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Conceptualising 'macro-regions': Viewpoints and tools beyond NUTS classification

Definitions are imposed but properties not. The basic question addressed by this paper is how to 'detect' objective socio-economic spatial structures instead of 'defining' them arbitrarily. The NUTS classification model is rather arbitrary. Not only have the administrative units been structured through 'accidental' historical conditions but the reliability of the measurement of the population in an area is disputable as long as the mobility is strengthened and the 'usual residence' becomes more and more vague. Concerning the auxiliary criteria, they are also heterogeneous and are rather perceptions imposed by decision makers than physical entities. The quantitative network analysis (QNA) approach is suggested as a tool to detect macro-structures regarded as socio-economic and natural infrastructure of a 'macro-region'. This is based on algebraic analysis of a number of variables such as flows of people migration, financial means, information, commodities, bio-diversity elements and parameters of the new relationship between urban and rural areas. In this paper, by using algorithms of QNA, such as Density of flows or Betweenness centrality of places, 'denser' networks of flows among places or more 'central' places can be differentiated from others, and thus can be used for a more substantial demarcation of 'macro-regions'.

Keywords: macro-region, NUTS, flows, quantitative network analysis, migration, rural-urban relationship, place

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Introduction

The aim of this paper is to present conceptual tools of complete[1] Quantitative Network Analysis (QNA) for detecting and analysing spatial macro-structures of flows of social, political, economic and ecological character. These macro-structures can be regarded as macro-regions, which are physically and not politico-administratively defined, as they are constructed by structures that exist independent of any arbitrary decision. The network analysis software Visone is used for this purpose. Hypothetical visual examples of networks are produced and processed with this software. The understanding of informal spatial structures of flows is important because these structures, and not always the formal ones, determine policy outputs.

Basic flows which are discussed in this paper are: a) migration (economic, social, political and environmental), b) relationship between rural and urban areas, c) information, d) financial means, e) commodities, and f) bio-diversity. Each of these flows composes a different spatially cohesive macro-region which can be of sub-national, national or inter-state character, as long as the flow network is characterised by relatively high density.

The hypothetical visual network examples will be from the field of migration, because this field seems to be closer to common everyday experience and simultaneously constitutes a much-discussed issue. Thus, it is considered to be more interesting and easy to understand than the other flows (e.g. information, bio-diversity, commodities) which eventually need more specifications in order to reach a similar level of understanding and stimulation for a typical reader. These flows will be discussed and the hypothetical network patterns of migration will be tried to be conceptually applied to the fields of other flows.

The engineering design of a software product for social network analysis is decisive for the perceptional output of a policy arena (Degenne and Forse, 1999; Hasanagas *et al*., 2010a). The formulation of 'smart' evaluation algorithms which should be abstract and simultaneously functional and meaningful for a wide range of heterogeneous policy fields, from socio-political up to ecological structure analysis (Anghel *et al*., 2010; Engler and Kusiak, 2010) is a diachronic, substantial and still challenging question in software engineering (Hand *et al*., 2001; Antonelli and Chiabert, 2010; Cisar *et al*., 2010; Zamfirescu and Filip, 2010). The examples suggested until now are mainly related to concrete fields such as rural-environmental (Hasanagas *et al*., 2010b), new rural-urban relationships, spatial (Dimen and Ienciu, 2005), industrial (Antonelli and Chiabert, 2010; Cisar *et al*., 2010), commercial (Kalay, 2006; Engler and Kusiak, 2010) and public administration issues (Henning and Wald, 2000). They depict a path leading to a more 'immaterial' perception of networks and to a sharper perceptiveness toward the institutional infrastructure of the reality, but without dealing with the challenge of detecting physically existing spatial macro-structures of politico-administrative importance.

In the literature, not only the density but also the hierarchy is a necessary factor of keeping a network cohesive (Simon, 1957; Popitz, 1992). However, hierarchy exists not only among organisations but also among places. This may look like an abstract approach but it also applies among places and constructs an order of 'superior' and 'inferior', 'rich' and 'poor', 'leading' and 'led', 'central' and 'peripheral' countries, cities and villages (Piore 1979, Kolmannskog and Myrstad, 2009, Hasanagas *et al*., 2010a; Papadopoulou *et al*., 2011).

This hierarchy has already been identified as a major dimension of power in policy networks that seems to replace incentives or formal regulations as driving forces for policy output (Eisenstadt 1995, Hasanagas 2011), but not at a spa-

[1] A network is a system of nodes and links among them. The complete network analysis detects all existing links of a specific content (e.g. migration flow, economic flow, information flow etc.) among all really involved nodes (persons, organisations, places etc.). In this paper, the nodes will be places and links will be various flows of migrants, economic means etc among them. A complete network analysis includes all nodes involved in a certain issue, in contrast to ego-network analysis which examines the relations of a certain node to other nodes. (Papadopoulou *et al*., 2011).

tial level, in the sense of defining macro-regions in a physical way. An attempt to copy the approach of network analysis to space dimension in order to conceive a kind of ‘ecological’ macro-region was suggested by Zetterberg *et al*. (2010). It is worth mentioning other kind of flows which are closer to social, economic and politico-administrative dynamics (Krott, 1990; Krott and Hasanagas, 2006).

Assuming that today, an intensive transition from ‘spaces of places’ to the ‘spaces of flows’ is experienced (Castells, 1989; Castles 2002), the use of network analysis software for re-conceiving the structure of ‘region’ and ‘macro-region’ becomes necessary for policy-makers and researchers. Migration is a flow which can be used for re-structuring a new constellation of borders and regions, as well as markets (Piore, 1979; Williams *et al*., 1997; Kolmannskog and Myrstad, 2009) and information flows (Barthélemy *et al*., 1988; Lianos *et al*., 2004).

The expected contribution of this paper is the suggested toolbox to conceive and detect physical (objectively existing) socio-political, economic and ecological spatial structures instead of ‘defining’ them through politics at national and supranational level. An example of such an arbitrary system is the NUTS classification model. This is based on administrative units and population as basic criteria as well as on geographical, socio-economic, historical, cultural or environmental circumstances, when it is necessary to define further aggregation of smaller units (EC, 2003). The administrative units have been structured accidentally through historical conditions. Apart from that, the reliability of the measurement of the population in an area is disputable as long as the mobility is strengthened and the ‘usual residence’ notion becomes steadily vaguer, especially in the framework of the new relationship between rural and urban areas. Concerning the auxiliary criteria of geographical, socio-economic, historical, cultural or environmental character, they are heterogeneous and are rather perceptions imposed by decision-makers, and also accidental incidences rather than physical entities.

A useful definition is the one which presents properties useful for predicting and planning. The NUTS system seems to be descriptive rather than explanatory. It ‘defines’ rather than ‘detects’, while a tool which ‘detects’ rather than ‘defines’ macro-structures regarded as socio-economic and natural infrastructure of a ‘macro-region’ is the QNA, which is based on algebraic analysis of a number of variables such as flows of people migration, financial means, information, commodities, bio-diversity elements and the new relationship between urban and rural areas. In this paper, by using algorithms of QNA, such as density of flows or Betweenness centrality of places, ‘denser’ networks of flows among places or more ‘central’ places can be differentiated from others, and thus can be used for a more substantial demarcation of ‘macro-regions’ beyond NUTS levels (municipalities, prefectures, states etc.).

Although it may sound too ambitious, this could be seen as a tool for a more acceptable and administratively effective re-conceiving and reconstructing of people communities, institutional arenas and nature protection areas beyond the will of decision-makers who set borders according to opinions or interests.

Using Quantitative Network Analysis for defining macro-regions

Defining a network

The flow of migrants among places (villages, towns and cities of various countries or within the same country in the case of internal migration) can be conceived as a network of population flow. The places can be regarded as nodes of the network and the flows as links among these places. The flows can be distinguished according to the cause of the migration: economic (to earn money), social (to find more convenient customs and rules or reputation), political (refugees or exiled people), or environmental (people searching for more convenient and/or safe ecological conditions).

A basic mathematical entity for operationalising and developing formulae for network analysis is the *link* (flow caused by economic, social, political, or environmental factors) from node (place) i to node j. The link (relation) from node i to node j is defined as: Z_{ij} (Brandes *et al*., 2003). If there is no flow in direction $i \rightarrow j$ then: $Z_{ij} = 0$ migrants population. The link is valued: $Z_{ij} = X$ *migrants population* flowed in a certain time (e.g. 37,657 migrants for economic reasons from 2006 to 2010). Thus, a complete migration network is defined by the migration cause (link form) and the time limits within which a researcher desires to examine the migration. In these terms, a network is really ‘complete’ only when the snowball sampling is exhausted by the researcher. This happens when the interviewed migrants do not cite to the researcher any new place, even if this means that all countries, cities or villages of the world will appear in the network.

In order to define a network more specifically, one should specify a) the link form: e.g. not generally ‘economic migration’ but ‘economic migration because of war in the place A’ or ‘economic migration because of bankruptcy of agricultural holdings’ etc., or/and b) the time horizon (e.g. 2000-2003).

A complete network is opened up through snowball sampling by detecting successively all chains of flows (using documents of migration, questionnaires of other appropriate method depending on the flow examined). The researcher knows that the network is fully detected only when no reference to a new place appears. Thus, nobody decides arbitralily which places belong to the network and the procedure of opening up is completed automatically. Naturally, this method includes also the bidirectional flows, which are also processed through the algorithms described below.

Interpreting network algorithms

Network density and complexity

Density (D) is a characteristic of the entire network. It is defined as the proportion that is calculated from the number of all flows occurring in the polygon divided by the number of all possible flows $(N^2 - N)$:

$$D = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} Z_{ij}}{N^2 - N} \quad (1)$$

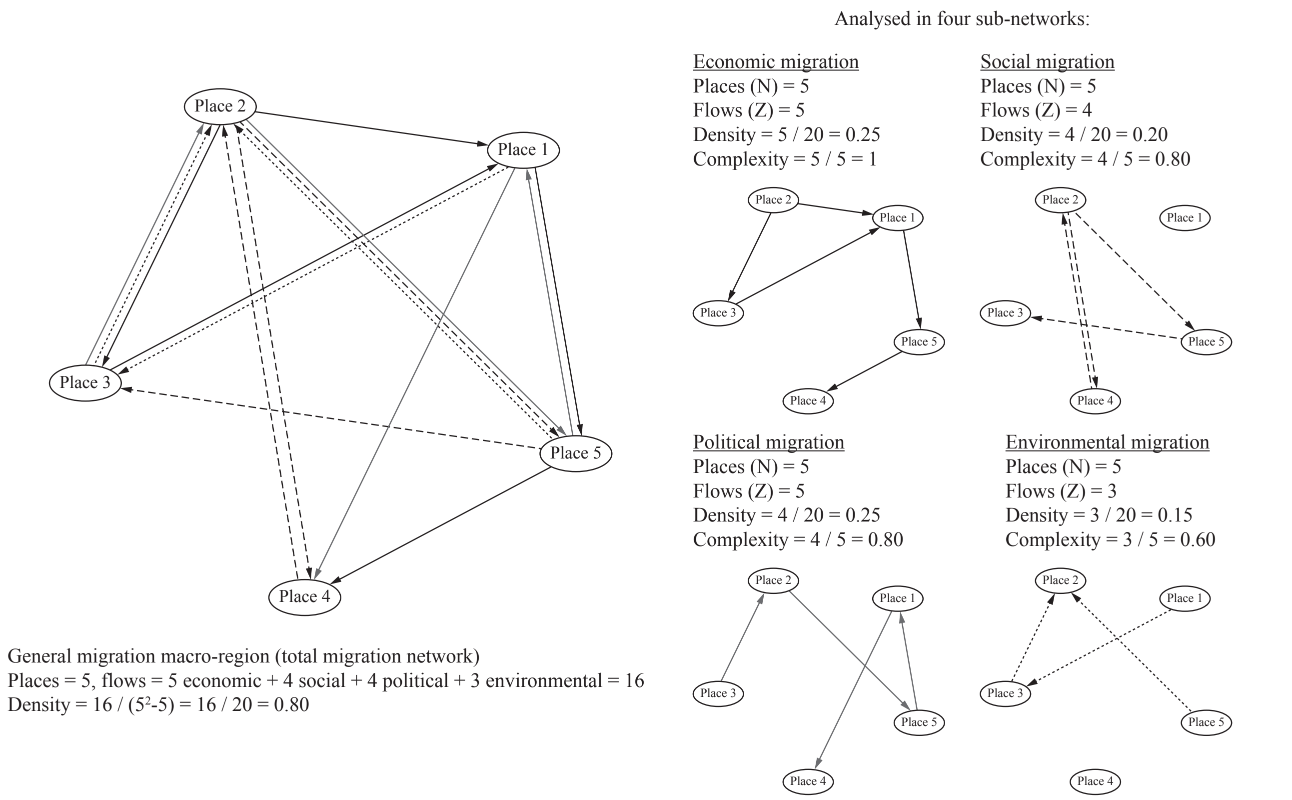


Figure 1: Visualisation of hypothetical migration networks: density and complexity.

where $i \neq j$, Z_{ij} is the link from actor i to actor j and N is the total number of places within the network. The links (flows) are measured in binary scale (inexistent = 0, existent = 1).

In other words, a network's (polygon's) density is the proportion of the existing diagonals to all possible (double-directed) diagonals. In a total macro-region such as in Figure 1, Density may be higher than 1 (or 100%) as the links between two places can be multiple (e.g. economic, social and environmental).

D is significant for the extent to which all possible migrants' 'chances for a new life' which can be tested at all possible places have been exhausted. But this should not be considered as the only indicator for intensity of activity, because e.g. a network with *N = 4* and *D = 100%* is still felt to be much simpler than a network with *N = 50* and *D = 30%*.

Thus, Complexity (*Comp*) is proposed as a more accurate indicator of the practical difficulties that can take place in the migration policy making at international level and is defined as follows (Hasanagas, 2012):

$$Comp = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} Z_{ij}}{N} \qquad (2)$$

The most complex of the hypothetical networks of Figure 1 is this of economic migration (*Comp* = 1). The simplest is this of environmental migration (*Comp* = 0.60). The complexity is an indicator which implies the *intensity of tasks* for a government or supranational authority dealing with the particular network. Thus, in the case of the macro-region of Figure 1, the most challenging task is expected to be the policy making in economic migration. Second comes the social and political migration (*Comp* = 0.80) and last the issue of environmental migration.

Place networks of higher density or complexity than other constellation of places can be regarded as macro-regions concerning the particular flow type: Macro-regions of migration flow, of commodities (macro-markets) or financial resources transfer among places, of special bio-diversity (migration of bird species), of scientific or general information etc. In this way, the macro-region is physically and not politically defined. Thereby, the regional, national or inter-state authorities (in case of transnational physical macro-regions) can more accurately design and deliver their policy in the relevant macro-region (migration, rural development, nature conservation etc.) and the private actors can also make more rational choices (investment in the right market, e.g. agricultural, forest products, high technology etc.). The poposed method can thus be used for defining macro-regions by demarcating the networks which have higher density or complexity than the density or complexity of the whole system of flows in Europe. A macro-region (sufficiently dense or complex network) can be extended over NUTS units or even be cross-frontier. Such a dense (or complex) network can be regarded as one single macro-region.

Place status

Not all places are equally attractive for migrants. The migrants are also not always able to reach the final target place immediately. Sometimes, they are obliged to pass through other places in which they have better chances of strengthening their position (first one may earn money in a village in order to go to a city, first one may strengthen his social reputation with a Master study in Britain in order to seek a career in the USA etc.).

Thus, status of a place can be perceived as an indicator of concentration of (supposed) chances and attractiveness of a place. The 'inferior' places function as successive migration 'steps' or 'bases' for 'superior' ones. Thereby, an informal hierarchy of places is constructed. If, for example, place A is a step for place B, place B for place C and B and C steps for place D, then place D is the most attractive one. In this case, place D is perceived as a 'promised land' which necessitates a gradual progress and self-development in the part of migrants.

The following formula for calculating the status of an actor in a network has been proposed (Katz, 1953):

$$T = aC - a^2C^2 + \ldots + a^kC^k \qquad (3)$$

where T is a matrix including the status values of all flows elements, and C is the algebraic matrix presenting the network, where the places are ordered horizontally and vertically and the elements are the flows among each other. If possible, the flows are preferably measured in metric scale (population of migrants) and not in binary (inexistent = 0, existent = 1).

The status of each place is expressed in the matrix T. A simplified description of the matrix T is as follows: The matrix T has horizontally and vertically the actors (nodes) in the same order. Its elements are the numbers of paths inter-connecting the actors. The Visone software calculates the share of the status of each place in per cent. This software also visualises the whole status hierarchy (Figure 2). Places located at higher layers have a higher status than these located at lower layers. Thus, they cannot have the same physical position.

The more 'steps' are precedent to a particular place and the more migrants flow to it, the higher status this place can be considered to have.

Within a physical macro-region, as defined above, such a hierarchy of places can disclose the much-discussed notion of the 'new rural-urban relationship'. The urban areas have been seen for long time as 'superior' to rural areas by many people from many points of view: firstly, the intensive migration to cities especially during the 20th century sets urban areas at the top layers of the status pyramid. Apart from that, the flow of financial resources, commodities and information dissemination potential were also concentrated in cities. An example of this inequality was that in Greece in the 1930s the rural income was seven times lower than the urban income, while agrarians were paying 2.4 times more tax than the urban population. Thus, not only social dynamics (migrants seeking a career or a 'better' life quality in cities) but also the tax system fostered such an inequality in status between rural and urban areas (Koutsou and Hasanagas, 2007). The only exception seems to be bio-diversity flow (rural areas were more attractive than cities for most species) (Hasanagas, 2009).

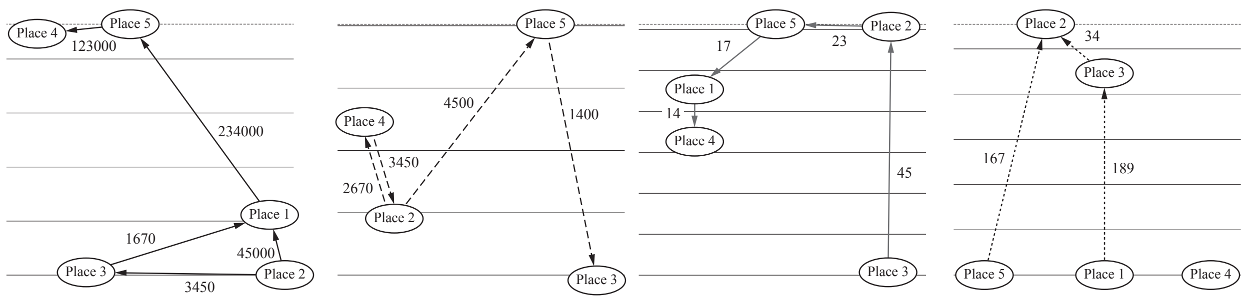
The ESDP (European Spatial Development Perspective) is an initiative for decreasing this status inequality (Papadopoulou and Hasanagas, 2011). If it proves effective, this will be depicted in the status pyramid by setting rural and urban areas at similar levels. A migration flow from cities to rural areas has been observed in many countries. This may lead to equalisation of status between rural-mountainous and urban areas. Of course, this is not the only dimension of the rural-urban relationship. Other dimensions may be the spatial distribution of employment, of the communication technology etc.

Finally, in case of natural disasters and increasingly extensive pollution, birds may also gradually change biotopes through survival of the fittest.

Place importance

The status of a place is insightful but not always feasible to be measured because data about the migrants' population are often unavailable. Thus, a more simplified indicator, Closeness centrality, can be used, where the flows will be valued in a binary scale (inexistent = 0, existent = 1) and not in a metric scale as in status.

The Closeness centrality (Cc) measures the distance d (i.e. the shortest number of links) between two places. If place A is a step for place B and the place B for place C (and there is no direct link from the place A to place C), then the distance from the place A to the place C is $d = 2$ (i.e. two links). The sum of all distances from place i to any other



Economic migration	Social migration	Political migration	Environmental migration
Place 1 = 7.76%	Place 1 = 0%	Place 1 = 22.75%	Place 1 = 0%
Place 2 = 0%	Place 2 = 23.14%	Place 2 = 30.28%	Place 2 = 55.40%
Place 3 = 0.57%	Place 3 = 14.69%	Place 3 = 0%	Place 3 = 44.59%
Place 4 = 44.98%	Place 4 = 26.97%	Place 4 = 16.34%	Place 4 = 0%
Place 5 = 46.67%	Place 5 = 35.18%	Place 5 = 30.61%	Place 5 = 0%

Figure 2: Visualisation of hypothetical migration networks: status (precise attractiveness calculated with flows ideally valued in metric scale). The most attractive place (village, city, country etc.) for economic immigrants is place 5 (46.7%) but the most attractive place for environmental immigrants is place 2 (55.4%).

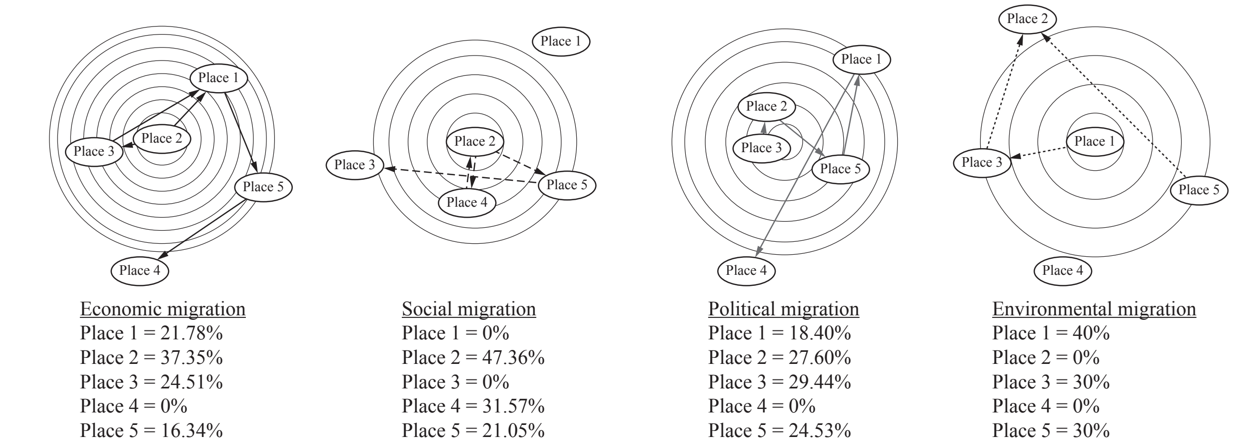


Figure 3: Visualisation of hypothetical migration networks: closeness centrality (less precise attractiveness than status, calculated with flows valued in binary scale).

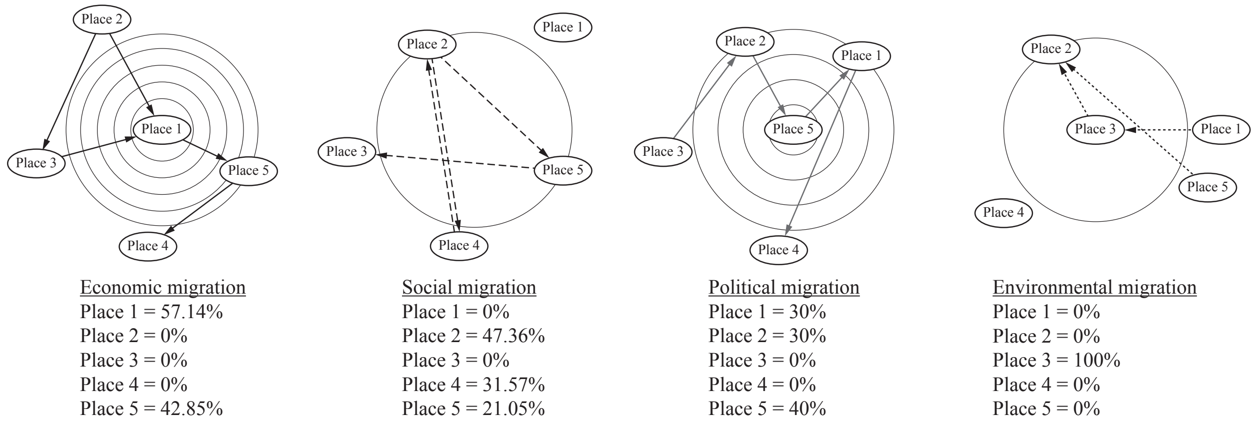


Figure 4: Visualisation of hypothetical migration networks: Betweenness centrality (place control potential calculated with flows valued in binary scale).

place is the closeness of the actor *i* and then the closeness centrality of *i* is defined as its inverse closeness:

$$Cc_{(i)} = \left[\sum_j d(j,i)\right]^{-1} \tag{4}$$

The fewer links are needed to connect *i* to all other places, the higher its *Cc* is. If a place is considered to offer better chances than the other places, then the migrants, the investors etc. try to reach this place immediately, without 'losing time' in other places. Thereby, this place acquires high closeness centrality. The *Cc* of each place is expressed in per cent. The Closeness centrality structures are depicted in Figure 3: the closer to the centre a place is located, the higher is its *Cc*.

In the case of information distribution, this algorithm can be especially useful, as information (scientific, political, environmental etc.) cannot be measured in pre-defined, objective and generally acceptable units, as financial means and population can be measured. Places with high *Cc* in information distribution are considered to be the most important ('central') ones which influence the other ('peripheral') places. In other words, the most influential public or private actors which formally or informally play the role of decision-makers in various fields (market, environmental, cultural, rural development policy etc.) are often located in 'central' places.

Control potential of places

The Betweenness centrality (*Cb*) (Brandes *et al*., 2003) quantifies the control (formal or informal) that may be exerted through a place *i*. It is defined as the sum of the ratios of shortest paths between other places that the place *i* sits on:

$$Cb_{(i)} = \sum \frac{|P_i(i,j)|}{|P(i,j)|} \tag{5}$$

where *P(i,j)* and $P_i(i,j)$ are the sets of all shortest paths between *i* and *j*, and those shortest paths passing through *i*, respectively. In the case of *Cb*, the flows are also measured in a binary scale (existent = 1, inexistent = 0). The *Cb* of each place is also expressed in %. The Betweenness centrality structures are depicted in Figure 4: the closer to the centre a place is located, the higher is its *Cb*.

A place with a high percentage of *Cb* plays the role of the go-between for many other places in term of shortest paths and, in this way, functions as a central control point for the flow and spread of migrants. When the place of the highest *Cb* is not identical with the place of the highest status or *Cc*, then migrants who appear there are 'passers-by' rather than persons who have decided to seriously invest their time and work in order to start a 'new life'. It is understandable that they may often not regard this place as a 'promised land' but rather as a place of accidental or unfortunate 'landing' where they should find the 'easiest' and contemporary way to 'survive'. Under these conditions, there seems to be greater susceptibility to resisting integration and developing deviant behaviour or illegal activities. If the authorities could distinguish places of high *Cb* which are not simultaneously of high *Cc* or status, they could focus their attention and concentrate their efforts on these places, and thereby become more effective.

The detection of places of high *Cb* is also of importance for producers and traders but also for industries in order to make more rational decisions on their establishment and to achieve optimal access to markets within economic macro-regions. Places of high *Cb* are also important for actors dealing with nature protection and bio-diversity researchers or forest policy analysts, as these places constitute attractive biotopes for bird species. Thereby, they can recognise macro-regions of natural heritage and more important biotopes within them.

In the case of information distribution, when places of high *Cb* can play the role of 'postman', while places of low *Cb* are the 'addressees'. When a place has high *Cb* and low *Cc*, then it mainly play the role of 'postman' and not of 'decision-maker' (Hasanagas *et al*., 2010b). Normally, places with high *Cc* have also high *Cb*. However, when such a differentiation appears, then this can be useful in order to distinguish the 'decision-maker' from the 'postman' in order to design and conduct lobbying activities more effectively.

Discussion

By applying algorithms used in QNA such as Density, Complexity, status, Closeness centrality and Betweenness centrality, macro-regions of social, economic, political and ecological issues can be physically depicted as existent networks of flows among places – practically place networks – and not politically (arbitrarily) defined. These macro-regions can be regarded as issue-based spatial macro-structures (networks of flows). Thereby, private and public policy makers and researchers can draw their attention to real structures and not to politically constructed structures, depending on subjective interpretation of demographic, politico-administrative or historical conditions. In this way, the policy-making can more accurately confront a real issue, and the policy analysis and research can become more independent from policy design. The algorithms can be used for detecting different features and in different issues (Table 1).

Using these algorithms in the appropriate cases, the policy makers and researchers can recognise physically existent macro-regions beyond NUTS or any other politically defined spatial unit. This may lead to more effective policy making at politico-administrative level and to a disclosure of properties of socio-political variables at academic level. Which flows (migration, commodities, information etc.) present the strongest cohesion (density) in these macro-regions and influence other types of flows can be a challenging question for future research and perhaps can initiate a new research field of both applied and basic character. Each flow may be further specified (e.g. commodity flow may be categorised as 'car flow', 'forest products flow', 'agricultural products flow' etc.). Additional flows may also be defined, measured and tested for possible

Table 1: Application of algorithms to analysis of macro-regions.

	Issue-based macro-region (issue-based spatial macro-structures) \ Algorithms	Density	Complexity	Status	Closeness centrality	Betweenness centrality
Use and evaluation of algorithms		Demarcation of macro-region	Assessment of intensity	Assessment of place attractiveness. More precise. Mostly appropriate for metric scales.	Assessment of place attractiveness. Less precise. Mostly appropriate for binary scales	Assessment of place control potential. Mostly appropriate for binary scales.
				Appropriateness (✓)		
Socio-political flows	a) Macro-regions of migration (economic, social, political, environmental)	✓	✓	✓	-	✓
	b) Macro-regions of relationship rural-urban areas (concerning the dimension of migration from cities to rural places)	✓	✓	✓	-	✓
	c) Macro-regions of information	✓	✓	-	✓	✓
Economic flows	d) Macro-regions of financial means	✓	✓	✓	-	✓
	e) Macro-region of commodities/cohesive market	✓	✓	✓	-	✓
Ecological flows	f) Macro-region of birds bio-diversity	✓	✓	-	-	✓

properties. The measurability and traceability of the flows remain a great challenge for inventory services and researchers. Also, in future research maps of NUTS regions and maps of new regions defined by this method can be compared.

It is evident that a macro-region defined by QNA is changeable depending on objective conditions and not on spontaneous and instantaneous politico-administrative decisions. It is not simply cross-frontier but also 'border-ignoring', as long as, for example, Thessaloniki (Greece), Rosdorf (a village in Germany), and London (UK) may be included in the same macro-region and characterised by high or low the same status, closeness or between centrality regarding a certain flow, disregarding how 'well known' or 'famous' they are, and without including the other villages, cities or countries which are located between them. This makes sense, as it allows recognising a cross-frontier group of places (macro-regions) which need to organise a more cohesive control system of flows and a stronger cooperation among them. Also, the importance of each place for each other within the hierarchy of the macro-region can be more objectively evaluated. This is the main strength and also the most challenging point of this approach. Some can see it as an 'opportunity', while others as a 'threat', depending on their interests. If such macro-regions also include places outside the EU, then this is a criterion about the real territorial cohesiveness of the EU.

References

Anghel, I., Cioara, T., Salomie, I., Dinsoreanu, M. and Rarau, A. (2010): Middleware for Smart Environments Management. International Journal of Computers, Communications & Control **V** (2): 148-159.

Antonelli, D. and Chiabert, P. (2010): Introducing Collaborative Practices in Small Medium Enterprises. International Journal of Computers, Communications & Control **V** (1), 8-19.

Barthélemy, P., Miguelez Lobo, F., Mingione, E., Pahl, R. and Weinig A. (1988): Underground Economy and Irregular Forms of Employment. Brussel: European Commission.

Brandes, U., Kenis, P., and Wagner, D. (2003): Communicating centrality in policy network drawings. IEEE transactions on visualization and computer graphics **9** (2), 241-253.

Castells, M. (1989): The informational city. Oxford: Blackwell.

Castles, S. (2002): Globalization and migration. Paper presented at Simposi International Europa – Mediterrania. Politiques d' Immigracion, Barcelona, Spain, 30 January – 1 February 2002.

Cisar, P., Bosnjak, S. and Maravic Cisar, S. (2010): EWMA Algorithm in Network Practice. International Journal of Computers, Communications & Control **V** (2), 160-170.

Degenne, A. and Forse, M. (1999): Introducing Social Networks. London: Sage.

Dimen, L. and Ienciu, I. (2005): Environmental management plan. RevCAD Journal of Geodesy and Cadastre **5**, 271–274.

EC (2003): Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS). Brussel: European Commission.

Eisenstadt, S. N. (1995): Power, Trust, and Meaning. Essays in Sociological Theory and Analysis. Chicago: University of Chicago Press.

Engler, J. and Kusiak, A. (2010): Mining Authoritativeness of Collaborative Innovation Partners. International Journal of Computers, Communications & Control **V** (1), 42-51.

Hand, D., Mannila, H. and Smyth, P. (2001): Principles of Data Mining. Cambridge, MA: MIT.

Hasanagas, N. D. (2009). Landscape Sociology [in Greek]. Athinai: Papasotiriou.

Hasanagas, N. D. (2011): Network Analysis Functionality in Environmental Policy: Combining abstract software engineering with field empiricism. International Journal of Computers, Communications & Control **VI** (4), in press.

Hasanagas, N. D. (2012): Digital Perception Functionality for Institutional Design: The forest policy issue of 'Loch Lomond & the Trossachs National Park' of Scotland as a case study. International Journal of Computers, Communications & Control **VII** (2), forthcoming.

Hasanagas, N. D., Styliadis, A. D., Papadopoulou, E. and Sexidis, L. (2010a): E-Learning & Environmental Policy: The case of a politico-administrative GIS. International Journal of Computers, Communications & Control **V** (5), 517-524.

Hasanagas, N. D., Styliadis, A. D. and Papadopoulou, E. (2010b): Environmental Policy & Science Management: Using a scientometric-specific GIS for e-learning purposes. International Journal of Computers, Communications & Control **V** (2), 171-178.

Henning, Ch. and Wald, A. (2000): On the theory of interest intermediation: A network approach illustrated with the case of the Common European Agricultural Policy [in German]. Politische Vierteljahreschrift **41** (4), 647-676.

Kalay, Y. E. (2006): The impact of information technology on design methods, products and practices. Design Studies **27**, 357–380.

Katz, L. (1953): A new Status index derived from sociometric analysis. Psychometrika **18** (1), 34-43.

Kolmannskog, V. and Myrstad, F. (2009): Environmental Displacement in European Asylum Law. European Journal of Migration and Law **11** (4), 313-326.

Koutsou, S. and Hasanagas, N.D. (2007): Rural Sociology and Rural Development [in Greek]. Thessaloniki: Alexander Institute of Technology.

Krott, M. (1990): Public administration in environmental protection. Results of a service-oriented policy analysis using the example of the forest protection as an illustration [in German]. Wien:Wilhelm Braumueller.

Krott, M. and Hasanagas, N.D. (2006): Measuring bridges between sectors: Causative evaluation of cross-sectorality. Forest Policy and Economics **8**, 555-563.

Lianos P., Petralias, A. and Boussoulas, C. (2004): Report on immigration in Greece. Athinai: European Migration Network, Centre for Planning and Economic Research.

Papadopoulou, E. and Hasanagas, N.D. (2011): European Integration. From Genesis to the Crisis [in Greek]. Thessaloniki: Grafima.

Papadopoulou, E., Hasanagas, N. D. and Harvey, D. (2011): Analysis of Rural Development Policy Networks in Greece: Is LEADER really different? Land Use Policy **28** (4), 663-673.

Piore, M. (1979): Birds of passage. Migrant labour and industrial societies. Cambridge: CUP.

Popitz, H. (1992): Phenomena of Power [in German]. Tübingen: J.C.B. Mohr.

Simon, H.A. (1957): Administrative behaviour: A study of decision-making processes in administrative organization. New York: Macmillan.

Williams, A., King, R. and Warnes T., (1997): A place in the sun: international retirement migration from Northern to Southern Europe. London: Routledge.

Zamfirescu, C.B. and Filip, F.G. (2010): Swarming Models for Facilitating Collaborative Decisions. International Journal of Computers, Communications & Control **V** (1), 125-137.

Zetterberg, A., Moertberg, U. M. and Balfors B. (2010): Making graph theory operational for landscape ecological assessments, planning, and design. Landscape and Urban Planning **95**, 181–191.