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**© Department of Planning & Regional Development,
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Pedion Areos
PC 38334, Volos, Greece
Tel: +30 24210 74452-55, & Fax +30 24210 74380
http:www.prd.uth.gr
e-mail: g-prd@prd.uth.gr

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EDITOR'S PREFACE

The 1st International Geomatics Applications "GEOMAPPLICA" Conference includes the current and ongoing research activities and advances in Geomatics. Earth sciences focuses on real world problems, not only of individuals or working groups from the public or private sector, but also from organisations, research institutes and universities around the world. The use of Geospatial Data is the rising force to the various applications of Geomatics, covering sciences spanning from conventional Surveying to Global Mapping Systems, Aerial Photography to High Resolution Satellite Imagery Processing and Spatial Data Analysis to Geospatial Programming. The conference has been designed to encourage the exchange of ideas and knowledge between diverse groups of the scientific community concerned by current research initiatives in Geomatics.

A total of 51 manuscripts are included in the proceedings. Participants from 14 different countries contributed their work to the conference. The book of abstracts is published in a hard copy volume with an ISBN number, whereas the full papers have been edited and appear in form of e-proceedings in a CD-ROM with a separate ISBN number.

The papers have been arranged in the following 13 thematic topics:
Natural Disasters (11)
Geospatial Data & Analysis (4)
Laser Scanning (2)
Land Property (2)
Geophysics (2)
Urban, Rural & Regional Planning (7)
Cultural & Natural Heritage (1)
Architectural Engineering (1)
Geographic Information Systems & Spatial Management (6)
Remote Sensing (7)
Civil, Environmental Engineering & Management (5)
Positioning - Navigation (2)
Cartography (1)

The editor would like to thank:
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- the reviewers of the papers for their invaluable assistance in order to ensure high scientific standards;
- all participants for their involvement in the exchange of knowledge, know-how and ideas, which is the essence of this conference;
- Grafima publications for their contribution.

Prof. Dr. Konstantinos Perakis
Editor of the proceedings of the "GEOMAPPLICA 2014" Conference

Table of Contents

Organising and Scientific Board iii
Organising Committee iii
International Scientific Committee iii
Editor's Preface iv
Contents v

NATURAL DISASTERS

- **Atmospheric hazards monitoring and forecasting**
  Vassilis Amiridis, Stavros Solomos, Alexandra Tsekeri, Eleni Marinou, Stylianos Kazadzis, Evangelos Gerasopoulos, Themistocles Herekakis, Charalampos Kontoes 2
- **BEYOND Center of Excellence: flood mapping and modelling**
  Alexia Tsouni, Charalambos Kontoes, Emmanouela Ieronymidi, Antonios Koukouvinos and Demetris Koutsoyiannis 9
- **BEYOND Center of Excellence: geophysical activity 'seen' from space**
  Ioannis Papoutsis, Charalampos Kontoes, Athanassios Ganas, Vassilis Karastathis, Stavros Solomos and Vassilis Amiridis 15
- **Developing a EO-based Service for Real-time Monitoring of Urban Temperatures**
  Iphigenia Keramitsoglou, Chris T. Kiranoudis and Panagiotis Sismanidis 22
- **Operational fire disaster management via Earth Observation in BEYOND**
  Charalampos Kontoes, Themistoklis Herekakis, Ioannis Papoutsis, Ioannis Mitsopoulos, Stavros Solomos and Vassilis Amiridis 29
- **Multi-sensor network for monitoring subsidence and seismic motion in Kalochori urban site, N. Greece**
  Emmanouil Rovithis, Alexandros Savvaidis, Konstantia Makra, Athanasios Ganas, Constantinos Loupasakis, Emmanouil Kirtas and Betty Charalampopoulou 36
- **Real time evaluation of Natural hazard through Shakemaps for the recent shallow earthquake events in Greece**
  Alexandros Savvaidis, Kiriaki Konstantinidou, Christos Papaioannou, Basil Margaris, Nikos Theodoulidis, Elena Zargli, Petros Triantafylidis and Despina Kementzetzidou 44
- **Defining shallow structure properties by composing ambient noise and geological data for seismic risk mitigation: The case of Serres City (N. Greece)**
  Nikos Theodoulidis, Basil Margaris, Alexandros Savvaidis, Emmanouil Kirtas, Emmanouil Rovithis 52
- **Strong motion network toward real-time risk assessment: the case of AHEPA hospital**
  Sotiria Karapetrou, Dimitris Raptakis, Maria Manakou, Kyriazis Pitilakis, and Dino Bindi 59
- **Land subsidence in southwest Cyprus revealed from C-band Radar Interferometry**
  Pantelis Michalis, Anthi Giourou, Betty Charalampopoulou, Zhenhong Li, Yongsheng Li 66
- **3D city model using LIDAR & Digital color imagery in Kalochori region**
  Betty Charalampopoulou, Charalampos Manesis, Konstantinos Tsivikis, Alexandros Savvaidis, Konstantia Makra, Athanasios Ganas, Emmanouil Rovithis 72

GEOSPATIAL DATA & ANALYSIS

- **Data combination in 3D city modelling**
  Cumhur Sahin, A. Alkis, Bahadir Ergun, Sitki Kulur, Fatmagul Kilic and Ali Kilic..... 83
- **Analyzing urban patterns of Hellenic cities using the Urban Atlas**
  Maria K. Pafi and Demetris Stathakis 89
- **Recording and analysis of the reforested areas in the municipal section of Akrotiri, using GIS**
  Androniki Tsouchlaraki and Virginia Bariotaki 95
- **Classification of multi-spectral satellite imagery using machine learning algorithms**
  Stamatis P. Georgopoulos 102

LASER SCANNING

- **Laser Scanning in the Service of the Visually Impaired**
  P. Tokmakidis, S. Spatalas, K. Tokmakidis, V. Tsioukas..... 108
- **Point cloud segmentation via neuro fuzzy method**
  Bahadır Ergün, Cumhur Şahin, Taner Üstüntaş..... 114

LAND PROPERTY

- **Spatial analysis of the residential real estate market in the Greater Athens Region, Greece**
  Polixeni Iliopoulou and Panagiotis Stratakis..... 122
- **Design of a Model for Managing Public Property in Greece**
  Eftychia Kalogianni and Efi Dimopoulou 130

GEOPHYSICS

- **Earthquake anomaly recognition through time series satellite data**
  Maria A. Zoran, Roxana S. Savastru, Dan M. Savastru 137
- **Wavelet approach for analysing a regional gravimetric geoid: Saudi Arabia case study**
  Abdulaziz Alothman, Rossen Grebenitcharsky, Basem Elsaka..... 144

URBAN, RURAL & REGIONAL PLANNING

- **Employment infrastructure in mountainous areas**
  Anastasia Stergiadou, Vasileios C. Drosos, Aristotelis – Kosmas G. Doucas and Vasileios J. Giannoulas 152
- **Spatial configuration of soil sealing: Cyclades islands case study**
  Georgios Tsilimigkas, Leonidas Liakos, Aikaterini Chatzikonstantinou 165
- **The National Geographic Information System for Asbestos Mapping**
  S. Bellagamba, F. Paglietti, S. Malinconico, B. Conestabile della Staffa, P. De Simone 172
- **Morphology of land use patterns of medium-sized Hellenic cities**
  Georgios Tsilimigkas, Demetris Stathakis, Anestis Gourgiotis..... 179
- **Development of an earthquake-refuge zoning model using GIS**
  Ioannis Katsios, Maria Vallatou, Sotirios Karalis, Andreas Tsatsaris..... 186

- **Evaluation of Land Reform Policies in Turkey**
  Tayfun Cay, Nuh Toklu, Omur Esen *193*
- **Legal framework spatial database for architectural heritage. FOSS application in Aegean islands traditional settlements**
  Leonidas Liakos, Georgios Tsilimigkas, Aikaterini Chatzikonstantinou *199*

CULTURAL & NATURAL HERITAGE

- **Historic Centers of Transylvania Cities: Prospects for the Protection of Architectural Heritage in Romania**
  Nikolaos C. Samaras and Adamantia A. Athanailidou *206*

ARCHITECTURAL ENGINEERING

- **Maintenance and Restoration of "Xenia Motel Zeus II" in Ancient Olympia: an approach for the sustainable existence of Xenia Hotels, works of Aris Konstantinidis**
  Nikolaos C. Samaras and Vasiliki D. Chrysina *214*

GEOGRAPHIC INFORMATION SYSTEMS & SPATIAL MANAGEMENT

- **Design of plug-in based open software framework for 3D GIS**
  Chen Gang, Li Heyuan, Chen Min, You Xiong, Lin Hui *222*
- **From Spatial Data Infrastructures to Planning Support Systems**
  Michele Campagna, Konstantin Ivanov, Andrea Matta, Pierangelo Massa *227*
- **Disaggregating GDP data in Greece using DMSP-OLS data as a proxy variable**
  Dimitrios Triantakonstantis and Demetris Stathakis *234*
- **An approach to flooding prediction using GIS and time series decomposition: An example of flooding in Mohawk River, New York**
  Antonios E. Marsellos and Katerina G. Tsakiri *239*
- **Wind park site selection of the Zakynthos island, Greece, by means of Geographical Information Systems and Remote Sensing**
  Maria D. Aktypi, Athanasios K. Moysiadis and Konstantinos G. Perakis *246*
- **Determination of Traffic Accident Black Spots on Afyonkarahisar-Konya Highways**
  Mehmet Ali Dereli, Saffet Erdoğan, İbrahim Tiryakioğlu, Murat Uysal, Hüseyin Akbulut, Süleyman Dündar, Mustafa Yalçın, Ahmet Emin Gülal, Yaşar Arslan, Mahmut Kantar, Alper Çabuk and Ömer Soysal *251*

REMOTE SENSING

- **Fixing the spatial congruency of remote sensing data for accurate pansharpening**
  Aristides D. Vaiopoulos, Konstantinos Karatzalos and Demetres Argialas *259*
- **Integrated IR-MAD and OBIA for supervised change detection: The case study of Polifitos Dam in Greece**
  Ch. Z. Pasiakou, M. D. Tsakiri- Strati, S. Siachalou and G. Doxani *266*
- **Visual satellite imagery interpretation for the city of Kastoria**
  Maria A. Lazaridou and Aikaterini Ch. Karagianni *279*
- **The effect of normalization for primitive object creation in SAR imagery above Aegean Sea**
  Konstantinos N. Topouzelis, Dimitra Kitsiou *286*

- **Weekly time series of LAI maps at river basin scale using MODIS satellite data**
  Nikolaos Silleos, Stavroula Strati, Ines Cherif, Charalampos Topaloglou, Thomas K.Alexandridis, Charalampos Iordanidis, Domna Stavridou, Styliani Monachou, Christos Kalogeropoulos, Georgios Bilas, Nikolaos Misopolinos, Tomas Fernando Chiconela, Waldenio Gambi de Almeida, Isnaeni Murdi Hartanto, Schalk Jan van Andel, Antonio Nunes, Antonio Araújo and Pedro Chambel-Leitao *293*
- **Temperature- urban land cover interactions derived from time-series MODIS and Landsat satellite data**
  Maria A. Zoran, Roxana S. Savastru, Dan M. Savastru, Marina N. Tautan..... *300*
- **Image classification with SVM in a NATURA 2000 network protected area in Central Greece**
  C. Topaloglou, G. Efthimiou, and K. Perakis..... *307*

CIVIL, ENVIRONMENTAL ENGINEERING & MANAGEMENT

- **The Development of a Multi-Criteria Decision Support System to Approach Forest Opening-Up Assessment**
  Vasileios C. Drosos, Sarantis-Angelos G. Liampas, Nikolaos A. Skondras and Christos A. Karavitis *314*
- **Development and testing of a simple soil erosion model**
  Sotirios Karalis, Ioannis Katsios, Efthimios Karymbalis..... *323*
- **Dynamics of strategic design systems in the forest opening up**
  Vasileios C. Drosos, Sarantis-Angelos G. Liampas, Naoum Tsolakis..... *330*
- **Applications of terrestrial laser scanning in coastal engineering**
  Theodore G. Panagou and Emmanouil K. Oikonomou..... *335*
- **Information System Development for Data Management of Analytical Measurements in Protected Areas**
  Georgios N. Kouziokas..... *341*

POSITIONING – NAVIGATION

- **Evaluation of Precipitable Water from GPS permanent networks over Greek areas using external data**
  S. Katsougiannopoulos, T. Papadopoulos, S. Bitharis, C. Papadopoulos and C. Pappas *349*
- **Mobile Signal Distribution via Spatial Visualization**
  Malik Muhammad Fahad and Mohammed Aldakhil..... *357*

CARTOGRAPHY

- **Cartographic Generalisation on UK Ordnance Survey Maps**
  Vasileios D. Kofinas and Athanasios K. Moysiadis..... *364*

Author index..... *372*

Subject index..... *375*

Sponsors..... *379*

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From Spatial Data Infrastructures to Planning Support Systems

Michele Campagna*[1], Konstantin Ivanov[1,2], Andrea Matta[1], Pierangelo Massa[1]
[1]Università di Cagliari, DICAAR, Via Marengo 2, 09123 Cagliari, Italy
[2]Tomsk Polytechnic University, Lenina Avenue, 30 Tomsk, Russia

*Corresponding author. E-mail: campagna@unica.it

Abstract
Developments in Spatial Data Infrastructures (SDI) offer spatial planners unprecedented wealth of digital spatial data and services, which may be used to support more informed decision-making in urban and regional planning. However, these resources are often underexploited due to lack of the necessary skills by practitioners, so missing the opportunity for innovation in the planning practices. Geodesign is an emerging approach which bridges the gap between spatial planning and design, and Geographic Information Science. The main underlying assumption in Geodesign is that geographic knowledge and geo-information technologies can support more informed design and sustainable decision-making in urban and regional planning. This contribution presents two different approaches developed by the authors to research in Geodesign. The first approach concerns the development of methodology-oriented 1st generation Planning Support Systems (PSS 1.0) for Local Land-Use Planning and Strategic Environmental Assessment (SEA-LLUP). The second approach concerns base research for the definition and development of process-oriented 2nd generation Planning Support Systems (PSS 2.0). The results aim at demonstrating how Spatial Data Infrastructures can be used as a base for Planning Support System implementation in spatial governance.
Keywords: Geodesign; metaplanning; Planning Support Systems; Land-use Planning, Strategic Environmental Assessment.

1. INTRODUCTION

Nowadays, developments in Spatial Data Infrastructures (SDI) offer spatial planners an unprecedented wealth of digital spatial data and services, which may be used to support analysis, design, and more informed decision-making in urban and regional planning. Since the early conceptualization in the late Eighties, SDI have been promoted as an innovative way to enable the public access and reuse of available Authoritative Geographic Information (A-GI) according to common data, technology, interoperability and policy standards. Both the underlying coordination and documentation of available resources into SDI may grant professionals and citizens an easier access to spatial data for diverse purposes.

Recently, the adoption of the Directive 2007/02/EC, establishing a shared INfrastructure for SPatial InfoRmation in Europe (INSPIRE) fostered the development of SDI in Member States and regions. SDI may provide beneficial impacts for public administration, developers and planning practitioners, and is growingly bringing innovation into environmental protection and the planning practices [1]. As a matter of facts, in several Italian regional governments such as Lombardy, Tuscany and Sardinia among others, the regional SDI represents the de-jure technical platform and knowledge base for the development of spatial planning and governance, eventually affecting the content and format of the planning knowledge. These resources are often underexploited due to the lack of skills by practitioners in properly taking advantage of SDI, and therefore opportunities for innovation in spatial planning are missed.

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According to the principles of the Rio Declaration in 1992, Agenda 21 [2] strengthen the role of information in decision-making as a fundamental dimension for the sustainability of development, and the European policies transpose these concepts into the practice of environmental impact assessment. The Strategic Environmental Assessment (SEA), introduced in Europe in 2001 by the Directive 2001/42/EC, aims to provide high level of environmental protection by the introduction of environmental considerations in plan-making according to sustainability principles. SEA can be defined as a structured, rigorous, participative and transparent process that is applied to plans and programs, in order to ensure the assessment of their potential impact on the environment [3]. However, after a decade of its adoption and widespread diffusion in Europe, several issues arose about its capability to inform decision-making in regional or local planning process [4].

In the light of these considerations, while traditional planning methods and tools may be outdated or lack in competitiveness, new approaches and tools would be a major opportunity for addressing SEA issues and for innovation in spatial planning.

Geodesign is an emerging approach to spatial planning and design which bridge the gap between planning itself and the Geographic Information Sciences. The main underlying assumption in the Geodesign approach is that geographic knowledge and geo-technologies may support more informed design and sustainable decision-making by means of project conceptualization, analysis, projection and forecasting, diagnosis, alternative design, impact simulation and assessment [5]. Central to Geodesign is the concept of metaplanning, which can be defined as the design of the planning process through the specification of actors, activities, methods, tools, inputs, outputs and workflows [6], in order to improve both process outcomes and its management and implementation. The innovation in Geodesign, compared to older planning approaches, falls on the extensive use of digital spatial data, processing, and communication resources, and on its different ways of implementation.

One possible way to foster its adoption relies on the integration of methods and tools in Planning Support Systems (PSS). The concept of PSS was introduced by Britton Harris in 1989 [7] as a user-friendly microcomputer-based planning system, which integrates GIS, sketch tools and spatial models for supporting the planning functions. PSS research produce promising results, however their diffusion in the practice is rather limited possibly for a lack in flexibility, thus of adaptability to contextual settings of the planning processes.

With the above premises, the paper is organized as follows. In section 2 the current results of a research project developed by the authors aiming at applying the Geodesign approach for the development of a Local Land-Use Planning and SEA (SEA-LLUP) PSS are presented. This 1st generation PSS, or PSS 1.0, can be a viable solution to exploit SDI resources as a support to spatial planning in the short-medium term. Then, in Section 3, base research results on 2nd generation PSS, or PSS 2.0, are reported: BPM methods and tools have been applied to implement the metaplanning concept in the urban and regional planning domain, arguing that metaplanning may both improve the process design and management and ease process-oriented PSS development accordingly.

2. THE APPROACH IN THE SHORT-MEDIUM TERM: A PSS 1.0

Spatial Data Infrastructures and services allow the sharing of official spatial data to support spatial planning at the local level; however their potential is not fully exploited. The pilot project on the Sardinia case study presented in this section demonstrates an advanced use of SDI spatial data and services for spatial planning support.

The core of the contemporary regional planning system in Sardinia is characterized by a Regional Landscape Plan (RLP) adopted for the first time in 2006. RLP defines protection rules for landscape

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safeguard and coordinates local development and municipal Local Land-Use Plans (LLUP), which in turn implement the RLP policies. In addition both the RLP and the LLUPs should undergo SEA along their preparation.

The spatial governance of the Sardinian planning system is supported since the early 2000s by the Regional Government Geographic Information System that provides all the main INSPIRE SDI components. The Sardinian Regional SDI (SRSDI) currently offers over 300 data layers and an unprecedented availability of spatial information, which can be used for supporting the Geodesign approach to address pitfalls in SEA-LLUP. In order to test the potential of the SRSDI as knowledge base for Geodesign, a PSS 1.0 prototype for SEA-LLUP has been developed by the authors.

The main features of the PSS allow supporting real-time planning collaboration and interaction among stakeholders, and the creation of the outputs, easing the editing of the environmental report. Innovative tools have been implemented in the PSS architecture, such as Land suitability Analysis [8] to support the real-time design of alternatives through the Sketch Planning tool, which allows on–screen hand-drawing using a digital pen and to immediately calculate the impacts of different solutions by interactive impact assessment models. These models are based on a structure of indicators able to evaluate which alternative design scenario provides better overall performance.

The indicators are implemented according to a Driver-Pressure-State-Impact-Response (DPSIR) framework. This framework defines an analytic system to evaluate the interaction between environmental and human systems [9]. The Driving Forces (D) define human needs that generate Pressures (P) on the environment, and consequently changes in its State (S). The DPS causal chain defines the causes [10] of the problem, and their impacts are evaluated through the Impact (I) component. The last component, the Response entails different alternative solutions to mitigate the impacts and/or provide societal responses to the problems [10].

Moreover, in the LLUP PSS a Spatial DPSIR (sDPSIR) model was developed implementing the DPSIR framework in a Geographic Information System (GIS) [11]. In the sDPSIR many of the DPS components are described by the RSDI spatial data themes. Each D-P-S component is represented by an indicator or combination of them in order to provide information about the system components and their relationships. At the same time the model can be used to populate SEA indicators. This way it is possible to fulfill regulation and official guidelines requirements, and also to inform interactively decision-making along the plan-making process.

According to the results of the impact assessment, diverse societal responses can be defined as plan options or actions in order to mitigates risks and control current environmental processes. The results can be used to support the collaboration among stakeholders. In fact, the SEA-LLUP PSS provides an interactive dashboard for the live evaluation of indicators performance. The dashboard defines automatically new quantitative value(s) for indicator(s) as soon as the planner sketches in the interface, enabling the real-time evaluation of the solution taken in the plan. Finally, an automatic reporting tool is included in the architecture of the PSS, allowing the inclusion of indicators performance through predefined templates in the environmental report.

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Figure 1. SEA-LLUP PSS: interactive sketch design and dashboard indicators

The SEA-LLUP PSS pilot demonstrates the potential of regional SDI for bringing innovation spatial planning methods possibly improving the knowledge base informing the decision-making process. Being based on the data of an INSPIRE compliant SDI, the SEA-LLUP PSS may be used for any municipality in Sardinia and also easily adapted to other regional context in Europe.

3. IMPLEMENTING METAPLANNING WITH BUSINESS PROCESS MANAGEMENT

Development in SDI however, thanks to the adoption of interoperability standards may in the future support the development of Service Oriented Architecture (SOA) for 2nd generation PSS, fostering a shift from methodology-oriented PSS 1.0 to process-oriented PSS 2.0. This shift is based on the implementation through BPM of the concept of metaplanning which supports process-orientation. Metaplanning can be defined as the explicit design of a planning process and should be introduced into plan-making process as a well-defined step. Indeed, metaplanning can increase the collaboration among actors and improve the reliability of the outcomes of the process [12]. Furthermore, Campagna [6] argues that also responsibility, transparency, and accountability in the planning process should be increased, as well as the definition of specific requirements for easing process-oriented PSS implementation. The latter purpose could be accomplished by coupling an appropriate methodological approach with a technical approach for the implementation of metaplanning on an operational level. In this paper the authors propose the use of Business Process Management (BPM) techniques as a valid approach for the metaplanning implementation. BPM includes concepts, methods and techniques to support the design and the analysis, as well as the administration, the configuration, and the enactment of business processes [13]. Hence, BPM can be applied to reach two main objectives: on the one hand it can support the process improvement (i.e. business perspective: design and analysis), while on the other hand it can simplify the integration of external information systems (i.e. IT perspective: configuration and enactment). Therefore, a solution for implementing the metaplanning in the urban and regional planning with BPMN is proposed. The approach relies on the use of a Business Process Management Suite (BPMS) for the modeling of planning process, and on a BPM engine for the orchestration of geo-processing services and the integration of external systems.

In a pilot project developed by the authors, Bonita BPM Community Edition v6.3.1 suite was chosen as BPMS. Bonita BPM is an open source platform with a complete set of BPM functionalities, accessible through an user-friendly interface. In Bonita BPM the configuration of the process is supported by connectors, which link data and processing services to the process activities. Connectors may take input from the end-user or directly from the process, and may pass the result of the execution to the following activities, or save them in external information systems. In the current version of the BPMS, built-in connectors to the most used productivity information system and services including messaging, databases, corporate information systems (e.g. CRM,

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ERP, or CMS), and web services (using SOAP protocol) are available. For example, business process tasks can send a pre-defined customized email to the customer using an email connector. Unfortunately, accessing spatial data (e.g. WMS, WFS or WCS) and processing services (i.e. WPS) requires special connectors that are not provided. Nevertheless, Bonita BPM allows the development and testing of new connectors using the Bonita BPM Engine APIs. Hence, the first challenge to be addressed in our pilot in order to implement a test-bed for the implementation of BPM-based metaplanning and for a 2nd generation PSS platform was to create connectors for spatial data and processing services.

Three different approaches have been tested so far in the project, including both complex (i.e. desktop applications) and atomic components (i.e. spatial data and processing services). The architecture of BPMS with external applications and web services is presented in Figure 2a. The examples are based on a single case study simulating a land suitability analysis [8], which can be considered as a sub-process of a more complex planning process model (Figure 2b). The sub-process involves a number of tasks that should be performed in coordination by different actors in the organizational environment (i.e. the planner and the decision-maker in this example). The execution ordering of activities and the sequence flow among actors, representing the handover of tasks, can be finely modeled through BPMN in Business Process Diagrams. During the process execution, actors interact with Bonita BPM Portal that provides the end-user interface for desktop and mobile whereby actors can manage the assigned tasks.

The first solution enables the integration of existing GIS application. For this purpose a custom connector that launches desktop GIS projects during the workflow run has been developed by the authors. This connector can be represented as a system script that enables to call desktop GIS applications on the end-user working station by executing system commands in the script interpreter (i.e. the Windows Command Prompt). This capability may allow the coordination of work among people and the assignment of specified activities according to individual roles. In the case study example the connector is used to automatically call a pre-configured GIS project in the planner platform to execute the LSA. This first approach aims at demonstrating how the integration of BPMS and desktop GIS application offers a technical environment able to coordinate collaborative activities among the actors of a planning process, supplying GIS (and not-GIS) to the BPMS run-time functionalities during the workflow execution. This first solution can be considered viable for planning support in those cases where the task requires relevant flexible human intervention. However, in a number of tasks which may be instantiated in an urban and regional planning process, more advanced automation may improve efficiency.

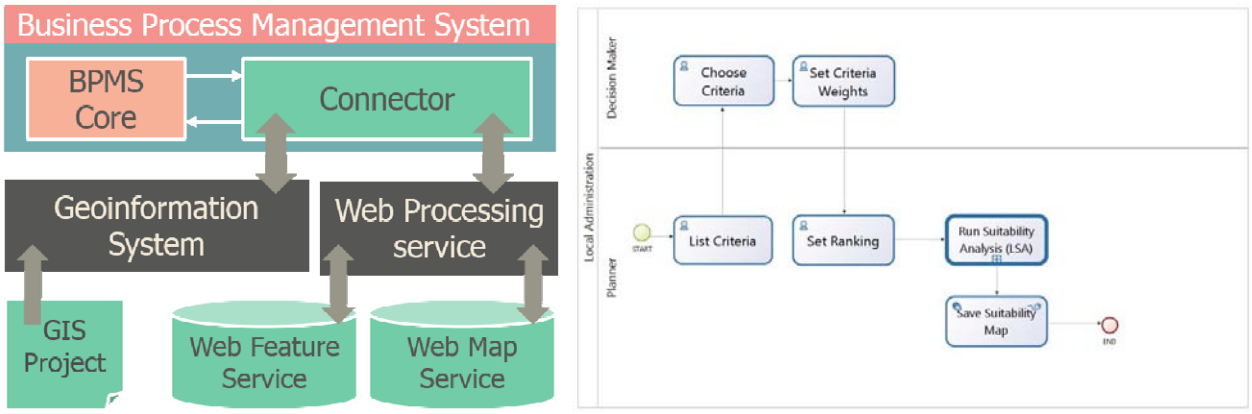

Figure 2. (a) The architecture of the BPMS. (b) Land Suitability Analysis BPD modelled in BPMN

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The second solution concerns the orchestration of standardized spatial data and web services directly within the BPMS. To this end, a custom connector invoking spatial web services (i.e. WFS, WPS) has been developed in Java, in order to enable the spatial services chaining by the BPMS. A special connector was developed to create and invoke requests to WPS by reading stored information in the process input data, acquiring input feature layers from WFS, and setting parameters for WPS execution. In this solution the 52°North WPS with 220+ SEXTANTE Processes extension on Apache Tomcat 7.0 was used. In this solution the first four activities are performed by humans, then the results are transmitted to the Run Suitability sub-process, which performs the WPS operations. The result of the LSA can be loaded in a desktop GIS application or can be published as a WFS layer on GeoServer for sharing. The purpose of this second solution is to demonstrate the orchestration of spatial web services via BPMS. Unlike the previous example, in this case a greater programming effort was required. However, this second solution may open further alleys for process-oriented PSS 2.0 development. However, despite current research efforts in web services technologies, the required set of geo-processing tools for urban planning is still not fully realized as standardized Geoprocessing Services (e.g. OGC WPS implementation) [14]. Hence, a third solution was developed to cope with this issue.

The latter approach aims to orchestrate spatial data and web services within the BPMS at the same atomic level as provided by the second solution, but involving the use of system script connectors and a web-service developed by the authors using Python. A web-service running on Apache Tomcat 7.0 executes Python scripts that invoke geo-processing functions and make them available via Common Gateway Interface (CGI). At the current stage of implementation of the reject, the web-service supplies a number of geo-processing functions including buffer, merge, union, add field and field calculator, but any other can be developed alike. Each of these services can be accessed by developing custom connectors, which can be represented as python scripts that control input and output parameters, querying the geo-processing models via CGI. The third solution may overcome issues regarding the lack of manifold functionalities on available WPS, but a great programming effort is required for the development of server-side Python scripts and related custom connectors. However, the integration of this solution may offer further flexibility to work on 2nd generation PSS research, until standard WPS will be implemented in more robust server applications.

4. CONCLUSIONS

In the last decade European Directives on Strategic Environmental Assessment and on Spatial Data Infrastructures generated favorable conditions for innovation in the planning practices. However, current pitfalls can be addressed only if the planners will be able to exploit available digital information resources to carry on knowledge-based design and decision-making processes. To this end, a Geodesign approach may offer reliable methods and tools to develop integrated Planning Support Systems.

On the base of these assumptions, this paper proposes two different approaches tested by authors to achieve results in the short-medium and in the medium-long term, concerning 1st and 2nd generation Planning Support Systems respectively.

On the one hand, the SEA-LLUP PSS shows a possible way to implement the Geodesign approach in the practice, and demonstrates how a regional SDI can be used as base for PSS implementation, providing a support for sustainable spatial governance. On the other hand, first results on metaplanning research shows how a BPM approach could be a viable solution for spatial planning process improvement and towards the agile development of process-oriented 2nd generation PSS.

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SUBJECT INDEX

ISBN: 978-960-88490-9-9

Subject Index

3DGIS, 222

AADT, 251
active fire detection, 29
Aegean islands, 199
aerotriangulation, 72
algorithms, 364
Arachthos river, 323
archaeology, 108
architectural heritage, 206
architecture, 108
Aris Konstantinidis, 214
artificial lake, 266
asbestos
  containing waste, 172
  risk mapping, 172
asking prices, 122
atmospheric hazards, 2

Biogeophysical parameters, 300
Bucharest, 300
burn scar mapping, 29

CALIPSO, 2
cartography, 364
city planning, 83
coastal engineering, 335
coKriging, 234
collocated accelerometric-GNSS stations, 36
Cyclades island, 165

Damage assessment, 15
decision
  makers, 314
  Support System, 314
digital image processing, 279
DSM, 72
dust, 2

Early earthquake warning, 59
earthquake(s), 186
  anomaly, 137
  loss, 44
  recordings, 36
  shelter zoning, 186
economic development, 330
Empirical Bayes, 251
environmental
  Information System, 341
  modeling, 323
  planning and management, 341
European Urban Atlas 2006, 179

Fire
  mapping and damage assessment, 29
  recovery, 29
FLEXPART, 2
flooding
  prediction, 239
  trigger level, 239
floods, 9
forest opening up, 314
FOSS, 199
fuzzy logic, 114

Generalization, 364
geodatabase, 95
geodesign, 227
geodetic signal, 144
geo-hazards, 15
GIS, 95, 172, 186, 239, 246, 251
GPS, 349
  meteorology, 349
graphics engine, 222
gravity data, 144
greater Athens region, 122
Greece, 165, 199
Greek cities, 89
Gross Domestic Product, 234
ground
  acceleration, 44
  subsidence, 36

Hellenic
  Cadastre (HC), 130
  cities, 179
  Statistical Authority, 89
high spatial resolution, 259
historic centers, 206

Image
  Fusion, 259
  interpretation, 279
INDES-MUSA project, 36

ISBN: 978-960-88490-9-9

Info Clouds, 72
InSAR, 66
integration, 83
IR-MAD, 266
Iteratively Re-weighted Multivariate
  Alteration Detection, 266

KZ filter, 239

Land
  Administration Domain Model (LADM), 130
  cover, 300
  management, 130
  reform, 193
  regulation, 193
  subsidence, 66
  surface temperature, 22
  use, 179
    Planning, 227
Landsat 8, 300, 307
landscape
  metrics, 165
  pattern metrics, 179
Large Urban Zones, 179
laser scanning, 83
Leaf Area Index, 293
legislation, 95
LiDAR, 36, 239
lidar ratio, 2

Machine learning, 102
maintenance, 206, 214
mapping, 9
  Change Detection, 266
  systems, 341
metaplanning, 227
methodological framework, 330
micro kernel, 222
MISR, 2
modelling, 9, 83
MODIS, 293, 300
monitoring, 59
multi
  -criteria analysis, 314
  -resolution analysis, 144
  -spectral data analysis, 102
multispectral, 259
NATURA, 307
natural
  disasters, 9
natural (cont.)
  hazards, 186
nearshore bathymetry, 335
Negative Binomial, 251
network analysis, 186
Night-Time Light Data, 234
noise and recordings, 59
normalization, 286
NUTS, 234

Object-based image analysis, 266
ocean, 286
operational fire monitoring, 29
Ordnance Survey maps, 364
orthorectification, 72

PCRaster GIS, 323
photogrammetry, 83
Planning Support Systems, 227
plug-in framework, 222
point cloud segmentation, 114
Poisson, 251
PostGIS, 199
PostgreSQL, 199
precipitable water, 349
PSI, 15
public property, 130
Pyqt, 199
Python, 199

Qgis, 199
Quality Index UIQI, 259

Radar interferometry, 15
rapid prototyping, 108
rational evaluation, 314, 330
real-time
  risk assessment, 59
  spatial information, 44
reforested areas, 95
remote sensing, 9, 102, 246, 279, 286, 293, 307
Renewable Energy Sources, 246
residential real estate market, 122
restoration, 214
Romania, 137, 300

SAR, 286

satellite
  remote sensing, 137

ISBN: 978-960-88490-9-9

satellite (cont.)
  sensors, 259
secondary sector, 152
seismic
  active regions, 137
  risk, 52
Serres, 52
SEVIRI, 22
Shakemaps, 44
shallow structure, 52
site
  effects, 52
  response, 59
smoke, 2
soil
  erosion, 323
  sealing, 165
spatial
  metrics, 89
  multivariate analysis, 102
  regression, 122
Spercheios river, 307
Strategic Environmental Assessment, 227
structural identification, 59
sustainable
  development, 152
  existence, 206, 214
SVM, 307

Terrestrial Laser
  Scanner, 335
  scanning, 108, 114
tertiary sector, 152
thematic maps, 95
time series, 66
  NOAA-AVHRR and MODIS data, 137
  satellite data, 300
tooling, 152
traditional settlements, 199
traffic accident, 251
Transylvania, 206
tropospheric delay, 349

Urban
  Atlas, 89
  environment, 279
  heat island, 22
  patterns, 89
urbanization, 300
use of rural land, 193

Vegetation indices, 293
Vrancea area, 137

Water wave surface, 335
wavelets, 144
WebGIS, 341
wildfires, 29
wind park site selection, 246
World Cultural Heritage, 108

Xenia Hotels, 214

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