. Prešov: FHPV PU. 106 s.

HOFIERKA, J. (2010). Geopriestorové a kartografické technológie v regionálnom rozvoji. In: Michaeli, E., Matlovič, R., Ištok, R. (eds.), Regionálny rozvoj a regionálna politika pre geografov. Vysokoškolská učebnica. Prešov: Prešovská univerzita v Prešove. 2010. s. 225–292. ISBN: 978-80-555-0065-2.

HOFIERKA, J. a MIČANÍK, R. (2011). Využitie open-source technológií pri vývoji a aplikácii webových GIS riešení na príklade systému Gisplan. Zborník príspevkov medzinárodnej konferencieOSSConf 2011 – Otvorený softvér vo vzdelávaní, výskume a v IT riešeniach, 6.7.-9.7.2011, Žilina, pp. 143-150.

HRUBÝ, M. (2006). Geografické informační systémy (GIS). Studijní opora. Brno: Vysoké učení technické v Brne. 91 s.

ICA (2013). Oficiálna stránka organizácie International Cartographic Association [online]. [cit. 2013-10-26]. Dostupné na: <icaci.org>

LÜNEN A. (2013). History and GIS: Epistemologies, Considerations and Reflections. London: Springer. 250 p. ISBN-13: 978-9400750081.

MICHALKO, M. (2012). Priestor ako hlavný koncept výskumu geografie. Smerom ku kritickému konceptu priestoru. In Acta Facultatis Studiorum Humanitatis et Naturae Universitatis Prešoviensis, Prírodné vedy, Folia Geographica. 19, PU Prešov, s. 196 – 209.

MICHALKO, M. (2013). Kriticko-geografická analýza regionálnej politiky: Teoreticko - metodologická báza a empirická aplikácia na príklade Prešovského samosprávneho kraja [dizertačná práca]. Prešov: FHPV PU. 2013. 145 s.

NETELER, M. a MITASOVA, H. (2004). Open Source GIS: A GRASS GIS Approach. Boston: Kluwer Academic Publishers. 417 p.

OGC (2013). Oficiálna stránka organizácie Open Geospatial Consortium [online]. [cit. 2013-10-26]. Dostupné na: <http://www.opengeospatial.org/>

OSGEO (2013). Oficiálna stránka organizácie Open source Geospatial Foundation [online]. [cit. 2013-10-26]. Dostupné na: <http://www.osgeo.org/>

PAVLOVSKAYA, M. (2009). Feminism, Maps and GIS. In: Kitchin, R. a Thrift, N. (eds.), International Encyclopedia of Human Geography, Vol. 4, Oxford: Elsevier. p. 37. ISBN 978-0-08-044917-3.

QGIS (2014). Oficiálna stránka projektu QGIS [online]. [cit. 2014-07-26]. Dostupné na: <http://www.qgis.org/>

RANGA, M., ETZKOWITZ, H. (2013). *Triple Helix Systems: Analytical Framework For Innovation Policy And Practice In The Knowledge Society.* Industry & Higher Education.Vol. 27, No. 3, pp. 237–262.

SMITH, H. L., LEYDESDORFF, L. (2012). *The Triple Helix in the context of global change: dynamics and challenges.* [cit. 2014-08-18] Dostupné na <*http://www.leydesdorff.net/th11/th11.pdf*>.

STALLMAN, R. (2013). Why Free Software Is More Important Now Than Ever Before [online]. [cit. 2013-10-26]. Dostupné na: <http://www.wired.com/opinion/2013/09/why-free-software-is-more-important-now-than-ever-before/>