



INDIVIDUAL, ORGANIZATIONAL AND TERRITORIAL CAPACITY BUILDING IN SPATIAL DATA INFRASTRUCTURE DEVELOPMENT

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1. Introduction

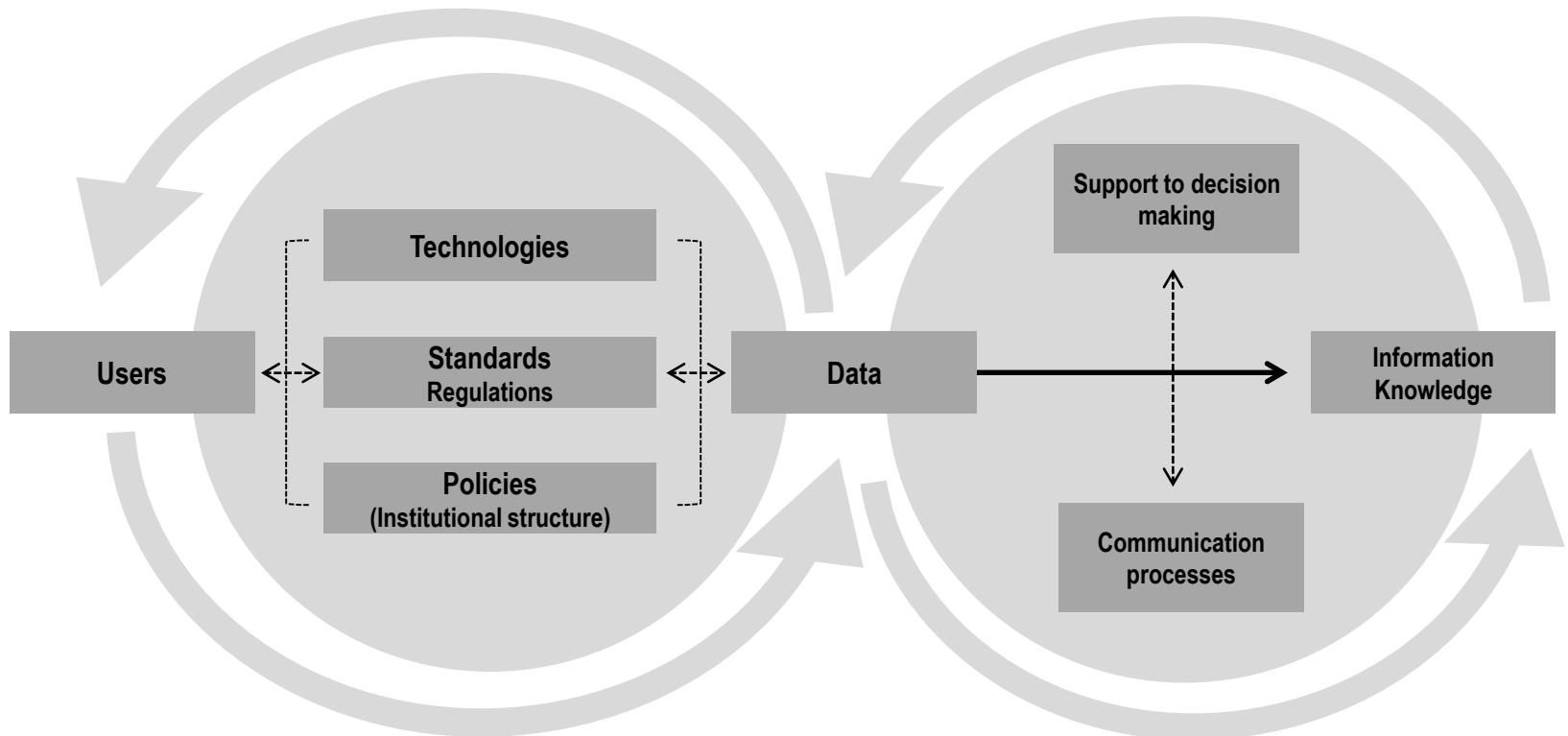
The scientific knowledge, technological and organizational innovation and policy options frame the development and diffusion of Geographic Information Systems (GIS) to implement Spatial Data Infrastructure (SDI) at a global (GDSI), national (NSDI) and local scale (LSDI).

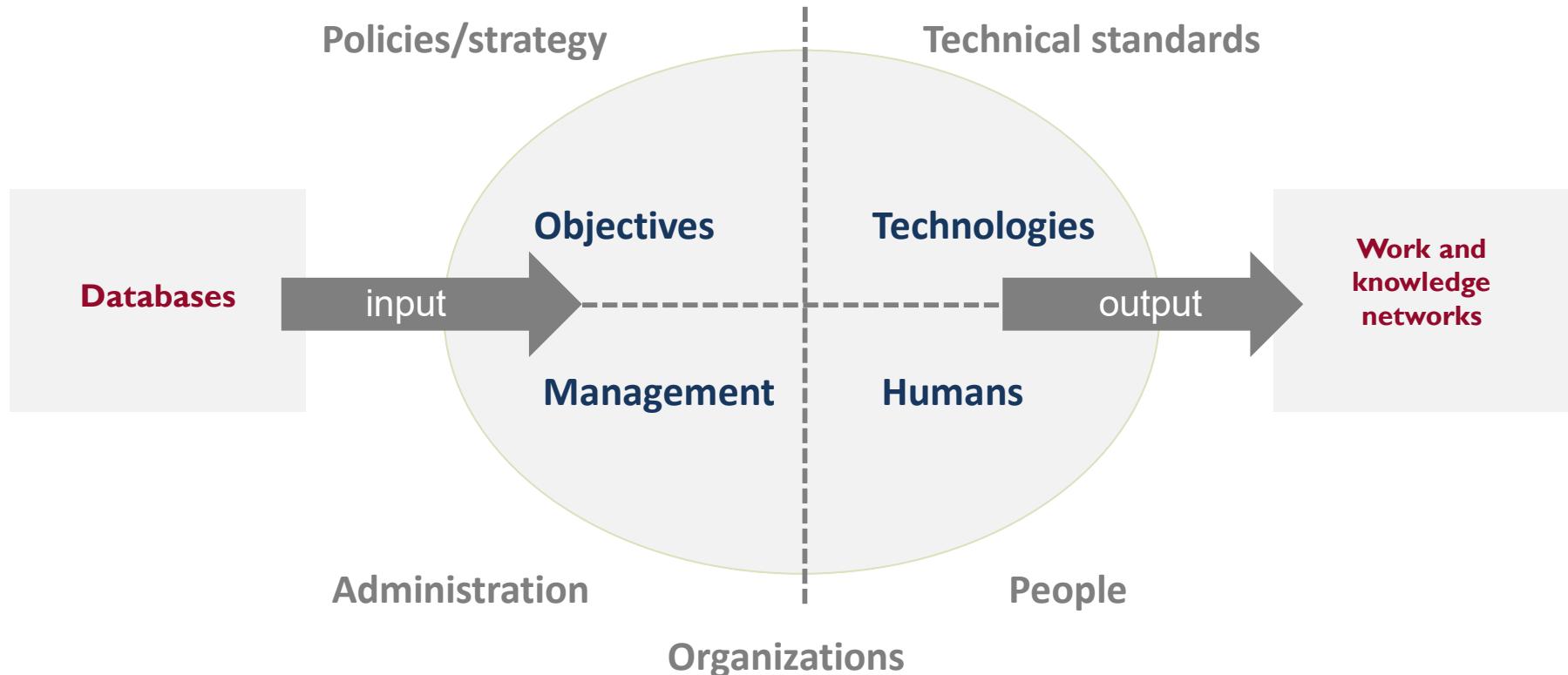
GIS and SDI integrate data, technologies, users, standards and policies in the production, management, sharing and application of spatial data and geographic information.

The GIS focuses on the data production and analysis, while the SDI prioritizes communication, sharing and access to data and data services between users and systems.

SDI are digital information infrastructures that promote digital governance initiatives, spatially enabled societies and communities led by public institutions for participation and social cohesion and inclusion, environmental quality, land sustainability and the generation of knowledge economies by public-private entities.







- i) The processes of physical and functional integration of GIS (**technological and human dimension**);
- ii) The processes of **innovation, dissemination / diffusion, adaptation and adoption of GIS**;



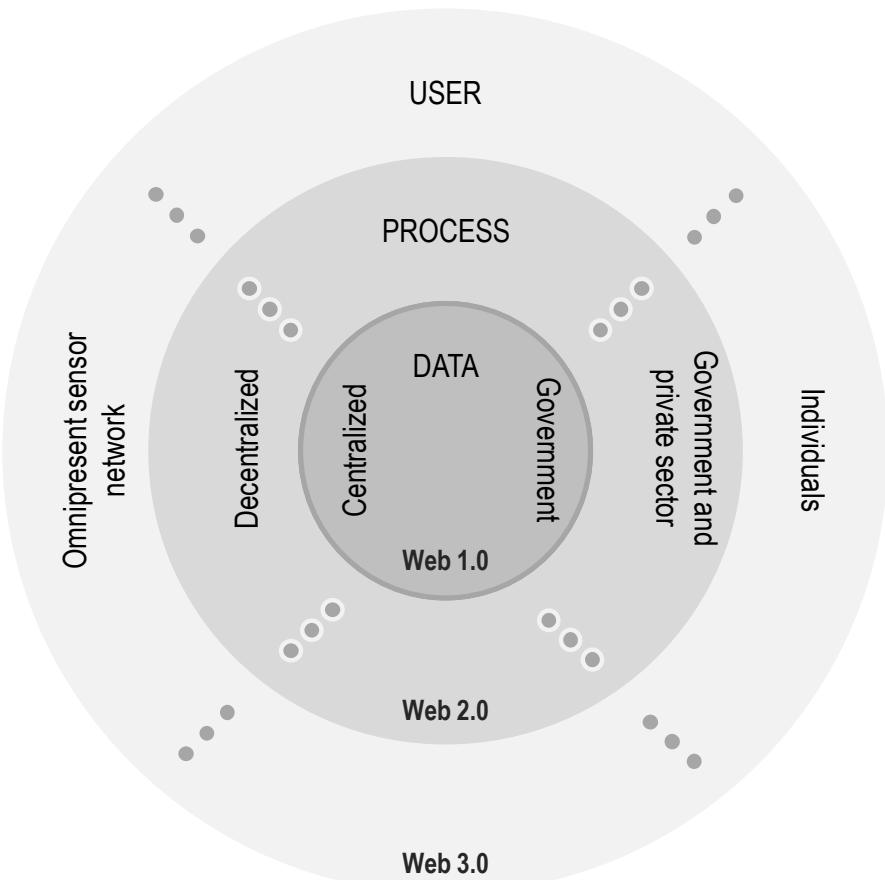


Fig. 2.17 – Representation of the evolution of concepts and elements present in different SDI generations (adap. de Sadeghi-Niaraki et al., 2010).



1. Local Spatial Data Infrastructures

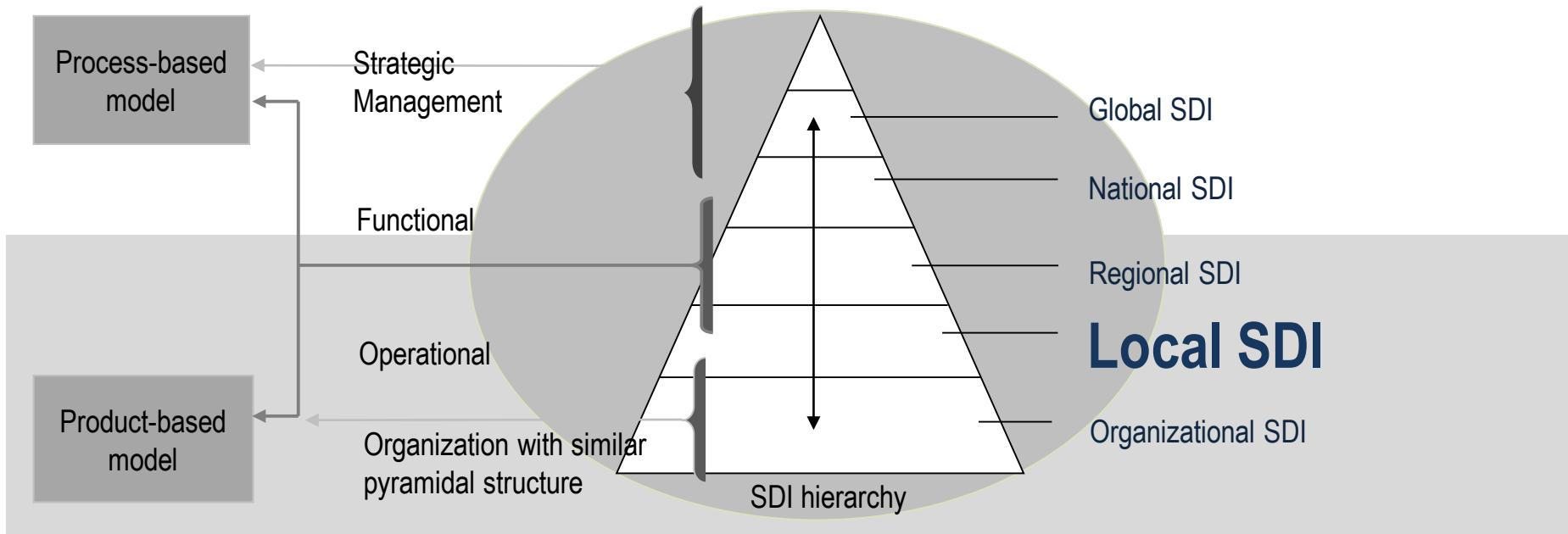


Fig. 2 – The various action and decision levels and SDI types



1. Local Spatial Data Infrastructures

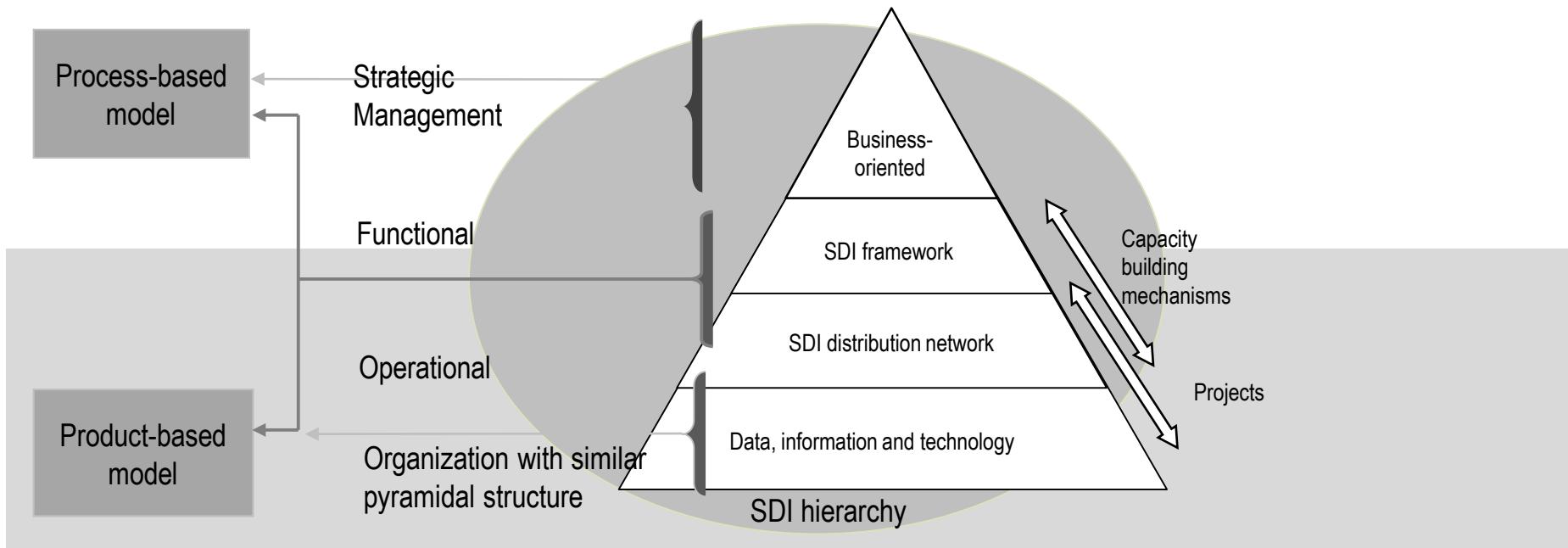


Fig. 2 – The various action and decision levels and SDI types



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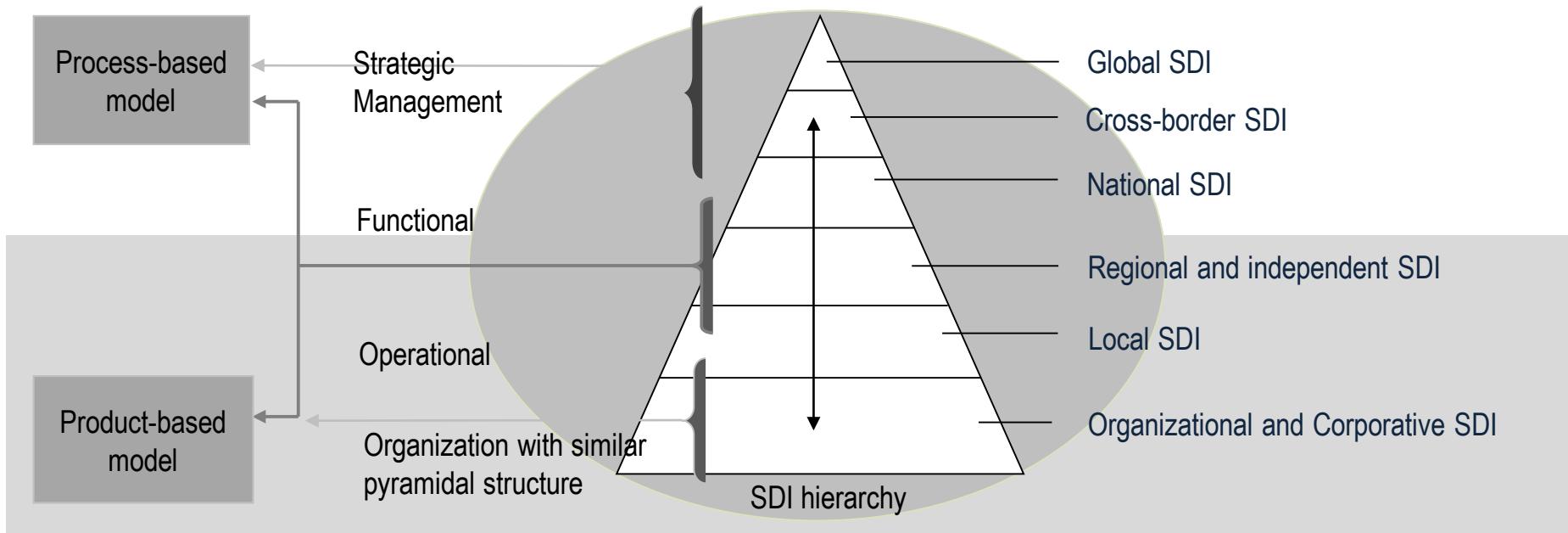


Fig. 2 – The various action and decision levels and SDI types



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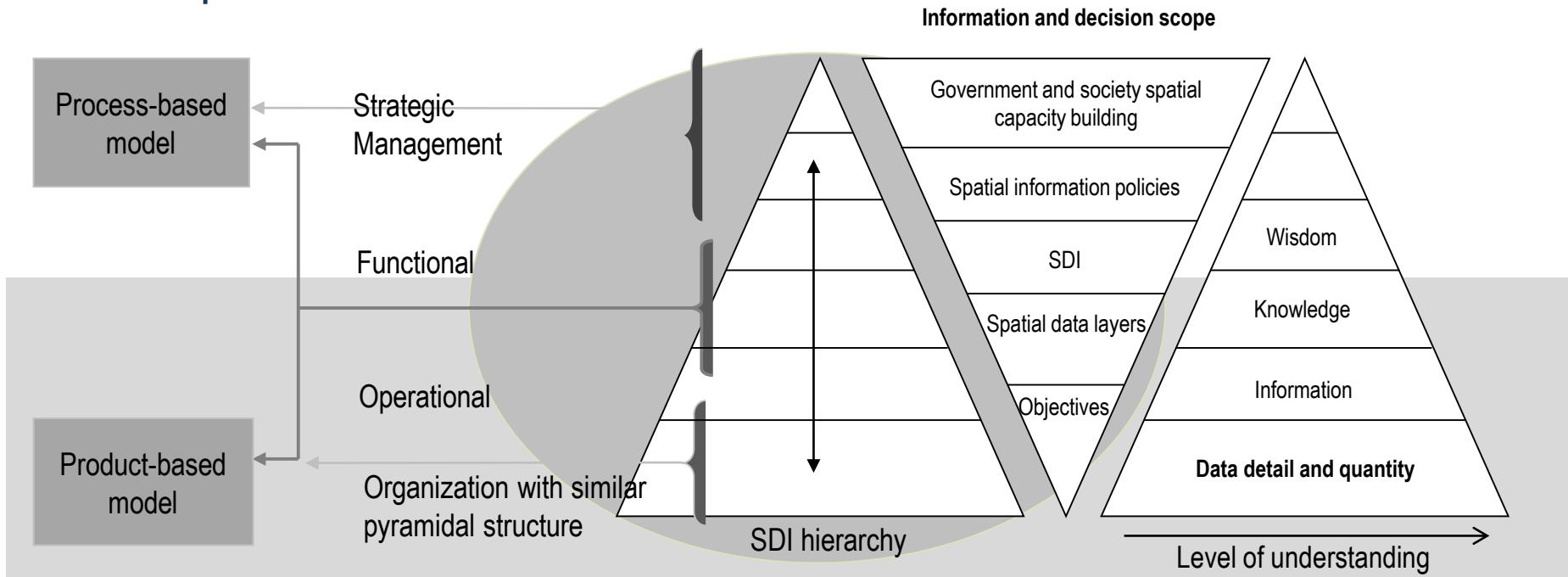


Fig. 2 – The various action and decision levels and SDI types



Introduction



The components, processes, and objectives of SDI use in Spatially enabled societies (Alonso, 2015)



The implementation and effectuation of the potential of these initiatives **relate to the technical and scientific field of developers and users**,
the ability to,
define an appropriate space and thematic scope,
a common strategic vision strong impetus and political and administrative leadership
associated with the reorganization and capacity building.

The individual, institutional and territorial capacity building is a central element in the design, implementation and maintenance of these socio-technical digital infrastructures.



The costs, challenges and potential impacts indicate the importance and the liability to develop SDI approaches and evaluation models,

Awareness... ,

Readiness...,

Maturity... ,

Performance....

and satisfaction....

SDI effectiveness/functioning from the user perspective/usability assessment models.



In this doctoral research, develops an approach and exploratory model, with **multidimensional, systemic, scalar, hierarchical and multilevel** (individual, institutional and territorial), **multidisciplinary, rational and formal exploratory evaluation model** that uses **interpretative analysis, ex- post, as a summative, guiding, evolutionary, dynamic and adaptive, participatory and formative methodologies.**

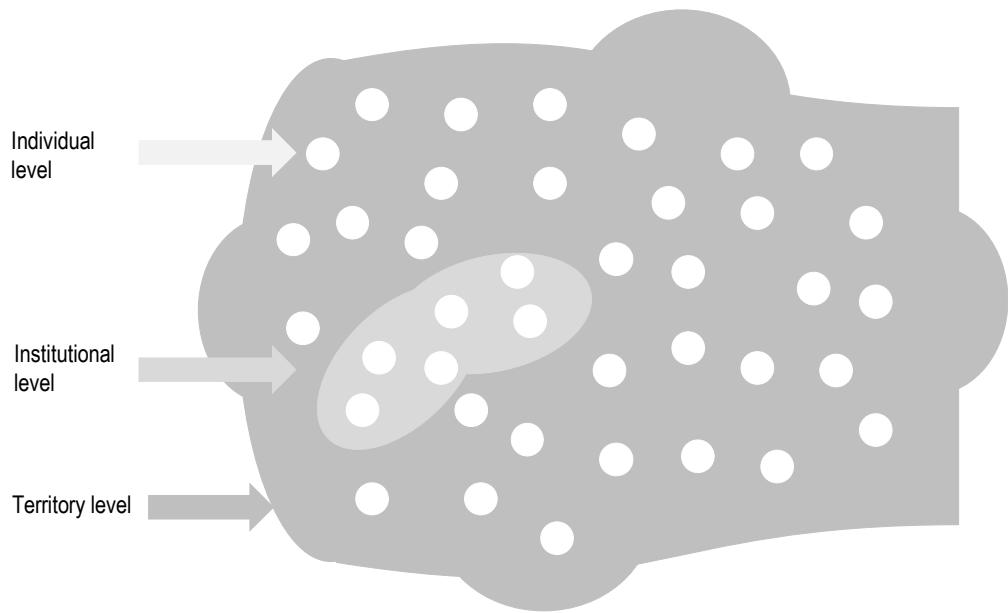


Fig. 4.2 – Relação espacial e funcional em termos conceituais entre os níveis de ação-decisão e capacitação individual, institucional e territorial.



3. THE RESEARCH PROPOSAL

The evaluation of WEBGIS evolution within the **Complex Adaptive Systems** framework and entities under **Actor-Network Theory** framework

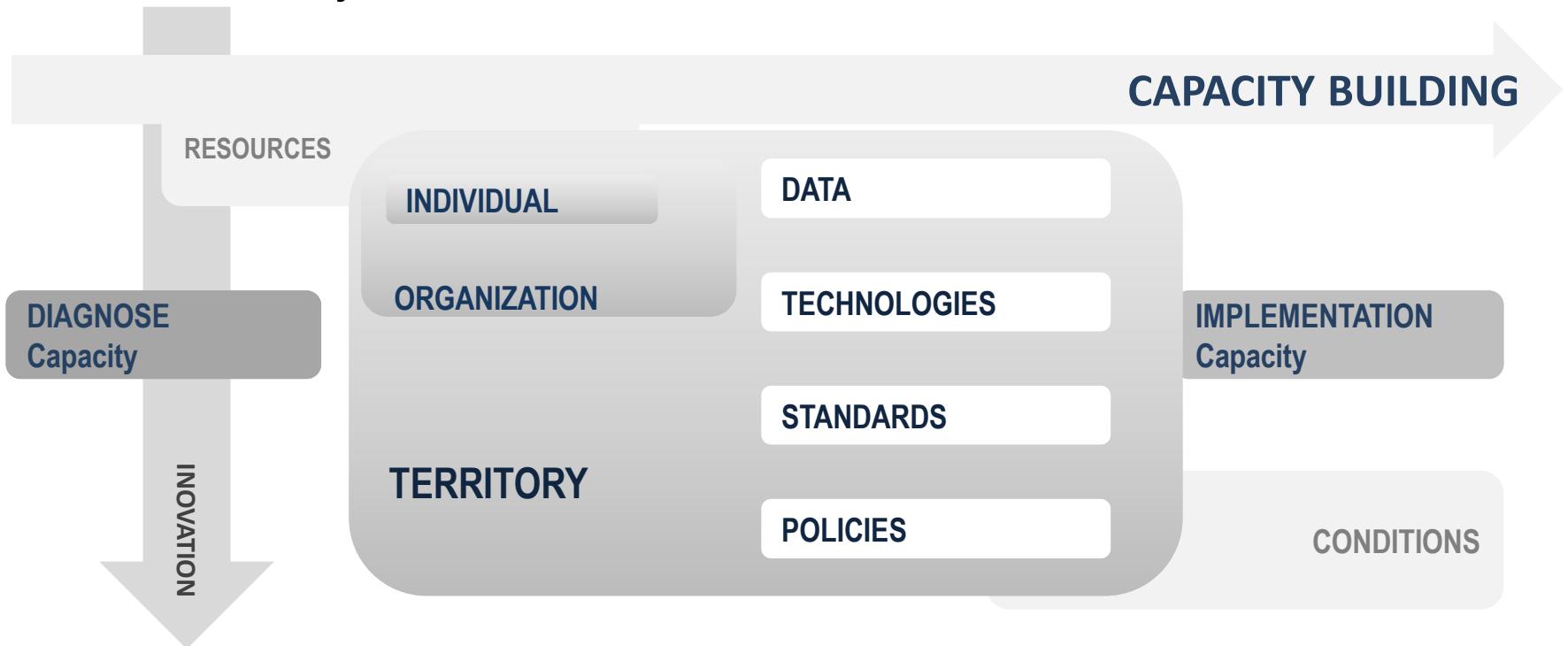


Fig. 2- The entities diagnose and implementation capacity and its relationship with capacity building, SDI development and territorial innovation



2. Methodology

This research includes a review and practical examples that explores the SDI complex nature, dynamic and multifaceted, as well as explores the evidence of the difficulty of designing/implementing approaches and SDI systemic/functional assessment models.

The SDI assessment model proposal considers the results of R&D+i projects, education and training developed on:

- i. the acquisition of knowledge, skills or attitudes of individual users;
- ii. and components (policies, standards, data, users, and technologies) at organizational and regional level (NW Portugal) through the SDI development phases.

This research aims to support, develop, experiment and propose an exploratory evaluation model of multilevel capacity building that question the extent to which GIS development projects enable individuals, institutions and regions to develop local SDI.



Table 4.8 – Group of indicators collected to evaluate the capacity building for the policies component.

		Definition
POLICIES	Indicator	
p1	Vision	The collective vision documented for the model, the object and the proposed, discussed and approved objective
	Mission and governance model	Mission of the proposed documented governance model
p2	Leadership	Establishment and dinamization of the activities as well as clarification of leadership responsibilities and authority
p3	Model and development plan	Definition of a model and approval of a medium-term development plan (for a period over 5 years)
p4	Financial and sustainability plan	Definition of a model and approval of a financing and sustainability plan (for a period over 5 years) that identifies and quantifies costs, sources of revenue, investment indicators and outcome metrics.
p5	Research plan and practice	Definition of a model, plan and establishment of achievement, access and participation in Communication and Geographic Information Technologies research activities
p6	Inovation plan and practices	Definition of a model, plan and establishment of achievement, access and participation in Communication and Geographic Information Technologies innovation activities, involving aspects related with technology transfer, property management and introduction of innovation.
p7	Policies and INSPIRE directives	Policies and policies implicit to the introduction of overall policies and INSPIRE Directive, regarding (publication, sharing and data access)
p8	National legal framework and standards	Policies and directives implicit to the introduction of the national legal and regulatory framework (publication, sharing and data access and National SDI participation)
p9	Data policies	Data policies (price, sharing, access and reuse policy)
p10	Partnerships and network policies and practices	Partnerships formulation and management for knowledge, experience, resources and products sharing
p11	Public and private partnerships	Partnerships formulation and management for knowledge, experience, resources and products sharing between private and public entities
p12	Authority and legitimacy	Acknowledgment, analysis, introduction, adaptation and assessment of aspects related with authority and legitimacy regarding the mission and activities within the statutory responsibilities framework or SDI partnership agreement
p13	Entrepreneurship and economy	Acknowledgment, analysis, introduction, adaptation, assessment and dissemination of experiences and initiatives to promote entrepreneurship and new economies as a result of the SDI partnership implementation
p14		



Table 4.9 – Group of indicators collected to evaluate the capacity building for the standards component.

	Definition
STANDARDS	
n1 ISO 19100 Standard	Introduction experience and initiatives of the ISO TC211 / ISO19100 series
n2 OGC Standards	Introduction experience and initiatives of the OGC Standards series
n3 Intellectual property	Standards concerning the registration and management of intellectual property and copyright (data registration and licensing)
n4 Privacy and confidentiality	Standards related with data record, privacy management and confidentiality
n5 Security	Data security and technology standards, including data integrity
n6 Data and services price	Standards concerning the definition and conditions for the application of data prices and data services
n7 Licensing	Standards concerning data and technologies licensing according to the users typology of and/or use
n8 Data custody and stewardship	Standards and agreements on data custody between SDI partners and users
n9 INSPIRE Directive application	Standards and agreements regarding the application of INSPIRE standards (Annexes I, II and III data modeling, filling metadata into profiles according to the INSPIRE Metadata Profile)
Internal regulation of data	
n10 modeling	Standards and agreements on the application of modeling and data standards and metadata profiles
Internal procedures	
n11 (accountability)	Standards regarding the development of internal processes and procedures associated with a framework of accountability
n12 External procedures (integration)	Standards regarding the development of external processes and procedures associated with a framework of accountability and interaction of technologies and systems
n13 Information Management System	Standards regarding the development of internal processes and procedures at the level of an information management system (COBIT.)
Management and quality	
n14 assurance mechanism	Standards regarding the development of internal processes and procedures at the level of management and quality assurance



Table 4.10 – Group of indicators collected to evaluate the capacity building for the users component.

USERS	Definition
u1 Hiring	Permanent or temporary recruitment of qualified human resources to perform functions and activities in the areas of C&GIT
u2 Professional stability	Stability and professional progression of human resources qualified to perform functions and activities in the areas of C&GIT
u3 Evaluation	Procedures for the evaluation of human resources to carry out functions and activities in the areas of C&GIT
u4 Collaboration	Procedures and processes for collaboration among human resources, groups, departments or communities to share common capabilities, resources and projects
u5 Coordination	Procedures and processes for coordinating human resources, groups, departments or communities in order to articulate common capacities, resources and projects for capacities
u6 Training	Project and actions of education and vocational training in order to train human resources, groups, department or community in knowledge, skills and attitudes around the subjects of C&GIT
u7 Research	Procedures and processes to promote, stimulate and participate in research projects, programs or networks
u8 Innovation	Procedures and processes to foster, stimulate and participate in innovation projects, programs or networks
u9 Accreditation and competences recognition	Procedures and processes to foster, stimulate and participate in projects, programs or networks for the recognition of competences for C&GIT users
u10 Mobility	Procedures and processes to foster, stimulate and participate in initiatives, programs or mobility networks of techniques with activity and functions in C&GIT applied in GIS and SDI



Tableo 4.11 – Group of indicators collected to evaluate the capacity building for the data and metadata component.

DATA AND METADATA	Definition
d1 Collection of Reference data (Annex I)	Procedures for capturing and modeling bases or spatial data sets according to INSPIRE Annex I Standards
d2 Collection of Thematic Data (Annex II)	Procedures for capturing and modeling bases or spatial data sets according to INSPIRE Annex II Standards
d3 Collection of Thematic Data (Annex III)	Procedures for capturing and modeling bases or spatial data sets according to INSPIRE Annex III Standards
d4 Data storage	Procedures for storing databases or spatial data sets in conditions of security and integrity
d5 Editing and data transformation	Processing procedures (spatial, formats) and editing of alphanumeric databases in databases or spatial data sets
d6 Data publication	Procedures for analogue and digital publication of databases or spatial data sets
d7 Data access	Procedures for managing access to databases, spatial data sets or data services by defining user profiles and application
d8 Database Management	Procedures for managing databases or spatial data sets or data services
d9 Database integration	Procedures for integrating spatial data sets or data services by developing standardization implementation or process implementation and interoperability tools
d10 Analysis and spatial modeling	Development and application of procedures and techniques for spatial data analysis and spatial modeling
d11 Internal quality	Development and application of procedures and techniques for evaluation and internal quality management of geographic databases (ISO 19113, 19114, 19138, 19157 and 19158)
d12 External quality	Development and application of procedures and techniques for evaluation and management of external quality of geographic databases (ISO 19113, 19114, 19138, 19157 and 19158)
d13 Quality assurance procedures	Development and application of management procedures and internal quality assurance of geographic databases (ISO 19157 and 19158)
d14 Metadata production	Development and application of metadata production procedures (ISO 19115 and 19139, MIG 3.0)
d15 Metadata publication	Development and application of metadata publishing procedures (ISO 19115 and 19139, MIG 3.0) in metadata manager and catalog



Table 4.12 – Group of indicators collected to evaluate the capacity building for the technologies componente.

Tecnologias	Significado
t1 Spatial data capture (location and georeferencing)	Development, installation and operation of procedures of geographic data technologies (telemetry / LIDAR, positioning system, dynamic segmentation, geocoding)
t2 Capture and image processing	Development, installation and operation of geographic data technologies (satellite image, high and low resolution aerial images)
t3 spatial analysis and decision support systems applications	Development, installation and operation of spatial transformation technologies, format and integration of geographic databases
t4 Storage technologies	Development, installation and operation of database storage technologies
t5 Security technologies	Development, installation and operation of database security technologies
t6 Communication and data mobility	Development, installation and operation of communication and mobility technologies (fiber, network expansion, cloud installation)
t7 Technology integration and interoperability	Development, installation and operation of technologies for the integration and interoperability of technologies
t8 Metadata management and catalog	Development, installation and operation of manager and metadata catalog technologies (geo-network)
t9 Mobile interface and technologies	Development, installation and operation of mobile interfaces and technologies (SIGWEB platforms, smartphone)
t10 Access (Geoportal)	Development, installation and operation of geoportal (consultation, space operations, user management, implementation of geo-web-services)



Collection of primary and secondary data

Variables normalization

Table 4.7 – Categorization scale of the obtained results obtained for the categorization of indicators for institutional and territorial assessment capacity

Value	Definition
0	Does not have a direct relationship between project outcomes on the component impact;
1	Not aware or entities do not intend to use;
2	Aware and have interest in knowing and applying the procedures or results developed in the projects.
3	Theoretical knowledge and development of individual (in territorial assessment) or institutional (in territorial assessment) competences;
4	Practical application by a limited set of individual users (in the territorial assessment) or institutional users (in the territorial assessment);
5	Internal publishing and dissemination by a significant set of users and significant influence on the functioning of the institutional or territorial context;
6	Internalization and institutionalization or maturity of the elements with the regular application or continuous improvement of the procedures or results;
7	Divulgação e disseminação externa mesmo com a ajuda ao nível da documentação e apoio à experimentação External publication and dissemination even with support at the level of documentation and experimentation.



2. Methodology

The model experimentation is associated with inventory, description and the processes analysis and outcomes of 61 R&D+i projects, education and training developed by CIGESA-IPVC from 2000 to 2015 on:

- the acquisition of knowledge, skills or attitudes of different GIST types of individual users;
- the components (policies, standards, data, users, and technologies) in the IPVC (institution) qualification;
- or throughout the region for the implementation of a local SDI of the Alto Minho (NW Portugal).





- Límites**
- Unidade de análise
 - Distritos
 - Municípios
- Hidrografia**
- Rios Principais
 - Superfícies de água
- Redes Viárias**
- Entradas principais
 - Estradas secundárias
 - Caminhos de ferro
- Cores Land Cover (2006)**
- Territórios artificializados
 - Tecido urbano contínuo
 - Tecido urbano descontínuo
 - Indústria, comércio e equipamentos gerais
 - Redes viárias e ferrovias
- Corine Land Cover (2006)**
- Áreas agrícolas e agroflorestais
 - Culturas temporárias de sequeiro
 - Culturas temporárias de regadio
 - Arozais
 - Vegetação
 - Pomares
 - Óleos
 - Pastagens permanentes
 - Culturas temporárias e/ou pastagens associadas à culturas permanentes
 - Sistemas culturais e parceirais complexos
 - Áreas aráveis
 - Áreas portuárias e semi-naturais
 - Sistemas agro-florestais
 - Áreas de extração de invertebrados
 - Áreas em construção
 - Espaguetes verdes urbanos
 - Equipamentos desportivos, culturais, lazer e zonas históricas
 - Agricultura com espaços naturais
 - Sapas
 - Salinas
 3. Florestas e mato natural e semi-naturais
 - Florestas de folhas
 - Florestas de resinas
 - Florestas mistas
 - Vegetação herbácea natural
 - Mato
 - vegetação escarpada
 - Florestas abertas, cortes e novas plantações
 - Praias, dunas e oásis
 - Rochedo
 4. Zonas húmidas
 - Pântanos
 - Vegetação esparsa
 - Áreas arroxadas
 - Turforas
 5. Corpos de água
 - Cursos de água
 - Planícies de água
 - Lagoas costeiras
 - Estuários
 - Mares e oceanos
- Instituto Politécnico de Viana do Castelo**
- Escola Superior Agrária (ESA)
 - Escola Superior de Ciências (ESCI)
 - Escola Superior de Desporto e Lazer (ESDL)
 - Escola Superior de Educação (ESE)
 - Escola Superior de Saúde (ESS)
 - Escola Superior de Tecnologia e Gestão (ESTG)



2. Results

The results set forth the advances in **production, modelling and data sharing and spatial metadata, the number of users and application areas, the use of international standards, the establishment of local, regional and cross-border processes and knowledge networks.**



Categoria INSPIRE

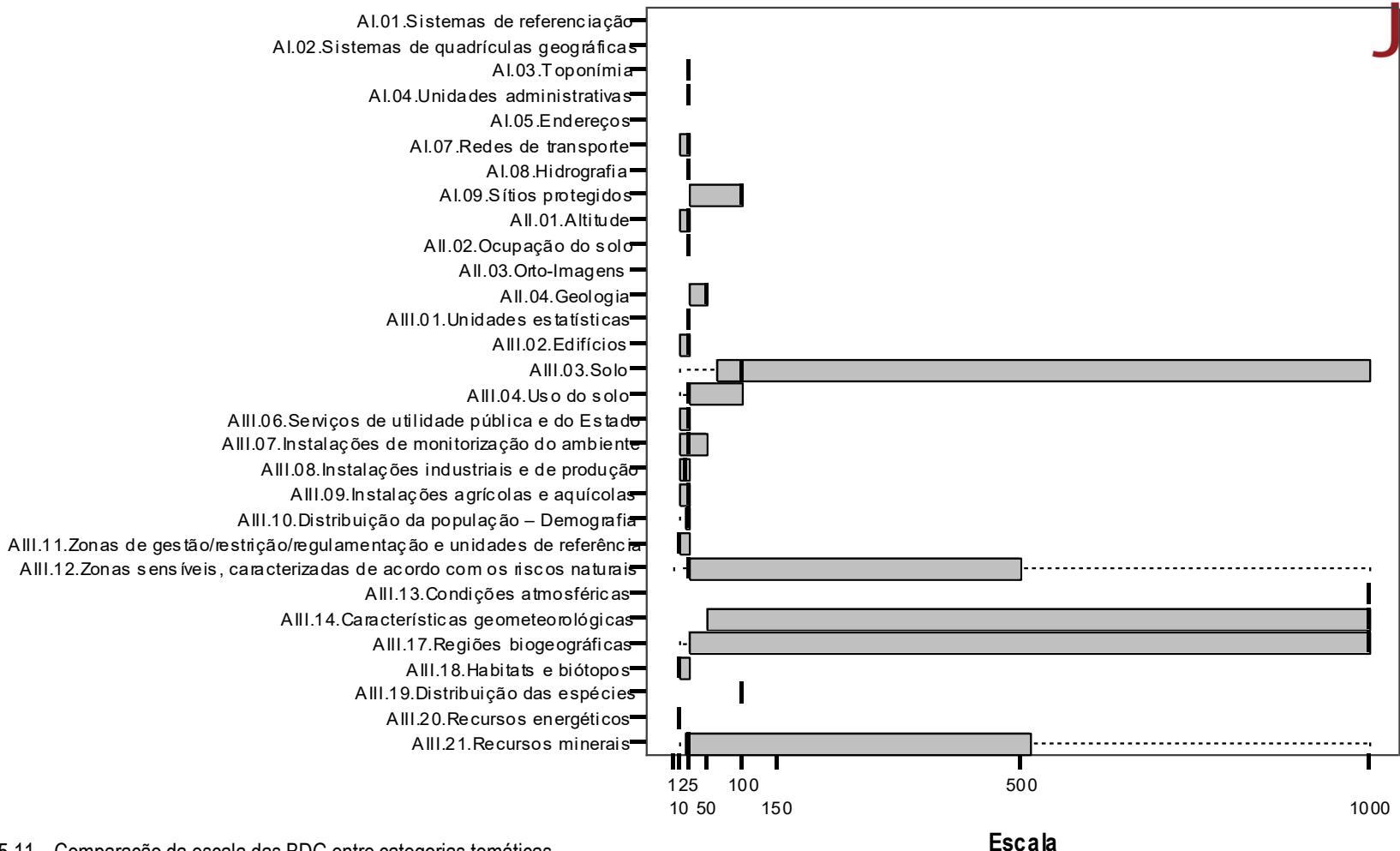


Fig. 5.11 – Comparação da escala das BDG entre categorias temáticas.



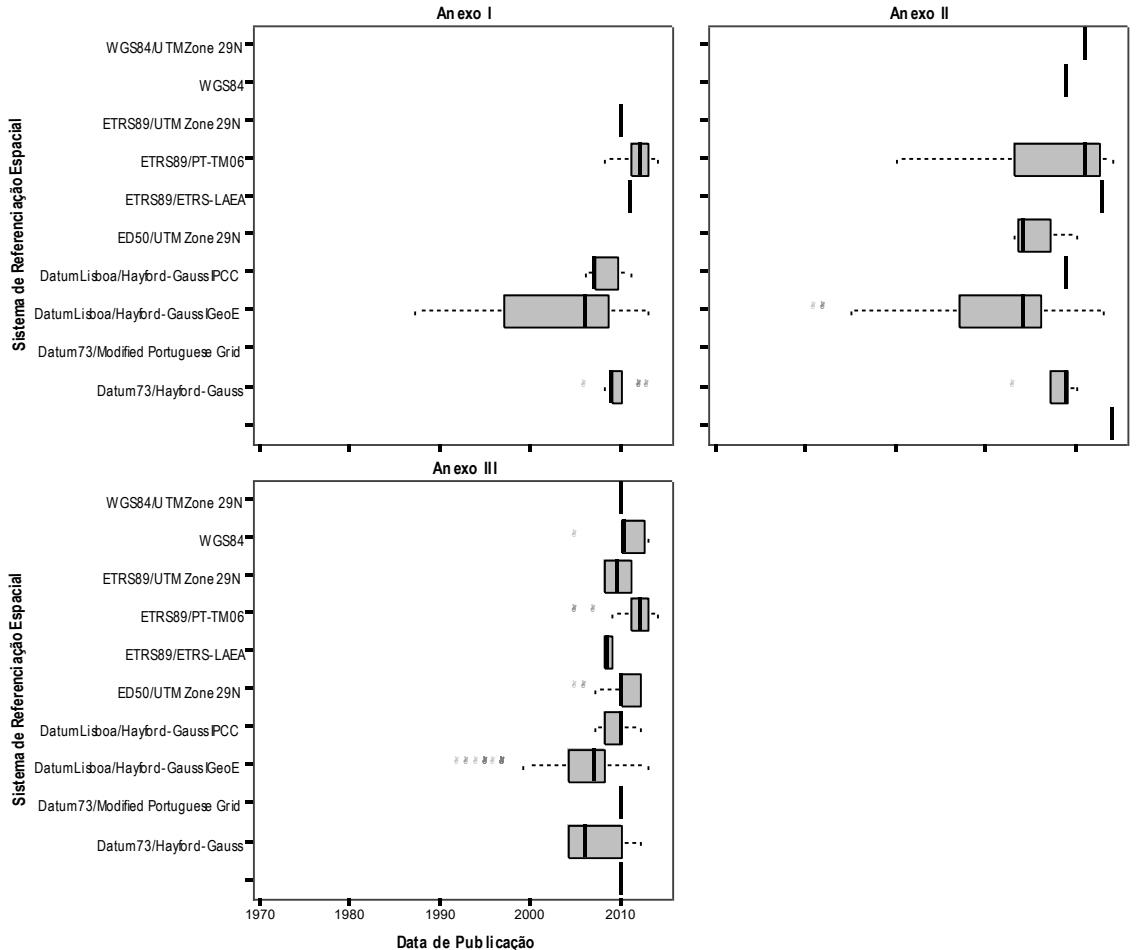


Fig. 5.13 – Relação entre sistemas de referenciação especial e data de publicação das BDG por Anexo da Diretiva INSPIRE (Anexo III.1).



Categoria INSPIRE

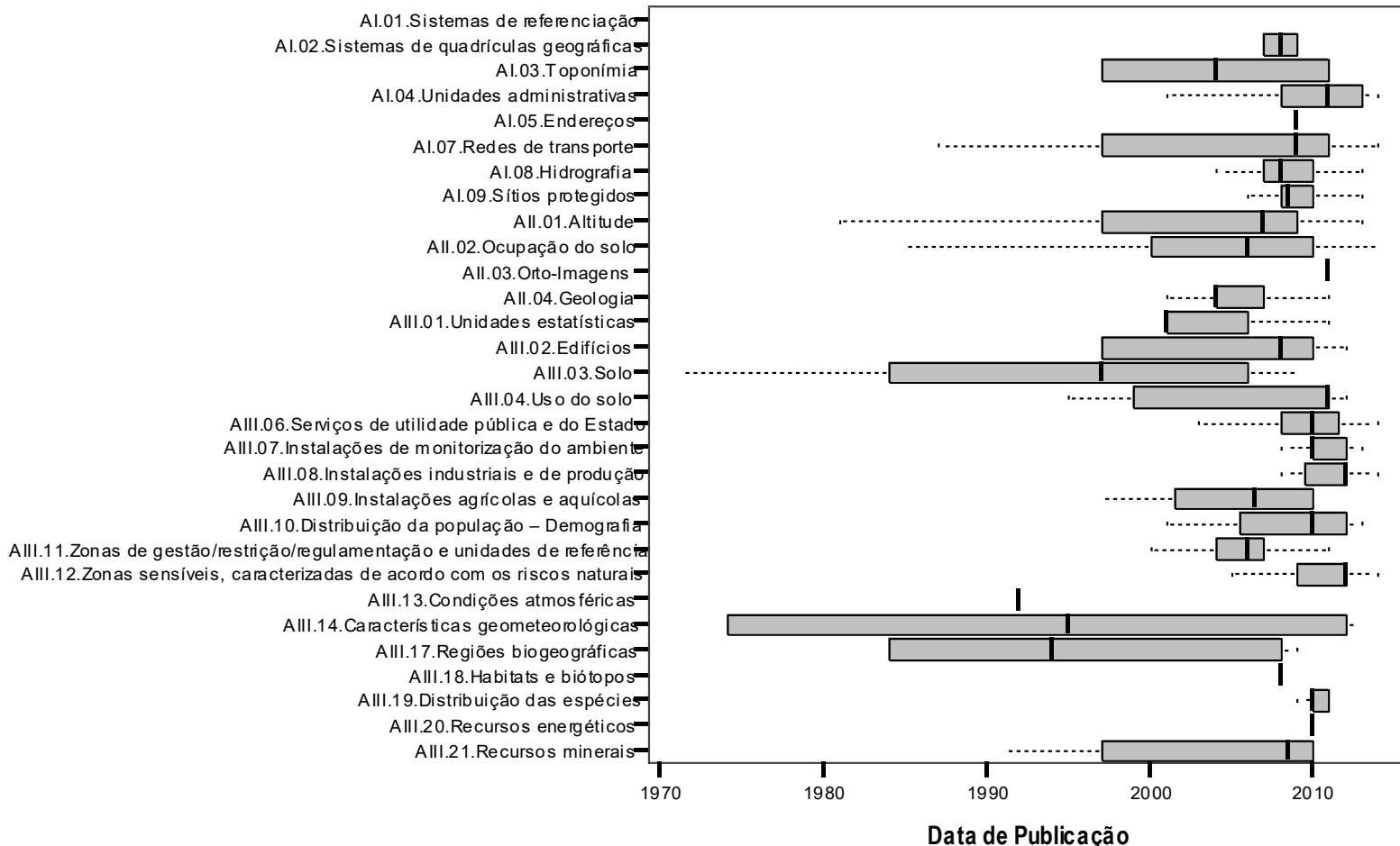
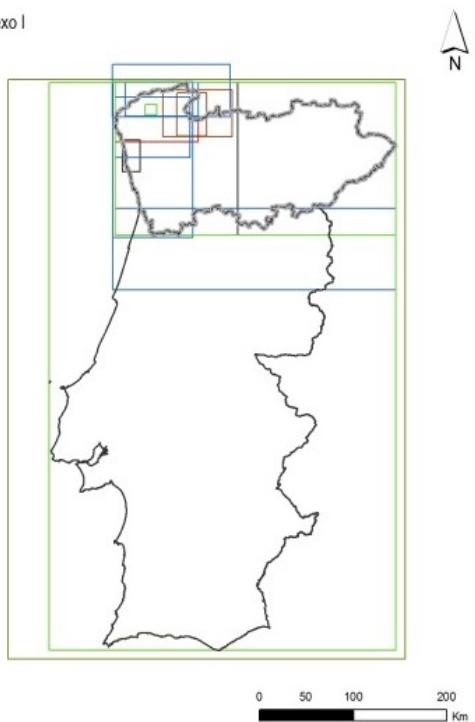


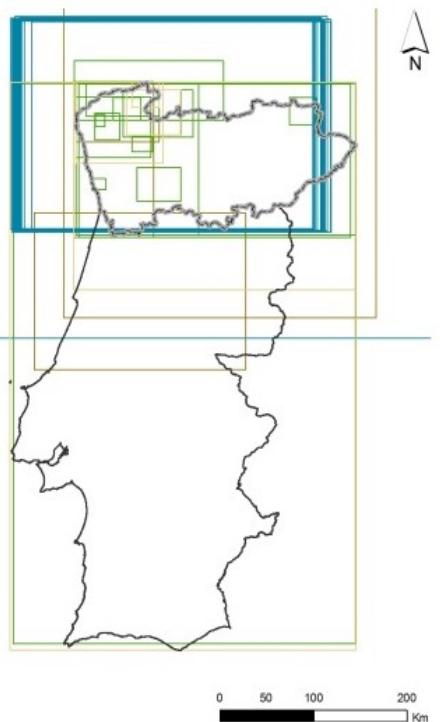
Fig. 5.12 – Comparação da data de publicação das BDG entre categorias temáticas [os outliers foram eliminados da representação para obter melhor leitura].



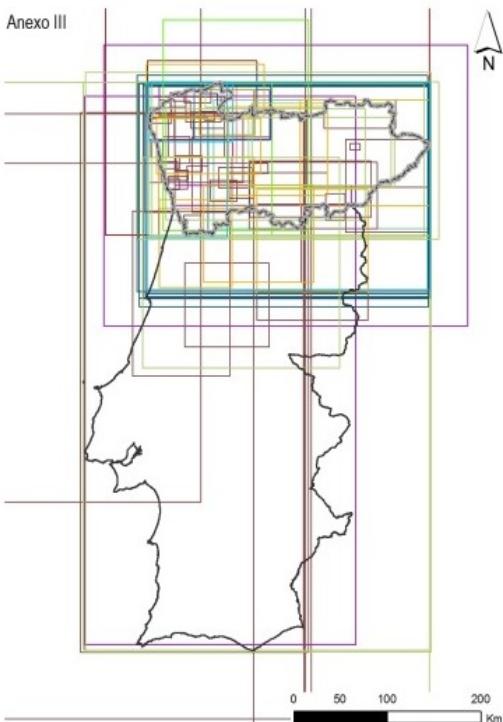
Anexo I



Anexo II



Anexo III

**Legenda**

- Região Norte
- Límite Administrativo de Portugal Continental

Anexo I - INSPIRE

- 02. Sistemas de quadriculas geográficas
- 03. Toponomia
- 04. Unidades Administrativas
- 05. Endereços
- 07. Redes de Transporte
- 08. Hidrografia
- 09. Sítios Protegidos

Anexo II - INSPIRE

- 01. Altitude
- 02. Ocupação do Solo
- 03. Orto-imagens
- 04. Geologia

Anexo III - INSPIRE

- 01. Unidades estatísticas
- 02. Edifícios
- 03. Solo
- 04. Uso do Solo
- 05. Serviços de utilidade pública e do Estado
- 07. Instalações de monitorização do ambiente
- 08. Instalações industriais e de produção
- 09. Instalações agrícolas e aquícolas
- 10. Distribuição da população - Demografia
- 11. Zonas de gestão/restricção/regulamentação e unidades de referência
- 12. Zonas sensíveis aos riscos naturais
- 13. Condições atmosféricas

- 14. Características geometeorológicas
- 17. Regiões biogeográficas
- 18. Habitats e biótopos
- 19. Distribuição de espécies
- 20. Recursos energéticos
- 21. Recursos minerais

Fig. 5.14 – Extensão geográfica das BDG por Anexo e categoria temática da Diretiva INSPIRE.



Simultaneously it explores the **challenges and formalization proposals, social adoption, political option and technical practice for the evaluation and continuous improvement of SDI development paths and impacts.**



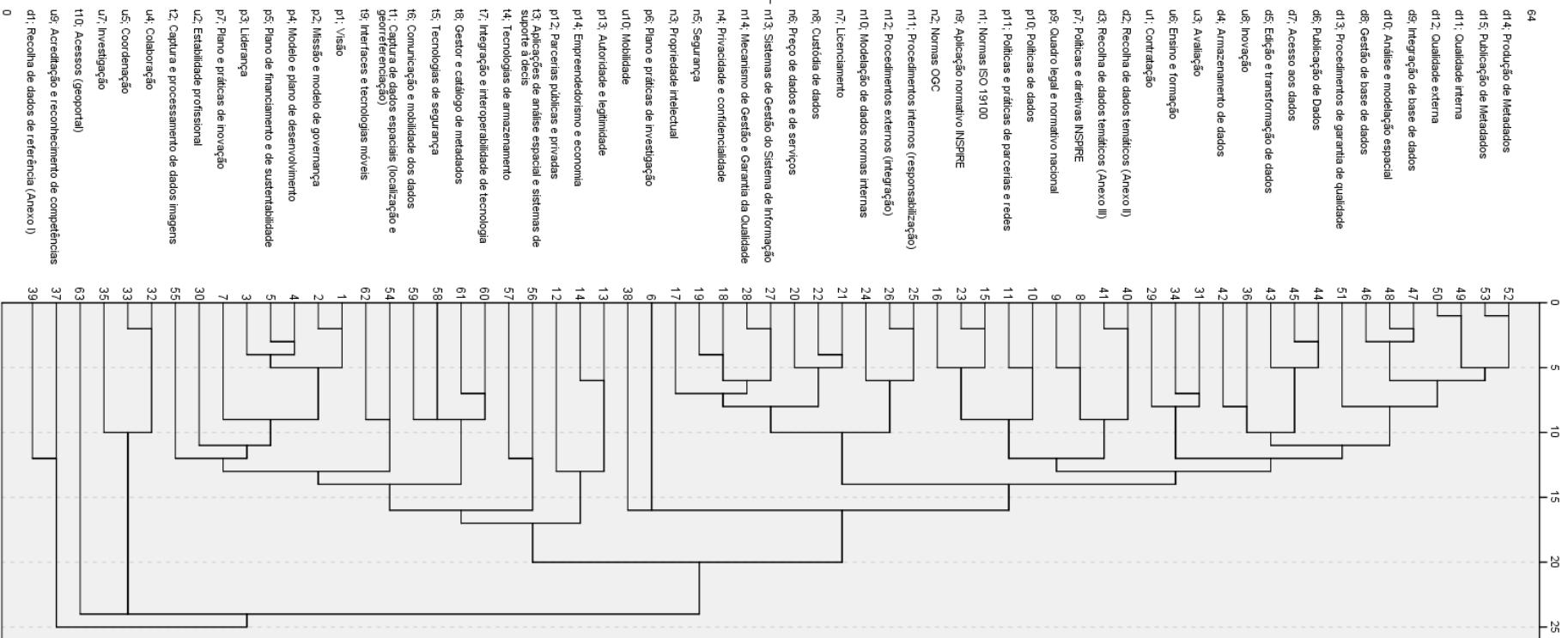


Fig. 5.18 – Análise de clusters das variáveis das componentes para cada avaliação da capacitação institucional.



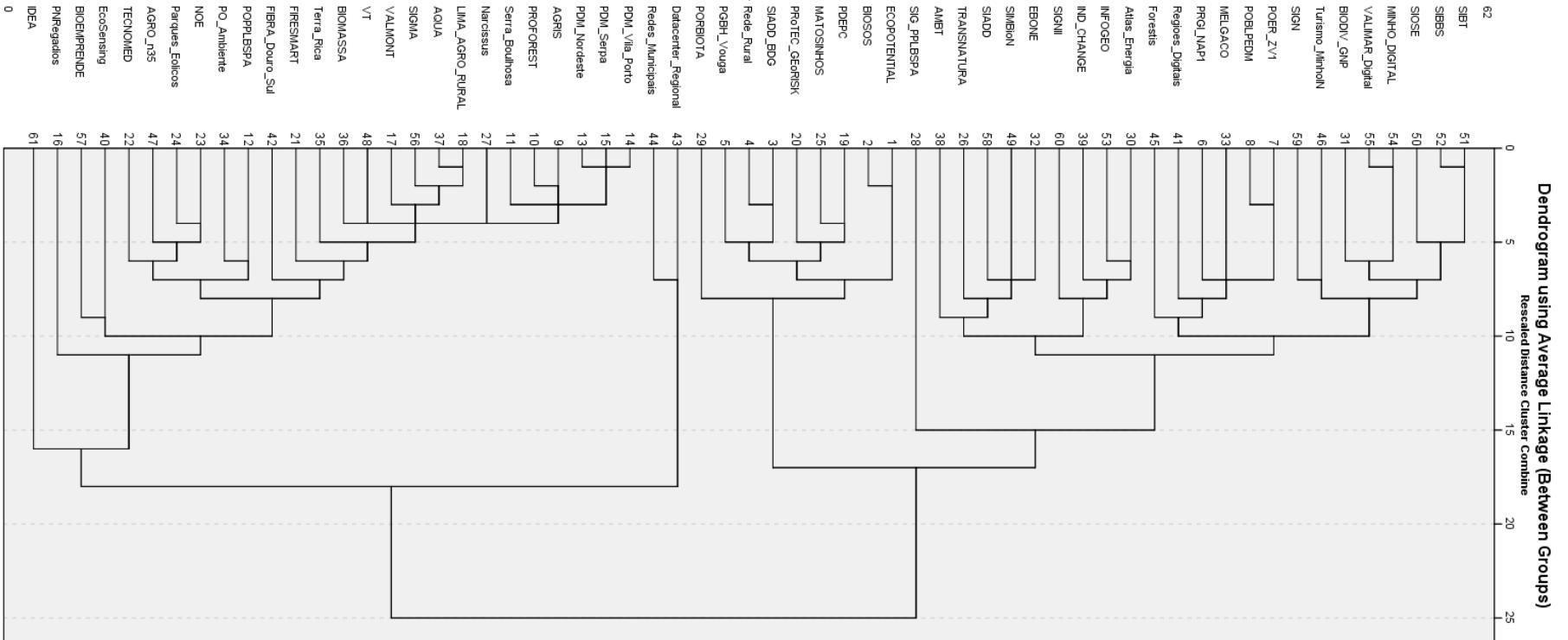


Fig. 5.19 – Análise de clusters dos projetos de I&D+i relativamente da capacitação institucional.



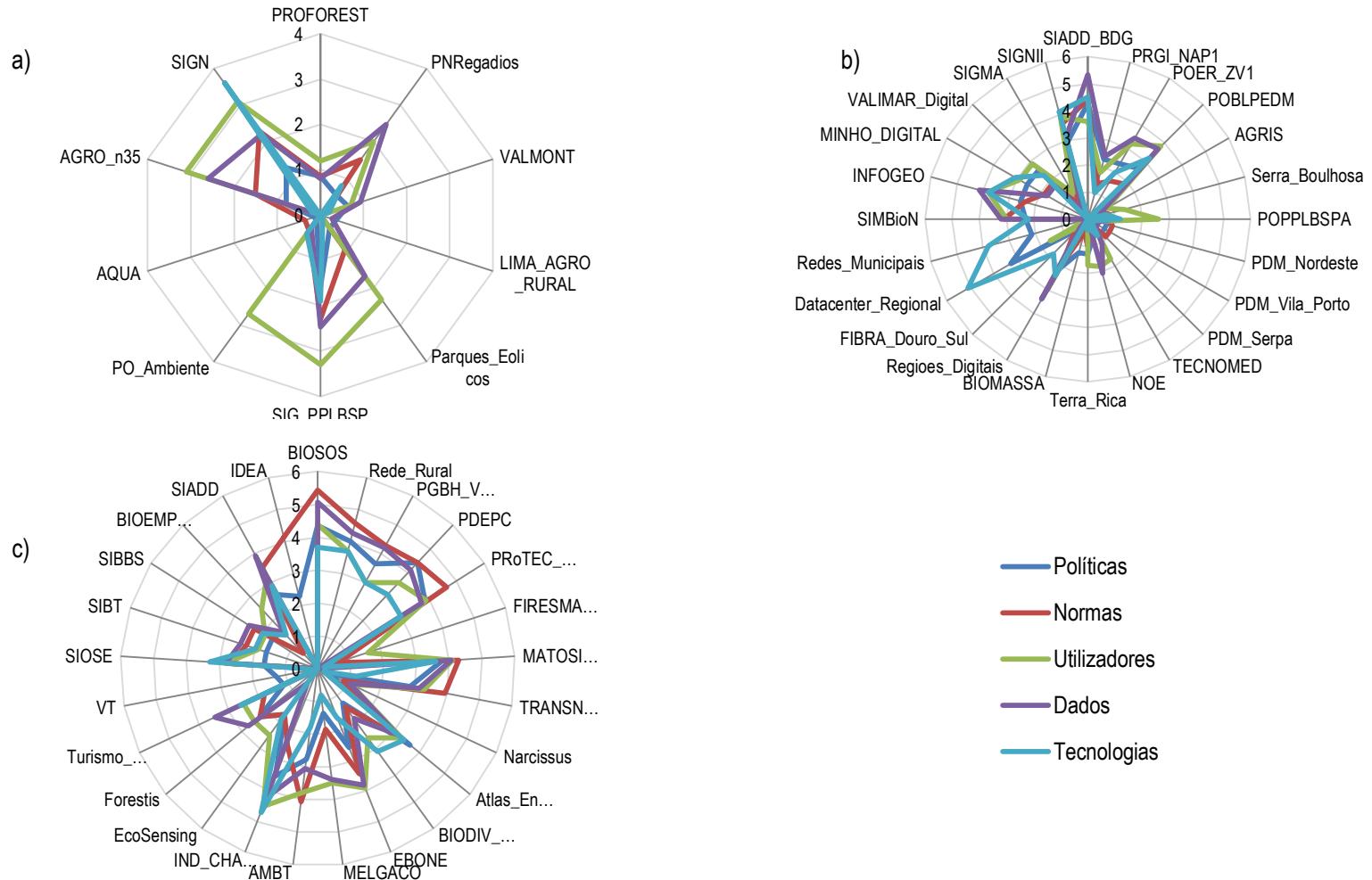


Fig. 5.20 – Avaliação da capacitação institucional por componentes, projetos e períodos de tempo a) até 2005; b) 2006-2010 e c) 2011-2015.



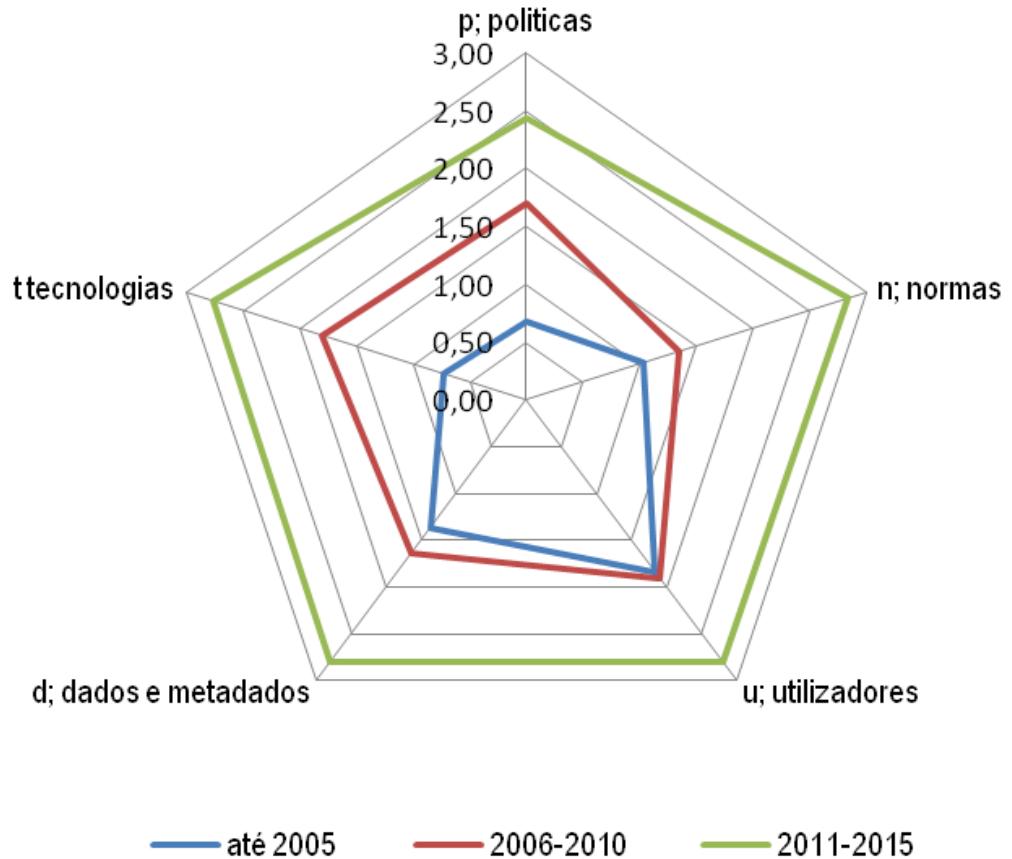


Fig. 5.25 – Avaliação da capacitação institucional por componentes e períodos de tempo



Dendrogram using Average Linkage ...

Rescaled Distance Cluster Combine

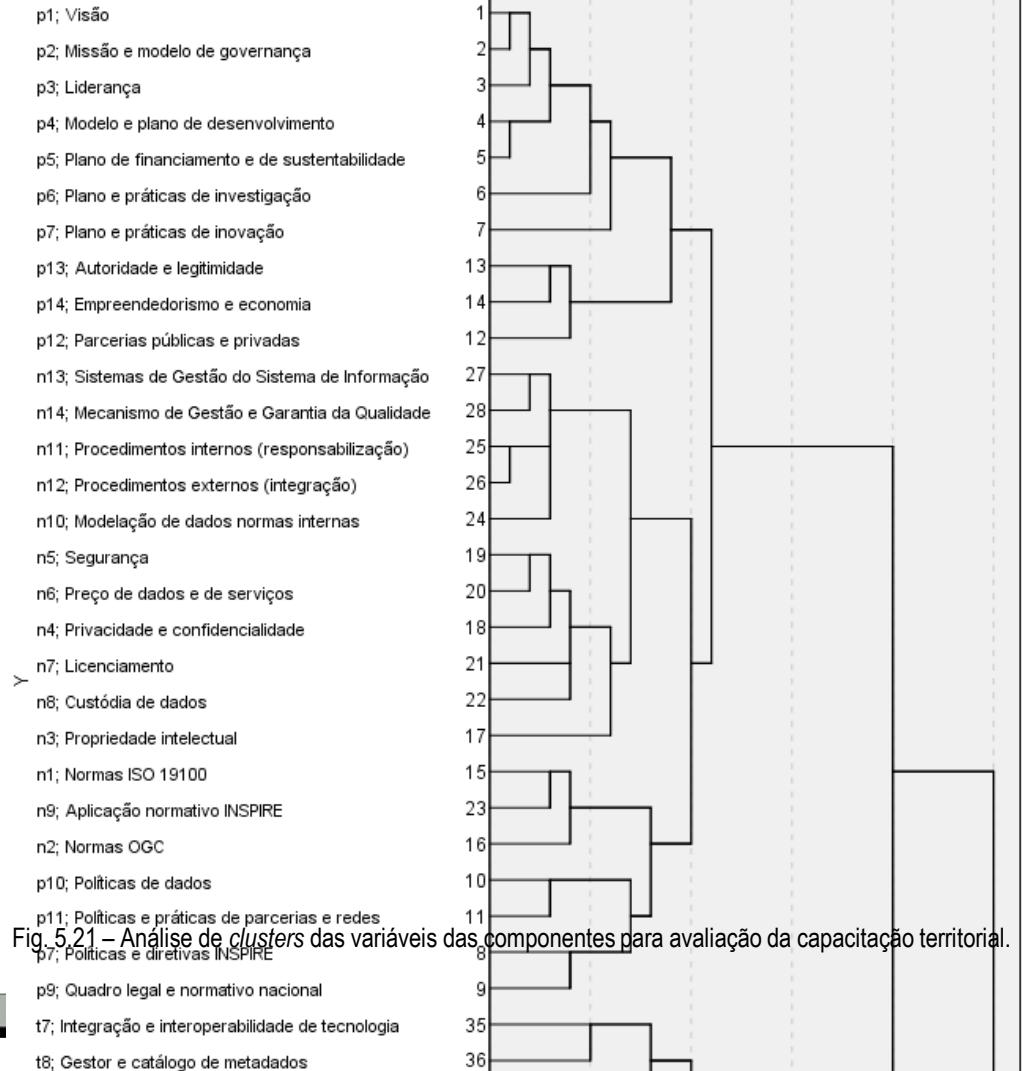


Fig. 5.21 – Análise de clusters das variáveis das componentes para avaliação da capacitação territorial.



Dendrogram using Average Linkage (Between Groups)

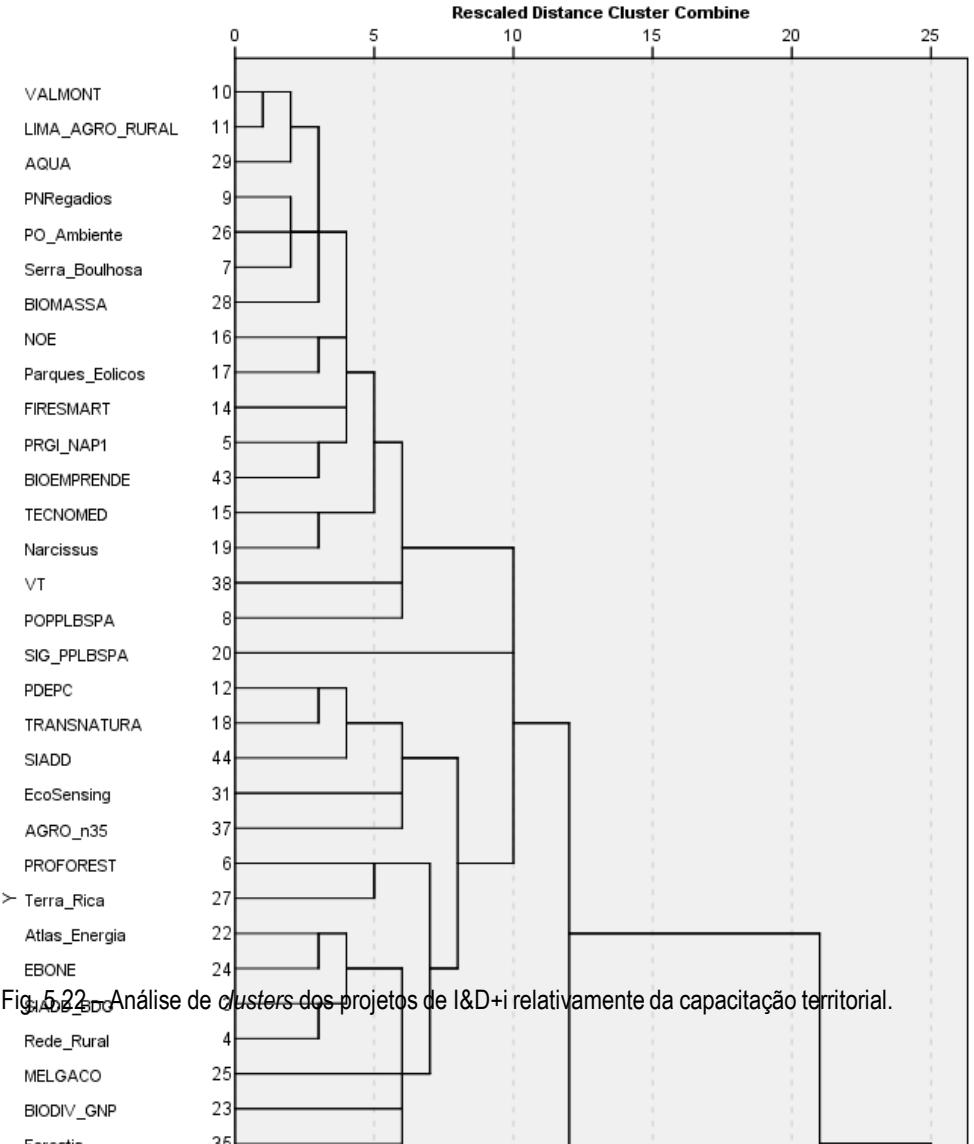


Fig. 5.22 - Análise de clusters dos projetos de I&D+i relativamente da capacitação territorial.



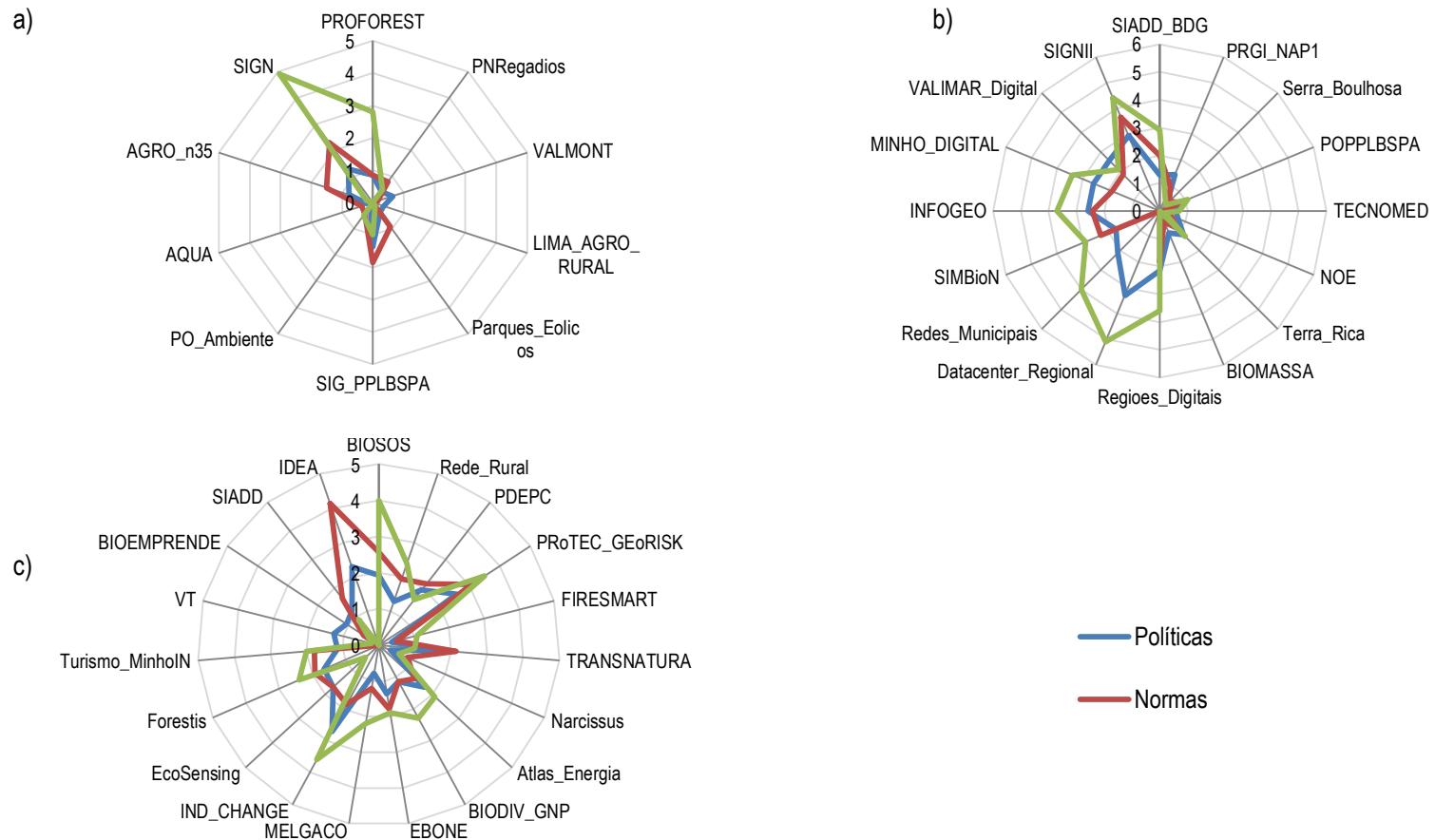


Fig. 5.23 – Avaliação da capacitação territorial por componentes, projetos e períodos de tempo a) até 2005; b) 2006-2010 e c) 2011-2015.



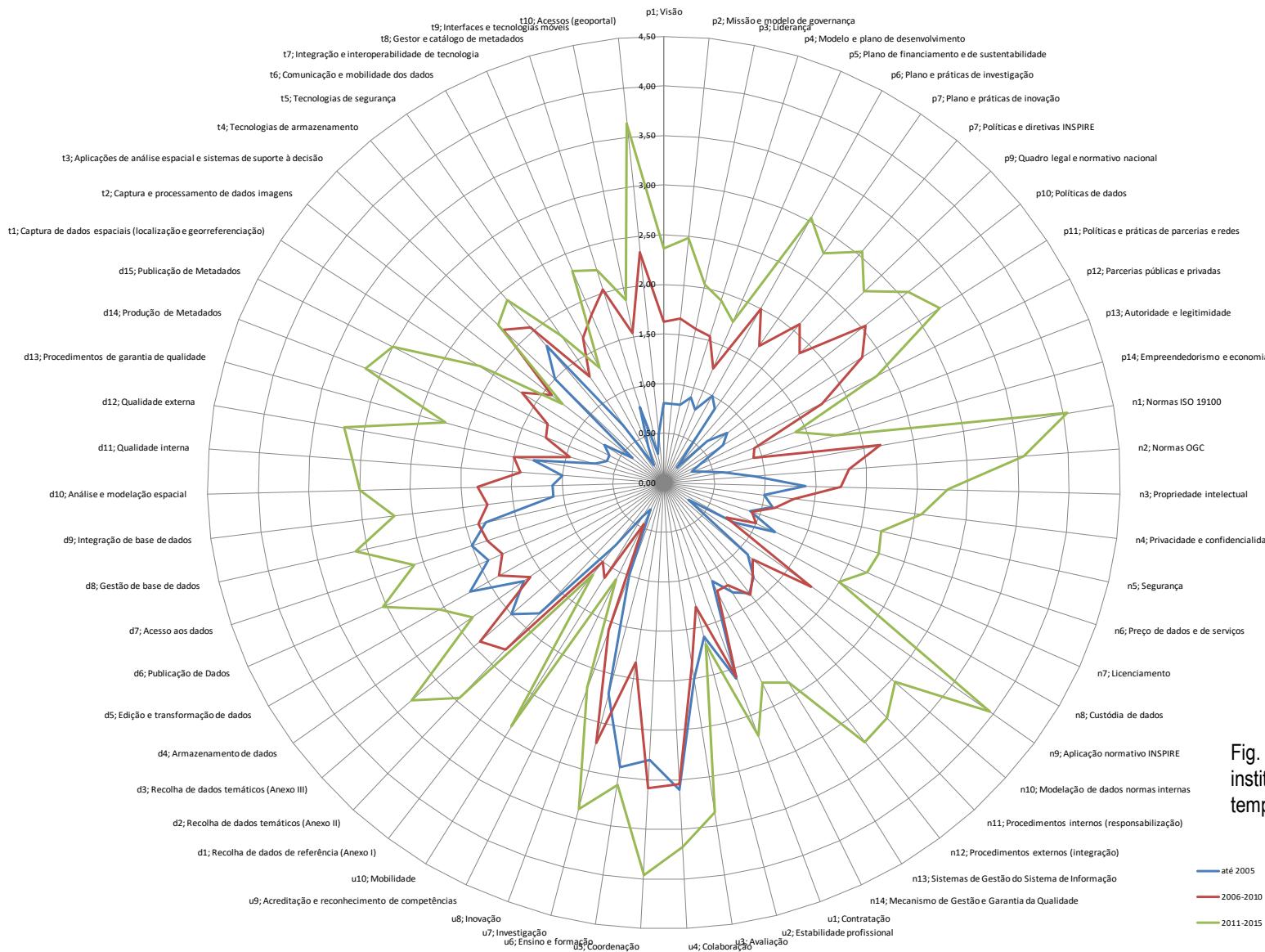


Fig. 5.26 – Avaliação da capacitação institucional por variável e períodos de tempo.

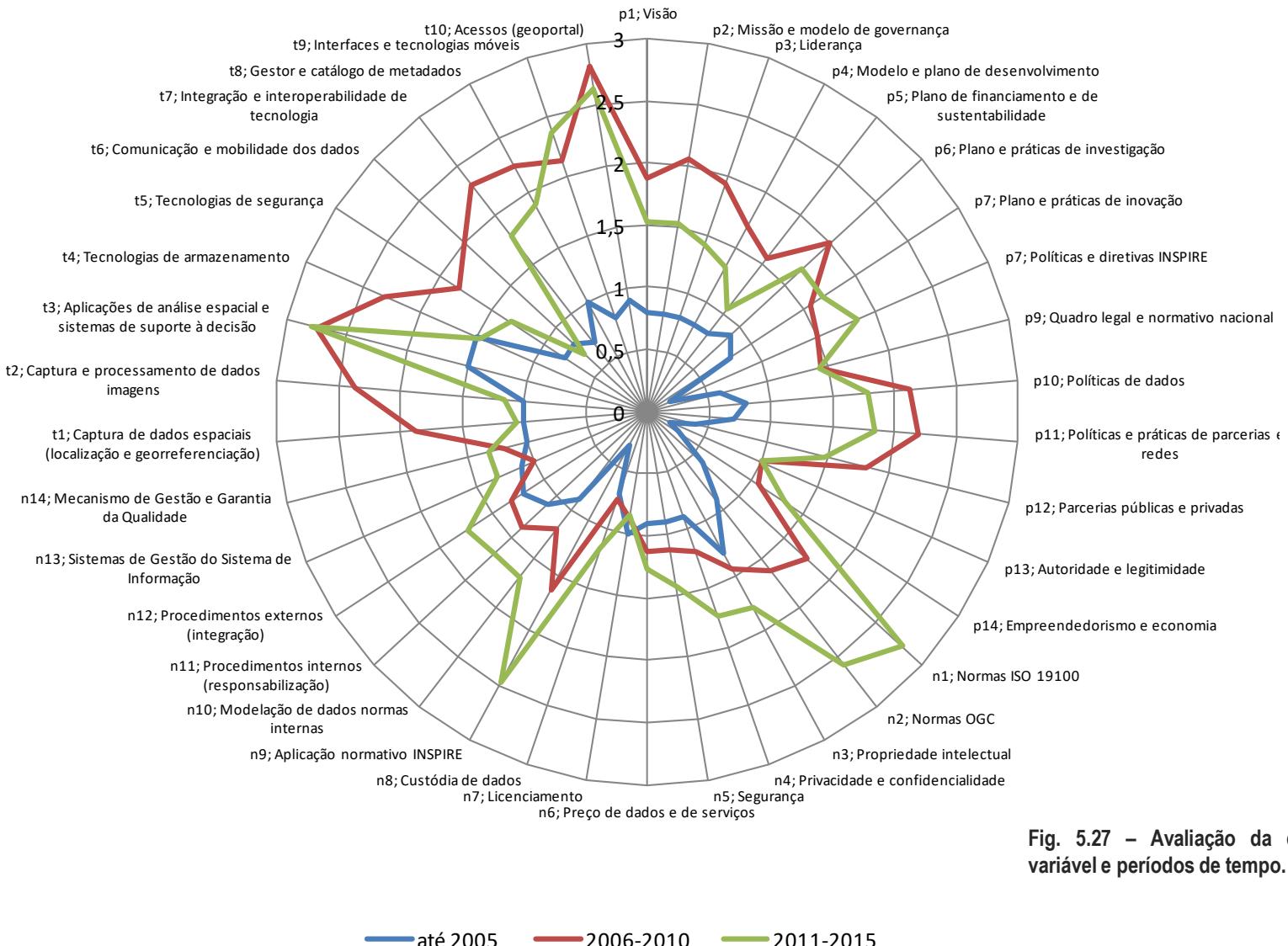


Fig. 5.27 – Avaliação da capacitação territorial por variável e períodos de tempo.

Conclusions and final remarks

The evaluation model proved to be adequate to evaluate the GIS projects results towards formalizing a proposal for a Local SDI of Alto Minho.

However, it is important implement and operationalize the model, as well as adapt and compare to other scopes or implementation phases.

The evaluation of published experiments and the evaluation of several case studies support the proposal of a conceptual nature model, systemic and holistic about the hierarchical capacity to develop and sustain a SDI.

The exploratory model of the multilevel capacity building assessment contributes to new scientific concepts, approaches and SDI multidisciplinary evaluation models, formulates and proposes references, tools, training contents, a research program, planning practices and GIS, SDI and project management and monitoring.

This research develop and propose an **exploratory assessment model of multilevel capacity building** that questioning the extent to which GIS development projects enable individuals, institutions and regions to develop local (sub-national) SDI.



Gracias por su atención

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