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This special issue collects a selection of peer-review papers presented at the 8th International Conference INPUT 2014 titled "Smart City: planning for energy, transportation and sustainability of urban systems", held on 4-6 June in Naples, Italy. The issue includes recent developments on the theme of relationship between innovation and city management and planning.

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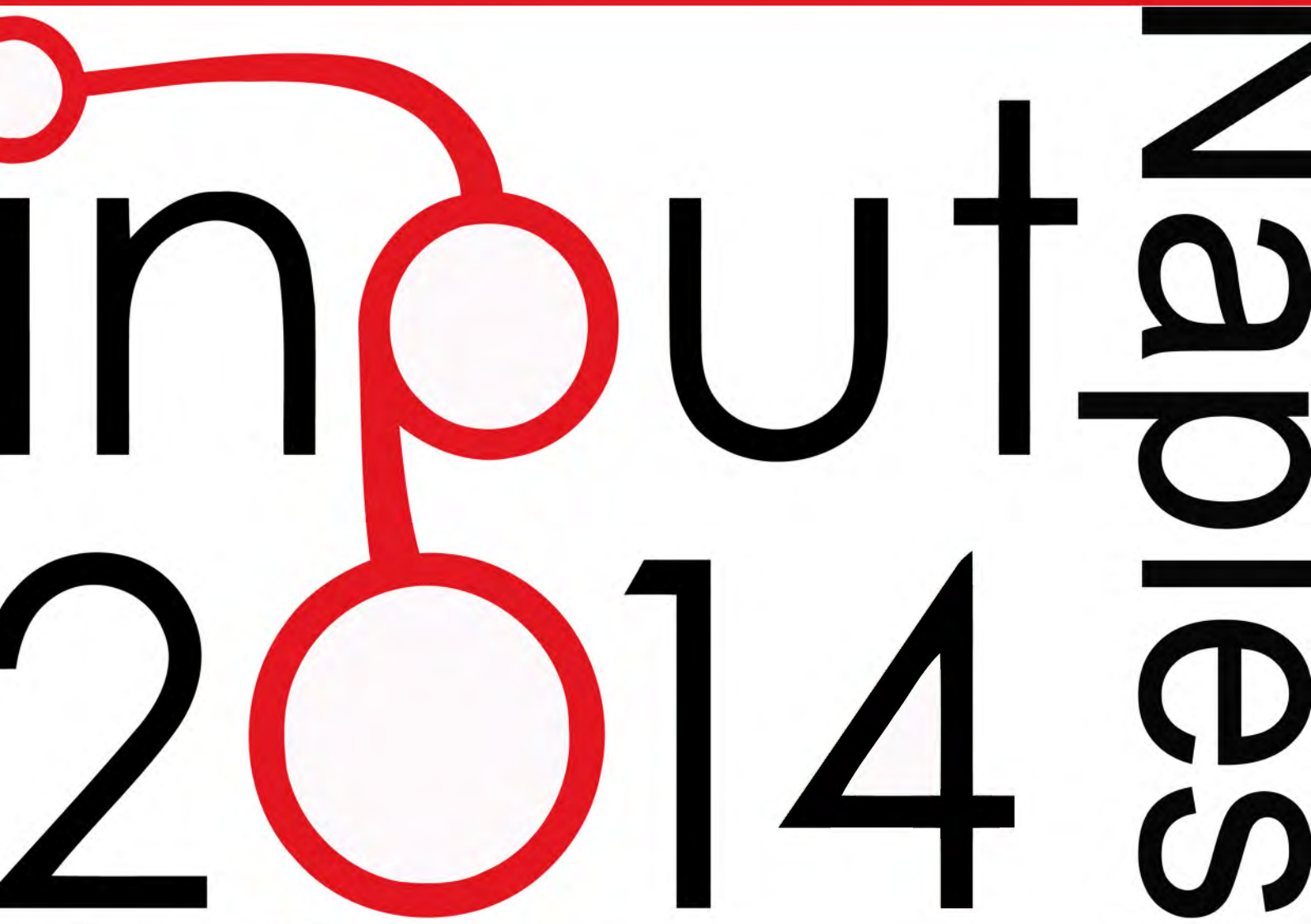

Smart City

planning for energy, transportation and sustainability of the urban system

Special issue, June 2014

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SMART CITY

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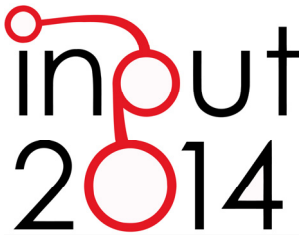
TeMA Journal of Land Use, Mobility and Environment

This special issue of TeMA collects the papers presented at the 8th International Conference INPUT 2014 which will take place in Naples from 4th to 6th June. The Conference focuses on one of the central topics within the urban studies debate and combines, in a new perspective, researches concerning the relationship between innovation and management of city changing.



TeMA Journal of Land Use, Mobility and Environment

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EIGHTH INTERNATIONAL CONFERENCE INPUT 2014

SMART CITY. PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

This special issue of TeMA collects the papers presented at the Eighth International Conference INPUT, 2014, titled "Smart City. Planning for energy, transportation and sustainability of the urban system" that takes place in Naples from 4 to 6 of June 2014.

INPUT (Innovation in Urban Planning and Territorial) consists of an informal group/network of academic researchers Italians and foreigners working in several areas related to urban and territorial planning. Starting from the first conference, held in Venice in 1999, INPUT has represented an opportunity to reflect on the use of Information and Communication Technologies (ICTs) as key planning support tools. The theme of the eighth conference focuses on one of the most topical debate of urban studies that combines , in a new perspective, researches concerning the relationship between innovation (technological, methodological, of process etc..) and the management of the changes of the city. The Smart City is also currently the most investigated subject by TeMA that with this number is intended to provide a broad overview of the research activities currently in place in Italy and a number of European countries. Naples, with its tradition of studies in this particular research field, represents the best place to review progress on what is being done and try to identify some structural elements of a planning approach.

Furthermore the conference has represented the ideal space of mind comparison and ideas exchanging about a number of topics like: planning support systems, models to geo-design, qualitative cognitive models and formal ontologies, smart mobility and urban transport, Visualization and spatial perception in urban planning innovative processes for urban regeneration, smart city and smart citizen, the Smart Energy Master project, urban entropy and evaluation in urban planning, etc..

The conference INPUT Naples 2014 were sent 84 papers, through a computerized procedure using the website www.input2014.it . The papers were subjected to a series of monitoring and control operations. The first fundamental phase saw the submission of the papers to reviewers. To enable a blind procedure the papers have been checked in advance, in order to eliminate any reference to the authors. The review was carried out on a form set up by the local scientific committee. The review forms received were sent to the authors who have adapted the papers, in a more or less extensive way, on the base of the received comments. At this point (third stage), the new version of the paper was subjected to control for to standardize the content to the layout required for the publication within TeMA. In parallel, the Local Scientific Committee, along with the Editorial Board of the magazine, has provided to the technical operation on the site TeMA (insertion of data for the indexing and insertion of pdf version of the papers). In the light of the time's shortness and of the high number of contributions the Local Scientific Committee decided to publish the papers by applying some simplifies compared with the normal procedures used by TeMA. Specifically:

- Each paper was equipped with cover, TeMA Editorial Advisory Board, INPUT Scientific Committee, introductory page of INPUT 2014 and summary;
- Summary and sorting of the papers are in alphabetical order, based on the surname of the first author;
- Each paper is indexed with own DOI codex which can be found in the electronic version on TeMA website (www.tema.unina.it). The codex is not present on the pdf version of the papers.

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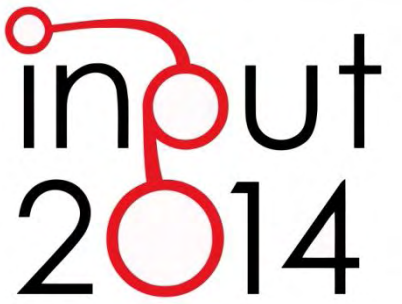

TRANSPORTATION INFRASTRUCTURE IMPACTS EVALUATION

THE CASE OF EGNATIA MOTORWAY IN GREECE

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ABSTRACT

To expand GIS abilities to the consideration of decision criteria, OR/MS researchers strongly pronounce in favor of developing synergies between GIS and multicriteria decision making tools. The rationale of this integration is the GIS ability to store and manage and visualize geographically referenced data and the efficiency of Operational Research tools for modeling decision problems. As a result, MultiCriteria Spatial Decision Support Systems (MC-SDSS) provide a consistent framework that allows alternatives' ranking combining both spatial data and DMs preferences according to a selected decision rule. Regarding to their applicability in situations that involve classification, multiattribute decision models are considered as a very attractive procedure in urban and regional planning concerning the appraisal of transportation infrastructure construction. In the present a spatial multicriteria evaluation of the impacts derived by the realization of Egnatia Motorway is performed. Egnatia Motorway is considered one of the most significant interventions that have taken place in Greece during the early pre-Olympic Games period and up to the year 2007. With a length of 670 km, it crosses 12 prefectures starting from the Igoumenitsa Port, which provides links by boat to Italy, ending to Kipi in Evros (Greek-Turkish borders). It is a dual carriageway with two traffic lanes per direction with an overall construction cost of about 6b€. Aiming to enrich Northern Greece's potential in transport industry and tourism, European Union has heavily invested in its construction. In the present paper an integration among GIS functionalities and multi-attribute decision making models such as Analytic Hierarchy Process (AHP) and Ideal Point Methods is proposed in order to estimate the impacts provoked by the construction and operation of Egnatia Motorway in regional level.

KEYWORDS

Multiattribute Decision Aid, AHP, Ideal Point Methods, GIS

1 INTRODUCTION

Land-use suitability mapping and analysis, that aim to identify appropriate spatial patterns for future land uses according to specific requirements, preferences, or predictors of some activity, have been widely accepted as one of major fields of interest between GIS analysts (Collins et al, 2001). The ability of the contemporary GIS software packages to support geoprocessing tools such as overlay procedures led both scientists and practitioners to refer to them as Spatial Decision Support Systems (SDSS). However, there is growing consensus about the limited role of GIS as SDSS (Pereira & Duckstein, 1993). This criticism is mainly addressed to the lack of adequate techniques that allow DMs preferences contribution to the final result; and to the fact that Boolean overlays identify as solutions only those that simultaneously satisfy all the analysis' criteria (Laaribi et al, 1996; Chakhar & Martel, 2003). Recent advances in both GIS technology and Multi Criteria Decision Making methods (MCDM) led many authors to recommend integrations between the two research areas. The rationale of this integration is the GIS ability to store and manage geographically referenced data and the efficiency of Operational Research tools for modeling decision problems. As a result, MultiCriteria Spatial Decision Support Systems (MC-SDSS) provide a consistent framework that allows alternatives' ranking combining spatial data and DMs preferences according to a selected decision rule (Anagnostopoulos et al, 2010).

Transport infrastructure is considered as a regional development project. The new European transport policy (EU–European Commission, 2002), has acquired a clear development dimension, and is directly linked to the policies for the social, economic and territorial cohesion of Europe. This is enhanced by evidence from numerous research studies (Vickerman, 1996; Faludi, 2006). European Spatial Development Perspective (ESDP) explicitly refers to the significance and the consequences of the European transport policy for the organization and development of the European area (EU–European Commission, 1999). It is suggested to assess the spatial impacts of European transport infrastructure on the basis of the following criteria: (a) impact on land use, (b) impact on productive systems of regions, (c) impact on spatial structure, (d) impact on the income and production, (e) impact through regional reinforcement measures, and (f) impact through the spatial differentiation of public intervention.

The Egnatia Motorway (Figure 1) is one of the largest transport projects constructed lately in Europe, and was included in the top priority projects of the Trans European Transport Networks (TENs-T). The motorway, 670km long, crosses Northern Greece horizontally from Igoumenitsa to Kipi on the Greek – Turkish border and is connected via vertical axes northwards to the Pan – European Corridors and via the PATHE (Patra-Athens-Thessaloniki) motorway and the western Ionian axis, to the rest of Greece. It is designed and built as a dual closed carriageway of international standards and comprises numerous long twin bridges, a large number of tunnels, 50 interchanges, 350 underpasses and overpasses, and 720 km of service roads. Moreover, it links all major urban centres, 4 ports and 6 airports (Egnatia Motorway Observatory, 2005).

At the national level, the Egnatia Motorway represents the backbone of the Northern Greek transport system, making it possible to break the isolation of remote Regions such as Epirus, Western Macedonia and Eastern Macedonia and Thrace. At the European level, it links Greece to Europe and the Middle East, while it operates simultaneously as a point of confluence for the merging transport flow from the Balkans and South-Eastern Europe. It is expected to operate as a zone of cooperation promoting selected economic activities, transport and energy networks, exchanges of technical knowledge, as well as the effective preservation of the environment and of cultural heritage. It is there that the Pan-European Corridors IV (Berlin-Sofia-

Thessaloniki), IX (Helsinki – terminating at Alexandroupoli) and X (Vienna- Belgrade-Thessaloniki) terminate (Spiekermann & Wegener, 2006).

In the present paper, an integration among GIS functionalities and multi-attribute decision making models such as Analytic Hierarchy Process (AHP) (Saaty, 1977) and Ideal Point Methods (Hwang et al., 1993; Tkach and Simonovic, 1997) is proposed in order to estimate the impacts provoked by the construction and operation of Egnatia Motorway in regional level. For that reason the 12 prefectures crossed by the motorway, are evaluated with the use of socioeconomic, environmental and transportation indicators. The proposed framework can be used as a valuable tool that allows public investments' evaluation in regional level, as well as inter-regional inequalities' estimations.

Fig. 1 Egnatia Motorway horizontal axis

2 SPATIAL MULTICRITERIA DECISION ANALYSIS

Rational decision making is characterized by a coherent sequence of actions that ensures DMs from dubious results in the final outcome. The methodological framework, as it has been stated by H. Simon (1960), can be distinguished in three phases. In the intelligence phase, decision space is well stated by the objectives and sub-objectives identification, and constraints criterion maps determination. In the design phase, feasible alternative scenarios are determined performing Boolean overlays among the constraints criterion maps. After the analysis decision table formation, criterion maps relative importance is estimated and utilization procedures of the geographical data are performed. Finally, in the choice phase suitability index maps are derived as the synthesis result of the per criterion utilities under a certain decision rule implementation.

2.1 ANALYTIC HIERARCHY PROCESS

Developed in the late 70s, AHP is a scaling method for deriving priorities (weights) for a set of activities according to their importance (Saaty, 1977). Since its release, the method has been widely used because it elicits DMs' preferences in a friendly and easily understood manner. As a procedure, AHP belongs to the family of methods that use pairwise comparisons in order to estimate relative preferences among decision analysis parameters in semi-structured decision problems. The method is based on three principles: the decomposition of the decision space to its fundamental elements, the comparative judgments, and the composition or synthesis of priorities.

The first of these principles is accomplished by breaking down the decision problem to its components by developing decision hierarchies. In general, the objectives tree is defined exclusively by the DMs aiming to

represent their experience and intuition over the problem. Comparative judgments principle has to do with the development of a solid base for establishing priorities among the decision parameters. Local priorities are obtained by comparing qualitatively each node against each of its peers with respect to its parent node using the nine levels of the fundamental scale of preferences (Saaty, 1995). Technically this is achieved by forming pairwise comparison matrices $A = (a_{ij})_{nxn}$, where the ratio a_{ij} assigned by the DMs expresses the dominance relation of the factor in row i when it is compared against the factor in column j. The measure of the dominance relation is determined by using the strict preference (A_iPA_j) and indifference (A_iIA_j) preference structures. Consequently pairwise comparison matrices are positive and reciprocals, and the elements in the diagonal equal to 1. Local (or relative) priorities or weights are then established as the principal eigenvalue λ_{max} of the pairwise comparison matrix solving the system of Equations 5. When the transitive property holds (Equation 6), the matrix is consistent and λ_{max} equals n. Since in real-life situations it is quite rare to obtain consistent judgments by the DMs, AHP provides measures of inconsistency as a function of the deviation between λ_{max} and n.

2.2 IDEAL POINT METHODS

Ideal point methods rank a set of alternatives A according to their separation from an ideal solution. They are based on an aggregating function that represents the relative closeness that originates in the compromise programming method (Zeleny, 1982). The principle of compromise is that the best alternative is closer to a hypothetical ideal solution (PIS: Positive Ideal Solution) $A^{PIS} = \{x_{i1}^{+}, x_{i2}^{+}, \dots, x_{im}^{+}\}$ that maximizes the DM's preferential system and as far as possible from an anti-ideal solution (NIS: Negative Ideal Solution) $A^{NIS} = \{x_{i1}^{-}, x_{i2}^{-}, \dots, x_{im}^{-}\}$ that minimizes it for each one of the analysis criteria (Hwang et al., 1993). f_j^{+} is defined as the performance of the ideal solution, $f_{\bar{j}}$ is defined as the corresponding performance benchmark of the anti-ideal solution alternative, and evaluation is performed via the separation measure, which is estimated in terms of distance metrics (Hwang et al., 1993; Tkach and Simonovic, 1997). The latter is achieved using Minkowski L_p measures. According to the physical property of the distance metrics, when p increases, the total is formed with greater emphasis given to the largest deviation (Lai et al., 1994).

In practice, particular interest presents the distance measures for p values equal to 1, 2 and ∞, corresponding to the well-known Manhattan (L_1), Euclidean (L_2) and Chebychev (L_∞) distances, respectively (DeMers, 2000). Given that the final ranking of the candidate locations is achieved by performing the addition operation of the per criterion DM's preferential system, criterion maps need to be standardized. Standardization (also known as normalization) enables criterion maps to be combined on the basis of a common reference scale, which most commonly ranges between 0 and 1. When ideal point methods are considered as the decision rule, the standardization process is usually linearly accomplished using the maximum score or the score range approaches (Zeleny, 1982; Hwang et al., 1993).

3 PROBLEM FORMATION AND EVALUATION CRITERIA

3.1 EGNATIA MOTORWAY OBSERVATORY INDICATORS SYSTEM

Egnatia Odos S.A. (EOSA) established and operates the Observatory of the Egnatia Motorway, which collects, processes, and provides valid and updated data regarding parameters in order to: (a) support the integrated management of the motorway, (b) contribute to the utilization of the project in the cohesion and development of a greater area, and (c) contribute to the harmonized assessment of TENs-T impacts on the cohesion of the European area (Vickerman, R., 2004). A central element for the operation of the

Observatory is the organization of the information system that provides a potential for recording, calculating, and monitoring of 50 various indicators. Among these indicators, twenty have been chosen for this particular application and have been subjected to the necessary changes and modifications in order to become suitable for the purposes of the research. The examined influence zone includes the transit route of the axis, which is directly influenced. For its definition, the spatial level which is represented by the Prefectures is considered more useful in operational terms. Therefore, the transit route from the West to the East consists of the following twelve Prefectures, which are part of five Regions: Thesprotia, Ioannina (Region of Epirus), Trikala (Region of Thessaly), Grevena, Kozani, (Region of of Western Macodonia), Imathia, Thessaloniki, Serres (Region of Central Macedonia), Xanthi, Rodopi and Evros (Region of Eastern Macedonia and Thrace). This area covers 32.000 Km2, representing 49% of the total surface of Regions and 24.5% of the national territory. According to the 2001 Census, the actual population adds up to 2.319.052 inhabitants. The Prefecture of Thessaloniki is the most populated of the Prefectures, since it concentrates 27% of the population.

Fig. 2 Egnatia Motorway and the examined alternatives

3.2 DECISION HIERARCHY FORMATION

The need for performing MCDA approaches in order to gauge the examined prefectures occurs given that there is no effective solution that dominates all the others in the analysis. Figure 3, shows the rankings of the alternatives to the examined indices. Granted that, it is rather difficult for both practitioners and researchers to handle effectively the amount of information. In order to avoid the above drawback AHP is used in the present paper aiming to establish a composite index of suitability enabling thus sufficient ranking of the alternatives.

In order to enable coherent evaluations among the analysis objectives and subobjectives a five level hierarchy is formed (Figure 5). The first level consists of the analysis goal which is the effective ranking of the examined prefectures while in the last level is occupied by the analysis alternatives. The twenty indices that are used for the alternatives evaluation are grouped under socioeconomic, environmental and transportation objectives that should be improved by the Egnatia Motorway realization. Moreover socioeconomic objective is further subdivided into socioeconomic and planning indicators in order to build clusters that ensure coherent evaluations during the process of deriving relative priorities i.e. the contribution of each objective to the final outcome. Finally the contribution of each alternative to the indices satisfaction is standardized using the maximum score method (Voogd, 1983).

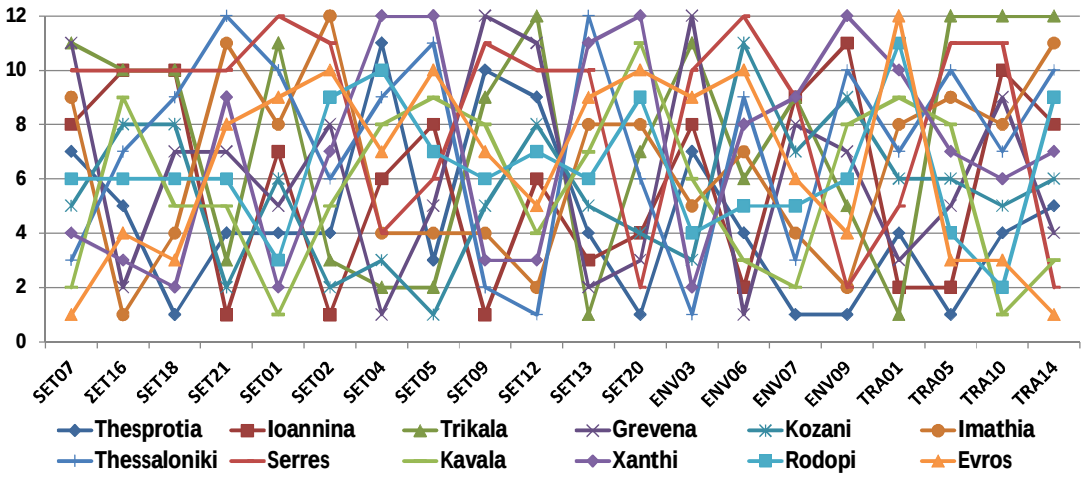

Fig. 3 Alternatives profile to the analysis criteria

3.3 SOCIOECONOMIC INDICATORS

SET01: It defines the percentage of 2011 population of every prefecture's municipalities which have the main axis of Egnatia Motorway passing within their boundaries comparing to the total population of the prefecture. The indicator's purpose is to assess the population which is potentially benefited directly from the road axis on the level of everyday trips.

SET02: It defines the Annual Average Domestic Product (GDP) 2000-2007 per prefecture. The improvement of transport infrastructure results in an increase of the production factors' mobility and markets' improvement of accessibility.

SET04: It records the average annual rate of change of the declared income per taxpayer 2002 – 2007 in constant prices 2000, per prefecture, as a factor of the area's level of development and prosperity.

SET05: It records the percentage of the unemployed change 2004-2008 per prefecture. The unemployment rate is considered to be one of the main indicators of the development status of a region.

SET09: It determines the population change 2001-2007, per prefecture. The objective of monitoring this indicator is the identification of the macroscopic effects of transport infrastructures improvement on the increase, retaining or decrease of a region's population.

SET12: It determines the change of density population 2001-2011 per Prefecture. Density is a basic indicator of the distribution of population in relation to the motorway's axis.

SET13: It records the Total Gross Value Added (GVA) Annual Rate Shift 2000-2007. The GVA is a basic structural characteristic of a regional economy and it is affected, among others, by the improvement of the movement of goods or the markets' accessibility.

SET20: It refers to the change of total work circle of the Enterprises 2000 – 2005, per prefecture. Entrepreneurship is potentially enhanced by the operation of transport infrastructure, as enterprises improve the accessibility and have an impact on increasing the production factors' mobility and on market integration.

3.4 SPATIAL INDICATORS

SET07: It records the distance (km) of the Industrial Areas and certain other productive infrastructure located in each prefecture from the closest intersection of the motorway. The optimum connection of the road network with the productive infrastructure is generally a basic development parameter of the productive activities.

SET16: It defines the percentage of change of urban land use (continuous, linear and un-continuous development) in the areas around the nodes of each prefecture.
SET18: It estimates the average change of land value 1998 – 2007 within the direct influence zone of the axis as well as in selected areas in each prefecture. The purpose of calculating this indicator is to examine the effects of the operation of the road axis on land value.
SET21: It records the change of attraction that takes place among the prefectures' capitals after the improvements in distance brought by the construction of Egnatia Motorway and depends on the exact distance from the road network before and after the operation of the Egnatia Motorway and on 2001 population.

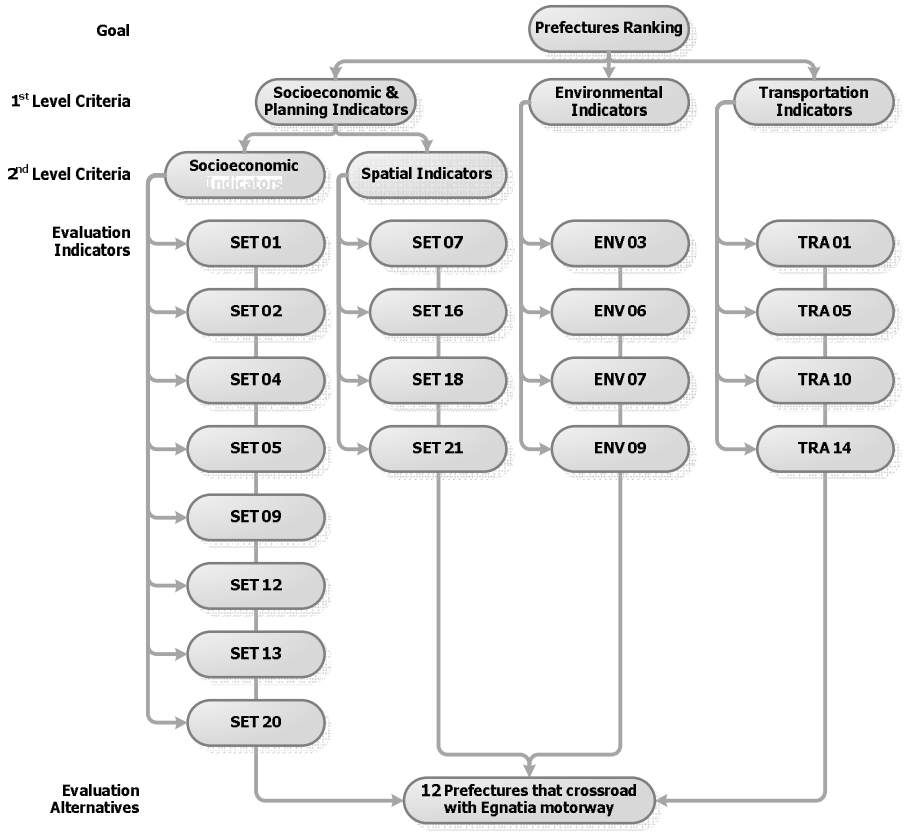

Fig. 4 Decision hierarchy

3.5 ENVIRONMENTAL INDICATORS

ENV03: It presents the change of fragmentation of organized settlements before and after the axis' operation per prefecture. The fragmentation of settlements is calculated as follows: [number of settlements] x [average permanent population] / [average area] x (1/100) and has important implications in their urban organization, proper operation as well as safety of their residents.
ENV07: It defines the change (%) of the technical surfaces along the Egnatia Motorway 1998 – 2007 per prefecture in the areas nearby the interchanges. The conversion of rural and natural land into technical surfaces is a cause of biodiversity loss and reduction of natural resources.
ENV08: It indicates the relation between the environmentally sensitive areas and the road network as well as the potential options that they would be affected by human activities.
ENV09: It captures the change in density of the crossings of the national road network with surface waters per prefecture (crossings/km), before and after the operation of the Egnatia Motorway and intents to identify the sensitive spots from the perspective of the potential impacts of the axis on water supply.

3.6 TRANSPORTATION INDICATORS

TRA01: It records the change (%) 2000 – 2005 in the average daily distance travelled (in km) per prefecture of the vehicles that travelled between two successive interchanges of the Egnatia Motorway during one year. The traffic volume is the basic indicator for the depiction and examination of the movement on the axis.
TRA05: It estimates the change of the average time distance between the capital cities of each prefecture after the operation of the Egnatia Motorway by road means of transport. The time distance between these cities is a basic indicator for the estimation of the transport cost of persons and goods.
TRA10: It estimates the change of the average time distance between the prefectures' capitals after the operation of the Egnatia Motorway by road transport modes. The time distance between these cities is a key indicator for assessing the accessibility and provides basic information for the calculation of the transport cost of persons and goods.
TRA14: It records the change (%) of the trips 1996 – 2006 before and after the operation of the axis within the boundaries of each prefecture. The impacts of the axis on the trips' characteristics are related to the change in mobility, the trips' extension and the operational linkage of the areas.

4 RESULTS ANALYSIS AND DISCUSSION

Socioeconomic and Spatial indicators present the strongest relative importance and in that manner their impact to the prefectures final rankings is strong. On the contrary transportation indicators derive the smallest relative importance. The derived improvement in terms of accessibility to the city of Thessaloniki by the surrounding residential areas consists the major factor that defines the importance of the environmental indicators to the formation of Thessaloniki Prefecture final ranking. With respect to the prefecture laying in the Northeastern part of Egnatia Axis it is noted that the significant improvement regarding the qualitative features of the road network and especially the obtained beneficiary role of the Egnatia Motorway to the reduction of the isolation factors to those areas. According to the prefectures rankings five classes are formed (1-2, 3-4, 5-7, 8-9, 10-12). Rankings spatial distribution for $p=1,2, \infty$ and TOPSIS method are presented in Figure 5.
Thesprotia is ranked to the first five places for all the examined decision models since the capital city of Igoumenitsa emerges as a combined transportation junction. Nevertheless, the new port of Igoumenitsa consists the major entrance gate to EU through the Mediterranean Sea. The high relative priorities that has been given to the factors that considers with the issues of isolation reduction and road network infrastructures improvement denotes the importance of Egnatia Motorway as major intervention that aims to enhance competitiveness. Egnatia Motorway intersects prefectures of Trikala and Serres only within a narrow piece of land and thus its impact to the local economies is indirect. The later provides a reasonable explanation for the fact that both these prefectures are ranked last for each one of the decision models. When Manhattan distance metric is considered as decision rule prefectures of Kavala, Kozani and Ioannina are ranked 2nd, 3rd and forth respectively since the average distance between the capital cities has been reduced the most in those prefectures by the construction of Egnatia Motorway. Thessaloniki is ranked 8th given the bad performance to all the environmental indicators and the existence of environmentally protected areas within its borders. Evros is ranked 10th even though it consists the entrance gate since the lack of the vertical axis limits the beneficiary role of Egnatia Motorway to the southern area of the prefecture.

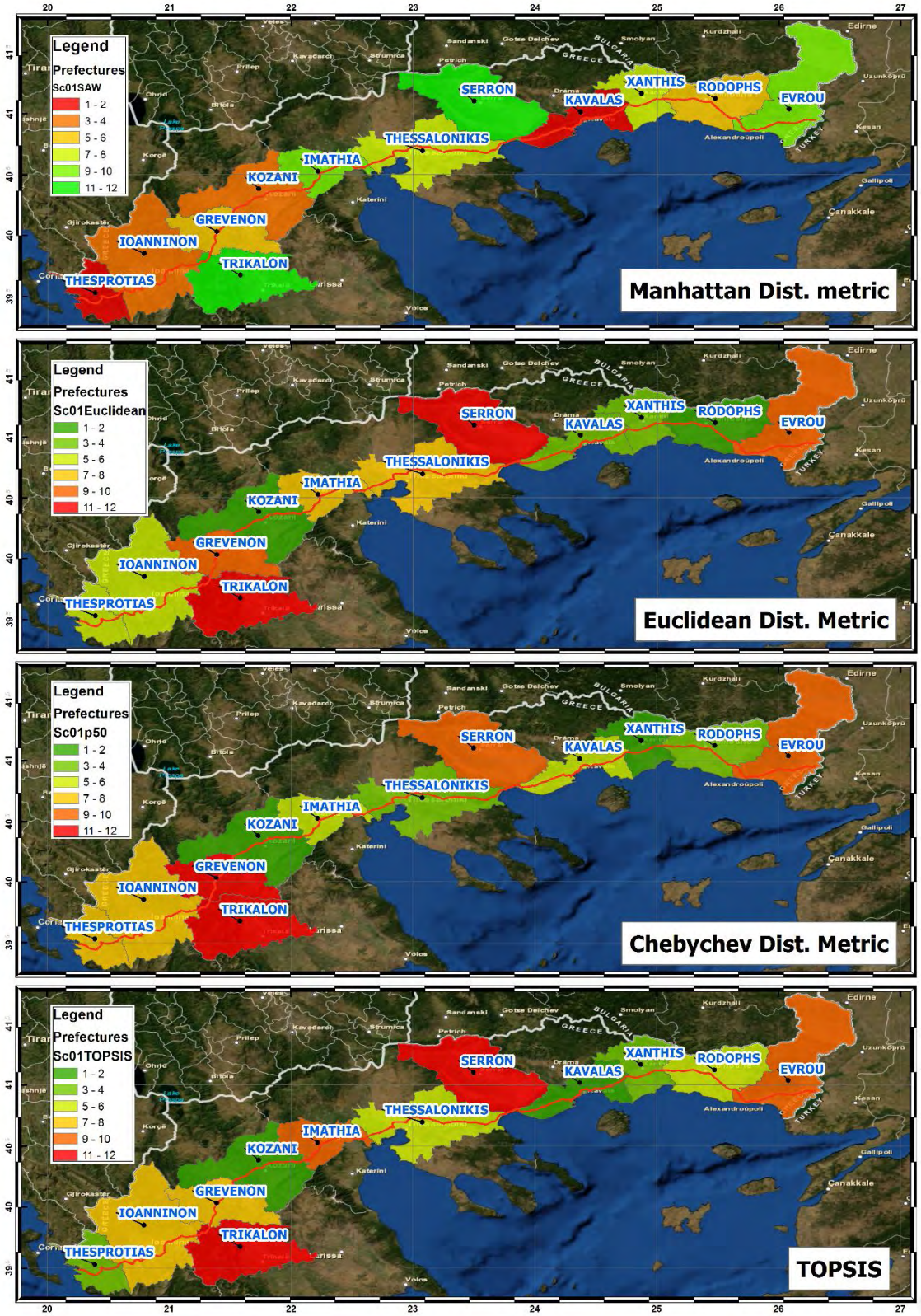

Fig. 5 Prefectures rankings for the examined decision models

The differences, occurred to the prefectures rankings that correspond to the performance of different distance metrics, for every one of the examined decision models are demonstrated in Figure 6. The first two columns present the prefectures rankings derived by the implementation of Manhattan and Euclidean

distance metrics. The next columns refer to the obtained rankings by increasing the value of parameter p. Chebychev distance metric is derived for p=50 which results to the elimination of tradeoffs between the analysis criteria. As a result Trikala and Grevena are ranked to the last places given that their performance to the most important indicator (ENV03) of the analysis is the worst among the examined prefectures. Finally TOPSIS method provides evaluations taking into account the distance from the anti-ideal solution as well.

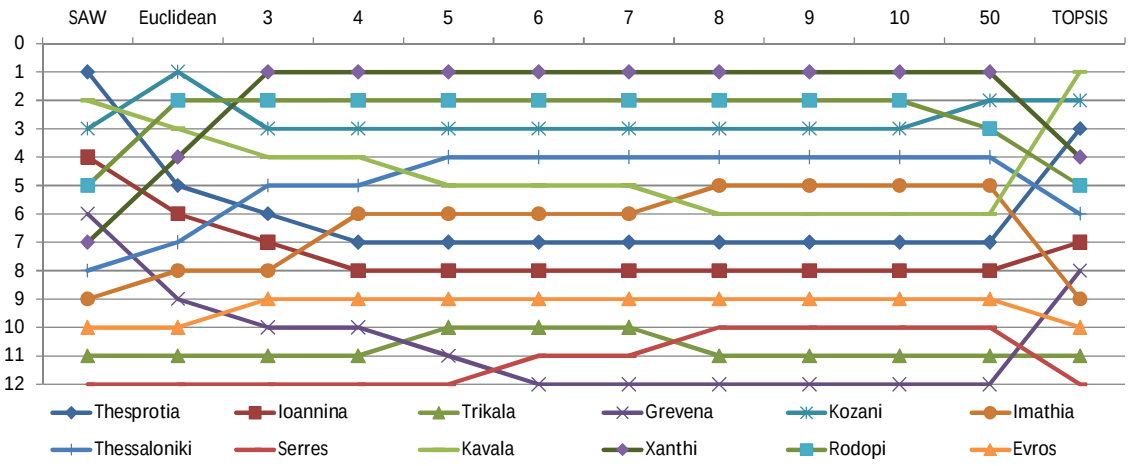

Fig.6 Prefectures rankings differences

5 CONCLUSIONS

The realization of Egnatia Motorway consists one of the most important interventions that have been utilized in northern Greece during that last two decades aiming to enrich connectivity among the capital cities and with the major international transportation axes. Since the establishment of the Observatory services by the Egnatia Odos S.A., a variety of socioeconomic, environmental and transportation indices have been developed with the aim to monitor and assess the spatial impacts of the motorway. In the present, twenty of these indices are combined in order to derive a composite index for ranking the prefecture that crossroad with the horizontal axis of the motorway. Technically this is achieved combining GIS technology and Multicriteria Decision Analysis methods. The approach combines GIS abilities for managing and visualizing spatial data while AHP provides a consistent framework for the integration of decision makers' preferences to the planning of future interventions. The above synergy allows practitioners and policy makers to identify and visualize the impacts provoked by the operation of significant public works and in the same time to identify the presence of intraregional inequalities. Thus, the proposed approach can be proved significant in order to support future decision related with the planning of future interventions in the examined area. Finally, an up to date edition with the performance of the examined indices is expected in order to estimate the impacts of the recent economic crisis with respect to the examined prefectures.

REFERENCES

Anagnostopoulos, K. P., Vavatsikos, A. P., Spiropoulos, N. and Kraias, I. (2010), Land suitability analysis for natural wastewater treatment systems using a new GIS add-in for supporting criterion weight elicitation methods:. Operational Research. An International Journal, 10(1), 91-108.

Chakhar, S., and Martel, J. M. (2003), Enhancing Geographical Information Systems capabilities with multi-criteria evaluation functions:. J. Geogr. Inf. Decis. Anal., 7(2), 47-71.

Collins, M. G., Steiner, F. R. and Rushman, M. J., (2001), Land-Use suitability analysis in the United States: Historical development and promising technological achievements: Environmental Management, 28(5), 611-621.

Egnatia Motorway Observatory (2005), Status of Regions Crossed by the Egnatia Motorway: Cohesion – Mobility – Balance – Environment: 1st Impact Report: Thessalonica: EGNATIA ODOS S.A. March.

EU – European Commission (1999), European Spatial Development Perspective – Towards a Balanced and Sustainable Development of the Union Territory. Luxemburg: Office for the Official Publications of the European Communities.

EU – European Commission (2002), White Paper – European Transport Policies for 2010: A time to decide. Luxemburg: Office for the Official Publications of the European Communities.

Faludi, A. (2006), From European spatial development to territorial cohesion policy: Regional Studies, 40(6), pp. 667-678.

Hwang, C.L., Lai, Y.J. and Liu, T.Y., (1993), A new approach for multiple objective decision making:. Comp. Oper. Res., 20,: 889-899.

Pereira, J.M.C. and Duckstein, L., (1993), A multiple criteria decision-making approach to GIS-based land suitability evaluation: International Journal of Geographical Information Science, 77(5), 407-424.

Saaty, T.L. (1977), A Scaling Method for Priorities in Hierarchical Structures: J. Math. Psych., 15: 234-281.

Saaty, T.L. (1995), Decision Making for Leaders: 3rd Edition, RWS Publications.

Simon, H.A. (1960), The new science of management decision. Harper and Row, New York.

Spiekermann, K. and Wegener, M. (2006), The role of transport infrastructure for regional development in southEast Europe: SEER SouthEast Europe Review for Labour and Social Affairs, 01.

Vickerman, R. (1996), Location, Accessibility and Regional Development: the Appraisal of Trans – European Networks: Transport Policy, 2 (4), 225-234.

Vickerman, R. (2004), Conflicts between transport policies and spatial development policies: perspectives on regional cohesion in European Union: 44th European Congress of the Regional Science Association, Porto.

Voogd, H. (1983), Multicriteria evaluation for urban and regional planning: Pion.

Zeleny, M. (1982), Multiple Criteria Decision Making, : McGraw-Hill, Inc.

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