ESPON

EUROPEAN SPATIAL PLANNING
OBSERVATION NETWORK

Applied Territorial Research

Building a scientific platform for competitiveness and cohesion

ESPON Scientific Report II, autumn 2006

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Colophon

The present report was produced by an editorial team anchored in the ESPON CU involving in particular, Roberto Camagni, Roberta Capello, Ed Dammers, Simin Davoudi, Sara Ferrara, Jérôme Gensel, Claude Grasland, Ingo Heidbrink, Dionissios Kalivas, Peter Mehlbye, Jacques Robert, Andreu Ulied, Volker Schmidt-Seiwert, Klaus Spiekermann, Micheal Wegener, Sabine Zillmer. The report received a final editing by the ESPON Coordination Unit with the help of Kai Böhme, Simin Davoudi, Moritz Lennert, Peter Mehlbye and Jozsef Szarka.

The report is based on the applied research work undertaken by the ESPON transnational project groups, involving more than 600 researchers. A list is of all ESPON Project is available in appendix 1.

Information on the ESPON programme and projects, the complete reports and the partners involved can be found on www.espon.eu

The ESPON website always presents the latest developments in the ESPON programme and findings from ESPON projects. It offers the opportunity to consult in detail the ESPON publications and tools, as well as all as the project reports and the corresponding indicators available in the ESPON database.

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FOREWORD

ESPON, the European Spatial Planning Observation Network, has been set up to support policy development and build a European scientific community in the field of European territorial development. The main aim is to increase the general body of knowledge about territorial structures, trends, perspectives and policy impacts within an enlarging European Union.

Based on a total of 34 applied research projects, the ESPON 2006 Programme has produced a substantial new body of knowledge on trends, perspectives, policy impacts, relationships and potentials within the regions and larger territories of the European territory, which have been communicated to and discussed among policy makers, practitioners, and scientists at all levels and across Europe.

ESPON results have started to find their way into policy documents. Also, building a European network dealing with applied territorial research has made substantial progress. Ensuring a network of excellence in this new research field is of utmost importance as the territorial dimension of the European policy development is now highly recognised.

The European Commission and EU Member States have stressed that there is a need to ensure a coherent approach to the development of the European territory, based on continuous observation of trends and developments as an instrument in support of territorial cohesion and competitiveness.

Observation and improvement of the knowledge base through applied research requires a scientific platform. During 2002-2006, the ESPON 2006 Programme has taken several steps forward in providing indicators, databases, models, mapping tools, and methodologies that could be shared by the partners within all 34 applied research projects. By this approach the ESPON 2006 Programme has ensured a high level of consistency between the different projects and supported an efficient implementation of the programme.

This ESPON Scientific Progress Report is mainly targeted towards the scientific community and serves the purpose of documenting the progress made on building a scientific platform by using existing methodologies and in some cases developing new ones. Please note that the report is not exhaustive in covering all scientific aspects of all projects within the ESPON 2006 Programme.

The ESPON Scientific Progress Report aims to provide a valuable base for further applied research action within the forthcoming ESPON 2013 Programme. It is closely interlinked with the ESPON Final Synthesis Report and the ESPON Atlas, which are published in parallel.

The results of the ESPON programme are disseminated in an open and transparent fashion in order to continually stimulate discussions on findings and methodologies related to European territorial development, both in the policy sphere and in the European research community.

The ESPON website at www.espon.eu provides extensive information on the ESPON programme. It always presents the latest developments in the ESPON programme and findings from ESPON projects. It offers the opportunity to consult in detail the ESPON publications and tools, as well as all project reports and the corresponding indicators available in the ESPON database.

Please note that the present report does not necessarily express the opinion of the ESPON Monitoring Committee and its members.

TABLE OF CONTENT

LIST OF FIGURES AND MAPS

CHALLENGES OF APPLIED TERRITORIAL RESEARCH

Undertaking applied territorial research at a pan-European scale is an innovative and challenging task that is long term and evolves step by step. Dealing with territorial dynamics requires a horizontal approach involving many themes at as detailed a geographical level as possible. It challenges the availability of data, indicators, models and methodologies that can ensure comparability between regions and larger territories when addressing the findings and results. Applied territorial research requires a multidisciplinary approach and the involvement of researchers from a variety of academic traditions. It also needs to be based on a scientific platform which develops and becomes more robust over time.

The ESPON 2006 programme has faced, and tried to overcome, a number of contextual constraints at the level of both the EU and Member States, including the gaps in available, accessible, harmonised and consistent territorially-relevant indicators and data and the dominance of the economic imperatives in data collection at European level.

The contextual challenges are coupled with challenges associated with the interdisciplinary nature of applied territorial research and the necessity to establish synergies between researchers who often work in their own disciplinary fields, come from different intellectual traditions, employ different methodological approaches, and have different views about what constitute knowledge and how problems should be framed.

Hence, any balanced reflections on the ESPON 2006 Programme and the scientific progress achieved needs to be embedded in an understanding of the wider context within which ESPON was born and has had to operate. This chapter aims to review the evolution of ESPON, its programme of applied research and its distinct institutional architecture. It also attempts to outline some of its key limitations and achievements.

1.1 The "ESPON way"

It is widely recognised that there has been an increasing focus on the territorial dimension in policies of the Member States and within the European Union in the last decade particularly after publication of the European Spatial Development Perspective (ESDP) in 1999. In general, the ESDP has provided a platform upon which the rationale for adopting a strategic territorial approach to policy has found a stronger voice both at the EU and the national and regional level.

As such, over the recent years the territorial dimension has gained ground in the EU policy agenda and maintained the momentum for a better integration of various EU policy sectors around territorially-based strategies. The adopted but not ratified Treaty for the EU proposing the aim of territorial cohesion and the development of EU Cohesion policy, including European territorial cooperation as objective, are clear examples of this agenda.

The impetus for establishing a programme devoted to applied territorial research was further reinforced by enlargement of the European Union. The need for applied research on territorial dimensions of EU policy also followed from the Lisbon (2000) and Gothenburg (2001) Declarations. Hence, the need to study the differential impacts on regions and larger territories of the new challenges and opportunities that are emerging from the efforts to reposition Europe on the global economic map and to ensure competitiveness and cohesion became paramount.

1.1.1 Towards the ESPON Programme

The idea of setting up a European territorial observation network goes back to the late 1990s. During the developmental stages of the ESDP it became clear that there is a need for improving the knowledge base which underpins the European policy's concern with regional differentiation and diversity and the need for balanced territorial development.

The policy vocabulary used in European policy development has presented difficult challenges of definition and policy application. While concepts such as 'polycentricity', 'cohesion', 'integration', 'territorial impact' and 'partnership' were (and still are) understood broadly, their precise meanings had evoked a lively debate among researchers and practitioners.

Furthermore, given that a territorial dimension of sector policies had hitherto been largely absent, both in the EU and in many Member States, developing these policy concepts into analytical propositions and indicators for policy options proved to be challenging and difficult, particularly where trans-European comparisons were to be made. Hence, it was evident that a well-established and integrated conceptual base and a coherent body of research at the European level to further develop territorial policy concerns was lacking.

However, the journey from the recognition of a need for further applied research and the establishment of an applied research programme needed some time. A major landmark in the chain of events that led to the formation of ESPON was the Commission's decision to support a test phase, a Study Programme on European Spatial Planning (SPESP), running from December 1998 to February 2000.

The Study Programme paved the way for the ESPON 2006 Programme showing the first results of applied territorial research involving the entire European territory and its regions. Importantly, it also brought together a first network of territorial researchers to carry out future research.

1.1.2 The ESPON 2006 Programme

ESPON was set up in 2002 with a five-year programme of applied research which has since engaged a wide range of researchers from across Europe. The Programme has been funded and managed jointly by the European Commission and the Member States. Its governing principles and financial rules are set within the framework of the Community Initiative INTERREG III.

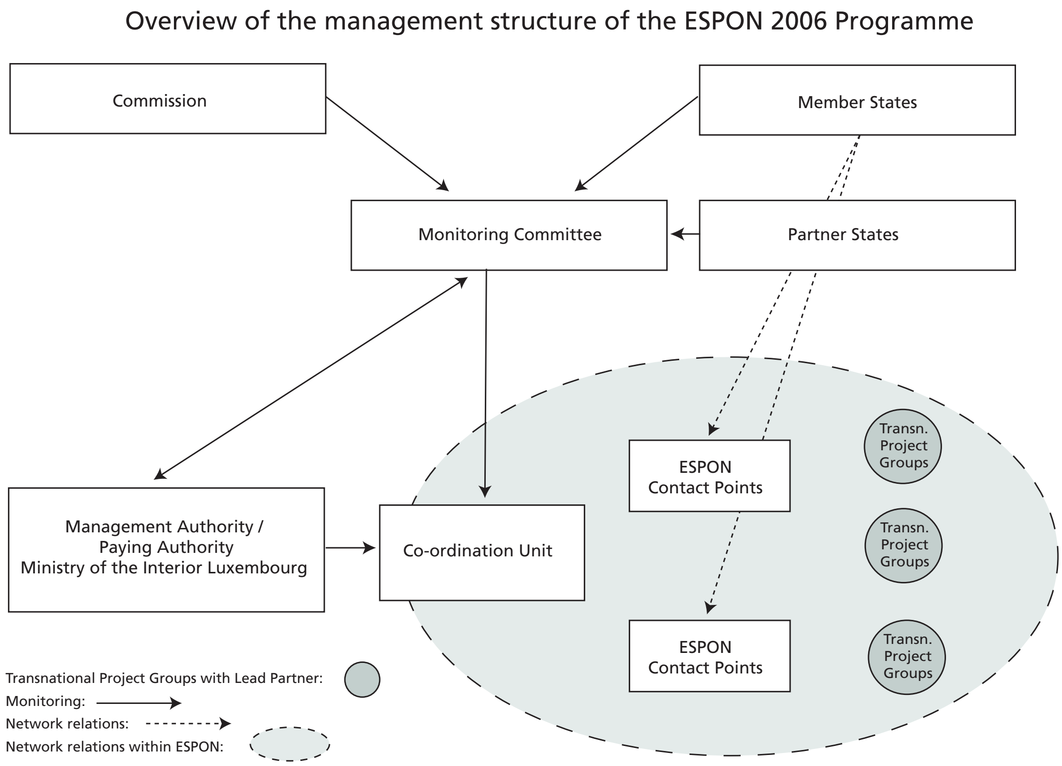
The strategic management and monitoring of ESPON are the responsibility of the Monitoring Committee (MC). The role of Managing and Paying Authorities is performed by the Ministry of the Interior and Spatial Development of Luxembourg.

The Monitoring Committee consists of delegates from 25 EU Member States and from the Commission. Neighbouring non-EU member states have also been invited to join the programme as full partners or as observers. Currently, Norway and Switzerland are partner states. This has substantially enlarged the scope and the reach of ESPON to incorporate territorial development issues beyond the EU.

The activities of the ESPON are facilitated and coordinated by a Luxembourg-based Coordination Unit (CU). The link between the CU and the research communities of the Member States is through the ESPON Contact Points (see Appendix 3). Drawing on their knowledge of the research capabilities in their country, the EPC network provides an interface between ESPON and territorial research communities in member and partner states. The EPC network has as well engaged in transnational activities and become engaged in national and regional dissemination of ESPON results.

Within this management and administrative framework, ESPON projects are funded on the basis of competitive tendering. Projects are undertaken by Trans-national Project Groups (TPG), a voluntary partnership between researchers from a range of disciplinary backgrounds from at least three but often many more European countries. More than 600 researchers from over 130 research institutes throughout Europe have been involved in the Programme since its inception, showing the expanding nature of the 'ESPON Community'.

The most distinct feature of the Programme, however, is that ESPON represents both a programme of applied research and a process of networking, linking policy makers with scientists. From the outset, there has been a deliberate attempt to link the European territorial policy concerns and policy communities with the research agenda and research communities. The following two subsections will elaborate on this.



Source: The ESPON 2006 Programme

Figure 1 Diagram of ESPON´s institutional structure

1.1.3 ESPON as a programme of applied research

ESPON thematic research priorities are driven by policy orientations regarding territorial cohesion, regional competitiveness and the achievement of a more 'balanced European territory'. Indeed, ESPON's emphasis on mapping the territorial diversity and differentiation has been to provide the knowledge base for the EU policy on territorial cohesion. Moreover, focus has been on the competitive position of the EU and its regions and cities in the global market, as promoted by the Lisbon Strategy, and the pursuit of sustainable development, as promoted by the Gothenburg Strategy.

The applied research projects under the ESPON 2006 Programme have been structured under 3 main priorities, outlined in Appendix 1.

Under Priority 1, Thematic Studies have examined trends on a variety of thematic issues related to regions and larger territories, including structural issues such as the urban system of Europe, the functionality of different urban regions and the growing interdependencies between urban and rural areas.

Under Priority 2, the emphasis is on examining the Territorial Impact of major EU sectoral policies such as Common Agricultural Policy (CAP), Transport and TENs, Structural Funds, and Research and Development.

Priority 3 has included a number of Cross-thematic and coordinating projects focusing on integrating and synthesising the results of other studies with an emphasis on producing: indicators for territorial analysis, integrated data bases and tools, typologies of the European regions, and territorial development scenarios.

1.1.4 ESPON as a process of networking

The network approach starts with the processes of bidding and undertaking applied research projects which require setting up research consortia from several European countries.

While in other European research projects such networking activities may be confined to the consortium members who are directly involved in the project, ESPON has taken one crucial step further and provided several arenas for all researchers, who cluster around the Transnational Project Groups, to meet frequently and exchange information, expertise and knowledge with each other.

Such arenas include not only frequent meetings of the lead partners of the individual projects, but also the six monthly ESPON seminars which is brings together project partners, the ECP network and the policy makers responsible for the ESPON programme. These have provided the opportunity for reporting the latest outcomes of individual projects, highlighting methodological and other challenges faced by the researchers, raising potential shortcomings, and monitoring progress in an open forum.

The seminars have created a dynamic environment for social learning through lively exchanges between policy makers and researchers. They have helped crossing the artificial boundaries which are often perceived to exist between the 'world of policy' and 'the world of research'. Four years of regular interactions have led to a better understanding among the 'ESPON community' that the interface between policy and evidence is not linear and unproblematic; that research and evidence do not straightforwardly feed into policy; leading to better decisions.

ESPON experience has shown that it is more constructive to acknowledge the existence of a world where the relations between policy and research are closely interlocked; and while conflicts and tensions may be inevitable, the issue is not how to eradicate them but how to treat them by engaging in a constructive debate and in a social learning process.

One illustrative example of this is the increasing engagement of the researchers in promoting the significance of territorial development policies. Similarly, the ESPON Monitoring Committee members have played an active role in stimulating high quality applied research by feeding in invaluable knowledge about various policy aspects. The adoption of the network approach has now become pertinent to the creation of a dynamic forum which has continued to recruit new researchers to the programme.

Another important aspect has been the transparent approach adopted by ESPON in the dissemination of results. All project reports (including draft interim reports and maps) have been posted on the ESPON website and are available for scrutiny by other researchers, policy makers, practitioners and the general public.

1.1.5 Dissemination and communication

Dissemination of results and communication with stakeholders has followed Priority 4 of the ESPON Programme: scientific briefing and networking. Efforts have been made exploring synergies between the national and EU resources for research and research capacity building through active dissemination and communication activities. Three ESPON synthesis reports, two ESPON Briefings, and two ESPON scientific reports, as well as the ESPON website providing free and inclusive access for all users as well as the already mentioned ESPON seminars are major activities in this respect.

Transnational seminars organised by the ECP network have also played an important role for ESPON. Consortia of ECP members have disseminated ESPON results to the national and regional policy and practice communities. Other attempts include the ESPON Scientific Conference (October 2005), which was an important stepping stone for multidisciplinary collaboration between European networks and associations with an interest in territorial research.

The dissemination and communication activities have resulted in ESPON findings, particularly those presented on maps, being drawn upon in EU policy documents, driving the territorial policy agenda as well as in some documents at national and regional level. It has also stimulated debate within the academic community with several papers either published in academic journals or presented in international conferences.

1.2 Approaches in the ESPON applied research

ESPON was set up to strengthen the evidence-base of the EU territorial development policy in general. The notion of ‘evidence-base’ is important here because, it implies that any reflections on the ESPON scientific challenges should cover at least two broad areas: firstly, the type and quality of evidence that has been produced by ESPON research; and secondly, the nature and extent of influence that such evidence has had on policy. Hence, the focus has to be on both scientific substance and knowledge transfer process.

1.2.1 Policy concepts and options for analysis

The notion of territorial cohesion calls for better integration of public policy and better coordination within and between governmental and non-governmental bodies. This implies that territorial cohesion is about targeting places rather than sectors as the focus of policy, and measuring policy performance by the ways in which the ensemble of sector policies are affecting places and life chances of people who live and work there. The implication of this policy discourse for ESPON applied research has been twofold.

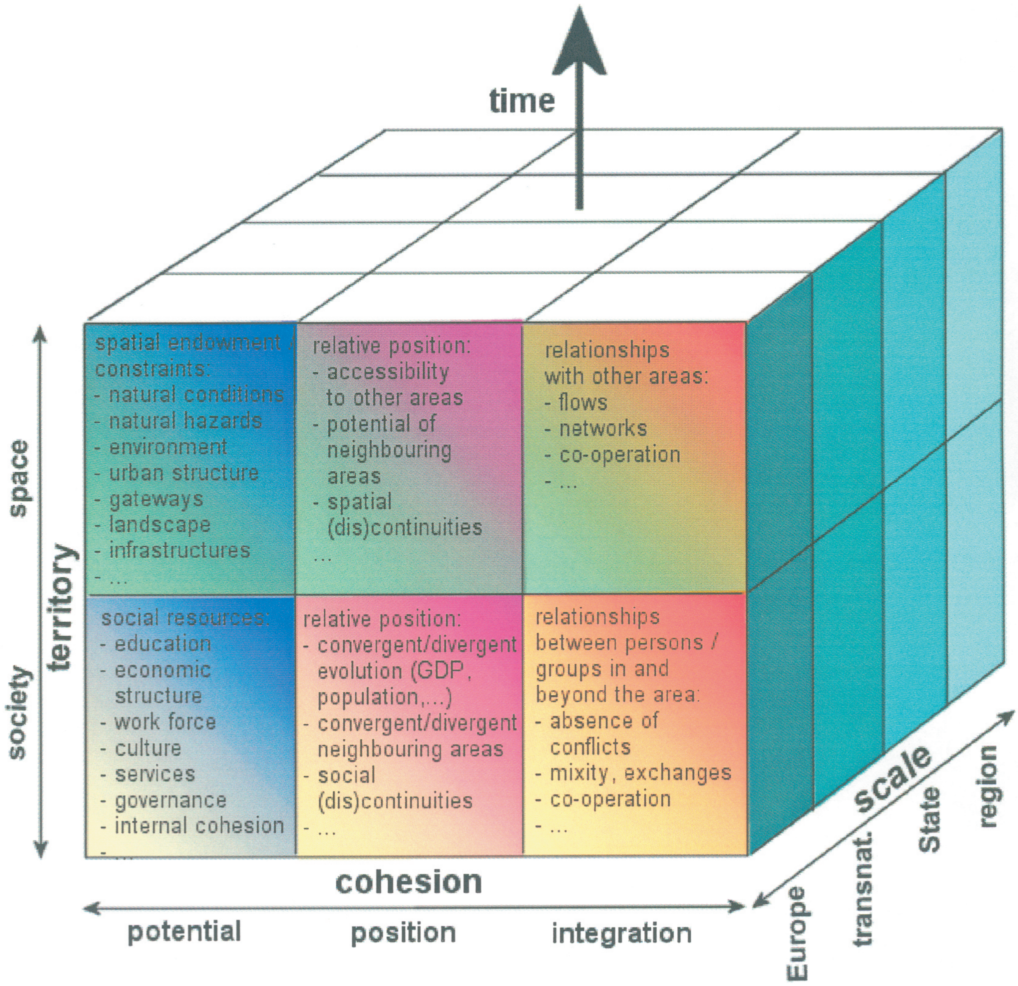
Firstly, the operationalisation of the concept meant that new ways of conceptualising and measuring peripherality and imbalances as well as potentials had to be sought. Hence, both researchers and policy makers have had to revisit some of the traditional indicators used for territorial and regional policy, such as GDP and unemployment, which do not necessarily capture the territorial diversity that are associated with structural imbalances. Factors such as demography, population density, accessibility, urban-rural relations, access to basic services, and risks from hazards were seen as critical in understanding territorial differentiation.

Secondly, quantifiable, pan-European indicators have had to be complemented by qualitative analysis and assessments. The qualitative approach often supported by in-depth case studies. The latter is a clear outcome of the collective learning process in which a consensus was reached between the researchers and policy makers in the ESPON community of the need for and the value of case study research methods in achieving an in-depth understanding of territorial trajectory.

1.2.2 The 3-level approach

As a first step ESPON has applied a 3-level approach assessing results on all three geographical scales (macro-meso-micro). Given the multiplicity of definitions for some of these territorial units (local and regional), three generic levels have been used as the basis for analyses. The micro level has been applied mainly to local and regional; meso level applied to national and transnational level; and macro level applying to European level. The 3-level approach partly reflects the complexity of multi-level governance and policy-making. However, it provides a systematic way of addressing development issues that might appear differently depending on the geographical scale approached, in some cases even revealing conflicting findings at different geographical scales related to certain policy objectives.

The various components of territorial policy have been summarized and visualised by the 'hypercube', including different levels of analysis, different dimensions of policies and different types of regional situations (the region's own potential, the relative position to other regions and the level of integration with other regions). Time is added to make the 'hypercube' dynamic. The 'hypercube' provides a systematic framework through which possible conflicts in goals and strategies as well as areas of complementarity can be identified.



Source: ESPON Project 3.1/Spatial Scenarios, 2004, 55

Figure 2 The hypercube

1.2.3 Geographical coverage of analysis

A major achievement of ESPON has been the geographical reach of its macro-level analyses. For the first time, these have been conducted at the level of 29 European countries (with a strong emphasis on the regional, NUTS2 and 3 units), creating a new territorial scale which has come to be called the 'ESPON Space'. This is an area which covers 25 EU Member States as well as Norway, Switzerland, Bulgaria and Romania.

By moving forward comparable information on the regions of Europe a new European dimension has become available in policy making and strategy building at the level of regions and larger territories. Similarly at the European level this information brings new aspects into the development of EU policies, in particular to policies related to territorial development and cohesion.

1.2.4 The data challenge

The most significant achievements in terms of new knowledge and valuable analysis are at the pan-European or macro scale, which has been a key focus of the

Programme. However this emphasis has had some drawbacks. For example, the nature and scope of the applied research have been heavily influenced by the availability of harmonised and comparable data for the whole of ESPON space including EU 25, Bulgaria, Romania, Norway and Switzerland. This has inevitably led to a selective approach to the development of indicators, criteria, models and typologies, using those which could be quantified by pan-European data.

At the micro level, given that the pan-European data for statistical regions (NUTS) do not have a fine-grained resolution, some of the ESPON analysis may appear too generalised and not taking into account the nuances of local differences. However, wherever possible, these shortcomings have been addressed through detailed case studies.

ESPON has shown the dominance of economic data and indicators in the EU data sources and their serious limitations. Extensive work through a number of ESPON projects has revealed the hegemony of economic indicators within the EU databases. Environmental indicators are gradually making their way into the EU policy discourses. Most strikingly is the limited number of social indicators available at the EU level. Out of 103 core indicators developed so far within the ESPON projects, only 4 can be considered as social.

This has made the various endeavours to achieve integrated analysis and indicators to support the understanding and operationalisation of strategies such as the Lisbon Strategy challenging. The gaps within European-wide, comparable regional data has also hampered the construction of knowledge on important dimensions of territorial cohesion.

However, ESPON has taken action and contributed to applied territorial research by its attempts to navigate, assess and make use of existing EU and national data bases. This work not only provides an invaluable directory of what data is available, in what forms, what degree of consistency and what level of access. It also highlights the existing gaps and limits in current state of territorial development indicators and data.

Improving the data situation needs political commitment and long term investment, mainly at European level, in terms of data collection and harmonisation. This has been stressed throughout the ESPON process. ESPON has begun to address these shortcomings through a number of exploratory projects, which will provide a point of departure for future applied territorial research.

1.2.5 Types of evidence in ESPON results

In general, it is possible to distinguish between at least four types of evidence, as listed below:

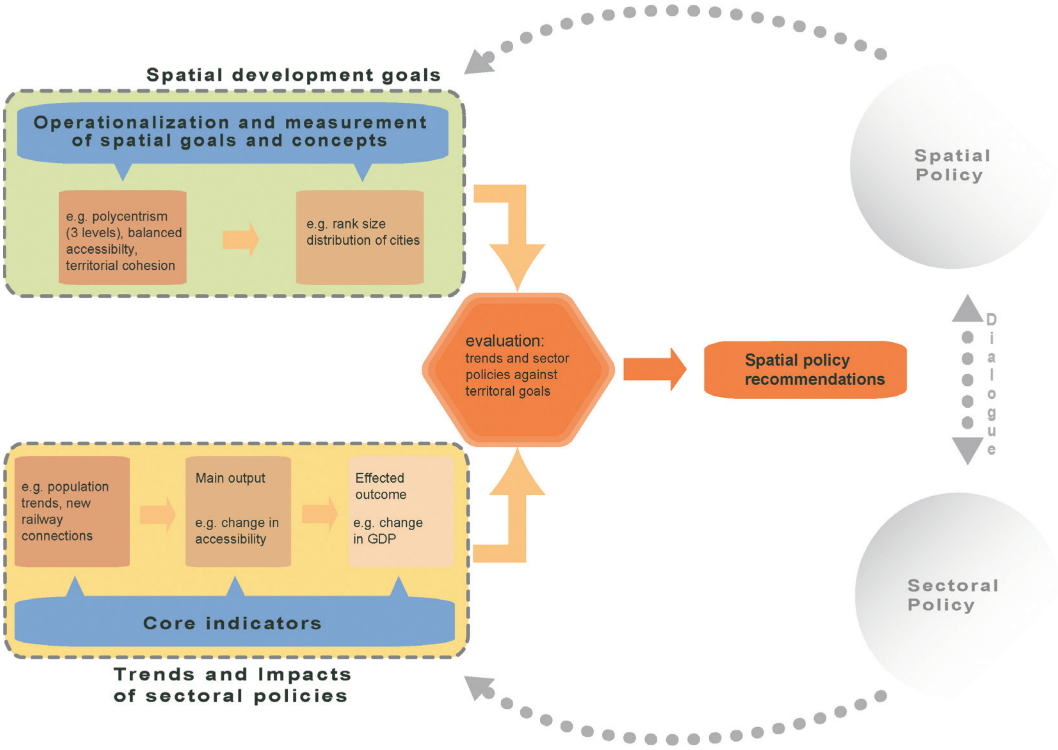
- Descriptive data on incidences or trends
- Findings which identify factors associated with conditions, demonstrating a causal relationships
- Assessments which more directly territorial effects of existing policies and programmes
- Policy analysis which recommend alternative policy options

Traces of these types of evidence can be found in within many projects that have been carried out within the ESPON 2006 Programme.

However, it is in the provision of the descriptive and policy analysis evidence that ESPON has made its mark more forcefully by producing a large amount of new insights into territorial development trends, perspectives and impacts.

1.2.6 Approaches joining research and policy

The link between territorial policy aims and objectives with territorial trends, perspectives and policy impacts within the applied research of ESPON has been guided by an approach that can be illustrated with the following figure:



Source: *Crete Guidance Paper, June 2006*

Figure 3 Basic methodological approach for ESPON research

In summary, the illustration shows an approach to the analysis where the main scientific tasks are (1) to operationalise the policy aims, objectives and concepts; (2) make them measurable and find indicators and data describing territorial development trends and policy impacts; and (3) compare and evaluate the empirical findings against the background of the territorial policy aims and objectives.

Serving a policy demand with evidence can however be done in different ways.

One way is applied research that is at the fingertip of policy makers, insisting on research to lead into 'punchy policy messages'. The ESPON research community did experience such demands particularly at the initial stages of its operation which coincided with rapid developments in the EU territorial policy and particularly the need for research inputs into the production of the Third Cohesion Report.

Given its applied nature and its commitment to respond positively to policy concerns, ESPON has managed to provide significant input in a very short period of time to strengthen the evidence base of the EU territorial policy agenda also at later stages of the programme implementation.

However, another way of conducting applied research is to emphasise on an evidence-informed policy rather than evidence-based policy. The more interactive is the relation between policy and research process, the higher is the likelihood of the results being used by the policy-makers, and hence making a difference. ESPON has already had such an impact. Its organisational architecture and particularly the twice a year seminars have provided ample space for policy-research interactions and a dynamic arena for collective learning.

Responding to policy concerns in a timely and effective fashion will remain an important part of ESPON's mission. The ESPON 2006 Programme has been committed to explore a more strategic approach to applied research in territorial development; an area which has hitherto not enjoyed a significant level of interest.

A strategic and proactive approach embraces both the need for a more direct delivery of evidence 'upon demand' serving the defined policy agenda and a more 'indirect' need for supply of information on the overall context and territorial trends, perspectives and impacts, which have not yet been captured and considered by policy makers, but which will influence the development of the European territory and call for a policy response.

PROVIDING COMPARABLE EUROPEAN DATA AND INDICATORS

Comparable regional data throughout Europe is one of the major challenges for applied territorial research. Collection and treatment of data in such a way that it allows for comparative analysis at regional level has been the focus of many ESPON projects and taken a substantial amount of their resources. Many projects within ESPON 2006 could only scratch the surface and highlight the severe lack of harmonised territorial information across Europe. The inclusion of new countries and new thematic fields in the future will only reinforce this issue. Much work, therefore, still awaits the research community.

This chapter provides a brief introduction on some of the efforts in data collection and generation that have been conducted under the ESPON 2006. Thus, the chapter gives a flavour of the common ESPON database, the work on indicators, typologies and modelling techniques that have been carried out by the projects. Looking ahead, the chapter also presents briefly the work on the development of a European territorial monitoring system and long-term database.

2.1 Building a common ESPON database

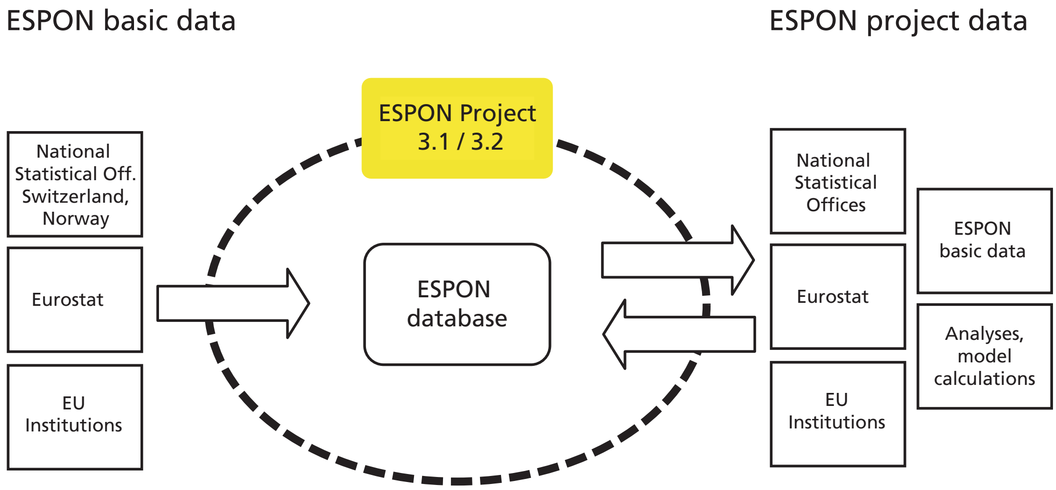
Collection, harmonisation and interpretation of available data are essential parts of territorial research. However, this becomes an extremely demanding task when it is applied across 29 countries, trying to reach full coverage at the lowest possible geographical level. Thus the ESPON projects have put collective efforts in these activities and jointly formed the ESPON database.

All projects were required to find, analyse and interpret relevant data in the context of their project. The network structure of the ESPON programme required a central conception and coordination of databases. Common standards had to be defined in order to secure and provide consistent and harmonised data to all project teams. Thus, the set-up of the ESPON database became one of the most important products of the ESPON programme. It was filled jointly by all transnational project groups (TPG) during the course of the programme, under the leadership of projects 3.1 (Tools) and 3.2 (Scenarios).

The ESPON database covers regional information for the EU Member States plus Norway, Switzerland, Bulgaria and Romania. The main task is to provide a wide range of regional thematic data to be utilised in quantitative and comparative analyses by researchers involved in the ESPON programme.

In general, the database includes two types of data: firstly, basic regional statistical data, and secondly specific, theme-orientated project data and computed indicators. The basic data covers fundamental information which is needed by different projects in the context of their analyses. In order to limit work and to avoid the use of different data for the same factual information, these were centrally prepared and made available to the projects on request. Examples of such basic data include population, labour market, and economic data.

Basic data for the EU Member States as well as for Bulgaria and Romania have been essentially provided by the Statistical Office of the European Communities (Eurostat). These have been complemented by data from the national statistical offices for Switzerland and Norway. Adjustments and harmonization to Eurostat definitions and calculation methods have been carried out by the ESPON Co-ordinating Project 3.2 (Scenarios).



Source: ESPON Project 3.2/Scenarios, 2006

Figure 4 Flowchart: input to the ESPON database

The resulting project data, however, are the outcome of the work undertaken by the project groups and can thus be seen as the collected scientific value added of the ESPON projects. In contrast to the basic data, the data are based on a widespread spectrum of regional statistical sources and the results of regional analyses as well as the results of model calculations (see chapter 2.2 for more information on how project indicators were constructed).

Up to now, the majority of data and indicators exist for the NUTS 2 level, which is the important level for European structural policy. For the small-scale NUTS 3 level fewer data and indicators exist. The provision of data and indicators on NUTS 3 level is an important task for the future work of the ESPON database. However, the NUTS system has been revised in 2003 and again in 2004 in some Member States. Such new national demarcations of the NUTS regions will make long-term territorial observations more difficult in the future (see chapter 2.5 for a proposal on how to address this issue).

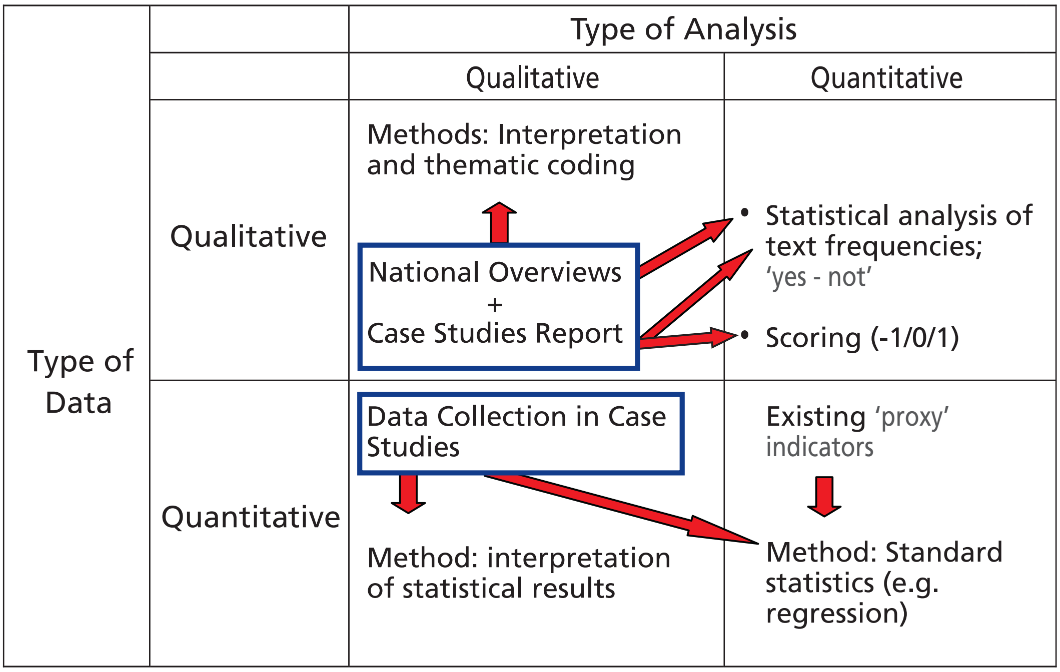
The systematic and harmonized collection of project data and indicators in the ESPON database has provided a solid starting point for future territorial observations of the European regions beyond the EU25 regions.

2.2 Indicators and typologies

To understand territorial structures and developments the data that has been collected needs to be analysed and summarised so that it becomes easily understandable for non-experts. One of the main tools for this is the selection or elaboration of indicators.

Here data can be understood as the representation of any kind of information in a standardised way, indicators are defined in the context of a specific need or question and can consist of either one single datum (thus simply representing a particular interpretation of this datum) or of a combination of several data. Indicators can also take the form of typologies summarising a variety of information into a single more qualitative indicator. As already mentioned in the previous chapter, all ESPON projects had to confront the challenging task of elaborating indicators and typologies in their field of study for all of the 29 countries in ESPON space and at the regional level. These constraints have obviously limited the possibilities and scientific freedom of the teams and many of the proposed indicators can certainly be improved. However, the mere existence of such information at this scale and its territorial scope represents one of the key achievements of the ESPON 2006 programme.

Indicators and typologies can be constructed from different sources: raw data, modelling results and qualitative methodologies. The adoption of specific methodological approaches depends on data availability, the scope, the theme and whether the aim is to describe territorial structures and developments or to analyse impacts of different territorially relevant policies. This will be demonstrated below. Within a single project several methodological approaches are often combined in order to gain a comprehensive and deepened insight into the respective territorial structures and developments. Figure 5 illustrates the coincidence of qualitative and quantitative methodological approaches through the example of the ESPON 2.3.2 project on governance. It shows how the quantitative and qualitative approaches are interlinked and feed into the global analysis.



Source: ESPON Project 2.3.2/Governance, 2006, 42

Figure 5 Coincidence of methodological approaches on governance

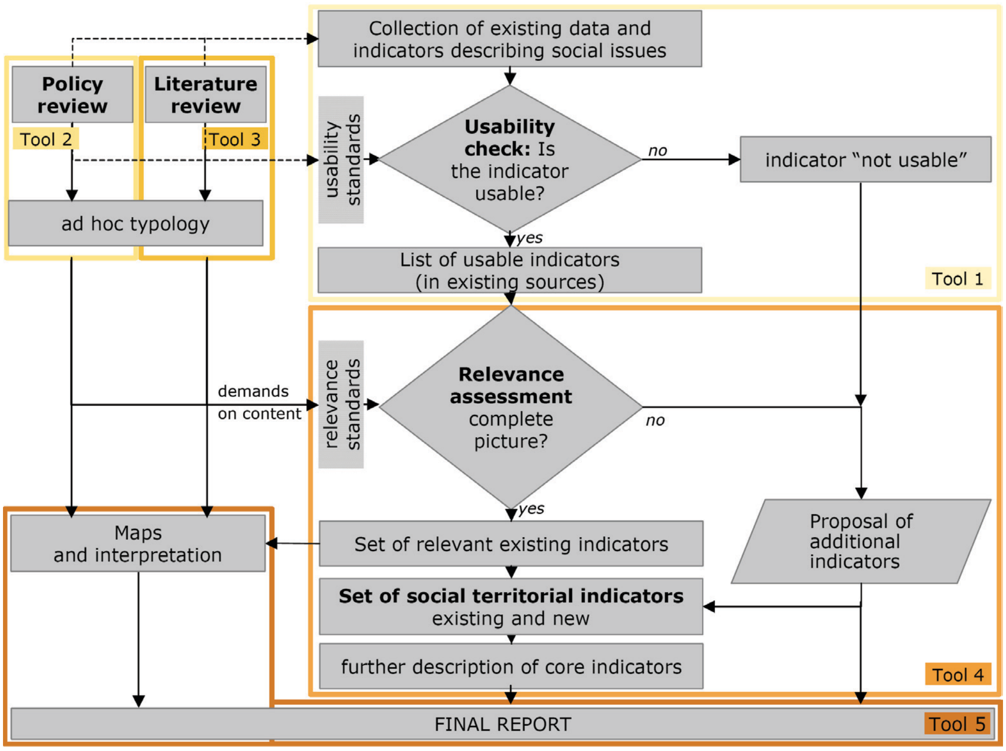
The following account focuses on how indicators have been identified or elaborated and analysed by different projects and how the projects have combined existing indicators to develop new indicators and typologies of territorial structures and development.

2.2.1 Developing European-wide territorial indicators and typologies

Due to the wide variety of topics covered by the different ESPON projects, both indicators and typology development vary considerably. In order to approach not only basic analyses of the respective topics but also develop typologies of territorial structures and development, the projects had to define their subjects of analysis carefully in order to achieve comparability across all countries covered by ESPON. In other words, to come to widely understood territorial definitions and concepts the projects needed to find a common language.

This problem can be illustrated by the ESPON Project 1.4.1 on small and medium sized towns (SMESTO). Not only do the limiting values of utilised indicators vary between different countries for the definition of what a SMESTO is, but also the indicator selection varies when it comes to qualitative measures of urban functions. The incomparability of national SMESTO definitions can be shown by the respective thresholds. For example, in some countries medium sized towns have an upper limit of no more than 50,000 inhabitants, whereas in other countries any town below this threshold is considered to be small. In some of the latter countries towns are still recognised as being medium size with a population of up to 200,000 or even 250,000. This indicates the broad range of definitional variations across Europe (ESPON Project 1.4.1/SM-towns, 2006, 52).

Therefore, the projects are faced with the identification of suitable indicators, which need to be understood easily and at the same time are able to describe the respective topic comprehensively and accurately. Furthermore, research at the regional level (NUTS 2 and 3) for the whole of the ESPON space is conditioned by limited comparable indicators, as mentioned in chapter 1. Consequently, the projects have to solve several methodological problems simultaneously with respect to indicator identification and the subsequent typology development. The importance of adequate indicator selection and development for ESPON wide territorial analyses is pointed out by the analytical structure of the preparatory study on social issues displayed in Figure 6. Here indicator selection is repeatedly part of the analysis at different stages of the project.



Source: ESPON Project 1.4.2/Social, 2006, 53

Figure 6 Relevance of indicator selection on social issues

The projects tackle the mentioned problems by estimating missing indicator values, choosing second best indicators, supplementing quantitative with qualitative indicators and adjusting regional values for different national indicator definitions and measurements. One example for data estimations is the appropriation of Structural Funds spending to NUTS 3 level by the ESPON Project 2.2.1/SF impacts (2005, 39). When such data is not appropriately and readily collected, several approaches have been adopted to develop an adequate database. If, for example, operational programmes are defined at NUTS 2 level whereas eligible areas are defined on smaller scale and geographically concentrated, then it has been possible to assign the Structural Fund spending to one or other NUTS 3 region. In other cases it has been necessary to contact programme managers and intermediary national or regional bodies who could localise respective spending in their territory. Finally, where neither of these options existed, estimations were to be related to relative figures, by assigning the amount spent in a NUTS 2 region to the respective NUTS 3 regions according to their population shares.

In total the vast majority of projects' analyses are based on a combination of quantitative and qualitative indicators. The nature of this combination depends partly on data availability and partly on the objective of the ESPON programme to provide ESPON-wide maps on territorial structures and developments. In cases of severe quantitative data limitations, attempts have been made to achieve this objective by standardising or scaling the qualitative indicators. In other cases different qualitative outcomes have been identified and mapped. The latter can be illustrated by the typology development in the ESPON Project 2.3.1 on the application of the ESDP. Here the application of different ESDP aims has been mapped on national level by differentiating between the occurrence of national policy changes, their reasons and their conformity with the ESDP (ESPON Project 2.3.1/ESDP impacts, 2006, 125).

Several projects have selected a number of indicators which are then combined for typology development in order to overcome restricted perspectives of single indicators. The utilised methods are consistent with those used for example by international organisations for calculating transformation and other indexes which are also based on various methodological approaches [1].

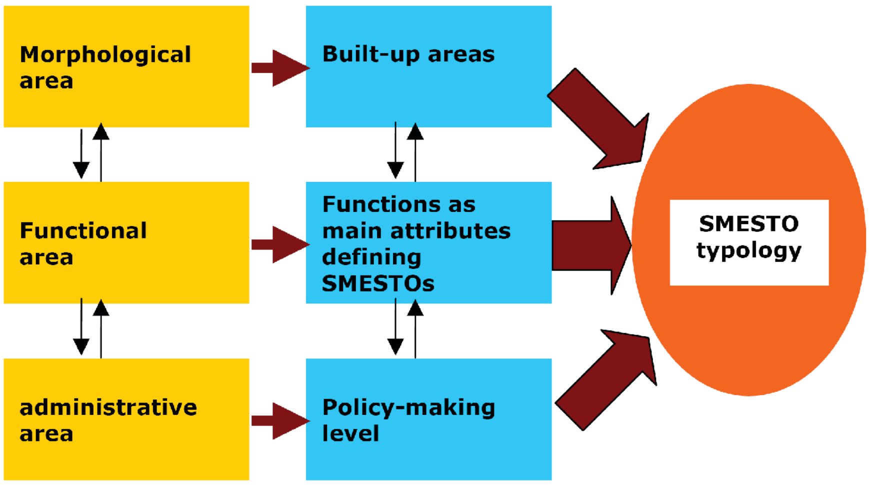
At the same time some indicators are more comprehensive than others. Indicator lists and databases contain relatively easily understood concepts such as population density as well as quite elaborated indicators on, for instance, functional urban areas (FUA). Although the data of the respective FUA indicator, which describes which FUA is primarily of relevance at local/regional, national/transnational or European level, appear to be simple, they contain a lot of hidden information from various categories.

Within the ESPON, typologies are seen as a particular form of indicator. As is stated in the Nijmegen Guidance Paper (2005, 8) ESPON typologies aim to "provide a special view of the ESPON space allowing to identify differences and analyse the causes of these differences. They are not simple benchmarking tools showing which region performs well on a particular indicator, but analytical tools which show the territorial structure of Europe." Thus, they are the result of an integrated analysis based on several factors and often building on more than one methodological

1 Methodologies for index development are further elaborated in the next section on quantitative methodologies.

approach. Nevertheless, typology development by the different projects is also of varying comprehensiveness. For instance, the typology of total population change with differentiation between net migration and natural population development compares positive and negative values of these three indicators. This leads to altogether six groups of possible outcomes, where for example an increasing total population coincides with positive net migration and negative natural population and vice versa (ESPON Project 1.1.4/Demography, 2005, 13).

Many other typologies are based on such crossings of individual indicators. But depending on the respective issue, they consist partly of a large number of developed indicators and/or combine quantitative and qualitative methods. The extent of the required information for comprehensive typology development is pointed out by Figure 7 drawing on the example of ESPON Project 1.4.1 (SM-towns). In many cases such broad understanding of typology development is necessary in order to avoid misleading pictures of the European territory. Examples for typologies which are based on a large number of indicators and different methods are the policy package options typology of the ESPON Project 2.2.2, dealing with policy impacts of pre-accession aid (ESPON Project 2.2.2/Pre-aid impact, 2005, 30) and Project 1.3.1 on the aggregated risk classification of the hazard project (ESPON Project 1.3.1/Hazards, 2005, 14). The latter represents the integration of two other complex classifications and indexes, which are based on fifteen types of hazards and four vulnerability indicators, ending up with twenty-five classes of risk in which hazards and vulnerability coincide to different extents and combinations.



Source: ESPON Project 1.4.1/SM-towns, 2006, 130

Figure 7 Process of the development of a typology of small and medium-sized towns

2.2.2 Quantitative approaches for territorial analysis

As already mentioned, the base of most of the work in ESPON was statistical data and in order to analyse this data many different quantitative methods were used. Rather than simply describing commonly known methods which have been applied, this section will focus on their specific use in ESPON. Yet, it can only provide an overview over the utilised quantitative methods (mostly ex-post) rather than giving an extensive account of every single approach.

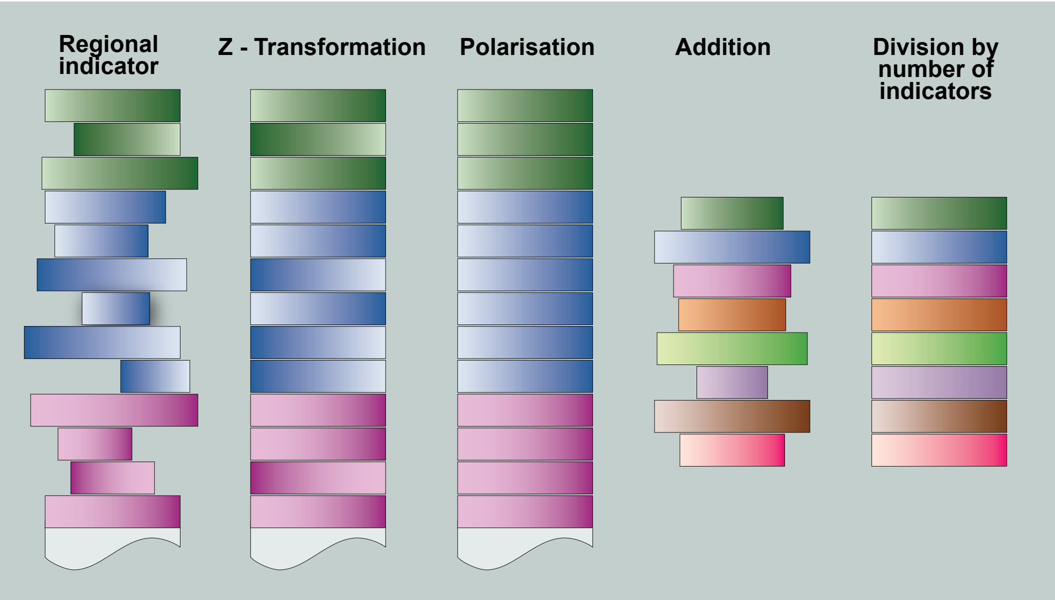
In many projects, quantitative description of the ESPON territory followed after extensive data collection procedures. In many cases, especially with regard to many policies like the Structural Funds and pre-accession aid, the required information was not available. In order to rectify this, steps had to be taken to develop structures which allow the collection of comparable regionalised data from different sources. Due to such efforts undertaken by many projects throughout the ESPON 2006 programme, it was possible to realise considerable progress not only in data collection but also in the standardisation of these processes.

Several projects use basic statistical methods like correlations and regressions, in order to identify relations between different indicators. Mostly this has been realised by panel data for all NUTS 2 and/or NUTS 3 regions across the ESPON space with time series analysis being limited to one or a few points in time. These methods are often closely applied in relation to territorial objectives. For instance the enlargement project (ESPON Project 1.1.3/Enlargement, 2006, 21) uses regressions for measuring the convergence of regions in terms of their GDP per capita in Purchasing Power Standards and GDP per capita growth rates. Recognising the relevance of other influences, some policy impacts projects have also used regression analysis. For instance the project dealing with pre-accession aid analyses the impact of different regional potentials and pre-accession aid spending on regional GDP per capita and the rate of unemployment. In this case, these indicators are used as proxy for cohesion and competitiveness indicators (ESPON Project 2.2.2/Pre-aid impact, 2005, 282). Similarly the impact of pre-accession aid spending on different potential indicators is analysed by the change of location coefficients. These coefficients link potential indicators to pre-accession aid spending.

Several indexes have been developed by projects for different thematic fields. In some cases, such as ESPON Project 1.2.3 on the information society, index development consists of the un-weighted combination of standardised and scaled indicators. In this specific project sub-indexes have been developed, each consisting of another indicator set. The sub-index values are calculated as the mean values of the respective indicator values. The same procedure has been applied for aggregating the sub-indexes to the regional index values (ESPON Project 1.2.3/Info-society, 2006, 40).

Multivariate methods like factor and cluster analyses are utilised to identify interrelated indicators. In the project on the impact of the common agricultural policy (CAP) the principal component analysis is used to transform correlated variables into a smaller set of uncorrelated factors, which are subsequently used as variables for clustering the regions according to agriculture related characteristics (ESPON Project 2.1.3/CAP impact, 2004, 323). This procedure aims at an identification and characterisation of regions with similar agricultural structures. In the project which 'zoomed' into territories from a cross-thematic perspective. Factor analysis is applied to visualise the latent structure of a set of variables which is also used in other analytical steps of the project. Hierarchical cluster analyses including the necessary standardisation procedures were applied to identify similar regional characteristics for different themes and across several themes (ESPON Project 2.4.2/Zoom, 2006, 26).

For the Regional Classification of Europe (RCE), ESPON Project 2.4.2 on 'Zoom' employs standardisation measures for the aggregation of indicators to comprehensive thematic classifications, as is described in Figure 8. In this case, the indicators are not only scaled to comparable levels (Z-transformation) but also adjusted for the direction of their effects on the regional situation. After polarisation, positive values indicate positive situations and negative values identify negative situations. Naturally, this polarisation involves some subjective assessment of whether a specific indicator's value presents a positive or negative situation when it is high or low. For each thematic field covered by the indicators a summarising index is built by aggregation. For better comparability across the themes common thresholds have been defined for all aggregated themes. This is done on the basis of the mean values and standard deviations (ESPON Project 2.4.2/Zoom, 2006, 25).



Source: ESPON Project 2.4.2/Zoom, 2006, 24

Figure 8 Standardisation of indicators for comprehensive regional classification

For further insights into the complexity of interrelations between the different thematic fields – indicated in figure 8 by different colours of the indicators – this project also applied a multi-criteria analysis. In such complex situations, where classification criteria can be of different quality, the ranking of alternatives across all relevant criteria requires additional information. In the multi-criteria analysis this is included by preferences, weightings and decision samples. As a result this method is able to visualise objective divergences and trade-offs between different criteria (ESPON Project 2.4.2/Zoom, 2006, 27).

Quantitative methods have also been used in the scenario building and futures studies within the ESPON Programme, particularly in the ESPON Project 3.2 on scenarios (see chapters 4.4, 4.5 and 4.6) but also in other projects dealing with future trends. One example is the ESPON Project 1.3.2 on natural heritage. Here the technique used is based on time series data extrapolations with regard to future developments in order to point out potential pressures on natural heritage (ESPON Project 1.3.2/Natural heritage, 2005, 32).

Although the application of these various quantitative methods has enhanced the understanding of territorial structures in Europe significantly, the majority of projects point out that this analysis has been accompanied by several data limitations which affect the interpretation of the results. Besides above mentioned data gaps, such limitations are linked to for example varying indicator definitions across countries, the (in)appropriateness of the territorial level of analysis and the varying sizes of NUTS delimitations (see chapter 4.1).

2.2.3 Qualitative approaches for territorial analysis

Due to the broad variety of factors influencing regional development, in many projects quantitative impact assessment and modelling were complemented by qualitative assessments.

A fundamental element of almost all projects has been the scientific review. These reviews usually include a literature review related to the project's theme. These reviews play an important part in developing hypotheses. The hypotheses are then tested against empirical findings, whether by means of quantitative or qualitative methods. For many projects these reviews also include the review of policy documents providing insights into policy objectives, structures, programming and so on. The literature review has also proved to be particularly important for a qualitative ex-ante assessment of policy impacts as it has been done by the pre-accession aid project (ESPON Project 2.2.2/Pre-aid impact, 2005).

In order to collect information for the whole of the ESPON space beyond the centrally available quantitative data, several projects also employed national studies. These were conducted on basis of standardised templates usually containing a guiding framework to which the projects' national experts could respond. When necessary and possible semi-standardised questionnaires were developed and sent to national experts outside the TPGs. For instance the hazard project has further enhanced this kind of analysis by obtaining expert opinions on specific types of hazards and by employing the Delphi method in selected case study regions in order to gain information on how to weight the relevance of different types of hazards for the development of the related typology (ESPON Project 1.3.1/Hazards, 2006, 8). It has been recognised that for a regionally unbiased expert opinion it is important to access experts with a European perspective.

A large number of projects also conducted case studies. These studies have been selected in different ways but largely on the basis of the outcome of initial quantitative analyses. While some projects explicitly chose cases that were relatively unique, others attempt to select the case study regions which could be largely representative of a specific situation. In the latter case, the selection was based on a number of defining criteria acting as reference points. Clearly, these criteria differ from project to project as their thematic fields and main analytical objectives differ.

Furthermore, case studies have been selected at different territorial scales. In some instances, NUTS 2 or NUTS 3 regions are taken as case study regions. In other instances, particularly where transnational integration issues were studied, cross-border areas or even transnational cooperation areas were selected as case studies. Almost in all projects which conducted case studies, the analyses were based on a common framework so that the results were as comparable as possible.

These qualitative methods also proved to be fundamental for the development of policy options in individual projects. Often only the interplay of qualitative and quantitative information and methods allowed the development of a comprehensive and European wide picture of the territorial structures. One particularly illustrating example for this interplay is the development of the global integration zones (see figure 9).

2.3 Modelling techniques

Models are used for communication but also for understanding the world. By playing around with models we try to understand how the world works and how undesirable futures can be avoided and desirable ones achieved.

For ESPON, spatial models are of particular interest. Spatial models are models with an explicit territorial dimension. Spatial models have become an important branch of scientific endeavour. Today their scale ranges from the sub-molecular to the astronomic. But even if one restricts the term spatial to geographical scale, the range of applications of spatial models is enormous. In the social sciences they include regional economic development models, land and housing market models, plant and facility location models, spatial diffusion models, migration models, travel and goods transport models and urban land use models. In the environmental sciences they include climate models, air dispersion models, rainfall-runoff models, groundwater models and biological ecosystem models.

Some of these applications have a long tradition. However, because spatial models are notoriously data-hungry and complex, the real rise of spatial modelling occurred in the 1960s with the general availability of large and fast computers. Today global climate models or models simulating flows in large transport networks would not be possible without the vast memory capacity and speed of computers. Data that previously had to be manually compiled such as land coverage, transport networks or small-area population and employment data are now routinely made available in digital form in many countries.

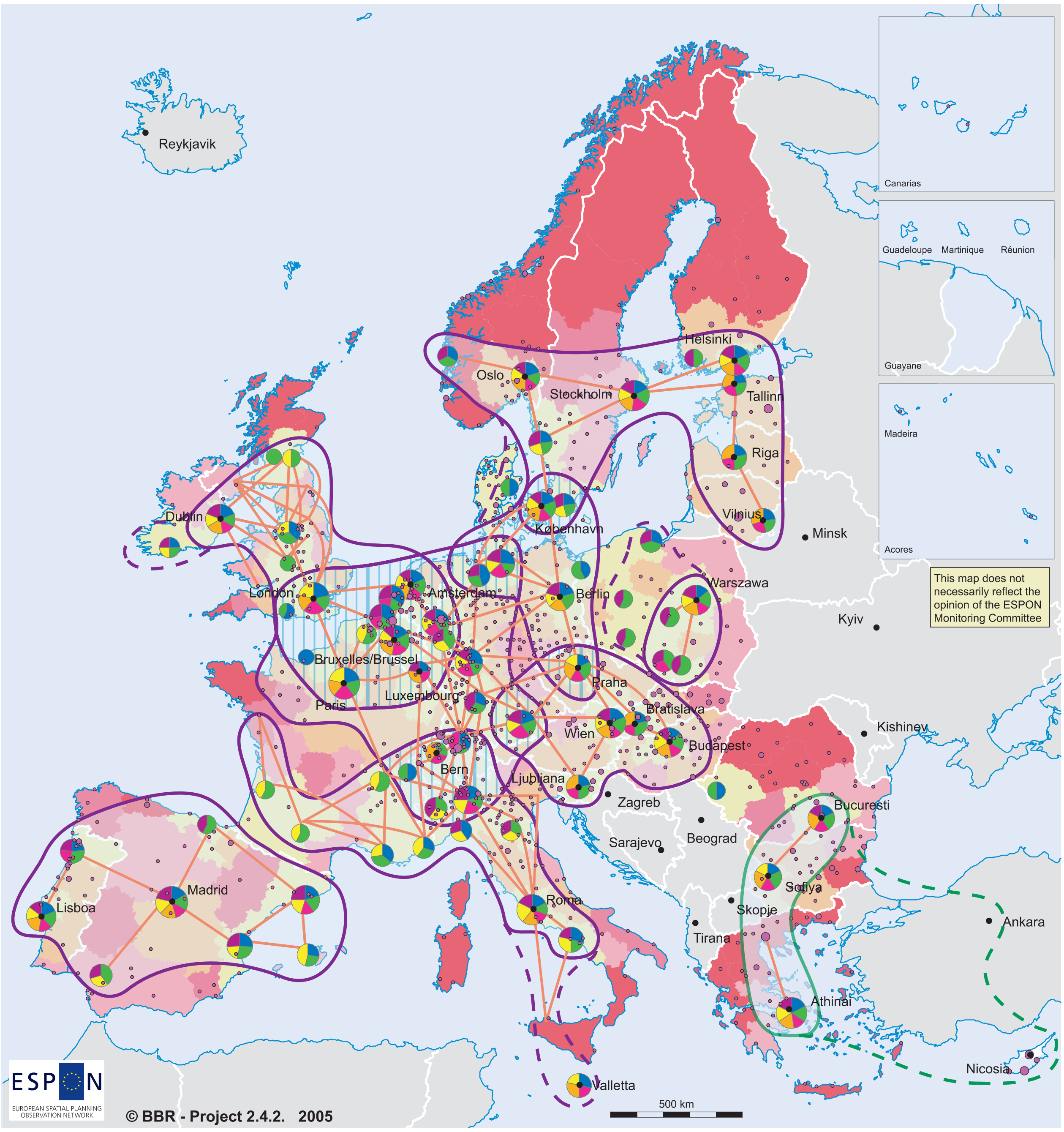
In technical terms, a model is a simplified representation of an object of investigation for purposes of description, explanation, forecasting or planning. A spatial model is a model of an object of investigation in bi-space (space, attribute). A space-time model is a model of an object of investigation in tri-space (space, time, attribute).

There are two categories of spatial models with respect to their degree of formalisation: conceptual and mathematical models. Conceptual models use quasi-natural language to outline the components of the system under investigation and highlight the linkages between them. Mathematical models make conceptual models operational by representing their components and interactions with mathematical constructs. The following discussion focuses on mathematical models.

Another important classification of spatial models is how they deal with uncertainty. Deterministic models generate repeatable solutions based on the direct evaluation of defined relationships, i.e. they do not allow for random variables. Probabilistic models are based on probability distributions and generate a range of possible solutions. Stochastic models are probabilistic models with conditional probability distributions taking into account temporal and/or spatial persistence.

A third classification refers to dynamics. In a static model all stocks have the same time label, i.e. only one point in time is considered. Static models are usually associated with the notion of a steady state or equilibrium. In a dynamic model stocks have two (comparative static) or more time labels which allow modelling of

Figure 9 Potential Integration Zones, their accessibility and profiles



Accessibility to the nearest MEGA by truck - travel time to reach the nearest MEGA in minutes

- up to 120
- 120 to below 180
- 180 to below 240
- 240 to below 300
- 300 and more

Travel times of one hour or less by air or rail between 71 MEGAs in 2003

Decision-making functions outside MEGA's by significance

- Global significance
- European significance
- National/transnational significance
- Regional significance
- Local significance

Metropolitan European Growth Areas (MEGA) by functional importance of global, European, national and transnational significance

Industry, Transport, Tourism, University, Administration, Decison-making

Size according to average value of related significance of functions

Potential European Global Integration Zones (EGIZ)*

- Strong Potential European Integration Zone
- Potential extension with improved accessiblity
- Future Potential European Integration Zone
- Potential extension with improved accessiblity
- Global integration hinge region

Regional level: NUTS 2

Origin of data: ESPON 1.1.1 Nordregio
ESPON 1.2.1 INRETS

No data on accessibilty for remote areas

Source: ESPON database

*The Potential European Integration Zones (EGIZ) were delineated on the basis of accessiblity to the nearest MEGA (regional chesion) and the travel time connections. The nucleus consists of at least one MEGA covering all functions of European significance evolution and processes. Dynamic models treat time as continuous or discrete. Models with discrete time intervals are called simulation models.

Spatial models are also classified according to their resolution in space, time and attributes, ranging from the macroscopic to the microscopic. Macroscopic models deal with aggregates, i.e. countries, regions or more or less homogenous groups of actors. Simulation models of individual objects are called micro-simulation models. There are many more ways of classifying spatial models but the limited space available here does not allow further elaborations. Beyond the above criteria, spatial models can be classified by:

- comprehensiveness: some models deal with only one territorial subsystem, whereas others deal with interactions between different subsystems.
- model structure: some models apply one single unifying principle for modelling and linking all subsystems while others consist of loosely coupled sub-models, each of which has its own independent internal structure.
- theoretical foundations: environmental models rely on physical laws, whereas socio-economic models apply theoretical approaches such as random utility or economic equilibrium theory.
- modelling techniques: these vary too, and may include input-output models, territorial interaction models, neural network models, Markov models or micro-simulation models.
- purpose of application: analytical models are used to describe or explain the state of the system under investigation at one point in time, whereas forecasting or planning models aim at predicting one or more paths of evolution of the system in the future.

The classification by purpose of application will be used in the remaining parts of this section to structure the description of models used in ESPON.

2.3.1 Analytical models

In the broadest sense all ESPON projects have produced analytical models as constructs to communicate perceptions and concepts. In this sense a map, a typology or classification, and even a qualitative hypothesis or conclusion, are models. However, to deal with all these models in this section would be of little use; moreover there are sections in this report explicitly devoted to some of them, such as the previous subsection on indicators and typologies and chapters 4.2 on cartography and visualisation and 4.3 on territorial impact assessment. In this section therefore only mathematical models applying specialised computer software are discussed.

Analytical models are models used for the analysis of the situation of the modelled system in the present or past. Therefore they are related to the methods of elaborating indicators discussed previously but differ from them in that they apply special computer software to calculate indicators which are more complex than simple levels or ratios or to analyse relationships between indicators, such as causal chains or policy impacts.

The analytical models applied in ESPON can be grouped by their object of study: One group of models uses statistical models to explore developments of regions. The second group of models uses network models to study networks. The third group of models uses a combination of models to analyse cities. These groups of analytical models will now be discussed.

Regions

In analytical models of regions the objects of investigation (observations) are regions, in ESPON usually regions of the NUTS system of regions:

- ESPON Project 1.1.3 (Enlargement) used regression analysis to test for convergence and auto-correlation analysis to analyse neighbour-dependent growth (ESPON Project 1.1.3/Enlargement, 2005, 43-51, 67-79).
- ESPON Project 1.2.2 (Telecommunications) used multiple regression to estimate missing data of telecommunications market penetration by NUTS 3 region (ESPON Project 1.2.2/Telecom, 2004, Annex 10, 73-108)
- ESPON Project 1.2.3 (Information society) estimated the diffusion of information technology in European countries by a logistic model (ESPON Project 1.2.3/Info-society, 2006, 104-105).
- ESPON Project 2.1.3 (CAP) also used correlation and regression analyses to explore the explanatory factors of the distribution of CAP and RDP support across regions (ESPON Project 2.1.3/CAP, 2004, 93-122).
- ESPON Project 2.2.2 (Pre-Accession aid) used bivariate correlation and multiple regression to estimate the economic impact of EU pre-accession aid (ESPON Project 2.2.2/Pre-aid impact, 2005, 97-101, 282-284, Annex, 73-77).

Networks

Network analysis models calculate indicators of networks between cities or regions using algorithms based on graph theory. The indicators can refer to nodes or links of the network, such as accessibility or flows.

ESPON Project 1.2.1 (Transport trends) applied a great variety of accessibility measures based on network analysis models:

- The ICON index measures the time or cost to reach the nearest node of a transport network, such as motorway exits, railway stations, logistics terminals, airports or seaports providing a minimum level of service, such as travel speed or number of trains. Several ICON indices are produced as a weighted aggregation of modal ICON indices (ESPON Project 1.2.1/Transport trends, 2004, 223-236).
- Other accessibility indices measure the average transport time or cost of goods transport to all regions in Europe taking account of the maximum driving hours of lorry drivers (ESPON Project 1.2.1/Transport trends, 2004, 237-242) or to all Metropolitan European Growth Areas (MEGA) defined in ESPON Project 1.1.1 (Polycentrism) (ESPON Project 1.2.1/ Transport trends, 2004, 242-256).
- Daily accessibility indices measure the number of customers or suppliers that can be visited in a round trip during a business day (ESPON Project 1.2.1/ Transport trends, 2004, 262-275).
- Potential accessibility indices apply an implicit transport model to calculate the number of destination in all regions weighted by a negative function of travel time or cost. Multimodal potential accessibility is calculated by an implicit modal split model as the logsum of modal impedances (ESPON Project 1.2.1/ Transport trends, 2004, 276-285).

In addition, ESPON Project 1.2.1 (Transport trends) calculated travel flows between NUTS 2 regions or various other destinations:

- Travel flows by purpose were calculated using the strategic KTEN travel model, which predicts trip generation, attraction and trip distribution by trip purpose and modal split as a function of distance combined with assignment to the road network (ESPON Project 1.2.1/Transport trends, 2004, 286-297). The KTEN model is described in Section 2.3.6.
- Similar results for freight transport were calculated using the NESTEAR freight transport model (ESPON Project 1.2.1/Transport trends, 2004, 298-327).
- Also flows of goods and travellers between seaports and airports and Metropolitan European Growth Areas (MEGA) were calculated (ESPON Project 1.2.1/Transport trends, 2004, 328-344, 347-356).

Other model applications in ESPON Project 1.2.1 include calculations of air pollution by road traffic (ESPON Project 1.2.1/Transport trends, 2004, 357-362) and network vulnerability to anthropogenic and natural hazards (ESPON Project 1.2.1/ Transport trends, 2004, 363-383).

Cities

Cities as nodes in networks and centres of regions are important objects of investigation in ESPON. The hierarchy of cities is expressed by the classification into Functional Urban Areas (FUA) and Metropolitan European Growth Areas (MEGA). Achieving balanced polycentric urban systems is one of the major objectives of the European Spatial Development Perspective (ESDP), which as well is mentioned in the Community Strategic Guidelines on cohesion adopted by the Council in October 2006.

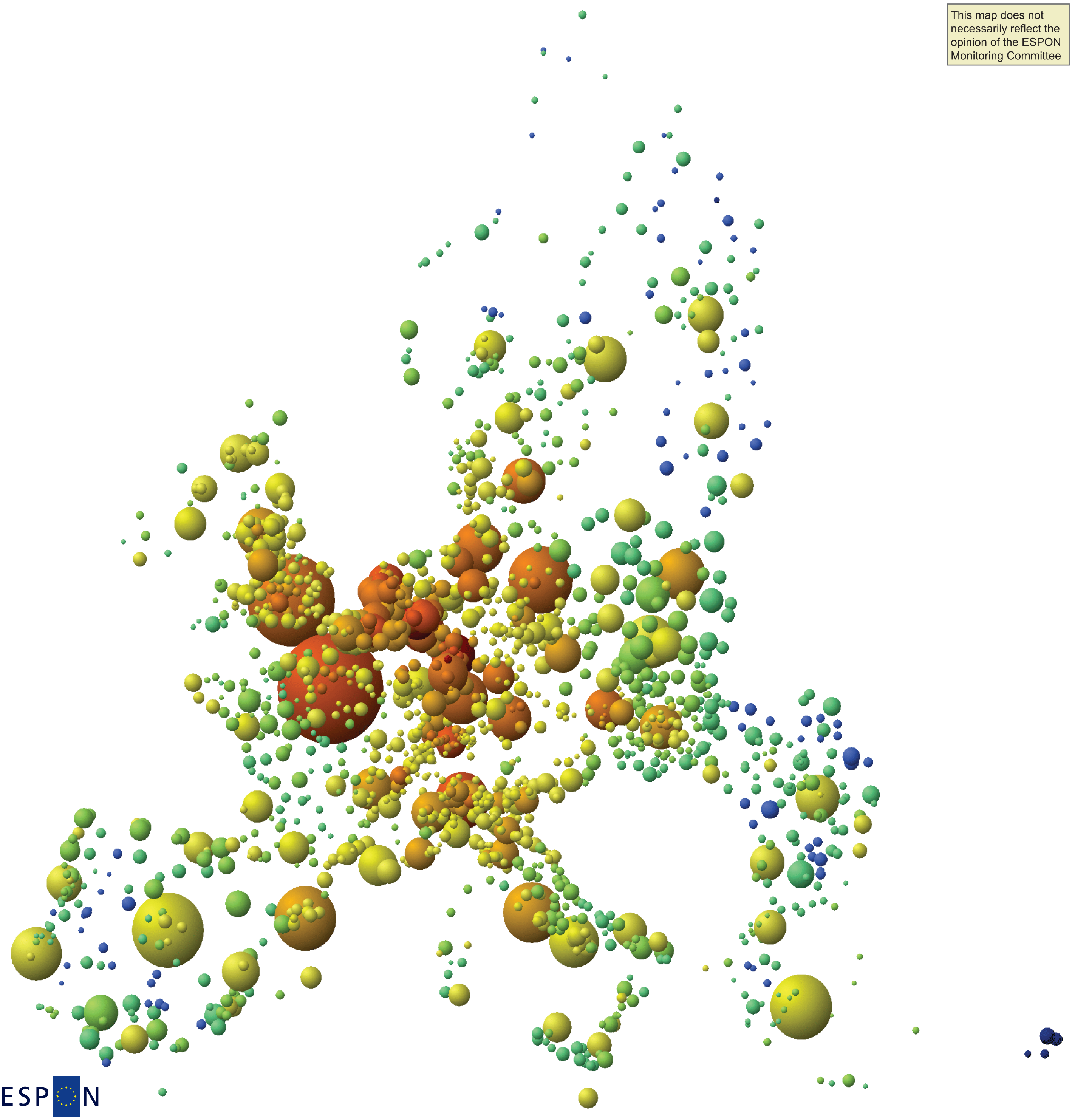
ESPON Project 1.1.1 (Polycentricity) developed a complex indicator of polycentricity combining three dimensions: size, location and connectivity (ESPON Project 1.1.1/ Polycentricity, 2004, 60-84):

- The size indicator measures the distribution of population and GDP based on the notion that a flat rank-size distribution is more polycentric than an urban system dominated by one large city.
- The location indicator measures the spatial distribution of cities assuming that a uniform distribution of cities across a territory is better for a polycentric urban system than one where all cities are clustered in one part of the territory.
- The connectivity indicator measures the distribution of accessibility across cities assuming that an urban system with good connections between lower-level cities is more polycentric than one in which all connections are concentrated on the largest city.

The method to calculate potential accessibility developed in ESPON Project 1.2.1 (Transport trends) was also used in ESPON Project 1.1.1 (Polycentricity) (see Figure 10), ESPON Project 1.1.3. (Enlargement and Polycentricity), and ESPON Project 2.2.1 (Transport Policy Impacts).

In addition, ESPON Project 1.1.1 (Polycentricity) developed a GIS-based method to delimit the catchment area of Functional Urban Areas (FUA) as the sum of the areas of municipalities within 45 minute car travel time from the centre of the FUA called Potential Urban Strategic Horizons (PUSH) (ESPON Project 1.1.1/Polycentricity, 2004,

Figure 10 Multimodal accessibility of Functional Urban Areas, 2001



ESPON
EUROPEAN SPATIAL PLANNING OBSERVATION NETWORK

Accessibility (ESPON Space = 100)

	0 < 20
	20 < 40
	40 < 60
	60 < 80
	80 < 100
	100 < 120
	120 < 140
	140 < 160
	160 < 180
	180 < ...

Origin of data: S&W

Source: ESPON Database

124-134). Based on the overlap of adjacent PUSH areas, Potential Polycentric Integration Areas (PIA) were identified based on the hypothesis that FUA which share a significant proportion of their commuter catchment area could solve planning and spatial development challenges through integrated polycentric development policies (ditto., 135-150).

2.3.2 Forecasting models

Forecasting models are distinguished from analytical models in that they deal with the future, i.e. predict the evolution of the modelled system. Usually there are more than one future development scenarios, each based on different assumptions on external developments, internal socio-economic trends and different policy environments. In this case what matters is not the absolute levels of the system variables but the differences between the scenarios. If the scenarios differ in the policies applied, the differences can be interpreted as their impacts. So the forecasting model becomes an ex-ante impact analysis model or a planning model (see also chapter 4.3).

In a technical sense, forecasting models are models which predict the evolution of one or more indicators over time. There are two kinds of forecasting models: comparative static models (one-shot forecasts) and dynamic models (evolution in several time steps over time). Only dynamic models can model time lags and delayed response by agents such as firms or households.

The forecasting or planning models used in ESPON projects are all regional models. This means that they forecast the development of the regions. They can be grouped by field of application into demographic models and economic models.

Demographic models

Regional demographic models forecast the development of regional population. The development of population is composed of natural population change (fertility and mortality) and migration. Only few ESPON projects have modelled population:
ESPON Project 1.1.4 (Demographic trends) applied a demographic cohort-survival model based on total fertility and mortality rates and a model based on migration rates to forecast several scenarios of natural population change and migratory balance until 2050 for NUTS 2 regions (ESPON Project 1.1.4/Demographic trends, 2005, 137-146).

In ESPON Project 2.1.1 (Transport Policy Impacts) the SASI regional socio-economic model (see below) contains a cohort-survival demographic model based on age-specific fertility and migration rates and a migration model based on economic push and pull factors for modelling population change until 2030 for NUTS 3 regions.

Economic models

Regional economic models forecast the development of economic performance of the regions as a function of external political and economic trends, such as globalisation and energy scarcity, and social and behavioural changes, such as ageing and changing work patterns.

ESPON Project 2.1.1 (Transport Policy Impacts) applied three models of regional economic development to forecast the regional economic impacts and cohesion effects of transport and telecommunications policies:

- The SASI model is a multi-regional recursive-dynamic model of regional socio-economic development of NUTS 3 regions based on regional production functions (ESPON Project 2.1.1/Transport impact, 2004, Third Interim Report, 52-70).
- The CGEurope model is a multiregional territorial computable general equilibrium model of regional economic development at the NUTS 3 level, in which transport costs appear as expenditures for transport and business travel (ESPON Project 2.1.1/Transport impact, 2004, Third Interim Report, 70-95).
- The STIMA model assesses the impact of information and communications technologies on regional economic growth and distribution at the NUTS 2 level based on regional production functions (ESPON Project 2.1.1/Transport impact, 2004, Third Interim Report, 96-124).

The SASI model was also applied in ESPON Project 1.1.3 (Enlargement and Polycentricity) with special attention to economic and cohesion impacts on the new Member States and accession countries. In ESPON Project 1.1.3 also the RESSET regional economic model was developed and tested. The RESSET models simulates change of population and employment at three levels, the whole of Europe, individual countries and NUTS-3 regions, as a function of changes in accessibility (ESPON Project 1.1.3/Enlargement, 2006, 183-197).

ESPON Project 3.2 (Scenarios) developed and applied the regional econometric model MASST. The MASST model is based on regional production functions but differs from the three regional economic models used in ESPON Project 2.1.1 (Transport impact) by its two-level construction in which a national model taking account of macroeconomic factors, such as private consumption, investments, public expenditure and imports and exports drives the lower-level regional economic model (ESPON Project 3.2/Scenarios, Third Interim Report, Vol. 4, 9-49). The MASST model was also applied in ESPON Project 3.4.2 (Economy) and is presented in this report in chapter 4.4. In addition, the KTEN travel model used in ESPON Project 1.2.1 (Transport trends) was also applied in ESPON Project 3.2 (Scenarios) and extended by a freight transport model becoming the K10 model (ESPON Project 3.2/Scenarios, Third Interim Report, Vol. 4, 50-84).

ESPON Project 2.1.3 (CAP Impact) analysed and presented the results of the CAPRI (Common Agricultural Policy Regional Impact) model. The CAPRI model forecasts the economic impacts of agricultural polices, such as payment schemes and quotas until the year 2009 on economic development in NUTS-2 regions in Europe (ESPON Project 2.1.3/CAP impact, 2004, 206-208).

EPSON Project 2.1.4 (Energy) developed national input-output models to forecast the impacts of energy price changes on regional economic development by economic sector (ESPON Project 2.1.4/Energy, 2004, 135-151).

ESPON Project 3.2 (Scenarios) developed a Territorial Impact Assessment model (called TEQUILA) and applied it to TENs policy. TEQUILA is a multicriteria model merging multiple impact assessment results coming from other ESPON projects (in particular from ESPON Projects 2.1.1 and 1.2.1, on transport; 1.3.1 on natural heritage; 1.3.3 on cultural heritage), encompassing a territorial utility function and a vulnerability function in order to take the specificity of the single regions into account. The model was also utilised in another ESPON Project, namely 2.4.1 on impact of environmental policies, at an aggregate territorial scale.

2.3.3 Conclusions

The review of analytical and forecasting models in ESPON has shown that in a relatively short period of time significant progress has been made in capturing the huge complexity of the large European territory in spatial models with high spatial resolution and great sophistication. The models applied have produced policy-relevant information responding to a variety of current policy issues. There is nothing comparable in other continents, not even in North America. A particular advanced feature of the application of models in ESPON is that in some projects several models have been applied in parallel to the same policy questions and with the same data. The comparison between the results of different models has contributed vastly to improving their reliability and credibility.

However, the review has also shown that the use of models has been very unevenly distributed across the ESPON projects.

There are projects which were clearly model-oriented, such as ESPON Project 1.2.1 (Transport Trends), ESPON Project 1.1.1 (Polycentricity), ESPON Project 2.2.2 (Transport Policy Impacts) and ESPON Project 3.2 (Scenarios). These projects applied large state-of-the-art computer models, which more often than not were developed over many years in other project environments before their application in ESPON. Only in few cases were complex simulation models specifically developed for an ESPON project, such as the STIMA, RESSET and MASST models. This points out to the fact that complex research tools like these require an incubation and maturation period beyond the duration of an individual ESPON project.

On the other hand there are many projects that have not applied models. That may not be surprising in projects with a distinct political science topic and approach, such as ESPON Project 2.3.1 (ESDP Impact) or ESPON Project 2.3.2 (Governance). However, there are also projects in which more rigorous evidence about spatial incidence, if not causal relationships, or forecasts of likely impacts of possible policies might have improved the substance, credibility and policy relevance of the results.

Several projects reviewed the state of the art of available models as an option but did not make an attempt to adopt any of them.

In some application areas this abstinence may be a consequence of the substantial effort necessary to even apply an existing model. This is certainly the case for transport and environmental models. Full scale transport models at the European scale require detailed regional population and employment data and a huge trans-European network database. Environmental models, such as climate or air dispersion models, require high-resolution meteorological, topography and emission data. Such models can only be maintained and continuously updated and refined by stable institutions and not in short-term projects. In these and a few other application fields therefore an institutionalised co-operation is appropriate.

However, even smaller, less complex models have a lifetime beyond the duration of an ESPON project. To demand that all models used in an ESPON project be made available after the project would ignore their experimental character at the cutting edge of the state of the art and that they represent an important intellectual property of their authors.

These considerations are relevant for the discussion about the feasibility of a European Spatial Development Support System (ESPON Project 3.1/Tools, 2004, 478-482). Clearly modelling techniques will form an essential component of such a system. However, the challenges to the authors of models in the public domain are enormous. Models in the public domain must be transparent and interactive and help the user to understand the behaviour of the system under study. Together with their data the models must be continually updated and improved and meet strict quality standards. It is likely that for this a permanent institutional framework will be required.

2.4 Piloting a territorial monitoring system

Territorial monitoring on regular basis and over a longer period of time is an important precondition for a sound analysis of territorial developments and trends which can inform policy making. This demand can not be accompanied by single ESPON projects which are often limited to delivering singular inputs on trends or snapshots on the territorial state.

First steps towards a more continuous territorial monitoring have been undertaken by the ESPON Project 4.1.3 on the "Feasibility Study on Monitoring Territorial Development based on ESPON Key indicators". This project started in June 2006 and can be considered a milestone in ESPON works on provision of data and indicators.

Identification of the key long term territorial policy objectives was a first step to support the monitoring and assessment of the evolutions of the European territory. This process was undertaken on the basis of the current policy debate related to intergovernmental processes - in particular the ESDP and the State and Perspective of the European Union- on the European policy objectives and priorities, especially in relation to Territorial Cohesion and the Lisbon Strategy. The research process has also actively involved the ESPON Monitoring Committee members and the Lead Partners of the ESPON projects.

As a result of this analysis the project team concluded that the search for appropriate indicators for European territorial monitoring should be structured in accordance with the following list of policy concepts and objectives:

Territorial Cohesion	**Lisbon**
Balanced distribution of population, wealth, cities, etc. Sustainable settlement structures	Assets for global competitiveness Innovative knowledge society Diversified regional economies
Infrastructure and accessibility	**Gothenburg**
Sustainable transport and energy	Healthy environment and hazard prevention
Socio-cultural	**Governance**
Socially inclusive society and space Diversified cultural heritage and identities	Territorially oriented governance

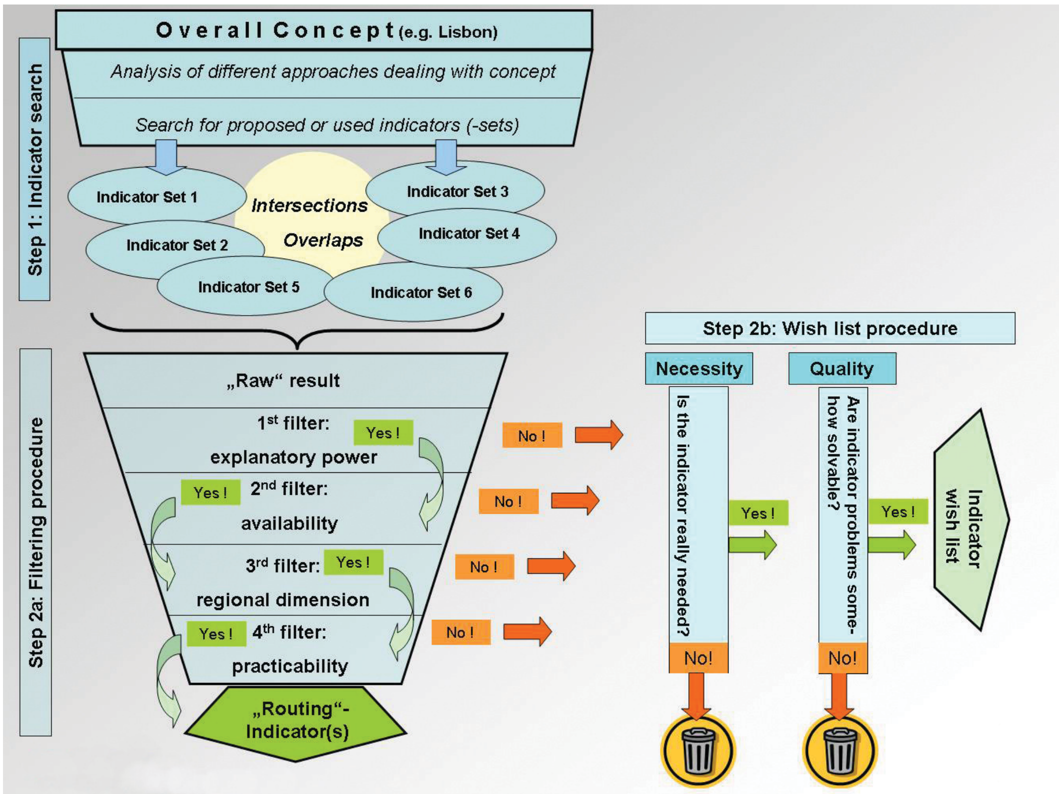
Source: ESPON Project 4.1.3/Monitoring, First Interim Report, 2006, 10

Figure 11 Indicative indicators for European territorial monitoring

The main challenge was then to identify which indicators should be used to measures the territorial development towards the identified objectives.

The components of a territorial monitoring system stand on a solid common base which is constituted by: the ESPON core indicators (see chapter 2.1); the ex-ante Territorial Impact Assessment tools (TIA – see chapter 4.3); and the results from the applied ESPON research projects. However, one the major remaining challenges is to secure a common methodology for selecting the most appropriate indicators for territorial monitoring.

The chosen indicators should in fact comply with common standards in relation to their quality and explanatory power. In order to satisfy these requirements the feasibility study, mentioned above, developed a multi-step approach which will act as a common guideline for selecting or suggesting indicators. The process started with a broad analysis of projects and documents dealing with the respective theme. Here, not only the findings from the ESPON projects were scrutinized (forming the core of the analysis as they cover the entire European territory), but also the results of many other relevant research activities. The obtained sets of indicators are then compiled and intersections and overlaps identified. As a result, a set of indicators was identified and prepared for the filtering procedure. The filtering procedure consists of 4 steps or filters as described below (see also figure 12):



Source: ESPON Project 4.1.3/Monitoring, First Interim Report, 2006, 8

Figure 12 Multi-level filtering process and Wish list procedure

1) Explanatory power: the first filter is the most challenging one. Each indicator will be checked for its ability to represent the thematic field which it comes from in the best possible way.

2) Availability: the second filter is the availability of the collected indicators. This is a basic necessity. It is futile to check any other quality criterion if the data is simply not available on a reasonable basis.
3) Regional dimension: NUTS 3 or below!
4) Practicability: Some indicators may be ideal only for mere scientific purposes but lack a clear link to practice.

The projects have developed a huge number of indicators, which are structured in the ESPON database (see above chapter 2.1). Out of this large number of indicators the projects have identified a smaller number of core and key indicators (see below box). This aimed at providing a better overview of indicators that are most relevant for territorial analysis. However, since some of these indicators so far only represent second best choices or are not readily available, these indicator lists have been expanded by so-called routing indicators.

Indicator lists in ESPON

Core indicators represent the most important indicators for the themes analysed by the different projects. Altogether some 100 core indicators have been identified from a total list of more than 1,000 indicators in the ESPON database.

In a second coordinating stage, **key indicators** have been selected from the core indicator list. This represents a much smaller number of indicators. This process of selection aims to link the thematic fields with territorial policy objectives.

Similarly, **routing indicators** not only describe one or other theme from a territorial perspective but also have a 'lighthouse' function in relation to policy objectives. However, they are based on the ESPON database and the core indicator list as well as explicitly including data from other sources. They also highlight shortcomings in data availability.

The term 'routing indicator' exceeds the currently existing definition or main idea of so called 'core or key indicators'. The major difference is that routing indicators must be able to represent much broader contexts and should even be capable of showing the tendency of a whole thematic field. They are really the most relevant existing indicators for a certain thematic fields. At each step of the filtering process, indicators will of course be sorted out. The ones that do not go through the filter of availability enter another procedure called "indicator wish list" procedure. Two more questions are asked in this procedure: first, if the indicator is necessary and second, if the problems with this indicator are thought to be resolvable with a reasonable amount of resources or and a reasonable time span. The entire process results in two lists. Firstly, the so called "routing indicators list" which consists of indicators that fulfill the quality criteria for a constant territorial monitoring. Secondly, the so called "indicator wish list" which contains desirable indicators with minor weaknesses that have a high potential to become routing indicators.

This study is expected to provide, by November 2006, a tentative territorial monitoring report giving easy to communicate information to policy makers on the structures and trends within the ESPON space and in relation to current policy objectives. The tentative report shall include maps elaborated on the basis of the proposed lists of ideal, key indicators or their viable alternatives.

2.5 Proposal for a long-term database

A long-term database is an important tool for the analysis of territorial development trends, as well as for a continuous territorial monitoring. Such a database faces however not only the challenges of the availability of harmonised data, but also challenges related to the changing of regional units. Therefore such a database has to control and manage the complexity of multiple and evolving territorial grids, as well as the possible heterogeneity and missing values of statistical data sources.

This section presents a conceptual model for the management of the evolving and spatio-temporal statistical indicators.

The Long-Term Database as part of ESPON Project 3.2 (Scenarios) is an application designed to fulfil two main purposes: a long-term storage of thematic and geometric data and a reliable estimation of missing indicator values.

The long-term storage of thematic and geometric data for territorial units of the European area, at different resolution levels -ranging from the state level (NUTS 0) to the commune level (NUTS 5) -implies tackling several issues:

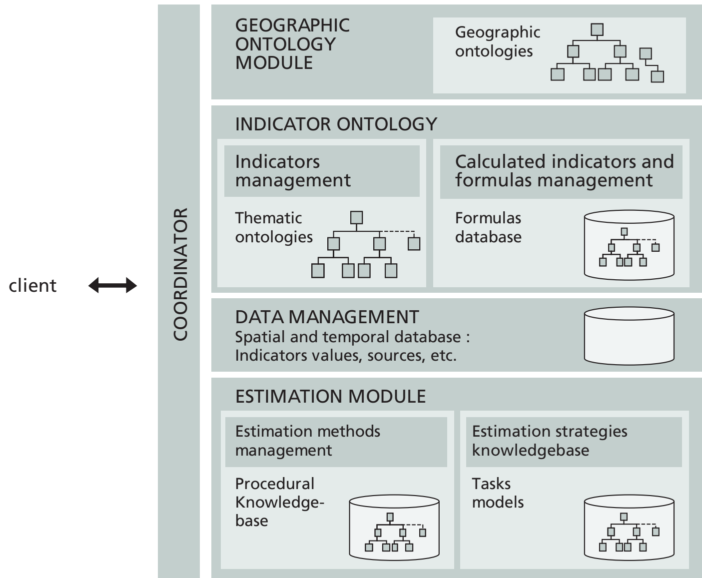
- Flexibility: the long-term database has to rely on a flexible schema so that new data (or types of data) can be easily added. This should allow scientists to use the long-term database for an extended period of time and keep the data up to date without having to build a new database for each new application.
- Data quality: the long-term database should keep track of the quality of the data it contains (validation of the data by organisms of statistics, genealogy of the data sets, automatic detection of data inconsistencies...).
- Usability: the long-term database should be usable as a shared resource. The application should help the users to easily understand which data are available (by using thematic and geographic ontology), while semi-automated data acquisition mechanisms should make the updating of the data easy while preserving the overall coherence of the structure. The application should be designed so that performance parameters are respected, even for very large data sets, by avoiding redundancies and using performance enhancing techniques (caching, indexing, etc.).

A reliable estimation of missing indicator values, either for filling informational gaps or for the purpose of simulation of past or future hypothetical situations, requires the design of several components:

- A set of generalized estimation methods in order to make it possible to automatically estimate unknown indicator values from the available information in the database (using known values for different territorial units or for different indicator types, at different moments in time).
- A set of generalized estimation strategies in order to be able to automatically select the most appropriate estimation method for a given situation, based on the collected knowledge of thematic experts.
- A mechanism for evaluating the quality of the estimated data, in order to take into account the accuracy of the method and the quality of the data used for estimation. This mechanism could be based on statistical observations, on an operational application of expert knowledge or on a combination of both.

The approach of ESPON Project 3.2 (Scenarios) in the design of the long-term database is modular and incremental. This allows, on the one hand, the building of independent modules, which can be developed and can evolve independently from each other; and, on the other hand, the development of evolving functionalities. This provides the long-term database with the basic modules upon which more advanced modules can be built in the development process of the application.

The extended long-term database is composed of four modules (see Figure 13).



Source: ESPON Project 3.2/Scenarios, 2006

Figure 13 General structure of the application of the long-term database

The Application Management Module (M1) manages a geographic ontology. This ontology is a gazetteer containing the hierarchy of geographic entities with their names in different languages and some relations between them. The most important relations described by the ontology are the territorial and semantic inclusion ones, which lead to the hierarchical structure of geographic entities (offering support for territorial estimation methods). Genealogy relations allow tracing back the origins of geographic entities (offering support for more efficient temporal estimation methods). Another function of the geographic ontology is the support for eliminating ambiguities in territorial queries, by detecting exactly to which geographic entity a query refers to (operates like a dictionary of geographic entities). Finally, it ensures the maintenance of data consistency of the database whenever updates are done.

The Indicator Ontology Module (M2) manages a hierarchy of themes and indicators that can be found in the database, with some relations that hold between them (aggregation, broader term, etc.). The indicators contained in this ontology are considered as basic ones and they correspond to simple stocks. This basic indicator will be used in the definition of other, more complex indicators. The main aim is to eliminate ambiguities in the thematic queries and to maintain data consistency on updates.

The Data Management Module (M3) provides the spatio-temporal dimension and consists of a relational database containing the whole set of geographic entities with their known indicator value.

The Estimation Module (M4) is composed of:

- An indicator formulas knowledge base which contains a set of complex indicators, together with the algebraic formulas allowing to compute them from other indicators stored in the database (stocks) or in the knowledge base. These constructed indicators range from simple ratios of stocks (e.g. GDP per capita) to more complex indicators like the remaining life index or the ETCI (see ESPON Project 3.2). It is important to note that this knowledge base also has a normative aspect, as it contains only indicators that are meaningful for statistical and spatial analysis: constructed indicators like "life expectancy at birth/surface", which have no practical meaning, will not be allowed. The main functionalities of this knowledge base consist in eliminating ambiguities for thematic queries and calculating constructed indicators.
- A hierarchy of methods which is a classification hierarchy of estimation methods, together with their code. The estimation methods can be either one-dimensional (based on only one information dimension - territorial, temporal or thematic) or composite, consisting of successive applications of one-dimensional methods. The functionalities of this component are limited to computing estimated indicators starting from "real" indicators existing in the database.
- An estimation strategy knowledge base which is an expert system based on a set of rules allowing the system to choose the most appropriate estimation method for a given situation. The choice of the method depends on the indicator type and on the richness and density of available data. The rules contained in the knowledge base are derived from the expertise of the thematic specialists (geographers, demographers,…) and from statistical tests.

The structure of the database is designed to support a long-term storage of territorial and thematic data concerning geographic units.

In parallel to the collection and organisation of data, ESPON has also developed a series of practical tools which allow the use and analysis of these data. This chapter will present some of these tools which are available from the ESPON website (www.espon.eu).

3.1 The ESPON database

The ESPON database is an important treasure of the ESPON community and a point of reference for most of the territorial analysis carried out under ESPON. All data collected and treated within ESPON projects is united in the ESPON database. Currently this database is based on the software Microsoft Access and provides a simple search interfaces to make the extraction of the desired data easy.

As of 1st June 2006, the database contains approximately 1900 data records, i.e. approximately 620 indicators, 520 raw data and 50 typologies. All data records include harmonized meta-data sets which cover extensive information on the data (description, source, calculation method, etc.).

The contents of the database are subdivided into 19 thematic categories which are further divided into subcategories. These thematic fields are based on the organization of the ESPON Data Navigator (see section 2.1.2).

At present, the most important fields of the database are the following: Employment and Labour Market (25%), Territorial Typologies (17%), Population (16%), Transport (14%), Land Use (6%) and Environment (6%).

The regional reference unit which is based on the Nomenclature of Territorial Units for Statistics (NUTS) has been made available by Eurostat. This uniform reference system has been developed for regional statistical purposes and is based on the institutional territorial units of the EU Member States. The hierarchical classification of the NUTS divides the Member States into three levels: NUTS 1, 2 and 3.

General access and use of the entire ESPON database are reserved at the moment to the participants of the ESPON programme. Large parts of the database are, however, publicly available at the website in the form of spreadsheets.

3.2 Finding data in Europe: the ESPON data navigator

The experiences from the elaboration of the ESDP and the analytical work for the SPESP in terms of the availability of regional information showed that the knowledge on the availability of and access to regional information would be a fundamental starting phase of the ESPON programme. It was clear that guidance for accessing regional information should be prepared concerning the EU and Member States as well as the EU candidate countries and neighbouring countries.

Gathering, processing and analysis of the statistical and geographical information and other quantitative indicators should be facilitated for the transnational project groups (TPGs). In this context, the Data Navigator Project was launched to create an overview or a so-called ‘sourcebook’ on European statistics, covering the national and regional as well as European and transnational level in order to support the ESPON research projects.

In the first round, in 2003, the Data Navigator was elaborated as a compilation of 19 inventories, one from each of the 15 Member States. Further input covered the

European and transnational level dealing with EU institutions, INTERREG and three contributions dealing with relevant data in the forthcoming EU members in Baltic and the CADSES area and one covering the Mediterranean basin. Additionally input came from the neighbouring countries: Norway and Switzerland. In 2005, separate contributions of the acceding countries replaced the first inputs and a general update of the time series and the availability has been carried out.

On the basis of the same questionnaire, the Data Navigator provides unique information on the principal sources on European Statistics. It offers access to main statistical series, geographic data sets, maps and databases and territorially relevant data on different regional levels. It also contains metadata on nomenclatures, periodicity, projection, scale, scope and quality of the data. For further needs, full contact details and responsibilities and any access conditions, including costs and copy rights, are listed.

The information stretches over the full range of potential thematic fields of interest within the ESPON project range. It covers the following themes: territorial typologies, population, employment and labour market, wealth and production, enterprises and investments, transport, research and development, utilities, telecommunication, household oriented infrastructure, land use, environment, agriculture, social situation, housing, cultural sites, tourism, and public sector. Sub-themes related to each of these categories allow further investigation in more detail. Within population, data sources are further divided into population structure, population movement and households.

The Data Navigator is available for download at the ESPON website.

An interactive version which enables individual online selection of data sources by themes, country, regional level and availability of geographic information in the form of maps is also accessible.

3.3 Making your own ESPON map: the ESPON Web-GIS

The ESPON Web-GIS is an application for map representation and territorial analysis of ESPON data via the internet, covering the entire Union (EU 25) plus Romania, Bulgaria, Norway and Switzerland and its regions (NUTS 0, NUTS 1, NUTS 2 and NUTS 3 level).

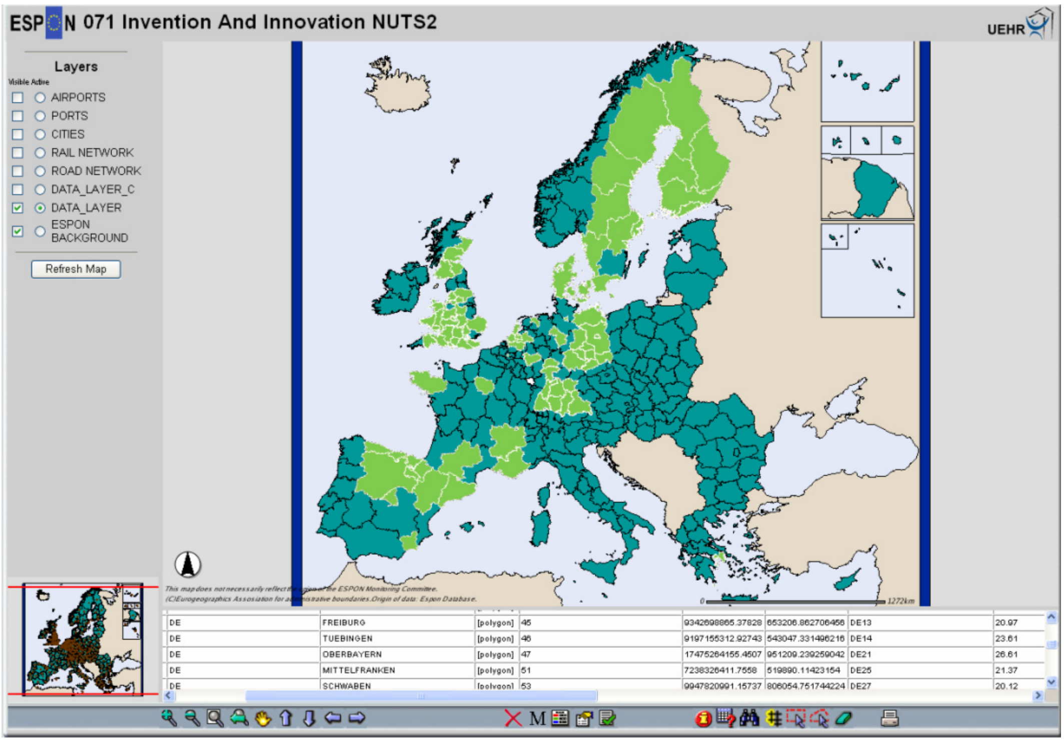
The ESPON Web-GIS contains tools in the field of territorial and/or non territorial statistical analysis. It includes two types of application: Interactive Mapping Analysis and Interactive Statistical Analysis.

The Interactive Mapping Analysis enables the user to visualise maps of selected indicators (organised according to the Data Navigator categories) in order to study the territorial distribution of a phenomenon for information purposes or for identifying possible territorial trends.

The Interactive Statistical Analysis enables the user to query the database using three criteria (Data Navigator category/subcategory, geographical level and time reference of the data). The user can display the results of the query as charts with the corresponding metadata, and some basic statistical information – min, max, average, coefficient of variation and standard deviation.

The ESPON WebGIS is publicly accessible at the ESPON website.

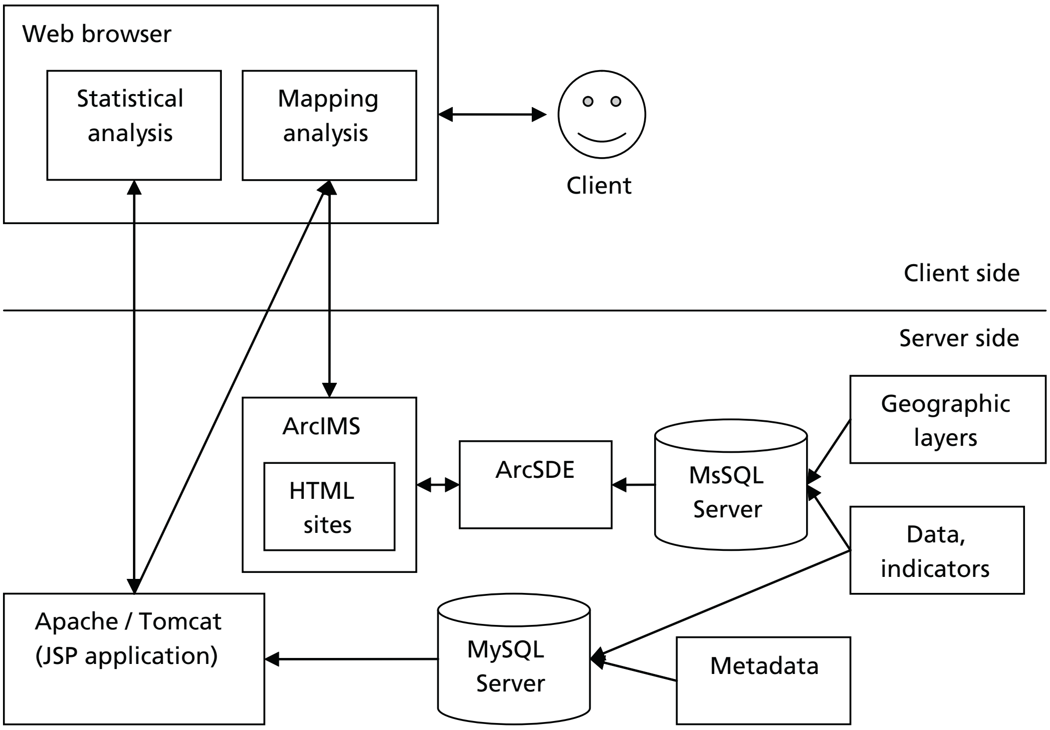
The ESPON Web-GIS application has been developed using the latest versions of the most widely used software platforms. Although it might be demanding, concerning the server side components, the final result is user friendly and does not require any special software other than a JavaScript capable browser. Although different platforms have been used for the implementation of the Interactive Mapping Analysis and the Interactive Statistical Analysis, the two parts have been combined in a single application.



Source: Screen-print from the ESPON Web-GIS

Figure 14 Using the interactive mapping analysis of the ESPON Web-GIS

All geographic layers and their corresponding data and indicators are stored in a MSSQL spatial database, managed by the ArcSDE server. The metadata are stored in a specially designed database, implemented in the MySQL platform, and are connected with the mapping analysis through a special interface built in JSP. The main part of the mapping analysis has been developed using the ArcIMS server. The user interface has been created by customizing the default ArcIMS HTML templates concerning both the appearance and the functionality (available tools) of the produced websites. One site has been created for each Data Navigator category and NUTS level (where data are available) to a total of 56 sites.



Source: ESPON Project 3.1/Tools, 2006

Figure 15 Overview of the ESPON Web-GIS architecture

3.4 Putting maps into perspective: the ESPON HyperAtlas

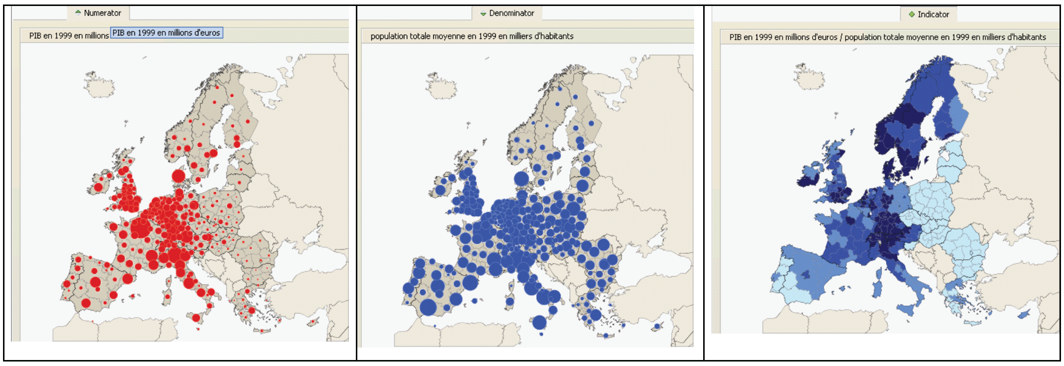
ESPON HyperAtlas is a software produced by the Hypercarte Project[2] in the framework of ESPON Project 3.1 (Tools) and then completed by additional work in the ESPON Programme. HyperAtlas is a tool for Multiscalar Territorial Analysis and gives the opportunity to derive several indicators on the basis of the ratio of two initial geographical indexes according to different territorial contexts. Multiscalar Territorial Analysis is based on the assumption that it is not possible to evaluate the situation of a given territorial unit without taking into account its relative situation and localisation. Regions belong to territorial and territorial systems. Indeed, from a policy point of view and in a social science perspective, contrasts and gradients are of much more interest than absolute values. Furthermore, aggregating and disaggregating territorial units make it possible to see how local values add up to form territorial contexts and regional positions. Whatever the indexes used for political decisions, they have to be evaluated in relative terms. This may be done according to various territorial contexts. Thus one territorial organisation may be examined from three different viewpoints that are related to three territorial contexts. They are differentiated according to the scale of political intervention or action they are referring to at global, national or local level. Thus, what is represented is the deviations to the three reference values associated to these different levels.

Taking the example of the European Union (25) at the level of the region (NUTS2 for instance), and using the wealth per resident in the regions (GDP/inh.) as the

2 http://www-lsr.imag.fr/HyperCarte/

observed index, the HyperAtlas makes it possible to consider the level of regional wealth relative to three territorial contexts, and not only from an absolute point of view. The chosen contexts may be for instance respectively: (1) the whole European Union (2) the country (3) the neighbourhood defined by contiguous regions. For such an indicator, HyperAtlas proposes seven maps.

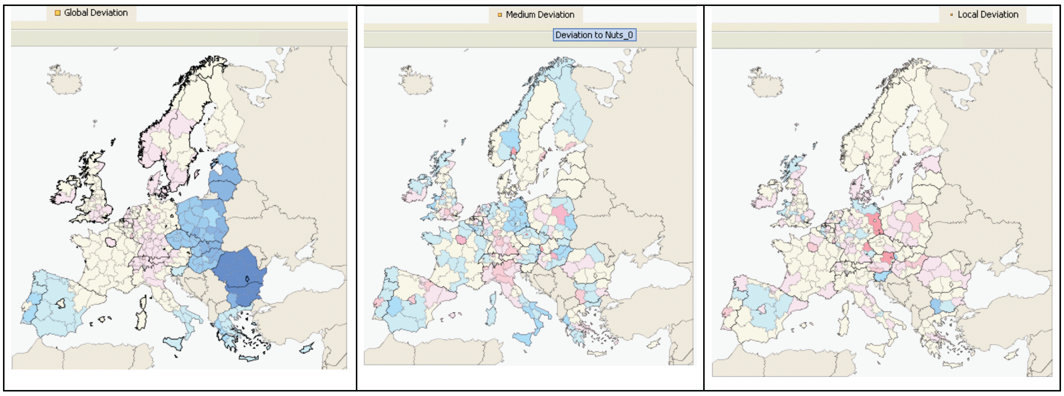
The first three maps described the two parent distributions (wealth and population) and their ratio, that is the chosen index's one (see Figure 16).



Source: Screen-prints from the ESPON HyperAtlas

Figure 16 Elementary maps: from size variables to the ratio

Then, the three maps show the relative distributions to the three chosen contexts. In the above example, these are: i) the deviation of a region to the European reference area, ii) the deviation of a region to its national reference area, and iii) the deviation of a region to the local reference area (see Figure 17).

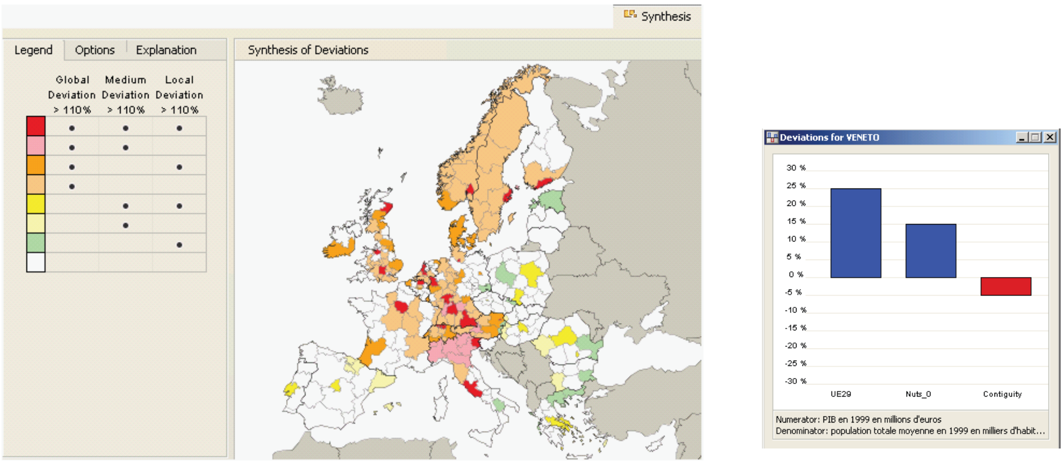


Source: Screen-prints from the ESPON HyperAtlas

Figure 17 Multiscalar representation: deviations to three contexts

The seventh map proposes a synthesis of the different combination of the three previous relative maps (see Figure 18). The user can click on the resulting map in order to obtain more specific information of a selected region (see table in Figure 18).

Thus, one can receive (a) the global view, and (b) the local information for a selected region.

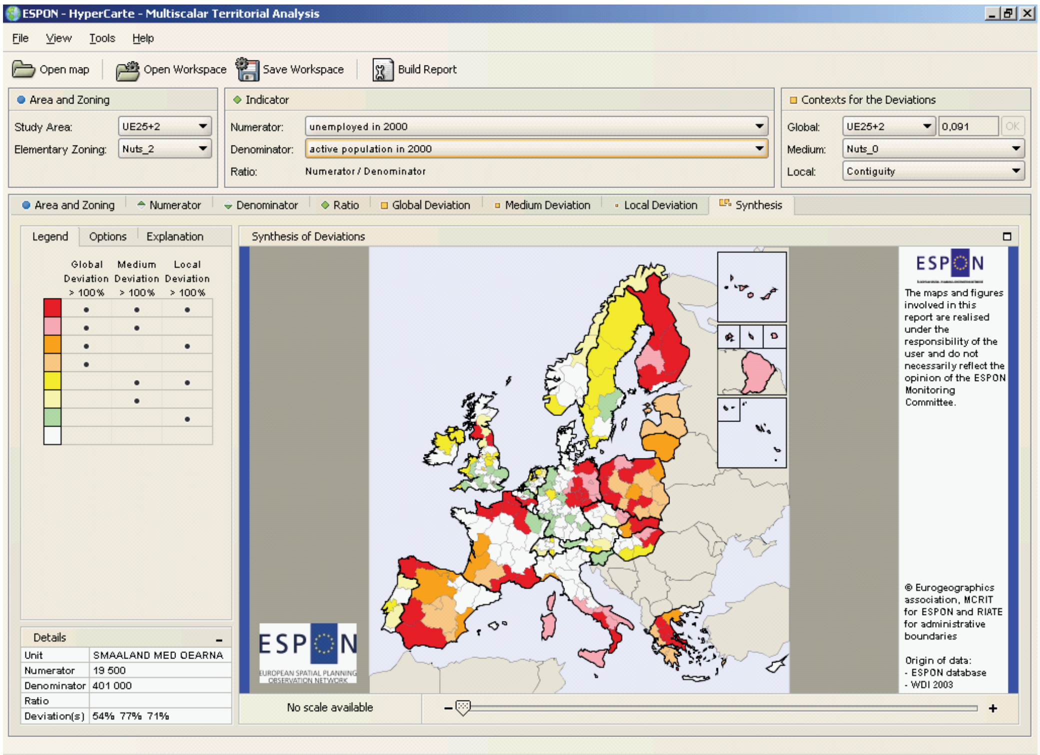


Source: Screen-prints from the ESPON HyperAtlas

Figure 18 Multiscalar synthesis

When the aim is to build political scenarios or evaluate propositions of structural funds, a synthetic view on the situations of regions is needed according to the various territorial contexts which can modify the situation of a given region. The question of equalization (transfer from "advanced" to "lagging" region) is very sensitive and it is important to propose a complete view of the scales where those equalization processes can take place, according to the principle of subsidiarity. As an example, we can analyse how the picture of "lagging" regions is modified when the previous criterion of Objective 1 (less than 75% of the mean value of GDP) is applied simultaneously at three scales (European, national, local). Simultaneously, it is possible to propose a typology of "advanced regions" based on the symmetric criteria of more than 133% of the mean value of GDP at those three scales. According to this methodology, it is possible to demonstrate that very few regions are "lagging at all scales" and "advanced at all scales". Many are in more complex situations like certain regions of Switzerland or Norway which are "advanced" at European scale but "lagging" at their national or local scales. Reversely, the metropolitan regions of candidate countries are very often "lagging at European scale" but "advanced at national and local scales".

The interface developed for the ESPON Hyper-Atlas is very simple (all functions are present on a single panel) and the survey realised by ESPON CU reveals that users could easily use this type of tool, even if they had never used any cartographic software or GIS (see Figure 19). The tool is particularly useful for users who want to explore data directly and obtain answers quickly without being obliged to draw on technical expertise. This question of "democratisation" of the access to territorial information is a crucial output which opens the way for a wide diffusion of information on territorial imbalances at all levels of political decision. One of the most important functions of the tool is the possibility to build in less than 5 minutes a complete "report" on the indicator of interest with the seven maps described above but also a table with all values of multiscalar deviation for all regions of the selected level. Another crucial topic is the possibility to modify the level of aggregation of units, jumping easily from NUTS3 to NUTS2 or even "unofficial" levels like mixture of NUTS2 and NUTS3.



Source: Screen-print from the ESPON HyperAtlas

Figure 19 General view of the interface of ESPON HyperAtlas

The revised version of ESPON HyperAtlas delivered in 2006 presents a good equilibrium between simplicity of use and performance. It is not intended to introduce more functionality in the actual package but simply to make the importation of new datasets and maps easier with a specific module called "Hyperadmin". Some improvements could also be proposed concerning the exportation format of the results of the report.

What is at stake is the elaboration of new software packages in order to make the access for the ESPON community to other methods of territorial analysis like smoothing methods or discontinuity and territorial autocorrelation analysis easier. In each case, the basic idea is to build very simple tools that are adaptable to the need of policy makers and researchers of the ESPON community.

The ESPON HyperAtlas can be downloaded from the ESPON website.

ESPON aims primarily on the provision of evidence on the territorial status, trends and perspectives for policy processes. The research needed for collecting the necessary evidence makes use of existing research approaches and methodologies. However, in the course of the Programme, it became evident that ESPON research teams need to develop new methodologies in order to improve the scientific evidence provided for policy processes.

In this chapter, a selection of such approaches developed during 2005 and 2006 is presented, in the hope that they will serve as the basis for further research and debate. Other approaches, which are not presented here, can be found in the various ESPON project reports.

4.1 The Modifiable Area Unit

Understanding the territorial variations of social and natural phenomena plays a major part in territorial research and policy development. It is important to be able to gain a representation of territorial inequalities, identify specific zones and discontinuities in space, and understand the underlying principle of the territorial organization of a phenomenon and its correlation with or relative independence from other phenomena. Traditional tools such as cartography, statistical analysis, and territorial modelling are used for that purpose. The results of these analyses are dependent on the definition of the studied units. This problem is nowadays well known and referred to as the Modifiable Area Unit Problem or MAUP. The research developed in the scientific support study ESPON Project 3.4.3 (MAUP) proposes an evaluation of this question and offers an analysis organised in 2 parts:

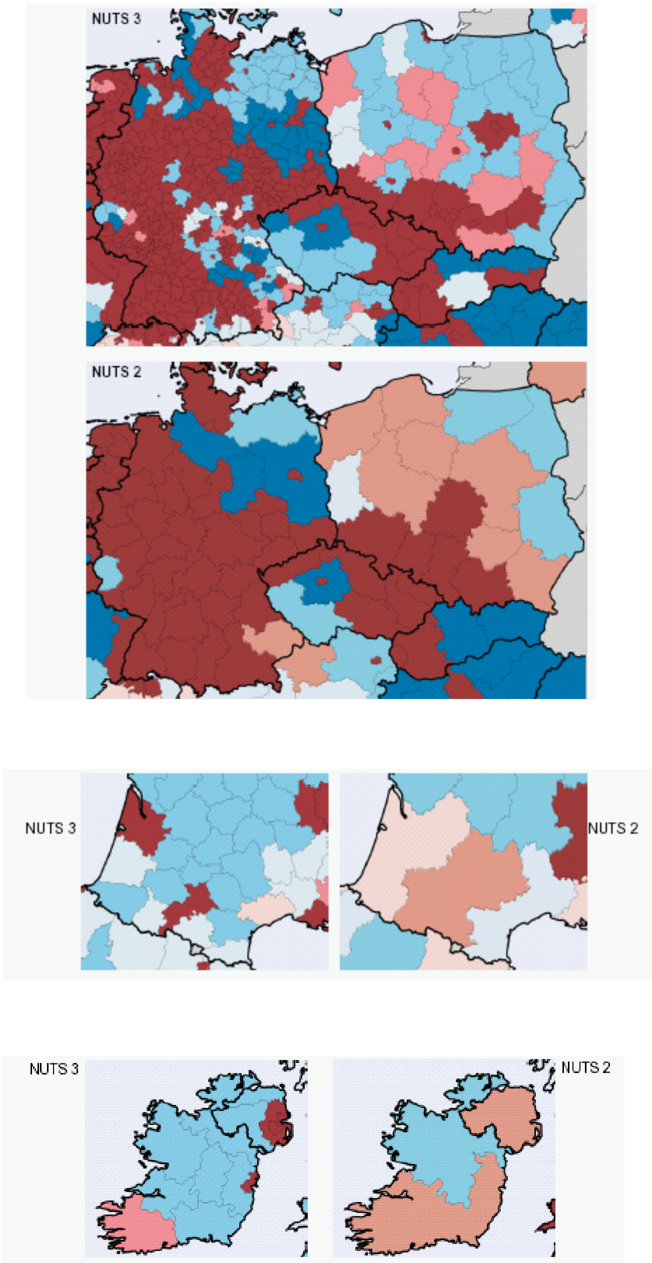
- What is MAUP from scientific point of view?
- Which progress can be proposed for future territorial research?

ESPON research suggests that the fact that statistical results and models' outputs vary according to the zoning which is used to define territorial entities, is not systematically a problem. On the contrary, it can provide useful information on the phenomenon and the process that is being studied. For example, a certain statistical treatment (for example a simple correlation measure) is applied to variables observed for a set of nested scales. Let's imagine two situations: 1) all measures are about the same for all scales; and 2) there is a significant difference in the results (the correlation varies for example from significantly positive to significantly negative). From a statistical point of view, the first case is seen as robust, the second one as unstable, and perhaps with a "preference" for the first one, because it is the only reliable one from statistical point of view. From an empirical point of view, the conclusion will be that in the first case the variables under study are (or are not) linked to whatever the scale of observation is, while in the second case the relationships follow a more complex multi-scalar structure. From that point of view, the second case is perhaps more interesting. Hence, the variations in results, the main element of the MAUP, constitute an exploratory tool and give an insight into the structure of space rather than being a problem. Indeed, showing these variations creates knowledge on the associated processes. Overall, while the MAUP does not provide the whole solution, with regard to permitting to infer a result obtained for a given territorial zoning to another one, it still offers a promising domain of consideration, with a high potential of knowledge creation. Indeed, the accumulation of work on this topic, combined with the performing technological environment offered by contemporary GIS, creates an ideal framework for methodological advances as is illustrated by the case studies. On the other hand, when it is well integrated in the methodological and conceptual framework of an application, it appears that the "P" of MAUP does not refer to "problem", but to "potential", "possibility" and "progress".

The following provides a few ideas for discussion on how the MAUP challenge can be taken forward in future territorial research:

- Adoption of a new hierarchy of NUTS division to be used for research and strategic purpose. Territorial analysis does not need to restrict the production of maps to the official NUTS 2 and NUTS 3 territorial divisions. This official delimitation could be used when needed but otherwise research can also be based on a revised NUTS division based on functional criteria and adopting a mixture of NUTS 2 and NUTS 3 units for its regional studies.
- Development of interactive cartographic tools making possible the delivery of alternative representation of the same phenomena in real time. Considering that different cartographic representation delivers different political messages which are complementary. It is important that alternative representation through multimedia and web technologies is produced. Maps will no more be stored on paper version or picture file but would be generated at the request of the user by interactive systems. The ESPON WebGis and Hyperatlas provide already tools going in that direction. Additional tools related to gridding method, pycnophylactic interpolation, cartogram, Gaussian smoothing, etc. might be worthwhile further considerations.
- Development of research on cartographic perception in relation to policy making. Because cartography is a major tool for decision in the field of territorial development. It is important to analyse the messages conveyed by the maps cautiously in order to verify the potential mistakes or biases. Moreover, it is possible to explore the consequence for political decision of what could be called an "Open Cartographic Method" where different decision makers try to reach a consensus based on a collection of maps of different types and scales. Like in Delphi method, it is possible to compare different interpretations of a set of maps by different experts who are isolated at the beginning and who, in following rounds, are informed about the interpretations of other experts. At the end of the different rounds, it should be possible to obtain a set of maps which are most relevant.
- Development of multiscalar statistical analysis methods for a better diagnosis of territorial trends and territorial impacts. In statistical terms, tools such as geographically weighted regression or territorial autocorrelation methods can be used which explore the relation between statistical parameters at different scales. There are many situations where two phenomena A and B do not display the same level or sign of correlation according to the scale of observation. For example, territorial segregation and imbalances at local level may disappear when the scale of observation moves up to the regional level. We can also determine that structural funds are positively correlated with economic growth in certain part of the European territory and not in others. Multilevel statistical methods are crucial for the development of tailor-made strategies of territorial development which take into account the local contexts and not just the average trends of ESPON territory.
- Enlarging scales of analysis in both directions: toward more local and more global levels. Territorial differences have been sometimes compared to waves of different frequencies and the question of MAUP can be understood as confusion between different frequencies producing noise in the perception

of the message. Following this comparison, the actual research developed in ESPON is limited to a relatively narrow band of territorial frequencies (between regional and European levels) which means that many messages are not interpreted and used because they are related to highest (World) or lowest (local) frequencies. It is true that the actual band of frequency (regional-European) is the core of the mission of ESPON, but the interpretation of this band would be more accurate with additional information on World dynamics and local dynamics. It means that, on the one hand, it is necessary to maintain research on the situation of Europe in the world (database at state levels) and, on the other hand, it is necessary to develop case studies at local administrative units (LAU1 and LAU2).



Source: ESPON Project 3.4.3/MAUP, 2006, 98-99

***Figure 20** An illustration of MAUP: the variation of Urban-Rural Typology at different levels of territorial aggregation (NUTS 2 and NUTS 3)*

4.2 Innovative cartography

Maps on the territorial status and trends in Europe are a key characteristic of ESPON. The presentation of applied research findings in forms of maps can follow different cartographic principles.

Looking across the maps produced by ESPON projects, it can be estimated than 80-90% of the cartographic efforts were dedicated to the production of maps that presented the distribution of a single variable or synthetic indices in the framework of the official NUTS2 and NUTS3 territorial divisions. This is partly because ESPON programme decided very early to harmonise the production of maps in order to gain added value through possibilities of comparison of maps established by different projects.

The fact that 10-20% of maps were produced on the basis of different cartographic principles, however, is a major achievement when compared with the maps used in other official EU documents, where almost all maps follow the classical solution of cartography in NUTS2 division (NUTS3 in a minority of cases) without including Switzerland or Norway. Innovative cartography was not an objective in itself, especially in the framework of an applied research programme like ESPON. Nevertheless, ESPON researchers tried to propose new cartographic solution because of a shared belief in the need for elaborating new concepts for European territorial development and planning. The innovative cartography has been linked, in ESPON, to the elaboration of innovative input to policy development. This is the point that will be illustrated by the following selected examples.

4.2.1 Exploring new territorial divisions

The elaboration by ESPON Project 1.1.4 (Demography) of a map of regional population variation 1990-2000 in unofficial territorial divisions (mixture of NUTS2 and NUTS3 unit) can be considered as a major milestone for innovative cartography as this map, for the first time, moved away from the use of official units and, despite this non-official form, was selected and published in the Third Cohesion Report. This has opened the way for visualisation of medium term evolution (10 years) which had never been done in other projects, which were constrained by the revision of 1995 version of NUTS division and hence could only look at short term evolution. But the enlargement of time series was not the only advantage of this experiment. MAUP demonstrated later that mixing the NUTS divisions or even building new functional regions derived from aggregation of NUTS3 units was a major challenge for ESPON because actual divisions induce mistakes in the evaluation of territorial trends and territorial organisations (chapter 4.1). Like the OECD, which uses a mixture of NUTS2 and NUTS3 units for its regional studies, ESPON has to engage a deep reflection on the choice of the most relevant territorial units for its further research.

Another important cartographic challenge which was discussed very early in ESPON meetings was the question of the territorial scope, i.e. the geographical territory to be covered by ESPON studies. The enlargement of EU toward the East has indeed produced an important revision of this territorial scale (new reference meridian for projection, new corner point in south-east due to the adhesion of Cyprus, inclusion of remote territories …) but many researchers and policy makers in the ESPON Monitoring Committee argued that it was not sufficient and that, in many cases, it was not possible to produce complete view of the situation of ESPON territory without including alternative templates for presenting the situation of Europe at world scale and including the neighbouring areas. The question was especially sensible in southern countries (such as France, Italy, Spain and Greece). These countries consider the relationship with southern countries (such as Morocco, Turkey and Middle-east) as a major driving force for the future development of their towns and regions.

Moreover, the majority of scientists and ESPON Monitoring Committee members admit that the exploration questions such as world competitiveness or gateway cities could not be fully achieved without considerations of the situation of Europe in the World. If the introduction of a new template at world scale was decided early through a preliminary study of ESPON Project 3.1 (Tools), the definition of a cartographic template for European neighbourhood would have been more complicated. This was later achieved by an in-depth study of the relationships between Europe and the rest of the World in ESPON Project 3.4.1 (World). This project also delivered a database on 168 states of the world coupled with a hierarchical division at 5 levels (WUTS) which should facilitate the work of future synthetic studies such as benchmarking of economic and demographic trends between world regions.

4.2.2 Exploring new cartographic tools

In many cases, the introduction of new cartographic solutions was directly related to the exploration of new policy options. The concepts introduced in ESDP (such as polycentrism, transportation corridors, urban-rural partnership, cross-border cooperation) and further completed by new political proposal (Lisbon Strategy, Territorial cohesion) could not be adequately analysed with traditional cartographic tools. New types of maps were needed in order to meet the expectations of policy makers responsible for territorial strategy making. The HyperAtlas, presented in chapter 3.4, is a concrete application of this idea.

In the field of accessibility, for example, the ESPON Project 1.2.1 (Transport trends) proposed at the same time classical maps of areal accessibility at NUTS 3 levels and innovative visualisation of accessibility in linear form (corridors) or even in 3-D in order to make the heterogeneity of access to high speed transportation network at short distance clearly visible. However, in this case, the innovation did not spread out of ESPON and the only maps of accessibility which circulated widely outside the ESPON community (e.g. in Cohesion Report) were the most traditional ones based on areal representation and not on dynamic networks. The same difficulty was observed for the analysis of polycentrism (ESPON Project 1.1.1) where the maps for structural situation (size of MEGAs) was widely published outside ESPON but the dynamic maps on flows of students or air traffic between cities were generally ignored. Maps using linear representation (flows, networks) are clearly more difficult to analyse because they are more complex than the static point-based representation of regions or cities. But, they are much better at representing the patterns of territorial interaction which are the driving force for long term change. Such maps should be used more often in future ESPON Programme.

The maps of discontinuities (cartography of differences between contiguous regions) was more easily accepted, probably because they had been presented earlier (in the SPESP) and also because they provided direct answer to crucial questions asked by policy level on competition and cooperation in cross-border areas. The linear representation used for the cartography of discontinuities was less of a problem than in the previous case because, it was generally associated with the areal representation of the variable under investigation and could be considered as a simple complement to traditional analysis of regional distributions. However, maps of discontinuities give a false feeling of simplicity and the choice of the criteria used for the measure of differences is always related to theoretical choices and empirical knowledge. In the case of GDP per inhabitant, for example, ESPON Project 3.1 demonstrated that the resulting discontinuities are clearly different if we focus on absolute differences (a region A with 5000 €/inh. GDP and a region B with 20000 €/inh. GDP are separated by an absolute difference of 15000) or relative differences (the previous regions A and B are separated by a ratio from 1 to 3). Moreover, discontinuities should be based on multiple criteria. Indeed, the study on ETCI realised in ESPON Project 3.2 (Scenarios) showed that they should be analysed both quantitatively (global level of difference on all criteria) and qualitatively (combination and orientation of differences for different criteria). What is revealed by discontinuities is the existence of asymmetric situations which are potential vectors of asymmetric flows between neighbouring regions.

The maps which were, curiously, most commonly and immediately accepted by ESPON members, despite their conceptual and methodological complexity, were the "smoothed" maps which propose a multiscalar territorial analysis of phenomena such as economic or demographic concentration. From theoretical point of view, this approach considers that it is not possible to examine a territorial structure (e.g. the distribution of population density or GDP/inh.) without introducing explicit assumption on the territorial interactions associated to this structure (e.g. flows of people or investments).

- If we consider for example that economic and demographic interactions take place mainly inside the limits of NUTS region, then the representation of the phenomena with classical areal map is correct.
- If we consider that many economic and demographic interactions take place mainly between contiguous NUTS regions, then the maps of discontinuities described above are the best representation.
- If we consider that economic and demographic interactions are simply decreasing according to a continuous function of distance (negative exponential or inverse to power), then the correct cartographic solution is a smoothed map based precisely on a neighbourhood function which is precisely what we describe as the real interactions.

In other words, if we consider for example that people looking for a job are generally limiting their search to a neighbourhood of within one hours from their home, we should produce maps related to labour market which are based on a decreasing function of time distance which is more or less equal to 0 for distance of greater than one hour. If we are interested in economic potential of cities which are developing daily connections, the good neighbourhood functions could be a multimodal distance (air, rail, road) where the interactions depend on the possibility to go and return in the same day. As it is generally not possible to specify the problem so precisely, the maps which have been proposed in ESPON use various span of neighbourhood, based for example on Gaussian function with distance parameters equal to 50, 100, 200, 400 km. Each span of neighbourhood displays a different map of the phenomena, indicating for example that a city with high level of attractiveness at local scale (50-100 km) can be located in a lagging region at medium scale (100-200 km) but also located in an area of average results at global scale (200-400 km); see for example Figure 21 derived from ESPON Project 3.2 (Scenarios).

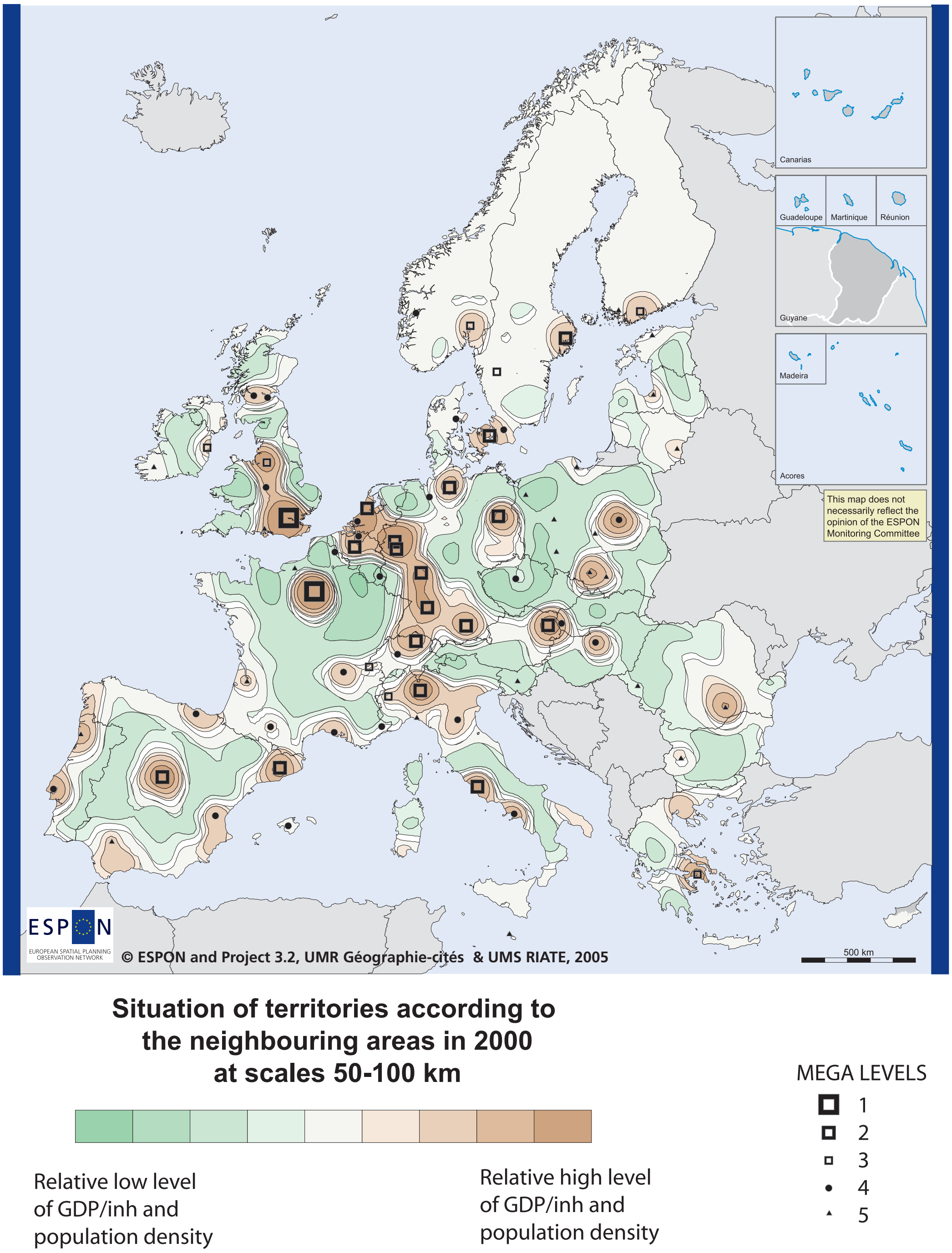
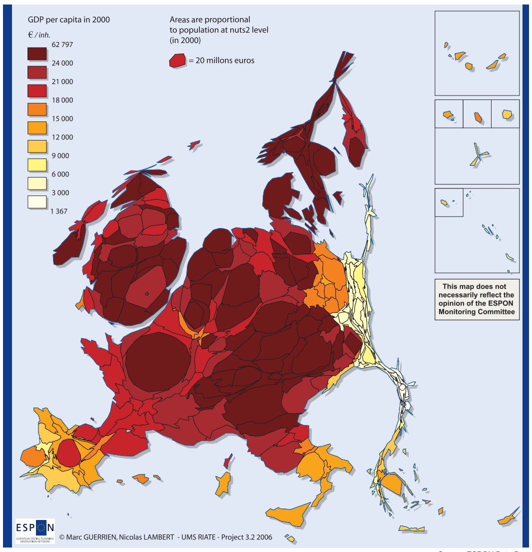


Figure 21 Multiscalar evaluation of economic and demographic polarisation in 2000

Implicit or explicit political messages delivered by maps

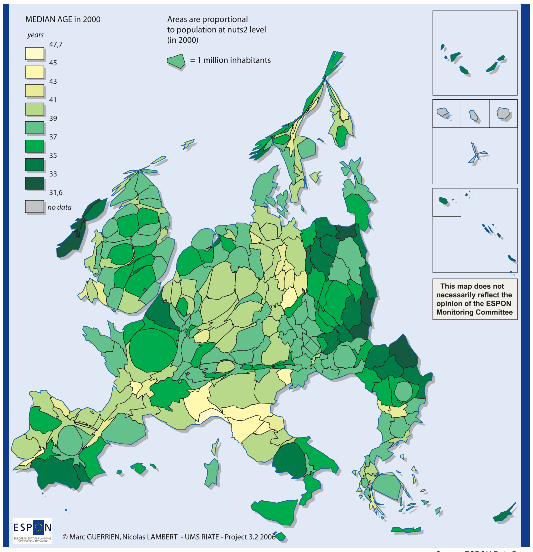
In conclusion, innovative cartography is not a target in itself but a tool for better communication of the results of the applied research on European territorial development in the policy process. Maps provide a major tool and support for decision making and for communication of policy options and they have to be very carefully elaborated as they deliver both implicit and explicit messages. A good illustration of this point is given by map transformations which are generally considered as simple pictures but are in fact the expression of serious political choices.

CARTOGRAM AREA OF GDP
AND GDP/capita IN ESPON 29 AREA IN 2000



Source: ESPON Data Base

CARTOGRAM AREA OF POPULATION
AND POPULATION AGEING IN ESPON 29 AREA IN 2000



Source: ESPON Data Base

Figure 22 Cartogram transformation as expression of implicit political choices

When a certain policy issue is considered as the main challenge for European regions, it is logical to produce a map which shows that the size of the region is proportional to their economic size at international level (measured therefore by GDP in € and not in purchasing power parity (PPS), because PPS are related to internal situation of states). In this framework, the map reveals a shrunk picture for eastern and southern Europe. If we add the GDP/inh (represented in colour), the feeling is reinforced and we can assume that only metropolises of Western Europe are really important in the race for global competitiveness. This may imply that Eastern Europe and rural area are not a cause for concern.

When cohesion is the policy issue, the focus is more on people who live in ESPON space and the choice of a projection made proportional to population is the application of the universal declaration of human rights of 1948. This principle of equality of men and women, young and old is a crucial message. It suggests that the priority is now on social cohesion and that the objectives of the EU are to make progress on equality of rights and opportunities for all citizens all over Europe. The median age (represented by colour) adds to the analysis a major characteristic of population. In the same way that GDP/inh is a measure of the intensity of economic production, median age is a measure of the accumulation of human experience (if high) or measure of human potential (if low).

Finally, it should be mentioned that innovative techniques also need innovative tools, notably innovative software. The ESPON HyperAtlas, presented in chapter 3.4, presents such an innovation.

4.3 Territorial Impact Assessments of EU sector policies

The need to consider territorial effects of sector policies is increasingly acknowledged. Both directly and indirectly EU policies have diverse and often unintended impacts on territorial developments. An effective exploitation of Europe's territorial capital requires deeper insights into the various territorial effects of sector policies as well as on how they structurally reinforce each other.

For the first time a number of EU sector policies have been assessed regarding their territorial impacts by ESPON projects. This pioneering work required first and foremost the development of a conceptual and methodological approach for the assessment of territorial impacts of EU policies.

4.3.1 ESPON's pioneering work

Drawing on experience from territorial impact assessments of projects, as well as on Strategic Environmental Assessment (SEA) and other experience in the field of impact assessments, ESPON projects have developed an approach to territorial impact assessments (TIA) which seemed to be best suited for the respective EU policies which was assessed by that project.
The common denominators for the various approaches were the so called minimum requirements which have been developed in parallel to the ongoing exercise (cf. text box).

TIA minimum requirements

Scoping

(a) What is causing the impacts?
Definition of the policy intervention(s) concerned: registered input dimension,
e.g. EIB grants for rail network element development, R&D support grant, direct income payment for farmers, ERDF expenditures co-financing government aids or public investments
➜ *Min: designation of policy intervention(s) actually recorded (assignable to EU budget lines)*

(b) What is changed by the intervention(s)?
Subject(s) **effected**, basis: hypothesis concerning cause-effect-relations (with, of course, varying empirical proof),
e.g. economic growth caused by improved accessibility, increased innovation capacity by new R&D jobs, lower unemployment by subsidising farms, increasing GDP per capita by ERDF expenditures
➜ *Min: designation of hypothesis concerning cause-effect-relations,*

(c) Which territorial level of observation?
Geographic reference: territories concerned (intervention/effect) territorial level(s) of observation, covering all, or selection (by what criteria),
e.g. NUTS 5, 4, 3, 2 regions, types of regions
➜ *Min: at least NUTS 2 regions*

(d) What has happened, what may happen in future?
Temporal reference (trends, scenarios) of gathered causes and effects,
e.g. the reference to changes, trends and developments actually happened in the recent, years is of crucial importance for the political perception of the results
➜ *Min: reference to past and future periods*

Analysing

(e) What output is registered, measured, appraised?
Topic of calculation,

e.g. relationship development investment amount – accessibility changes, R&D expenditures – employment growth, indirect payments – changes of average farm income, ERDF expenditures – increasing GDP per capita
➜ *Min: designation of the topic of calculation*

(f) What is the topic described, by which indicators?
Type of **indicators** selected,
e.g. statistical variables, survey data, qualitative appraisals
➜ *Min: qualitative appraisals*

(g) Which political goals and orientations are referred to?
Criteria for examination: (objectives, goals, concepts, derived from official documents, in particular the ESDP and the Second Cohesion Report),
e.g. balanced territorial development (supporting concentration of activities or a decentralisation at macro. meso and or micro level), polycentric development, (at macro, meso and/or micro level), connectedness and accessibility (supporting a core-periphery pattern or a more polycentric structure), clearance of overloaded corridors, overcoming socio-economic disparities, improving or hampering natural and cultural assets
➜ *Min: designation of the goals facing (if so: derived from ...)*

(h) How is the analysis performed?
Technique of analysis,
e.g. correlation analysis, simulation model, case studies to test hypotheses, classifying regions
➜ *Min: designation of the technique of analysis*

Concluding

(i) What is defined as "territorial"?
Used **definition** of ´**territorial**´,
e.g. convergence – divergence of regions, reference to cohesion, competitiveness, according to which spatial model, effected type(s) of regions, territorial features
➜ *Min: designation of (assumed) meaning of ´territorial´ (if so: derived from ...)*

(j) What do the results look like?
General **format of outcome**: statements (figures, significant results),
e.g. covering the whole territory (all regions),typology of regions, mapped results (based on quantitative and/or qualitative categories)
➜ *Min: one outcome for each region (whole territory), mapped results*

Certainly it is not possible to reflect each of the single approaches in detail here. However, a rough overview on some approaches can be provided with regard to various aspects as outlined in the minimum requirements. It has to be noted that this overview dates back to early 2004 and thus it might be not reflect the latest developments within the projects.

TIA Minimum requirements	2.1.1 Transport &TEN	2.1.2 R&D	2.1.3 CAP	2.1.4 Energy	2.2.1 Structural Funds	2.2.2 Pre-Accession Aid	2.2.3 Structural Funds in urban areas
Reference to causing policy inter-ventions	no reference to inter-ventions (highly aggregated)	financial actions (RTD Frame, ERDF, ESF)	financial actions (EAGGF)	investments, energy supply & energy relations (in 5 ´blocks´)	EU-funding incl. national co-financing	Phare and pre-accession aid measures	ERDF, ESF, CI Urban (30 inter-ventions)
Hypothesis on cause-effect-relations	several existing complex models	speculations only	- ´direct´ regional income - income multiplier	5 types of energy territorial impacts	economic disparities	Economic and social performance	Positive impacts on urban areas
Regional scale (min. NUTS 2)	NUTS 3	NUTS 2 (NUTS 1 for some)	NUTS 2/3 (estimations)	NUTS 2	NUTS 2/3	NUTS 3 (NUTS 2 for some)	NUTS 3/5 for observation NUTS 2/3/5 for analysis
Reference to past & future inter-ventions	no reference to past hypothesis about future impacts	primarily backwards	only ex-post analysis	review ´way forward´	Meta-evaluation of previous SF interventions	Analysis of past inter-ventions, ex-post analysis	1994-1999 2000-2006
Inter-ventions/ effects registered	accessibility regional welfare	Input and context variables	subsidies farm income	energy - investment - production, - consump-tion, - service in 5 ´domains´	SF at regional level, regional development trends and changing disparities	Economic and social performance	structure of interventions
Quanti-tative/ qualitative appraisal	Quantitative Scenario analysis	mainly quantitative	mainly quantitative	mainly quantitative	mainly quantitative	Quantitative and qualitative analysis; test of working hypothesis	mainly quantitative
Concepts/ goals referred to	cohesion efficiency v. equity	balanced development polycentric development competi-tiveness	cohesion environ-mental protection	Three ESDP guidelines	territorial cohesion, polycentric develop-ment; balanced develop-ment,	Balanced territorial competition and equity of economic and social cohesion	missing
Technique of analysis	simulation models classification of regions case studies	aggregate statistical analysis case studies	aggregate statistical analysis case studies	Input-Output model; aggregate statistical analysis case studies	comparing maps of regional distribution case studies	Cluster analysis, gini-coefficient, regression analysis	aggregate statistical analysis of 25 urban areas case studies
Applied under-standing of ´territorial´	regional disparities	´Islands of R&D´ (regions)	regional disparities	regional disparities	cross-sectoral approach to space	regional disparities	declining industrial urban areas
Territorial reference of outcome	several typologies of regions	typology of regions	typologies of regions	typologies of regions	typologies of regions	Typologies of all regions	typologies of regions

Source: ESPON Project 3.1/Tools, 2004, 435-436

Figure 23 Overview on Territorial Impact Assessments in ESPON projects

In addition to the differences appearing in this general overview, it should also be noted that some of the projects focused on ex-post territorial impacts, whereas others looked mainly on ex-ante territorial impacts.

Generally, the nature of an ex-post evaluation is different from the ex-ante one, in the sense that costly empirical inquiries are needed beyond analytical, econometric exercises. Regional data on environmental, cultural, socio-psychological elements, on the settlement structure and land uses, are not easily available with the appropriate frequency (and the evaluation cannot just rely on "proxies", like the ex-ante one). Secondly, these variables, structural in nature, change very slowly and are affected simultaneously by trends, processes and causes that may be very far from, and more powerful than, the EU policies under scrutiny. Ex-ante assessments on the other hand are more likely to work on a ceteris paribus assumption. Thirdly, ex-post evaluation cannot escape the time dimension. Policies have to be fully developed and assigned sufficient time to generate all their direct and indirect effects. This could imply a time span long enough to make the inquired cause-effect relationship too weak, relative to the parallel changes in the general context.

As a consequence, ex-post assessments should be selective instead of generalised, both in terms of indicators and in terms of target regions; rely on a small set of specific indicators that should be collected yearly; search for unintended negative outcomes of policies in different fields of the society and the territorial realm, rather than for the intensity of the expected outcomes; be more oriented towards the identification of critical territorial trends that require policy innovations and re-orientations than towards the precise identification of cause-effect relations.

4.3.2 Towards a territorial impacts assessment model

Based on the experience made within ESPON, a new operational model for Territorial Impact Assessment was built inside the ESPON programme. This model which might stimulate the discussion on future territorial impact assessments has following characteristics:

a) The three main dimensions of territorial cohesion are the basic elements on which the assessment methodology is built: Territorial Efficiency Quality Identity Layered Assessment Model – TEQUILA;

b) TEQUILA is a Multi-criteria Model: given the multiplicity of the "dimensions" of territory, this well-known assessment approach seems the most appropriate. The three dimensions of the territorial cohesion concept and their sub-components become the criteria in the assessment model, namely:

   Territorial efficiency:
   - Efficient and polycentric urban system; inter-regional integration
   - Resource efficiency: consumption of energy, land, water….
   - General accessibility, infrastructure endowment
   - Competitiveness of production system; attractiveness for external firms
   - Sustainable transport: share of public transport and absence of congestion
   - Development of city-networks; compact city form, reduction of sprawl
   - Reduction of technological and environmental risk

Territorial quality:

- Reduction of interregional income disparities; employment performance
- Conservation and creative management of natural resources
- Access to services of general interest
- Quality of life and working conditions
- Quality of transport and communication services, safety, emissions
- Reduction of poverty and exclusion; multiethnic solidarity and integration

Territorial identity:

- Conservation and creative management of cultural heritage
- Quality of urban and rural landscapes
- Cooperation between city and countryside
- Development of region-specific know-how and knowledge
- Accessibility to global knowledge and “blending” with local knowledge
- Development of territorial “vocations” and “visions”
- Development of social capital; shared behavioural norms

Of course, the list of criteria should be carefully inspected in order to ensure completeness and independence and avoid double counting. They can obviously also change if policy objectives change.

c) The weights of the three dimensions and sub-criteria are defined in a multiple, transparent and flexible manner through internal expert discussion, or Delphi enquiries;
d) The impact of EU policies on each dimension/criterion and sub-criterion is defined using ad hoc studies and/or expert judgements, quantitative analyses or qualitative assessments: the model accommodates all alternatives in a consistent way;
e) The model provides a General Assessment of the potential impact (PIM) of EU policies on the overall European territory (1st layer) as a simple weighted average of PIMs on the single dimensions;
f) The preceding “general” assessment must be made truly “territorial” by considering the specificities of the single European regions, given that:
    - the same potential impact may have different effects according to regional specificities,
    - the intensity of the policy application may be different in different regions,
    - the relevance of the different “criteria” of the assessment method is likely to be different for different regions (e.g.: the same increase in income has a different significance according to the development level already achieved by individual regions)
    - a region may not be subject to a specific policy
g) Therefore, the model supplies a Territorial Impact Model (TIM) assessing the impact of the policy considered on single regions (2nd layer) (see text box). The potential impact on each region and criterion (given by specific studies or calculated according to “policy intensity” in each region) is multiplied by two terms expressing the specificity of the single regions and their sensitivity to a specific impact: a vulnerability term, determined mainly by geographical conditions, and a desirability term, expressed by a socio-economic utility function. Given the present data availability, TIM can be applied at the NUTS 3 level and the results can be easily mapped.

TEQUILA-SIP: a first implementation of TEQUILA

The methodology presented above was utilised to build a prototype, operational model, designed in order to be simple, user-friendly and interactive - TEQUILA SIP: Interactive Simulation Package - and subsequently applied to the definition of the territorial impact of TENs policies.

The SIP package defines in a transparent and flexible way the transformation/ normalisation procedure of all indicators employed and the form of the utility functions and vulnerability functions. All these elements, together with the weights of the single criteria, may be changed interactively and the results are automatically re-computed. SIP automatically presents a chart for each indicator (and the 1328 NUTS 3 regions of the ESPON space), for each summative TIM (on efficiency, quality and identity) and for the general territorial impact (aggregated for the EU and for each region).

The Territorial Impact Model

$TIM_r = \Sigma_c\ \theta_c \cdot S_{r,c} \cdot (PIM_c \cdot PI_r) \cdot PA_r$

TIM = territorial impact (for each dimension: efficiency, quality, identity)

c = criterion of the multi-criteria method

r = region

θ_c = weight of the c criterion	$0 \le \theta_c \le 1$; $\Sigma_c\ \theta_c = 1$
$S_{r,c}$ = sensitivity of region r to criterion c	$0 \le S_{r,c} \le 1$
PIM = potential impact of policy (abstract)	$-5 \le PIM_c \le +5$ (in qualit. analyses)

PI = policy intensity (in region r)

PA = policy applicability (a 0/1 variable)

The rationale for the previous equation is the following: as in risk assessment, where risk = hazard (potential risk) x vulnerability, here the territorial impact is the product of a potential impact (PIM) times a sensitivity indicator (S). In its turn, $S_{r,c}$ is a set (vector) of regional characteristics defining two main elements: vulnerability/receptivity to impact (mainly geographic indicators) and desirability of the dimension/criterion (technically a utility function, mainly socio-economic indicators) for region r:

$S_{r,c} = V_{r,c} \cdot D_{r,c}$

The final proposal is presented in the Final Report of the ESPON Project 3.2/ Scenarios (2006).

4.4 Exploring the European territory through regional econometric models

Econometrics have been employed in a number of ESPON projects often to a minor degree but in some projects also more extensive use of regional econometrics have been made. As mentioned in chapter 2.3, models can be a useful tool in territorial research, notably when it is future-oriented.

This chapter will present the MAcroeconomic, Sectoral, Social and Territorial (MASST) model in further detail as an example of regional econometrics used for applied territorial research in ESPON.

Just as the K10 model presented in the next chapter, the MAcroeconomic, Sectoral, Social and Territorial (MASST) model was created in order to quantify and territorialise the scenario foresights developed within the ESPON Project 3.2. MASST is a macroeconomic forecasting model consistent with the general ESPON philosophy that considers the efficiency and quality of territorial assets and socio-economic relationships to be the driving forces behind regional competitiveness and performance. Factors like accessibility, infrastructure endowment, local innovative capacity, local urban structure and geographical position are intrinsic to the logic of the model, and have been identified as crucial variables in the economic explanation of regional success in Europe. These local factors are complemented by macroeconomic, national ones which also play an important role in the model's logic for the interpretation of regional performance.

The model is therefore a predictive model for regional growth and forecasts territorial scenarios based on different assumptions concerning: a) national macroeconomic tendencies and policies (e.g. interest rates, exchange rates, inflation rate, public expenditures, geographical reorientation and size of FDI, trend in public debts, revision of the Maastricht parameters, increase in energy price, attitude towards East-West and North-South migration, trend in fertility rate and in population aging, trend in saving ratio); b) new institutional arrangements (widening vs. deepening of the European Union); c) European policies (e.g. geographical orientation and amount of structural funds and community agricultural policy; transport infrastructure priority choices; flexible vs. rigid application of the Lisbon agenda and of Maastricht parameters).

The MASST model is capable of forecasting medium to long term trends in real regional GDP growth and convergence trends, as well as in demographic variables (population growth and migration flows) at NUTS 2 level, under alternative assumptions on macroeconomic tendencies and policy options. When these qualitative assumptions are "translated" into quantitative terms and inserted into the MASST model, the latter enables the magnitude of the likely effects to be identified. The results should be interpreted as the tendencies and relative behavioural paths of regional GDP and population growth that will take place under certain conditions.

The MASST model reflects the modern conceptualization of regional growth. The model specification, in fact, defines regional growth as a competitive, bottom-up, endogenous and cumulative process. The endowment of local material resources, such as labour and infrastructures, and of non-material resources such as the quality of human capital and the presence of value added functions, are all factors that- in the MASST model- can explain the capacity of a region to grow at a rate above the national average. Regional competitiveness is therefore closely linked with the presence of endogenous resources and with the region's ability to exploit its potentialities.

In MASST, local factors matter. However, the model considers a second family of development factors, these being macroeconomic and national. It is well known that all regions belonging to a nation state are deeply affected by the national performance, a fact justified in economic terms by the relevance of: a) wholly macroeconomic elements, namely interest rates, exchange rates, inflation rate, public expenditure; b) institutional and generalised structural factors like the efficiency of the public administration, general education level of the population, the characteristics of the labour market relations. The bottom-up, "generative" nature of regional performance is therefore fully acknowledged, and it is incorporated into the internal logic of the model in a manner that seems extremely innovative within the existing literature.

The close interdependence between regional and national growth is an important feature of the model, since it allows forecasts to be made of, i) feedbacks from both spontaneous national or regional economic trends and policies on regional growth and on income redistribution among regions; and, ii) simultaneously, with pure bottom-up logic, of the effects of regional dynamics and policies on national growth.

Moreover, MASST does not confine its explanation of regional growth to economic material resources alone. This is because two elements of a different nature play an important role in determining regional growth in the model: social and territorial. In MASST, regional growth is in fact also conceived as a social and a territorial process: both demographic tendencies (population growth and migration flows) and increasing returns in the form of agglomeration economies and territorial growth spillovers perform an important role in the explanation of regional growth differentiations.

MASST is an innovative regional forecasting model capable of strengthening territorial scenario forecasts from various perspectives. Firstly, its strong interdependence between the regional and national levels of analysis allows emphasis to be given to both local and national trends as well as policies on regional (and national) growth. From this perspective, MASST is a multi-layer ex-ante impact assessment econometric model. Indeed, the model allows measurement of the impact of national (and supranational) trends and policy options on both regional and national growth, as well as the impact of regional dynamics and policies on national and regional growth, doing so in a way unprecedented in the literature.

Secondly, MASST gives territorial and social elements a role in explanation of regional growth. The MASST model comprises cumulative and self-reinforcing growth processes rooted in well known territorial increasing returns and in proximity advantages; in modern terms, in dynamic agglomeration economies and territorial spillovers.

Thirdly, MASST can be integrated with another ESPON model, the KTEN model. The latter yields the values of future accessibility at NUTS2 level under different assumptions on European transport policy choices in TEN and TINA projects. These values are an input to the MASST model, which in turn forecasts regional per-capita GDP levels and GDP growth; the MASST outcome becomes an input to the KTEN model, which, on the basis of these values, forecasts future traffic flows at NUTS 2 level.

MASST has been successfully applied to the three qualitative scenarios developed within the ESPON 3.2 project (Scenarios): a baseline, a competitive, and a cohesion scenario. Qualitative assumptions characterising the three scenarios were translated into quantitative values and inserted into the MASST model. GDP growth rates and per capita GDP levels at 2015 for each NUTS 2 of 27 countries were obtained; forecasts for Switzerland and Norway – which were added at the end of the project because of the lack and inconsistency of some data – were based on a simplified, extrapolative/comparative sub-model with the same logic as MASST, but not reflecting the comprehensive interregional interaction logic of the model as a whole.

The competitive scenario – which assumed a liberal economy based on: private sector more than public sector resources, a flexible labour market, and an intensification of financial investments in strong and rich areas and of value added functions – foresaw concentrated growth in the strongest areas of the countries together with an unexpected decrease in total regional disparities. This latter counter-intuitive result is explained by the fact that the increase in intra-national disparities was counterbalanced by a steep decrease in disparities among countries.

In the cohesion scenario – which was based on assumptions opposite to those of the competitive scenario (i.e. a more diffused territorial distribution of resources) – the most surprising result was the limited effect on the catching-up process of Eastern countries with respect to the baseline scenario, the latter being based on the assumptions that current socio-economic tendencies will last for the next decade and a half, and that no strong external shocks as well as no drastic changes in macroeconomic and structural policies will occur to generate changes in the present situation. As figure 24 shows, only a few regions register a GDP growth rate in 2015 greater than in the baseline scenario, and this is especially the case in the weakest and lowest level income regions.

MASST has also been applied within the ESPON Project 3.4.2 (Economy), in order to analyse the territorial effects of national macroeconomic policies and changes in macroeconomic contexts. Simulations were run in order to determine the regional effects of one single external shock at a time deriving alternatively from individual macroeconomic policies (fiscal policies, interest rates policies), direct and indirect macroeconomic decisions linked to macroeconomic trends (exchange rates movements), effects of combined supply side policies / fiscal policies / macroeconomic trends (cost competitiveness variations), macroeconomic trends, allowed by macroeconomic policies (inflation).

MASST is a useful instrument for ex-ante policy assessment and territorial forecasts. However, in the future its potentials can increase in several respects. Firstly, as more and better data becomes available at regional level, the model will be made more robust. Secondly, the model can be enlarged to include the role of the sectoral component on regional growth. This will allow regional forecasts to be differentiated also on the basis of the productive structures of the regions. Secondly, MASST can incorporate a more direct linkage between single macroeconomic factors and policies and their regional impact. Thirdly, the model can be made more sensitive to the effects of specific orientations of structural policies (e.g. orientation of cities towards SMEs, towards R&D and innovation) and trade policies. Fourthly, the macroeconomic part of the model can be improved by reinforcing its internal logic. Lastly, if sufficient data are available, the model can be estimated and run at NUTS3 level.

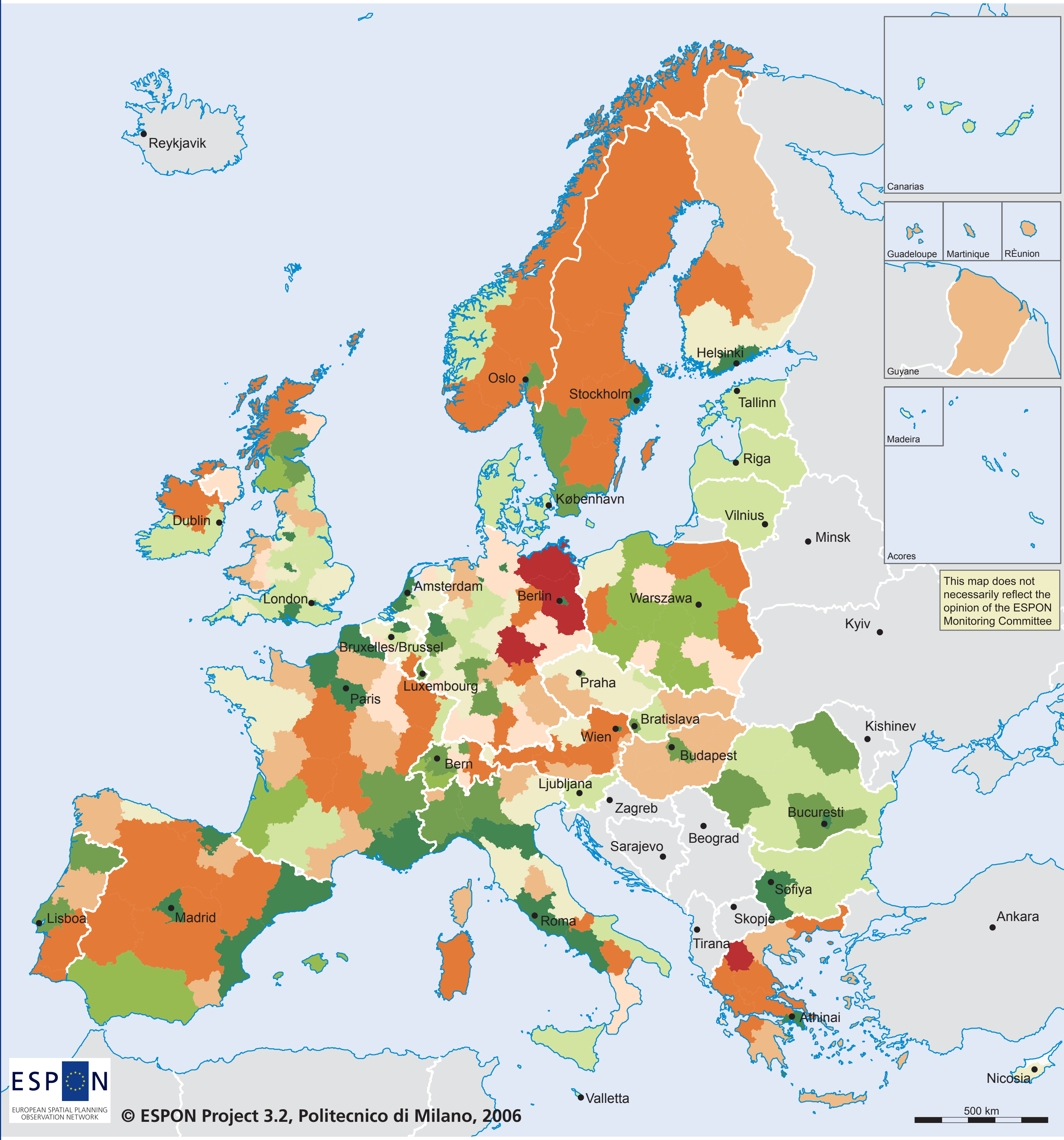
4.5 Strategic forecasting, examples in the field of transportation

Strategic forecasting has been discussed with great interest within the ESPON community and a number of projects have made efforts to integrate strategic forecasting in their work. This has been particularly visible in the field of transportation, where both forecasts on transport developments and territorial impacts of transport policies involve aspects of forecasting.

This chapter provides a brief introduction into one of the models used, the K10 model. Parallel to the MASST model presented in the previous chapter, the K10 model was developed within the ESPON Project 3.2 (Scenarios) for transport forecast, territorial development and environmental impact analysis with a 2030 time horizon and a pan-European geographic scope.

The K10 is the further development of the KTEN model, constructed to compute advanced accessibility indicators and developed for the Union's Territorial Strategies

Figure 24 Real GDP growth rate in 2015: difference between cohesive and baseline scenario



Real GDP growth rate 2015 - difference between cohesive and baseline scenario

- less than -0.31
- -0.31 to below -0.2
- -0.2 to below -0.12
- -0.12 to below 0
- 0 to below 0.08
- 0.08 to below 0.16
- 0.16 to below 0.24
- 0.24 to below 0.37
- 0.37 and more
- no data

© EuroGeographics Association for administrative boundaries

Regional level: NUTS 2
Origin of data: ESPON Project 3.2, Politecnico di Milano, MASST Model

Source: ESPON database

linked to Trans-European Transport Networks study, for EC/DGTREN in 1997. The KTEN passenger traffic forecast module was developed to facilitate the strategic analysis of the trans-European Transport Networks on a wider pan-European and Mediterranean scale in the framework of ASSEMBLING 4th European Research Framework project (2001). KTEN was already applied in ESPON Project 1.2.1 (Transport trends) but in the frame of the ESPON Project 3.2 (Scenarios) (2004-2006) it was further developed by redefining the passenger module of KTEN and developing a new freight forecast module.

KTEN is a sequential 4-steps model with combined modal split and assignment on multimodal networks KTEN. It uses STREAMS model results, WTO and EUROSTAT Air Traffic OD databases as benchmark and/or reference for result validation. Given the positive results of KTEN applied to passenger transport, the model was extended to cover freight and logistics, based on the results and methods of already existing freight models, such as STREAMS and SCENES and others under development for DGTREN, such as DESTIN. Results of K10 have been analysed against the results provided by ASSESS for the revision of the White Book on Transportation (June 2006).

The goal of KTEN's further development and application within ESPON Project 3.2 (Scenarios) is to provide an interactive meta-model framework to include most of the strategic aspects that are missing in more specialised transport forecast models. The objective of improving the KT10 has been twofold: firstly, to extend the meta-model to cover freight, and secondly, to enrich the scenario building capabilities to cover significant variables which include an explicit territorial dimension, consistent with other ESPON Project 3.2 (Scenarios) developments. It is important to note that the K10 model does not take into account intra-regional traffic even though this is often the source of congestion, especially in densely populated areas. Current models and databases do not offer a sufficient resolution for evaluating such traffic.

K10, as most transport forecast models, uses demographic projections (based on population growth) for the generation of passenger trips and economic projections at regional level (based on GDP growth) for the generation of freight movements, as well as changes in transport costs due to, for instance, more expensive oil price, and network changes due to completed TEN projects already in progress. Additional network changes that are not related to TEN could also be part of the reference scenario if the data is available.

K10 is divided into five different modules. The infrastructure definition module allows defining which infrastructure will be constructed in each scenario. The choice of the TEN infrastructures to be built is somewhat arbitrary in most transport modelling exercises. In principle, all TEN projects should be expected to be completed by the year 2020, but given the slow evolution of infrastructure investments, additional hypotheses are needed to define which links will be built. K10 formulates investments programmes consistent with the rational of each scenario. To do so, K10 has a module that estimates the potential marginal increase in traffic per road and rail links in relation to the cost of infrastructure. This determines the inclusion or exclusion of the project in the investment programme depending on the investment threshold adopted for each scenario, thus defining objective investments programmes consistent with alternative European territorial development policies.

The passenger forecast module generates the matrices of passenger trips between NUTS 2 regions. This module needs inputs to produce a forecast matrix consistent with the defined scenarios. It also incorporates the costs matrices calculated in the infrastructure definition module to define the modal split. The model allows selecting the desired horizon year for the simulation. This directly affects the values of GDP and population used.

The freight forecast module generates the matrices of freight flows between NUTS 2 regions. It also needs some inputs to produce a forecast matrix consistent with the defined scenarios. Its also incorporates the cost matrices calculated in the infrastructure definition module to define the modal split.

The assigning module allows assigning the calculated matrices to the infrastructure networks. Here there are no parameters to change, provided that the infrastructure network itself has a set of velocity values depending on the type of link. The results of this module are the flows of freight and passengers in each of the network links.

The previously obtained flows are then used in the territorial and environmental indicators module to calculate different indicators to assess: i) territorial impact by means of changes in accessibility, infrastructure endowment, connectivity; accessibility changes in term of travel costs, population at less than 3 hours and GDP at less than 3h; ii) economic efficiency impacts by means of variation on traffic in each link against project costs, using a proxy of standard traffic intensity threshold, iii) environmental impacts by means of emissions using standard emission ratios for all pollutants and hypothesis concerning the evolution of transport technology; accidents based on standards per intensity of traffic and type of link; land use changes crossing new infrastructure links with CORINE land-use coverage.

The K10 and MASST (presented in the previous chapter) models are interlinked. K10 takes as input demographic and macroeconomic forecasts provided by MASST model at regional level and provides as its main outputs the interregional flows for passenger and freight, traffic in transport multimodal networks, accessibility changes, energy consumption and transport-related emission. An important number of feedbacks between MASST and K10 were carried out, since demographic and economic changes affect transport demands and infrastructure investments. However, it is also true that infrastructure investments change the relative endowment existing in each region in relation to others, modifying also its economic development opportunities.

In conclusion, K10 is a "state-of-the-art" transport forecast model with less market segmentation in the transport market than other strategic European models and with more territorial and strategic orientation.

From the cartographic point of view, the basic pan-European multimodal transport networks used to support the KTEN model have come from ASSEMBLING research (4th EU Framework Programme, DGTREN). Other complementary graphic layers (mountains, rivers, administrative levels, etc) were produced by the model authors in previous works. While the inclusion on other databases (e.g. administrative limits at NUTS 5 level, Natura 2000, etc.) can be of interest, the existing databases mostly cover the current needs of K10. The graphs cover the EU and eastern European countries including Russia, as well as North of Africa and Middle East. It contains trans-European links (roads, rail, ports, airports, inland waterways). The transport network contains all existing and planned high speed, upgraded, conventional and main rail lines, and existing and planned motorways, expressways, main and regional roads, local roads, streets, and roads connecting ports and airports to the rest of the networks (61,000 rapid links and 30,000 rail links). The rail and road network database contains information on high speed trains, TEN and TINA programmes.

Apart from road and rail transport links, the cartography contains 749 airports separated in different level of passengers per year and 37 airlines. Concerning ports, it contains 842 seaports and 1012 port lines, 30 river ports and 158 inland lines. Finally, 1,308 projects have been geo-referenced, 424 of which (mostly related to transport projects), have been introduced with cartographic precision and graph structure (e.g. for road projects all sections are included and linked to the existing road networks). Finally the geographical scale of core networks is approximately 1:500,000, with more detail in cities and around transport terminals.

4.6 Thinking the future: scenario building techniques

In addition to forecasting techniques, in a number of projects scenario techniques have also been employed in order to better describe future perspectives of territorial development.

This section presents some of the efforts and progress made concerning the scenario building techniques. The section focuses on ESPON project 3.2 whose main focus was developing territorial scenarios. Other ESPON projects also present large numbers of "scenarios" but these should be considered as alternative inputs for or outcomes of model calculations and not as narrative descriptions of possible futures that focus on causal processes and decision points.

Why do we need scenarios? Scenarios can facilitate territorial policy-making in different ways. They provide insights into the most important trends and driving forces determining the territorial development of the EU. They also provide insights into the structural difficulties and potentialities these trends and driving forces may generate at the European and other levels. By presenting some alternative visions about the future they may be helpful to policy makers to prepare themselves for the inevitable uncertainties related to future territorial developments.

Besides, scenarios explore some alternative policies at the EU and other administrative levels with their expected territorial impacts. Despite the sectoral character of EU policies they generate important territorial impacts. The scenarios provide further insights into the (dis)advantages of these policies from a territorial viewpoint. By doing this they may be helpful to enhance synergies and co-ordinated decisions relevant for the territorial development and the cohesion of the enlarging EU.

Moreover, scenarios provide some points of reference for policy discussions. This is important since they operate not only at different administrative levels but also in different Member States with different practices and institutions regarding territorial policy-making. Because of that policy makers think and speak in very different ways. In this respect it is important that scenarios embody different but comparable images of the future. Policy makers may refer to these images in order to discuss their expectations and their desires related to the territorial development of the EU.

Furthermore, the scenarios may provide policy makers with arguments to gain support from the sectoral policies for their preferred territorial policy. This is particularly true in the case of territorial policy where the EU has no formal competency and lacks adequate policy instruments. Hence, scenarios will facilitate the informal ministerial meetings (as well as other meetings) and the complex negotiation processes that take place between these meetings.

Keeping in mind that ESPON project 3.2 is the first scenario project exploring territorial developments throughout Europe, important achievements have been made. Nine sets of thematic scenarios and one set of integrated scenarios have been developed. Thematic scenarios explore possible future developments related to demography, socio-cultural issues, transport, energy, economy, rural development, climate change, enlargement and governance. The integrated scenarios consist of three scenarios exploring possible territorial developments in Europe until 2030 (a baseline scenario, a cohesion oriented scenario, a competition oriented scenario) and one scenario proactively exploring desirable territorial developments. They explore the nine themes in an interrelated way.

The scenarios provide various insights into the territorial developments from the European to the regional level together with their driving forces. They also provide insights into alternative EU policies with their mutual relations and their territorial impacts in relation to important EU objectives such as improved competitiveness and territorial cohesion. The integrated scenarios are closely related to the models dominating the discussions about Europe: the "social model" and the "liberalisation model" and hence are central to the high level political debates in Europe. By exploring alternative policies together with their desired and undesired impacts, these scenarios aim at provoking further discussions.

A combination of qualitative techniques (literature review, creative thinking, workshops) and quantitative techniques (data bases, model calculations) have been used in the development of the scenarios. The thematic scenarios are mainly of qualitative nature. The integrated scenarios have been made with the aid of MASST, KTEN model and the ISDD (Indicator for Sustainable Demographic Development) on the basis of the ESPON database. The main steps of the scenario approach are:

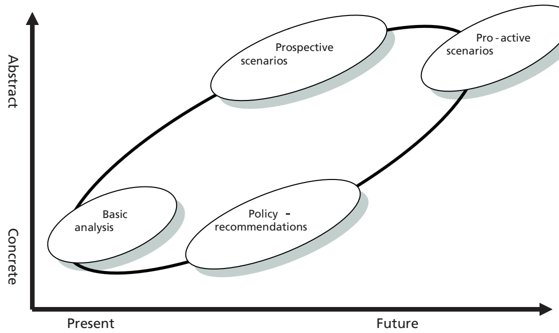
- Making thematic scenario bases: collecting and integrating for each theme a wide range of information sources in order to understand the past and present trends and driving forces in order to be able to explore the future development of the theme in a realistic way.
- Building thematic scenarios: elaborating for each theme two or more alternative policy scenarios taking into account the wider context of the policy, the policy itself, its territorial impacts, and the final image of the EU.
- Combining them into integrated scenarios: using the thematic scenario bases to develop an integrated scenario base and using the thematic scenarios to feed into integrated scenarios, taking the mutual relations between the themes into account.
- Testing the integrated scenarios: using some different 'wild cards' (low-probability-high-impact-events, like a breakthrough of the hydrogen economy) to test the stability of the integrated scenarios and to introduce surprises.

An approach for the validation and communication of the scenarios has been developed, targeting different groups and using various techniques. The Monitoring

Committee, being the main stakeholder, provided an important and on-going guide in the actual development of the scenarios. During the meetings, the ESPON Monitoring Committee members also provided important expertise on territorial developments throughout Europe. The ESPON community has been involved by utilizing several ESPON seminars. The interactive workshop appeared to be the most stimulating and productive technique for discussing the scenarios. A panel of experts was established to validate and comment on the scenarios. While the panel was over-represented by Western Europe, this was compensated by the fact that most of them were 'transnational' in their expertise. Other policy makers and scientists have also been consulted during the national and regional presentations and workshops. The Knowledge and Communication tool (K&C) website provides a knowledge-base and communication tools that may be useful for them.

Notwithstanding these achievements further improvements could be made. Firstly, more attention could be paid to the qualities of the scenarios. A greater contrast between the scenarios would provide more surprising insights, such as in more deviating trends, driving forces and EU policies with their territorial impacts. This would stimulate policy processes to "learn more from the future". The presentation of an undesirable scenario first and the desirable scenarios after that could be helpful to mobilise support. The 'limits to growth' published by Meadows et all in 1972 was very useful in this way. A sharper focus, particularly of the integrated scenarios, would make them easier to understand and would enhance their explanation power. The scenario logic would be clearer and the user is less likely to get "drowned in information". Scenarios should therefore explore in more depth a limited number of themes (e.g. four or five most important themes related to territorial development) and trends and driving forces (e.g. six or seven). The explanation power could be further improved by making a distinction between the territorial impacts generated by the trends and driving forces and those generated by EU policies.

Secondly, the scenario approach could be made more cyclical as was the initial idea behind the scenario project. A scenario cycle consists of the following building blocks: making a scenario base (comparable to the integrated scenario base described above), building prospective scenarios (exploring the most important trends and driving forces with their territorial impacts), designing pro-active scenarios (exploring various desirable future states of the EU territory with the EU policies required to realise them), deriving policy recommendations (providing input for a strategic vision on the near future). Figure 25 gives an overview.



Source: ESPON Project 3.2/Scenarios, First Interim Report, 2004, 107

Figure 25 Building blocks of the scenario cycle

By going through the cycle several times the scenarios are developed in a gradual and systematic way. The first cycle consists of a series of scenario workshops in which a great variety of policy makers and scientists participate. In the second cycle essays about the scenarios are written and maps are made using a great amount of existing literature and maps. In the third cycle variables and relations are derived from the essays and maps. This happens with the aid of techniques like group model building. In the fourth cycle relevant data are gathered and model calculations are made. The first cycle is most qualitative and creative in character, ensuring a holistic appraisal of the scenarios, including issues which are not quantifiable. The last cycle is most quantitative and scientific in character, ensuring the consistency of the scenarios and an in depth analyses of them.

The most important advantages of the cyclical approach are that this approach makes it easier to: a) develop a consistent set of integrated scenarios and to work them out for some themes of strategic importance, b) integrate the qualitative and quantitative techniques in a systematic way, c) make a clearer distinction between territorial impacts generated by trends and driving forces and those generated by EU policies, and d) develop a set of inspiring and contrasting scenarios that are at the same time realistic.

Thirdly, it is important to further develop quantitative information and modelling on the social issues. Quantification of scenarios on dimensions which are complementary to competitiveness and accessibility requires that serious data limitations will be overcome. Measuring the social and environmental dimension of territorial cohesion for the whole ESPON area is a particular challenge ahead.

Finally, the validation and communication approach could be further developed. The Monitoring Committee as the key stakeholders provided an important guide in the development of the scenarios and provided important expertise on territorial developments. But the other side of the coin is that the scenarios became the victim of "institutional feasibility". Influenced by the Monitoring Committee, the scenarios are so closely related to the existing policy paradigms that they can hardly surprise policy makers. Notwithstanding the importance of high scientific standards the quality of the scenarios could be improved by allowing more creativity and "out of the box thinking". Regarding the ESPON seminars workshops aiming at the generation of creative ideas and workshops aiming at the validation of the results could be alternated. The external experts could be involved in a more systematic way by applying the Delphi technique. Validation and communication should not be underestimated since participants learn more from the scenario-building process than from the scenarios themselves.

4.6.1 Scenario visualisation

Some maps, images and eyes-catching illustrations have become political icons in Europe, such as the satellite image of the light from cities produced by NASA, the map of road traffic, first produced by CEDRE, now by United Nations, or the famous Blue Banana. These and other images and illustrations have served as powerful tools for shaping attitudes, changing opinions and mobilizing supports. Maps make both future opportunities and established conflicts more explicit. So, it is not surprising that the Spatial Development Committee nearly 10 years ago failed to agree on which maps to include in the European Spatial Development Perspective (ESDP) document, as did the European Parliament with regard to writing a short text of European history, just a few pages to add to all national histories.

ESPON researchers faced a similar challenge; i.e. having difficulties to reach a consensus for a common vision for the future of Europe. The processes of map making and history writing always run in parallel to other important discussions such as the future allocation of Structural Funds. It is therefore understandable that policy-analysts and policy-makers have become attentive (and acquainted) to European maps, images and eye-catching illustrations.

The map-making technique

It is significant that the ESDP's final document contained no map of Europe but small vignettes that illustrates policy aims in abstract terms, with no geographic reference. In this way, it became clear to readers that the Member States were the only responsible authorities for the ESDP application in their own territories. Even if this outcome is understandable from a political point of view, the European territory is more than just the juxtaposition of national territories, because social, economic or environmental dynamics are not restricted to the national borders and because many places in Europe need cross border cooperation to solve common problems or to take advantage of existing opportunities. When analysing these territorial development issues, maps are of course indispensable tools, independently of the political readings they may have.

Based on the experience of the ESDP, when the SPESP was launched, a research group was created to explore alternative methods to produce maps that could visualise ESDP in a scientifically sound and politically relevant way. The paramount goal was to provide policy-analysts' and policy-makers' alternative ways of visualising policy aims and territorial problems and opportunities. The idea was to open up the scope of possibilities of maps to go beyond being a mere tool for highlighting political conflicts and more of a mechanism for exploring dynamic trends and policy impacts.

The works of this group, integrated by representatives from most countries and professional backgrounds, was open to many alternative approaches ranging from filtering and manipulating thematic maps produced by GIS software tools (in order to remove geographical precision and gain more political relevance) to inventing arbitrary symbolic languages somehow based on the tradition of spatial planning and European-policy studies, and also to illustrate policy aims.

In fact, all approaches involved an implicit process of translating "scientific languages" (in this case cartographic conventions) into "policy-oriented languages". Scientific languages have clear advantages providing objective visualisation of territorial problems and opportunities, as well as mapping future trends (the "real context" for policies); on the other hand, more symbolic languages easily represent abstract policy aims and somehow shape desired futures.

Overall, it became clear that any method of representation involves a combination of scientific, artistic and political languages. While scientists generate more and more rational questions, artists provide intuitive answers to rather unknown questions and politicians take decisions based on a number of scientific, political and moral factors.

It is important to be aware of whom we are communicating with, taking what role, and using which kind of language. The merit of smart images is to focus on meaningful questions and highlight relevant juxtaposition. The goal is not to produce perfect maps, but maps that are scientifically reliable and politically relevant and clarify issues that are difficult to express in text. For example, within the ESPON Project 3.2 (Scenarios) different type of languages have been used to express and visualise alternative visions for Europe in 2015-2030. These include: narrative, tables and matrices presenting projections and forecasts of for example regional migration and CO^2 emissions per square kilometre, raster or thematic maps, interactive multimedia animations, hand-made sketches, policy-oriented texts, and policy-oriented maps. The project has been exploratory in this sense.

Thematic maps

In the framework of the ESPON Project 3.2 (Scenarios), in order to map a single variable, such as CO^2 emissions from transports, at least nine different maps were needed in order to represent the three time horizons (2000, 2015, 2030) and at the three scenarios (baseline, competitive and cohesion, as described above in the MASST model). Considering the variable in relative terms (its growth in relation to the previous time horizon, or in relation to other scenarios), and its ratio in relation to other variables (e.g. road traffic growth, or GDP growth), the number of maps needed will run into hundreds, just to analyse one single variable evolution, and using the same geographic reference. When data needs to be displayed at different geographic levels (like CO^2 that can be represented from raster cells of 1 km square to NUTS V, NUTS III or NUTS II), then the amount of interesting maps become enormous, not to speak about combining different thematic maps. Software tools capable of computing such a huge volume of maps are not the complete solution since still their analysis requires reading and comparison. There is no other solution than starting from formulating an hypothesis, and then analysing a minimum set of maps that contains maximum information, checking if they validate our hypothesis or not, and establishing a critical reading of the map leading to change its design, the mathematic model producing the data mapped, or reformulating our hypothesis. In this respect, final maps have to reflect a sort of agreement between subjective intuitions and the model's more objective outcomes. Mutual respect between the map and the map-maker is essential.

Often, the most useful ESPON 3.2 maps represent the differences between the competitive and cohesion scenarios in relation to the baseline, 2015 and 2030, because absolute differences between the scenarios are not large enough to be easily observed.

Fuzzy maps

Usually data is mapped through the graphic attributes of the geographic elements where they are attached (GDP growth through patterns in NUTS II, traffics in colours for road links...). In some cases, maps produced in this way may give the impression of too much precision. This happens when mapping estimates and predictions, or values that are only available in some places but not everywhere. When the goal of the map is just displaying the overall pattern of a given variable, through time or through the territory, the use of fuzzy maps are more appropriate since they smooth excessive details and provide an overview.

In some cases, however, such as the maps representing emissions from transport activities, fuzzy maps are indeed more accurate visualisation of data calculated for each transportation link than regional aggregates.

Dynamic maps

Because ESPON Project 3.2 (Scenarios) deals with the future of Europe, dynamic maps showing the evolution of a given variable are of great interest. In order to allow for this kind of visualisation, three time horizons were calculated (2000, 2015 and 2030) and always each variable is represented for these three scenarios, either in absolute values or in relative growth between the time periods. A web-based application which facilitates a user-friendly dynamic visualisation of thematic maps has been developed using original Java libraries.

Political maps

Several attempts have been made to visualise prospective and normative scenarios. Among different existing options, the experience of Europe 2000 and Europe 2000 + was considered of great interest, in line with the SPESP approach based on super imposing of symbols representing political aims on a geographic reference background that smooth out unnecessary precision but still contains basic information concerning territorial dynamics.

Multimedia animations

A number of multimedia animations have also been designed. Their aim is to raise awareness. These animations are designed according to the actual scenarios and will be used to present, in an interactive way, thematic maps, fuzzy maps and political maps (see http://www.mcrit.com/scenarios/index.htm).

The current scientific platform for European applied territorial research, of which important elements from ESPON have been presented above, represents an investment for future territorial policy development. Many elements can be further elaborated; improvement of the data situation is a high priority and update of data becomes an issue as time passes; new methodologies and an intelligent application of existing ones are all among the challenges ahead for scientific networking on applied territorial research. In this process it is of course important to learn form the ESPON 2006 Programme in advancing further future research, analysis and studies envisaged within the forthcoming ESPON 2013 Programme.

5.1 Lessons from the ESPON 2006 Programme

In summary, the ESPON 2006 Programme provided substantial improvement in comparable information, evidence and knowledge for European regions, often presented as European maps, and made available for policy makers and practitioners at European, transnational, national, cross-border and regional/local levels.

This improvement was ensured through applied research projects and studies carried through by transnational teams of researchers and consultants. A European network of academics was built which provide a basis for further consolidation of a European network of scientific competence in the field of applied territorial research. Furthermore, the progress made has been consolidated in a scientific platform including the ESPON database, mapping tools, models, use of existing and new methodologies as well as scenarios.

Evaluation of the ESPON 2006 programme during its implementation has confirmed its achievements, highlighted its limitations and pointed out areas for improvements.

Among the key achievements is the provision of comparable information covering all regions of Europe, which strengthen the possibility of applying a European dimension in policy making and offers regions to position themselves in the larger territorial context.

The 3-level approach adopted in the analysis and the interpretation of results has also been mentioned as a way of supporting a systematic discussion of policy objectives as some EU-wide developments affect different territorial scales differently.

The approach taken to involve policy makers and scientists in a dialogue during the project implementation has been contributing to the ESPON results and ensured the ambition of ESPON's applied research to support of policy development.

An important area for improvement in relation to a scientific platform is the provision of comparable regionalised data for the entire European territory, which generally was seen as a major challenge given that Eurostat does not currently provide the variety of data necessary for the ESPON exercise. This makes it necessary to continue a data acquisition from national and other sources and validation of these datasets in order to progress on European territorial evidence.

Other improvements proposed related to further deepening and widening of ESPON results, the possibility of increasing the concrete use of ESPON results in targeted analysis of parts of Europe as seen from a European perspective.

Altogether, observations made during the implementation of the ESPON 2006 Programme have given fruitful experiences and lessons to be learned for the future in providing evidential support to territorial policy development. These experiences as well as the progress made on a scientific platform for European applied territorial research will be included in the preparation of the ESPON-2013 Programme.

5.2 A new ESPON 2013 Programme

It has been decided to continue ESPON in 2007-2013 and a new programme is envisaged to begin by January 2007. The programme continuation will aim at a European observation network for territorial development and cohesion.

In the last four years, ESPON has provided a sound evidence base for the further evolution of European territorial policy in general. Despites its short time scale ESPON has substantially improved the amount of data, indicators, typologies, models and scenarios related to the European territory.

The results and the scientific platform established makes it possible to further communicate with the wider policy and practice communities with regard to major socio-economic and environmental trends as well as EU sector policies which influence and shape European territorial development. It has shown that a territorial dimension of trends, perspectives and policies matters and can help or hinder the realisation of policy objectives, such as the Lisbon and Gothenburg agenda.

The challenge for the ESPON 2013 Programme is to build on these strengths and to take major steps forward both in observing and forecasting European territorial dynamics and in making the knowledge base available for policy makers and practitioners at different geographical scales and types of territories.

The ESPON 2013 Programme intends to develop further knowledge and generate further analytical evidence through applied research. More emphasis will be placed on explaining or interpreting causal relationships and the differentiated impacts of the EU policies on different parts of Europe. Further attempts shall be made on complementing the technical analyses with qualitative case study approaches; on promoting the deepening as well as widening of the analyses; and on expanding the research agenda and methods of analysis.

In terms of policy-research relations, ESPON 2013 will increase profoundly the interaction with policy makers and practitioners. It is vital for evidence-based policy development to ensure direct dialogue between researchers and policy makers, and also through targeted analysis which prove the usefulness of ESPON evidence in policy processes for regions and larger territories. This can support a political commitment to a long term investment in a European agenda for applied territorial research.

As an applied research programme the themes of the ESPON 2013 Programme will to a large extent be driven by the policy agenda. The fact that the policy agenda has a tendency to change rapidly will be best accommodated by the input from the Monitoring Committee during the programme implementation.

As an important base for ESPON 2013, the work on consolidating a scientific platform for European territorial applied research and targeted analysis will continue. Improvement of data availability, updating and development of the ESPON database, indicators, models and methodologies and establishing a system for monitoring will all be pursued as necessary elements for an evidence-based policy support.

The progress achieved within the ESPON 2006 Programme on a scientific platform for applied European territorial research, which has been presented in this report, will be the starting point for making further progress in the ESPON 2013 Programme.

ANNEX

LIST OF ESPON 2006 APPLIED RESEARCH PROJECTS

Priority 1: Thematic projects

1.1.1 The role and specific situation and potentials of urban areas a nodes in a polycentric development
1.1.2 Urban-Rural relations in Europe
1.1.3 Enlargement of the European Union and the wider European perspective as regards its polycentric spatial structure
1.1.4 The spatial effects of demographic trends and migration
1.2.1 Transport Services and networks: Territorial trends and basic supply of infrastructure for territorial cohesion
1.2.2 Telecommunication services and networks: Territorial trends and basic supply of infrastructure for territorial cohesion
1.2.3 Identification of spatially relevant issues of the information society
1.3.1 The spatial effects and management of natural and technological hazards in general and in relation to climate change
1.3.2 Territorial trends of the management of the natural heritage
1.3.3 Impact of cultural heritage and identity
1.4.1 The role of small and medium sized towns
1.4.2 Preparatory Study on Social aspects of EU territorial development
1.4.3 Urban Functions
1.4.4 Preparatory study on feasibility on flows analysis
1.4.5 Preparatory study on spatially relevant aspects of tourism

Priority 2: Territorial impact projects

2.1.1 Territorial Impacts of EU Transport and TEN polices
2.1.2 Territorial Impacts of EU Research and Development Policy
2.1.3 The territorial impact of CAP and Rural Development Policy
2.1.4 Territorial trends of energy services and networks and territorial impact of EU Energy Policy
2.1.5 Territorial impacts of European Fisheries Policy
2.2.1 Territorial impacts of Structural Funds
2.2.2 Territorial impacts of the "Aquis Communitaire", Pre-Accession Aid and PHARE/TACIS/MEDA Programmes
2.2.3 Territorial impacts of Structural Funds in urban areas
2.3.1 Application and effects of the ESDP in Member States
2.3.2 Governance of urban and territorial policies from EU to local level
2.4.1 Territorial trends and policy impacts in the field of EU Environment Policy
2.4.2 Integrated analysis of transnational and national territories based on ESPON results

Priority 3: Cross-thematic projects

3.1 Integrated tools for European spatial development
3.2 Spatial scenarios and orientations in relation to the ESDP and EU Cohesion Policy
3.3 Territorial dimension of the Lisbon/Gothenburg Process
3.4.1 Europe in the world
3.4.2 Territorial impacts of EU economic policies and location of economic activities
3.4.3 The modifiable areas unit problem (MAUP

Priority 4: Research briefing and scientific networking

4.1.3 Feasibility study on monitoring territorial development based on ESPON key indicators

LIST OF ESPON INDICATORS AND TYPOLOGIES PUBLICLY AVAILABLE

The following indicators and typologies (status October 2006) are available to the public at the ESPON website (see Scientific Tools and there Database Public Files).

ESPON basic indicators

Area NUTS 2: Area in square kilometres

Area NUTS 3: Area in square kilometres

Population NUTS 2
Population total 2003, Population density 2002, Share of female population 2003, Share of male population 2003, Share of population < 14 years 2003, Share of population > 65 years 2003, Share of high aged population (> 75 years) 2003, Share of female population < 14 years 2003, Share of female population > 65 years 2003, Share of female high aged population (> 75 years) 2003, Share of male population < 14 years 2003, Share of male population > 65 years 2003, Share of male high aged population (> 75 years) 2003, Development of total population 1995- 2003 in %, Development of female population 1995- 2003 in %, Development of male population 1995- 2003 in %

Population NUTS 3
Average Population 2003, Average male Population, share in %, 2003, Average female Population, share in %, 2003, Population density 2002, Development average population 1995-2003 in %

Employment and Labour Market NUTS 2
Active population total 2001, Share of active population < 25 years 2001, Persons employed Total 2001, Share of persons employed male 2001, Share of persons employed female 2001, Share of persons employed in Agriculture in % of total 2001, Share of persons employed in Industry in % of total 2001, Share of persons employed in Services in % of total 2001, Employed persons, Employed persons, national, Share of employed persons, national, < 25 years, in % of total, Share of employed persons, national, > 65 years, in % of total

Unemployment NUTS 2
Unemployment rate total 2004, Unemployment rate female 2004, Unemployment rate male 2004, Unemployment rate, age < 25 years, 2004, Development of unemployment rate 1999-2004 in percentage points, Development of unemployment rate, female, 1999-2004 in percentage points, Development of unemployment rate, male, 1999-2004 in percentage points

Unemployment NUTS 3
Unemployment rate total, Unemployment rate female, Unemployment rate male, Unemployment rate under 25 years, Development of unemployment rate 1998-2001, Development of unemployment rate, female, 1998-2001, Development of unemployment rate, male, 1998-2001, Development of unemployment rate, <25 years, 1998-2001

Wealth and Production NUTS 2
GDP in Purchasing Power Parities per inhabitant 2003, GDP in Euro per inhabitant 2003, Development of GDP in Purchasing Power Parities per inhabitant 1999-2003, Development of GDP in Euro per inhabitant 1999-2003

Wealth and Production NUTS 3

GDP in Purchasing Power Parities per inhabitant 2003, GDP in Euro per inhabitant 2003, Development of GDP in Purchasing Power Parities per inhabitant 1999-2003, Development of GDP in Euro per inhabitant 1999-2003

Research and Development NUTS 2

Patent applications to the EPO per persons employed 2002, Total intramural R&D expenditure 2002, FuE Business Enterprise Sector, personnel, 2003

ESPON project indicators:

Regional Classification of Europe

RCE - classified economy, RCE - classified Lisbon performance, RCE - classified labour market, RCE - classified demography, RCE - classified naturalness, RCE - classified natural hazards, RCE - classified technological hazards, RCE - classified accessibility

Spatial typologies NUTS 2

Settlement Structure Typology (Six basic types), Typology of household telecommunication, Typology of business telecommunications access and uptake, Typology comparing household and business telecommunication, Typology of household and business telecommunication, Typology Multimodal Accessibility Potential, Typology of lagging regions. Typologies of regional specialisation and GDP per capita 2001, Typologies of regional specialisation and GDP per capita 1995-2001, Spatial classification coast, Spatial classification border, Spatial classification Pentagon EU 15, Spatial classification Pentagon EU 27 plus 2, Part of Interreg North-Sea Programme, Part of Interreg CADSES Programme, Part of Interreg Atlantic-Area Programme, Part of Interreg Programme "Non continental and overseas cooperation areas", Part of Interreg Programme "Northern-Peripherie", Part of Interreg Alpine-Space Programme, Part of Interreg Programme "Archimedes", Part of Interreg Programme "Baltic Sea", Part of Interreg Programme "Medoc-Area", Part of Interreg Programme "South-West-Europe", Part of Interreg Programme "North-West-Europe", Objective 1 region, Objective 2 region

Spatial typologies NUTS 3

Typology Settlement Structure (Nine basic types), Typology Multimodal Accessibility Potential, Typology of lagging regions, Urban-rural typology, Spatial classification coast, Spatial classification border, Spatial classification Pentagon EU 15, Spatial classification Pentagon EU 27 plus 2, Part of Interreg North-Sea Programme, Part of Interreg CADSES Programme, Part of Interreg Atlantic-Area Programme, Part of Interreg Programme "Non continental and overseas cooperation areas", Part of Interreg Programme "Northern-Peripherie", Part of Interreg Alpine-Space Programme, Part of Interreg Programme "Archimedes", Part of Interreg Programme "Baltic Sea", Part of Interreg Programme "Medoc-Area", Part of Interreg Programme "South-West-Europe", Part of Interreg Programme "North-West-Europe", Objective 1 region, Objective 2 region

Population

Typology crossing mobility and migratory balances, Internal migratory balance, Total migratory balance, External migratory balance, Internal mobility by region, Mobility by region relative to national mobility, Typology of migratory balances by age classes, Dependency rate 1995, Dependency rate 1999, Share of NUTS 2 average population 1999 living in NUTS 3 regions with population decline 1995-1999, Share of NUTS 2 area comprising NUTS 3 regions with population decline 1995-1999, Population between 15 and 64 years in 2000 (%) (Model A), Population between 15 and 64 years in 2025 (%) (Model A), Population between 15 and 64 years in 2050 (%) (Model A), Population between 15 and 64 years in 2000 (%) (Model B1), Population between 15 and 64 years in 2025 (%) (Model B1), Population between 15 and 64 years in 2050 (%) (Model B1), Population between 15 and 64 years in 2000 (%) (Model B2), Population between 15 and 64 years in 2025 (%) (Model B2), Population between 15 and 64 years in 2050 (%) (Model B2), Population between 15 and 64 years in 2000 (%) (Model B3), Population between 15 and 64 years in 2025 (%) (Model B3), Population between 15 and 64 years in 2050 (%) (Model B3), Population with 65 and more years in 2000 (%) (Model A), Population with 65 and more years in 2025 (%) (Model A), Population with 65 and more years in 2050 (%) (Model A), Population with 65 and more years in 2000 (%) (Model B0), Population with 65 and more years in 2025 (%) (Model B0), Population with 65 and more years in 2050 (%) (Model B0), Population with 65 and more years in 2000 (%) (Model B1), Population with 65 and more years in 2025 (%) (Model B1), Population with 65 and more years in 2050 (%) (Model B1), Population with 65 and more years in 2000 (%) (Model B2), Population with 65 and more years in 2025 (%) (Model B2), Population with 65 and more years in 2050 (%) (Model B2), Population with 65 and more years in 2000 (%) (Model B3), Population with 65 and more years in 2025 (%) (Model B3), Population with 65 and more years in 2050 (%) (Model B3), Average score on indirect "ageing"/ "depopulating" indicators, Average score on indirect "ageing"/ "depopulating" indicators, Grouped (quartiles), National Total Fertility Rates 1999-2000, Ageing Population (4 groups) 65+/total population, Ageing "Labour Force" (4 groups) 55-64/20-64 years, "Labour Force" Replace-ment (4 groups) 10-19/55-64 years, Post-Active Dependency (4 groups) 65+/20-64 years, Aged People vs. Youth (4 groups) 65+/15-24 years, Share of children (4 groups) 0-14/ total population, Changes in Natural Growth Potential (4 groups), Ageing Population (indexes) 65+/ total population, Ageing "Labour Force" (indexes) 55-64/20-64 years, "Labour Force" Replace-ment (indexes) 10-19/55-64 years, Post-Active Dependency (indexes) 65+/20-64 years, Aged People vs. Youth (indexes) 65+/15-24 years, Share of children (indexes) 0-14/total population, Changes in Natural Growth Potential (indexes), Total fertility rate 1990, Total fertility rate 1995, Total fertility rate 1999, External immigration, Migratory balance by regions between 1996 – 1999, Absolute migratory balance 1996-1999, Migratory balance 17.5 to 27.5 years old, Migratory balance 32.5 to 42.5 years old, Migratory balance 52.5 to 67.5 years old, Variation of the population 2000-2050 (%) (Model A), Variation of the population 2000-2050 (%) (Model B0), Variation of the population 2000-2050 (%) (Model B2), Variation of the population 2000-2050 (%) (Model B3), Share (%) of population in the ages 65+ 1990, Share (%) of population in the ages 65+ 1995, Share (%) of population in the ages 65+ 1999, Total population development 1996-1999, Natural population development 1996-1999, Net migration 1996-1999, Type of rural area, Relative depopulation, quartiles, Population change 1990-2000, Population change 1990-1995, Population change 1995-2000

Wealth and production NUTS 2

Deviation - Gross Domestic Product by Population, 'purchasing power standards per inhabitant, around Nuts 2's neighbours, Deviation - Gross Domestic Product by Population, 'purchasing power standards per inhabitant; index EU-15, Deviation -

Gross Domestic Product by Population, 'purchasing power standards per inhabitant; index Nuts 0, Deviation - Gross Domestic Product by Population, 'purchasing power standards per inhabitant; index Nuts 2's neighbours.

Transport NUTS 3
Number of commercial airports, Number of commercial seaports, Length of road network (km), Length of railway network, km, Traffic in commercial airports, Connectivity to commercial airports by car of the capital or centroid representative of the NUTS3, Connectivity to commercial seaports by car of the capital or centroid representative of the NUTS3, Time to the nearest motorway access, by car of the capital or centroid representative of the NUTS3, Daily population accessible by car, Daily market accessible by car in terms of GDP, Potential accessibility air, ESPON space = 100, Potential accessibility rail, ESPON space = 100, Potential accessibility road, ESPON space = 100, Potential accessibility multimodal, ESPON space = 100, Accessibility time to market by road, Accessibility time to market by rail, Accessibility time to market by rail and road

Communication technology NUTS 2
Share of Internet users to100 inhabs regression, Proportion of firms with own website regression

Land use NUTS 3
Share of artificial surfaces, Artificial surfaces per 1000 inhabitants (in 1999), Artificial surfaces per Gross Domestic Product (in 1999), Share of urban fabric, Share of arable land, Share of permanent crops

Environment NUTS 3
Occurrence of snow avalanches, Large scale droughts in Europe, Regional earthquake hazard potential, Extreme temperatures, Regional flood hazard potential, Forest fire hazard, Occurrence of landslides, Occurrence of storm surges, Occurrence of tsunami runups and tsunami potential areas in Europe, Volcanic eruptions during the last 10 000 years, Approximate probability of having winter storms and for tropical storms probable maximum intensity, Air traffics hazard potential, Chemical plants hazard potential, Potential risk of radioactive contamination on NUTS3 regions, Classification of Oil-SUM values

Agriculture NUTS 2
Percent of UAA which is arable, Percent of UAA (Utilisable Agricultural area) that is fallow, Percent of farm holders aged <65

Tourism NUTS 3
Number of overnight stays, Number of tourists' arrivals

Public sector NUTS 2
Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing capital-supply-potential, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing environmental quality, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing geographical position, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing potential of innovation, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing institutional conditions, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing labour market potential, Percentage of regional Pre-

Accession-Aid (PHARE, PHARE CBC, ISPA) addressing regional market potential, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing urbanisation & localisation advantages, Total Pre-Accession-Aid spending (PHARE, PHARE CBC, ISPA) 1998-2000 Average Annual Pre-Accession-Aid spending (PHARE, PHARE CBC, ISPA) 1998-2000, All Structural and Cohesion Fund expenditure, Structural Fund expenditure (R), Structural Fund expenditure (S), Structural Fund expenditure (A), Cohesion Fund expenditure (T), Cohesion Fund expenditure (E)

Public sector NUTS 3
Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing capital-supply-potential, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing environmental quality, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing geographical position, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing potential of innovation, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing institutional conditions, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing labour market potential, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing regional market potential, Percentage of regional Pre-Accession-Aid (PHARE, PHARE CBC, ISPA) addressing urbanisation & localisation advantages, Total Pre-Accession-Aid spending (PHARE, PHARE CBC, ISPA) 1998-2000, Average Annual Pre-Accession-Aid spending (PHARE, PHARE CBC, ISPA) 1998-2000, All Structural and Cohesion Fund expenditure, Structural Fund expenditure (R), Structural Fund expenditure (S), Structural Fund expenditure (A), Cohesion Fund expenditure (T), Cohesion Fund expenditure (E)

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www.espon.eu

The European Spatial Planning Observation Network (ESPON) is set up to support policy development and to build a European scientific community in the field of territorial development. The main aim is to increase the general body of knowledge about territorial structures, trends, perspectives and policy impacts in an enlarged European Union.

The purpose of this ESPON Scientific Report II is to document the progress made on building a scientific platform for applied European territorial research by using existing methodologies and in some cases developing new ones. Please note that the report is not exhaustive in covering all scientific aspects of all projects within the ESPON 2006 Programme. More information is available in the Final Project Reports at the ESPON website.

The EU Commission and the EU Member States have stressed the need for further applied research providing evidence for territorial policies. The ESPON 2013 Programme will take the challenge building further a scientific platform for applied territorial research .

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