THE EMERGENCE OF THE GEOGRAPHY OF NETWORKS

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Networks have become rather frequent notions of our times. Although they always existed, one can contemplate their huge increase within the last forty years, which coincides with the development of technology and the parallel process of globalization. For the purposes of this article, networks shall be comprehended mainly in view of their spatial/geographical implications. From this point of view, networks are composed of the nodes and links/connections. Nodes represent the principal agents of the networks on the one hand, and links embody the flows of information and energy as well as materials among these nodes on the other hand. Taking into account the distinctiveness of the time-spatial dimension of networks that is visible mainly in comparison with time-space categories of the real world, we are fully entitled to speak about the necessity of *the birth of the geography of networks*.

The main aim of this article is the definition of the geography of networks, the conceptualization of its principal notions and approaches, and the delineation of its main domains. Geography of networks as a newly suggested field of geography will be compared to traditional human geography. Comparative approach as well as the method of analogy appear to be appropriate tools for the derivation of the essential time and spatial structures of the geography of networks.

The distinguishing feature of this paper is the conceptualization of networks from the spatial perspective. This point of view is applied not only due to the expected boom and qualitative advancements of networks but also with regard to the extraordinary features of elementary philosophical categories of ›time‹ and ›space‹ in the framework of the networks. Networks accelerated the pace of the transition from the traditional extensive forms of spatial developmental processes to the intensive ones.[1]

From the territorial point of view, the principal agents of networks most commonly originate from higher levels of the settlement system, such as capitals or important economic centres. Localities of higher rank in the framework of spatial hierarchy are intensely interconnected not only due to the transport, capital flows, know-how transfers and other interactions, but also for the sake of essential actors living in those centres. The hierarchy of networks is mostly in compliance with the hierarchy of the settlement system.[2] Usually, the initial point of the creation of networks is connected with personal meeting of interested parties or the principal agents of networks.

Networks constitute spatial equivalents of currently widely exerted projects at the labour market. Both networks and projects are very flexible and efficient. They substantially reduce overall costs of particular activities and it is possible quite easily to choose the right people for (temporary) participation. They bring a profit to individuals. The development of networks is fully in compliance with the emergence of small and flexible firms that replaced former big bureaucratic organizations.[3]

Networks represent a rather wide concept that is applicable in numerous fields and is frequently exerted by both scholars and practitioners. Their applicability is apparent also in the field of spatial sciences described in this paper. Networks are one of the key concepts explaining the growing functional integration on the worldwide scale. However, they are increasingly applicable also to the lower ranks of the settlement hierarchy and in connection with local embeddedness they represent one of the modern and principal factors of regional development and regional competitiveness.[4] It is plausible to state that networks became an inherent part of the qualitative characteristics of territories and increasingly influence spatial structures as well as spatial interactions.

Both creation and further growth of networks are based on the advantage for both parties (i.e. for the member of the network as well as the newcomer). This advantage applies rather to the founding member of the network. While an origin of the networks is usually based on informal or personal ties and connexions, their further development and growth is closely connected with technology as well as quick distribution of information (the Internet is a typical example). New members of the network come largely from the spots that have sufficient informational resources (including Internet) and less frequently from the setting with good informal connexions. Individuals with good connexions usually form the core of the network.

5 Harvey, D.: The Condition of Post-modernity. An Enquiry into the Origins of Cultural Change. Oxford: Blackwell 1989.

6 Giddens, A.: The Constitution of of Society: Outline of the Theory of Structuration. Cambridge: Polity Pr. 1984; Giddens, A.: The Consequences of Modernity. Cambridge: Polity Pr. 1990.

7 Harvey 1989.

8 Massey, D.: Power Geometry and a Progressive Sense of Place. In: Bird, J./Curtis, B./Putnam, T./Robertson, G./Tickner, L. (Eds.): Mapping the Futures: Local Cultures, Global Change. London: Routledge 1993, pp. 59-69.

9 Giddens 1984 and Giddens 1990.

10 Giddens 1990, p. 64.

When the potential new member possesses sufficient informational resources, he or she actively looks for the advantages resulting from the membership in the particular network. If the profit exceeds the costs of joining the network, the individual becomes the member of the network provided that it is possible to join the particular network from outside.

After a certain time of smooth functioning, networks tend to become increasingly institutionalised and formalised. Usually, if the advantage for the member of the network passes away, he or she abandons the network or becomes its inactive part. ›Utility‹ is the key notion that keeps the network working regardless of geographical distances.

The essential characteristics of networks are closely connected with the processes of time-space compression[5] and time-space distanciation[6]. While Giddens focuses on the ›stretching‹ of relations over distances, Harvey points to the reduction of time to overcome these distances. As a consequence of their distinct character and in view of the above-mentioned universal processes, networks overcome time and spatial barriers to a certain extent .

Harvey refers to the manner in which globalization appears to shrink geographical distance and time[7]; in a world of instantaneous communication, distance and time no longer seems to be a major constraint on patterns of human social organization and interactions. Quickly advancing time-space compression undoubtedly represents one of the most relevant impacts of the informational revolution and accompanying phenomena of global character. The concept describes the increasing movement and communication in space, the widening of social contacts in space and the human perception of such changes. Growing spatial mobility and overcoming spatial barriers are enabled by technological progress in the field of production, transport, communication and information. According to Harvey, the world of the 1960's was thus one fiftieth of the size of the 16th century world. Increased functional integration made possible by time-space compression has, in turn, led to the emergence of a global scene of accumulation, consumption, distribution, production and differentiation, and equally important, growth of networking.

Massey focuses on the formation of so-called power geometry of time-space compression.[8] Various individuals and social groups play different roles in the framework of our contracting world. There is a sharp discrepancy between those that act as parts of the global communication network and others that lack the access to global networks. The same holds true for virtually any kind of network. The uneven distribution of the options to become a part of networks stems from the differences between educated and low-skilled people, cities and country, younger and older generations or wealth and poverty or the number of connexions.

Giddens speaks about the geographical expansion of social contacts.[9] He uses the concept of ›time-space distanciation‹ that leads to the weakening of the integration of social relations in localities and their expansion in a virtually global space. The concept of ›time-space distanciation‹ directs our attention to the complex relations between local involvements (circumstances of co-presence) and interaction across distance (the connections of presence and absence).[10] In other words, time-space distanciation means that relations between local and distant social forms and events become ›stretched‹. It becomes possible to entertain relations over distance, to interact with ›absent others‹.

While ›time-space compression‹ has a lot to do with the initial formation of networks, ›time-space distanciation‹ contributed significantly to the spreading of the networks on a worldwide scale. Both mentioned processes speed up the creation and development of networks as well as their expiry, if the reasons for their functioning pass.

Networks always bring profit or an advantage to the individuals, but not necessarily to the whole society. From the spatial standpoint, their impacts are mostly selective ones and they strengthen the gaps among various social groups according to their access to informational resources, social stratification and informal connexions. Networks succinctly reflect the cumulative and selective orientation of societal and spatial development.

Qualitative interpetation and explanation of the formation and augmentation of networks seems to be lucid enough. However, the conceptualization of the geography of networks would be incomplete without quantification of their fundamental features. As mentioned, from the technical-spatial perspective, networks are composed of the nodes and links/connections. Nodes represent the principal agents of networks on the one hand and links embody the flows of information, energy as well as materials among those nodes on the other hand.

11 Cf. also Johnston, R.J./Gregory, D./Smith, D.M. (Eds): The Dictionary of Human Geography. Oxford: Blackwell ³1994, pp. 233-235.

Networks comply with planar graphs both in technical and morphological-spatial terms. It is thus possible to express the structure and some characteristics of networks exactly and graph theory provides us with an appropriate mathematical apparatus:

$$\delta = \frac{NN * (NN - 1)}{2}$$

where δ is the possible number of connections and NN the number of the nodes.

$$\alpha = \frac{RNC}{\delta}$$

where α is the connectivity of the network and RNC the real number of connections/edges, and δ is the possible number of connections.

$$\beta = \frac{RNC}{NN}$$

where the β index not only describes the mean number of connections/edges per node, but values less than 1 indicate a tree-like network with no circuits, RNC is the real number of connections/edges and NN the number of the nodes.[11]

These formulae allow us to express selected significant features of networks and facilitate the conceptualization of the geography of networks from the quantitative point of view. These relations embody the different characteristics of ›regular‹ space and space of flows and nodes or network space. The quantitative conceptualization further serves as a necessary complement of qualitative features of networks.

If we want to define the elementary categories of the geography of networks, it is necessary to start with traditional spatial sciences, as spatial sciences were formed throughout the centuries. Considering that the initial point of the creation of networks is of social nature and that any further expansion of networks is based partly on social circumstances and partly on spatial-technical conditions, the categories of Human Geography serve as an appropriate benchmark for the conceptualization of the geography of networks. Human geography generally deals with the creation, development and rules of the spatial socio-economic order. Consequently, we are entitled to use the method of analogy for the derivation of the elementary time-spatial categories of the geography of networks.

   The subject of Human Geography is the identification of regularities and continuities of the origin, development and spatial-hierarchical organisation of socio-economic systems that form spatial structures and processes. The object of the Human Geography is landscape, since landscape provides the environment for life as well as all activities of society. Concurrently, the subject of the geography of networks can be defined as the identification of regularities and continuities of the origin, development and spatial-hierarchical organisation of networks. From the geographical standpoint, networks are the subset of socio-economic systems. The object of the geography of networks are networks that are composed of the nodes and links.

   In order to delimitate the geography of networks more precisely, further conceptualization is necessary. As already suggested, networks can be comprehended as social, spatial and technical entities. In every kind of geography, time-space perspective and conceptualization are perceived as essentials. As it is apparent from table no.1 and no. 2, from the time-spatial point of view, *networks constitute a certain compromise between physical-societal or traditional territories and virtual or infotechnological spaces*.

   The characteristics of the networks are based partly on the features of real spaces and partly on the qualities of virtual spaces. Sometimes, the traits of networks are similar to these in physical space or in virtual space, but very often, the networks can be perceived as a missing

qualitative link between physical and virtual spaces. The following table shows an overview of essential characteristics of traditional physical spaces, quickly evolving network spaces and virtual/infotechnological spaces.

	Physical space/territories	Networks	Virtual space/infotechnologies
Borders	Fixed state and administrative borders.	Semi-borders. Networks have no fixed borders but at the same time, it can be controlled and decided, who acts as an insider and who is outsider.	Borders do not exist in case you have an access to the proper technology and you know the right information. Global and local exist concurrently.
Administration	State, regional and local administration. History, tradition, particular institutions and power centres.	Power centres exist but are mostly clandestine. They are constituted just at the beginning of the formation of network.	Self-control, knowledge of right information. Power centres do not exist.
Identity relation we-others	Community versus different communities. Culture versus different cultures. Nation versus different nations. Different languages. These relations are not of elite but of differentiating nature. Differentiation in various domains of life.	»We-others« is replaced by »Insiders-Outsiders« relation, since numerous networks are of elite nature. This relates only to networks, while identity relations in ›space/territories‹ category can be examined in numerous fields.	The others do not exist, only we. We use infotechnologies, therefore we are similar. Slang and widely used English that acts as a sought Esperanto. Obviously, there is the competition between different systems and there are different programming languages but they do not erase uniting link in the form of the usage of infotechnologies and the movement in the virtual spaces.
Public-private spaces	Clear distinction between public and private.	Rather than with ›public-private spaces‹ we are dealing with ›internal-external spaces‹. No or limited acces to internal information for outsiders.	Simultaneous public and private spaces. Protected sites, passwords or encoded protocols are existing but they all are penetrable with the right know-how, that can be obtained via computer networks.

Table No. 1: Networks from a Spatial/Geographical Perspective

	Physical space/territories	Networks	Virtual space/info-technologies
History/Past	Historical events and experience.	(Limited) history and memory. Semi-history.	No history and no memory. Infotechnologies lack the feeling and consciousness. They have no memory in a human sense (e.g. memory of wars and other historical-critical events).
Present time	Concentration on both the present time and the future.	Operating in the present time, but projects are usually planned for the future.	Only present time. Infotechnologies go on-line, can be programmed but lack the feeling of the future.
Working time/leisure	Clear division between working time and leisure.	Working time and leisure are semi-divided.	Work and game are sometimes blended.

Table No. 2: Networks from Time Perspective

The formidable boost of networks within the last two decades changes numerous relations within the society, which subsequently influences the relation of the society towards the environment. While many psychologists, sociologists, economists or polithologists tackled the new ›network‹ challenge eagerly, geographical/spatial insights remained largely omitted. This paper brings an idea of the geography of networks that conceptualize time-spatial aspects of networks. While the subject of the geography of networks was defined as the identification of regularities and continuities of the origin, development and spatial-hierarchical organisation of networks, the objects of this field of geography are networks as such. Strikingly enough, networks constitute a certain compromise between physical-societal or traditional territories and virtual or infotechnological spaces. Geographers and other spatial scientists thus stand vis-à-vis further elaboration and development of the geography of networks. This paper attempts to delimitate the fundamental issues of the geography of networks.

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