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Metaplanning: About designing the Geodesign process

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HIGHLIGHTS

- Metaplanning is about the design of the planning process.
- Metaplanning is a core element in Geodesign.
- Metaplanning can be implemented with Business Process Management.
- Metaplanning improves actors collaboration and make the process transparent.
- Metaplanning supports process-oriented 2nd generation PSS design and implementation.

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ABSTRACT

Geodesign entails complex processes involving multidisciplinary teams of professionals supporting stakeholders and communities in devising and choosing sustainable future development scenarios for their territories. The roles and the relationships among the actors may vary according to the underlying planning paradigm or style which the local normative and socio-cultural factors shape in the actual practices. Methods and tools to be used in the process phases may vary accordingly. A Geodesign study is characterised by the integrated usage of Geographic Information Science methods and tools to transform spatial data into relevant knowledge for informed design and decision-making. Thus, central to Geodesign are such issues as how to design and manage such complex processes, and how to orchestrate digital methods and tools in Geodesign support systems architectures. To address these challenges, the concept of metaplanning is proposed as an aid to the design of Geodesign processes. Expected benefits of the metaplanning exercise include better process understanding by the participants, improvements in management, and enhanced process transparency and accountability. Moreover, metaplanning may drive the integration of digital information technologies to support the Geodesign workflows.

After the formalization of the concept, a Business Process Management (BPM) approach to metaplanning is proposed for its operationalization, aiming at both improving the Geodesign process and easing the creation of process-oriented 2nd generation Planning Support Systems. After a critical discussion on the possible advantages of the metaplanning approach to the design of process-oriented Geodesign workflows and support systems, issues setting the future research agenda in this domain are outlined.

1. Introduction

Geodesign recently gathered great momentum among a growing community of scholars, industry researchers, and practitioners as a novel design approach aimed at informing decisions on future territorial changes on the base of robust environmental knowledge. While such an approach may find deep disciplinary roots which date back to about one century of urban planning and design tradition (Miller, 2012), it is in current time that advances in Information and Communication Technology (ICT) are starting to enable its full potential thanks to widespread availability of digital geographic data and processing tools.

As an emergent approach to spatial planning and design, Geodesign in broad sense entails complex processes through which multidisciplinary teams of professionals, decision-makers, and institutional, private, and public interested parties, or stakeholders, as well as other participants, or actors, may collaborate in devising and choosing sustainable change scenarios affecting the future of communities and territories. An underlying assumption in a Geodesign study is that the process is characterised by the integration of Geographic Information System (GIS) and Science

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methods (Goodchild, 2010) and ICT tools to transform spatial data into relevant knowledge to inform design and democratic (spatial) decision-making.

In line with the debate on sustainability of development, spatial planning, seen as a political, techno-administrative decision-making process carried on in specific local socio-cultural settings, should involve not only substantive, but also instrumental and contextual objectives. While substantive objectives concern issues about what to do to achieve a better environment, or how to change the territory, for more sustainable living (e.g. wise management of environmental resources and safeguard of cultural heritage, risk reduction, or safety and health improvement), contextual and instrumental objectives deal with the unfolding of the decision-making process including the role of the actors, their activities, and the methods and tools to be used. Both of the latter objectives are influenced by local conditions (in space and time), so in general they are differently combined in each process.

In Agenda 21 (UNGA, 1992) two of its 40 chapters are specifically dedicated to the role of the scientific and technology community in sustainability, and to the role of information in decision-making. In the US since 1969 the National Environmental Policy Act introduced the ecological approach to planning, though much work still has to be done to properly use ecological information to inform sustainable design (Steiner, 2008). More recently in Europe, Directive 2001/42/EC proposed a structured, rigorous, participative, open, and transparent environmental impact assessment based process (Fischer, 2007), namely Strategic Environmental Assessment (SEA), to be applied to plans and programs which may generate impacts on the territorial systems, including urban and regional plans. Not only SEA requires to develop robust knowledge on the environmental conditions on the base of which alternative change scenarios should be developed and then assessed in terms of resulting impacts, but it also fosters a new role for the public which should be offered access to information regarding the environmental conditions, the change scenarios, their impacts, and, last but not least, the way the process is carried on until the final decisions are made. Nevertheless, after more than a decade of SEA application, concern is often raised about its actual efficacy with regard to its capacity to inform decision-making in the regional or local land-use planning process (Fischer, 2010; Sheate, Byron, & Smith 2004).

Left aside bureaucratic attainments, the role of the technical rationality in planning changes according to spatial and temporal contexts with the different political, administrative and socio-cultural settings which may occur. These conditions affect the roles the actors – including the planner itself – have in the planning arena, the way they participate (Arnstein, 1969), and the way they affect the final decisions. Hence in practice, the influence of those decisions on the future territorial development patterns – informed or not by the technical rationality (Flyvbjerg, 1998) – varies accordingly. It is not always straightforward for the community, as well as for the different actors involved in the planning process, to understand the “why” and the “how” decisions are made. This may be considered a major issue when dealing with the sustainability of the development processes, for it involves such important dimensions as responsibility, accountability, transparency, and eventually democracy in decision-making. In fact, the concept of sustainability of development is a complex one for it entails, as expressed by the principles of the Rio Declaration (UN, 1992), many dimensions to be considered along with the development processes, which in turn should be democratic, environmentally savvy, and based on informed decision-making.

Hence, research in sustainable spatial planning should address two major issues, which are still poorly understood and not adequately tackled in the practice: more reliable methods are needed in order i) to inform the design of the territorial development by environmental considerations, and ii) to govern the development process so that it may be clear how, when, and why decisions are made, by whom, and on behalf of whom. These appear to be such relevant issues that if not properly addressed may undermine any endeavour towards sustainability in a planning process.

Advances in ICT standardization and the ever growing availability of authoritative (i.e. Spatial Data Infrastructures, SDI) and Volunteered sources of Geographic Information (Craglia et al., 2012) are constituting a fertile socio-technology environment in many countries worldwide for the implementation of Geodesign. In Europe many advanced regional SDI are already starting to affect spatial government processes (Campagna & Craglia, 2012; Craglia & Campagna, 2009). However, oftentimes planners are still missing the opportunity to bring innovation into practice. This may be due in some contexts to the lack of institutional concerns for the technical rationality in spatial planning and decision-making, or, in other, to a lack by the professionals of the necessary skills to exploit new digital data sources, methods, and tools, or to a combination of both. The recent growing concerns on the Geodesign debate may have been originated by awareness in academia and industry of the latter issue, to address which new Geodesign curricula are currently under development (Foster, 2013). Indeed not long time ago, analyses on GIS education in urban studies and spatial planning curricula in the US and in the UK (LeGates, Tate, & Kingston, 2009) showed in many cases it was mostly limited to basic GIScience notion and skills, and in seldom cases only GIScience methods and tools were entering into an higher role in the specialisation of fully ICT-aware spatial planners, who in this case would be capable of applying a Geodesign approach. Not surprisingly, in a recent study undertaken in the US, Göçmen and Ventura (2010) found that the lack of proper training is felt by professional planners practicing in the public administration as a major barrier to the full exploitation of GIS as a decision support tool in plan-making, limiting its use to management tasks and routine activities.

Geodesign may therefore constitute a very timely solution for practitioners to improve their capabilities to exploit the opportunities offered by geographic digital data and methods availability to inform design in order to agree on sustainable development scenarios. However, if so far Geodesign as an approach to (geographic) knowledge-based planning and design already showed the potential to address such issues as informing design and limiting undesirable impacts, to a lesser extent it has been investigated how it may empower planners to support the management of transparent, responsible, inclusive, and accountable decision-making processes. Undoubtedly the two classes of issues are closely related.

Whatever the level of integration (i.e. tight viz. loose) of geospatial methods and technologies a group of actors will be using in Geodesign process, we can consider a Planning Support System (PSS) by its early definition (Harris, 1989) as an architecture for coupling a range of computer-based methods and models into an integrated system for supporting the planning functions. Many commercial and open-source method-oriented PSS software exist which enable the implementation of such an architecture, representing the 1st generation of PSS. However, if the planning functions may vary substantially according to the scale, the focus and the local context of a planning or design exercise, they should stem from the specific process at hand. Thus, a PSS as a workspace enabling a Geodesign workflow should be process-oriented, and Geodesign methods should include a strong process management component aiming both at improving the process and at orchestrating the integration of the supporting technology. To this ends the concept of metaplanning is proposed in this paper.

Metaplanning can be defined as the design of the planning process. In real-world urban and regional planning practice, metaplanning is usually not mandatory, hence it is seldom explicitly applied. As a result making sense of complex multi-actor processes may turn out a cumbersome task, causing misunderstanding among the collaborating actors and lack of transparency for some stakeholders and for the wider public. This may be not a minor shortcoming for not only recent theoretical approaches to communicative rationality in planning call for comprehensibility, integrity, and trustfulness in the process (Healey, 1993), and the overall quality of the process should be a central aspect of evaluation (Khakee, 1998), but also for binding regulations (e.g. SEA Directive in Europe) may require a careful documentation and analysis of the ways and the reasons why decisions are made. Nevertheless in the SEA practices, only an ex-post evaluation of some specific part of the planning process (i.e. degree of public participation in consultation or reliability of data sources) if any is commonly given, and an ex-ante metaplanning approach is most of the time neglected.

In the light of the above premises, in the next section the concept of metaplanning is formalised with regards to the spatial planning domain. In Section 3, Planning Process Modelling is introduced as a method for implementing metaplanning in practice with the objectives of improving the planning process and easing the design and implementation of a 2nd generation of Planning Support Systems based on process-orientation. In Section 4, Business Process Management (BPM) methods and tools are introduced as a mean for metaplanning operationalization. In Section 5, an explanatory example of planning process modelling is given as a proof of concept showing how to implement metaplanning in practice. The paper concludes with a discussion on the opportunity for metaplanning and 2nd generation PSS development, and an agenda for further research on the Geodesign as a process.

2. Metaplanning

The term metaplanning can be generally defined as a method or technique that can be used to generate ideas for process improvement. The term is found both in management sciences and artificial intelligence literature. In management science, according to Emshoff (1978) research on metaplanning theory is needed for inefficacies usually addressed to poor planning are actually due to poor metaplanning. This is often the case in the planning practice. The start of a spatial planning process may be triggered by a normative requirement or by the acknowledgement of a problem to solve. A public authority (e.g. a municipality, a metropolitan agency, a county, a province, or a regional government) with its decision-makers, assigns to a professional planner the role of coordinator of a group of specialists to support the development of a plan, represented in his final version by documents such as texts, tables, and maps. Between the start of the process and the plan is eventually adopted and issued, a number of stakeholders (e.g. sector agencies, non-governmental organisations, representatives of the private sector and/or of the civil society, citizens, and so forth) may be involved to participate. The involvement of these latter actors may be prescribed by law or deliberated within the process by decision-makers, with or without the planner's recommendation. The roles and the activities of all the actors may also be prescribed (with a certain level of details) or deliberated, or more likely a combination of both. Defining the role of each actor, their activities, and the expected products and results should be an early concern of the (meta-) planner, in order to avoid the risk to make stakeholders involvement ineffective, to lose control of the overall process and, at a later stage, of the expected outcomes. Thus the way the process unfolds should be planned and documented as well as the final future scenario chosen for the implementation in the plan adoption. In other words, a poor planning of the (spatial planning) process may risk to generate confusion, to lose control, to disperse resources, and eventually to end up with a poor (spatial) plan.

In Artificial Intelligence the concept of metaplanning is often used with reference to a situation in which the opportunity to choose from a number of alternative plans exists. According to Wilensky (1981), whenever alternative plans can be adopted as alternative solutions to a given problem (i.e. in the context of spatial planning it should be read here as alternative "planning processes"), the choice is guided by metaplanning for meta-objectives are used to select the plan which maximize the advantages. Specifically metaplanning relies on a second body of knowledge, the metaplanning knowledge, which is used to plan a solution to a problem. Hence, knowledge about "how to plan" should include a set of metagoals which can be achieved through a set of possible alternatives metaplans. In urban and regional planning the metaplanning knowledge should therefore include both theoretical knowledge about the unfolding of the process dynamics (i.e. general knowledge about planning theory styles or approaches) and the political awareness on the process objectives (i.e. the contextual policy strategies for development and sustainability), and it may include any input knowledge from and about the local community. Thus, metagoals should include not only growth strategies and sustainability criteria, but also metagoals on the process dynamics, such as for instance inclusiveness, transparency, accountability, responsibility.

The concept of metaplanning is tightly related to Geodesign. According to Steinitz (2012) in the second iteration of the Geodesign framework the planner (or the Geodesign team) chooses and clearly defines the methods for the study according to a decision-driven approach. It is in the second iteration that all the six models of the Steinitz Geodesign framework are clearly defined (or designed) before the Geodesign study (i.e. the planning process) is fully implemented (i.e. III Iteration). Thus, the second iteration of a Geodesign study may be thought of as an instantiation of the metaplanning concept aimed at defining the road-map for the operational plan-making implementation.

The practice of metaplanning as a key preliminary step in the process has however seldom attracted the attention of scholars and practitioners in spatial planning. Notably as an exception, DeBettencourt, Mandell, Polzin, Sauter, and Schofer (1982) introduced the concept of metaplanning in spatial planning as a way to make planning more responsive to its users in a thought-provoking paper which however has mostly been forgotten (i.e. only 8 citations according to scholar.google.com and none in Scopus.com, both visited last on 1 May, 2014). According to DeBettencourt et al. (1982) the exercise of metaplanning may produce positive benefits to the planning process including the reduction of uncertainties on the process, its outcomes, and to enhance internal and external transparency. As such, it should help to fulfill SEA principles which often are however mostly neglected in the actuality of the practice.

If metaplanning is a design activity (i.e. the design of the process), its product should be a representation of the process which can be used to improve the process and share its metaknowlwdge. However, while DeBettencourt et al. (1982) in their work focused on a metaplanning approach centred on the relationships between the planning process and its products, here an alternative metaplanning approach is proposed focusing not only on the management, the improvement, and accountability of the process but also on the relationships between the planning process and its supporting information system, or on the orchestration of methods and technology to support the Geodesign study. The motivations and the implications of both approaches stand on similar assumptions and issues; nevertheless they are found through different reasoning paths and aiming at different objectives, with the two perspectives somewhat confirming and reinforcing the need for a metaplanning approach.

3. Planning process modelling

The starting point of metaplanning is the representation of the planning process. A complete metaplanning exercise should answer among others such question as: Who are the actors and their roles? At what stage of the process? What tasks are performed by whom? In what sequence? What are the tools used to solve each task? In what way? What is the available information? What format? Which accuracy? What are the contextual constraints (i.e. normative, socio-cultural?). In order to answer such questions in an integrated manner a reliable language able to express the semantic complexity of the planning process is needed.

Natural language, graphical notations or more sophisticated formalizations (e.g. ontology languages) are commonly used in planning research, education and practice to describe planning process models for different purposes. Perhaps the most common type of process models are those found in natural language description both in planning text books and in regulations. While the natural language can describe any perspectives and details of a planning process, it is not well suited to present a model in a compact form as graphical notations can do. In planning text books often diagrams are found which describe the planning process as an activity workflow through block diagrams or flowcharts. Some examples of this kind of models can be found in Steiner (2008, p. 11) or LaGro (2001, p. 2), where major tasks in an ecological or land planning process are shown in their (not necessarily strictly linear) sequence, or with an even stronger focus on the planning process in Hall (2002, p. 211–229). More rich graphical notations, such as use-case diagrams in Unified Modelling Language (UML) express not only a list of activities or steps but more broadly the interactions between parts of a system and roles (known in UML as an "actors") to achieve a goal (Cockburn, 2001). Ontology languages may be also used to express with a rich semantics the knowledge about the planning domain.

While the representation of the planning knowledge is not an entirely new subject of research inquiry, its study has mostly been aimed at other purposes than metaplanning. In many cases however interesting contributions to metaplanning may be found. Different formalizations can be used to express different aspects of the planning knowledge including knowledge bases, analysis and decision support methods, products and rules, roles and relationships between actors, or the process as a whole. In some cases representations attempt to formalize in an integrated manner the existing theoretical knowledge on the process, in other cases they may be aimed at integrating descriptions of existing planning tools. In some cases ontology languages are used while in other ones different formalizations are proposed, but in many the aim concerns the formalization of metaplanning knowledge.

A recent initiative coordinated by the University of Redlands, in collaboration with about fifteen academic institutions and private sector partners, developed a set of ontologies describing the body of knowledge on methods for Spatial Decision Support (SDS). The project produced a web application that collects and makes accessible in a systematic way, a descriptive ontology of concepts related to existing methods and their properties and relations, presenting relevant information to aid the choice of the appropriate method in a given situation. The concepts that describe the domain of spatial decisions methods and support tools are organised and described explicitly using ontologies corresponding to the main functional components, such as type of problem, decision-making environment, type of process, process steps, type of actors involved, information resources and processing methods, and so on (Li, Raskin, & Goodchild, 2008). Each concept is represented by a set of attributes and relationships with other concepts. The result is the construction of a useful tool to support the planner in learning and in choosing the most appropriate to the context SDS case. More recently, Li, Ervin, Flaxman, Goodchild, and Steinitz (2012) on the same fashion proposed an ontology for Geodesign.

On a similar fashion, without explicitly referring to the use of ontologies, Yeh and Qiao (2004) proposed a framework for the construction of Planning Support Systems (PSS) based on the explicit description of components (i.e. the planning processes and the planning support systems) that can be reused in an integrated manner to the construction of the PSS as a function of boundary conditions of the specific planning process. Even in this case an explicit description according to a shared language aids the planner choice of the more suitable methods and tools for the performance of a phase/activity in a planning process. Also, according to Shi and Yeh (1999) due to high complexity, uncertainty, and subjectivity urban and regional planning processes are a difficult domain of study, and the development of case-based reasoning systems can support the extraction of relevant knowledge from past case studies in order to support the improvement of future processes.

Hopkins, Kaza, and Pallathucheril (2005) proposed the concept of Planning Data Model which, through the use of a shared language as a tool for the representation of plans and territorial policies, supports a shared understanding in the construction of integrated normative reference frameworks for spatial planning. Scorza, Las Casas, and Murgante (2012) more recently proposed an ontology approach to support the rationalization of regional development programs through a systematic view of the whole complex of regulations, policies, objectives, actions and actors that interact in the process of construction and management of program.

All these examples suggest different but potentially complementary approaches to planning knowledge or metaplanning knowledge representation, reinforcing the need to use shared models to address planning process complexity in order to operationally manage processes, tools, products, relationships, and practices.

In the next section, Business Process Management is proposed as an operational way to implement spatial metaplanning aiming at managing the process in its complexity, and making it more transparent and accountable to users. This approach moreover will ease the integration of process-oriented 2nd generation Planning Support Systems.

To date, case studies on Geodesign and Planning Support Systems often focused on the use of single geospatial methods tools within a given planning task (e.g. using a web-GIS interface or a mobile device to allow citizens to georeference photographs about their interests and concern) or in the integration of different tools to support more complex methods and PSS (Brail and Klosterman, 2001) (e.g. simulation of growth, 3D representation of the scenario, evaluation of impact indexes). The former approach to PPS research may be considered technology-driven, while the latter maybe considered method-driven focusing on integrated PSS. The approach proposed here, which may support the development of a PSS design framework, should be instead considered process-driven. While technology-oriented and method-oriented research on ICT planning support has been flourishing over the last two decades or so producing the first generation of PSS, process-oriented PSS research is becoming more actual only recently.

Recent research and methodological approaches proposed for PSS design, acknowledged the PSS implementation gaps (Vonk, Geertman, & Schot, 2005), urge for devising methods for narrowing this gap. Maruna and Maruna (2005) proposed the Rational Unified Process as a method for PSS design by which using UML it would be possible to help creating a dialogue between PSS developers (i.e. system engineers) and the users (i.e. planners). Such an approach would be needed to tailor the PSS to the contextual planning process which in general is always varying case by case. More recently, under similar assumptions, such kind of approach was demonstrated by a real planning case study, where existing spatial decision support tools have been re-adapted to new planning processes thanks to a close interactive and iterative dialogue between spatial model developers and planners (te Brömmelstroet & Bertolini, 2008). Fostering the dialogue between the users and the PSS system developers has been proven successful also by another recent case study according to which the application of a socio-technical method as alternative to more traditional system engineering methods was a success factor for PSS adoption and effective use by planners (Vonk & Ligtenberg, 2010).

In this paper, the use of Business Process Management (BPM) methods and techniques are proposed as innovative approach to 2nd generation PSS design and implementation. The recent shift from object- to process-orientation in information system design sees BPM as the most advanced and comprehensive approach for process modelling supplying end-to-end IT support for organizations in developing Service Oriented Architectures (SOA) (Erl, 2005). Such an approach appears currently very promising given the boost in developments in SOA, which thanks to a set of flexible design principles provides the environment for the loose-integration of distributed services to build web-based applications according to the Software as a Service (SaaS) licensing and delivery model (Greer, 2009). Research in geospatial technologies which are most relevant for Geodesign have been recently concerned by the integration of geoprocessing web services growingly made available by Spatial Data Infrastructures (SDI) and the first results are promising for the full integration of the geospatial component within SOA (Friis-Christensen, Lutz, Ostländer, & Bernard, 2007; Friis-Christensen et al., 2009Friis-Christensen, Lucchi, Lutz, & Ostländer, 2009; Klopfer & Kanelopulos, 2008).

The starting point of PSS design in process-oriented research according to the metaplanning approach should therefore be planning itself. On the base of the latter assumption, if we want to design a PSS which would be accepted and effectively used by planners we should consider a PSS from a perspective which is relevant to planning. In this paper we propose this approach in order to narrow the gap between PSS developers and planners. If BPM may offer the long-awaited tools for creating a dialogue among the people involved in PSS design we should start from the user (i.e. the planners), asking planners to focus more on the process.

4. Implementing metaplanning with Business Process Management

BPM includes concepts, methods, techniques, and tools to support the design and analysis as well as the administration, the configuration, the enactment of business processes. A business process can be defined as a set of activities which jointly realize a business goal and that are performed in coordination in an organizational and technical environment (Weske, 2012).

The two main objectives of BPM are the documentation and improvement of processes (i.e. business perspective: design and analysis) and the automation and monitoring of the supporting information system (i.e. IT perspective: configuration and enactment). Hence, the application of BPM methods and techniques in spatial planning may on the one hand represent a formal way to operationalise metaplanning while on the other hand it may support the design of process-oriented 2nd generation PSS. Although this paper mainly focuses on the first issue, some references are also given with respect to the second one in the remainder up to the point of demonstrating its feasibility.

The basis for BPM is the explicit representation of processes with their activities and execution constraints between them. A business process model is a set of activity models and execution constraints among them. From this perspective, urban and regional planning processes-including Geodesign as a specific instance of the latter- can be considered as business processes and Planning Process Models (PPM) can be designed accordingly. As introduced earlier, in planning theory and practice several languages are commonly used to describe planning processes ranging from natural language descriptions, such as in the articles of planning regulations, to graphical notations, such as workflow diagrams in planning handbooks. However, most of the latter lack the semantic richness necessary to define in an easily readable compact form planning process models to be used to analyze, administrate and enact process instances.

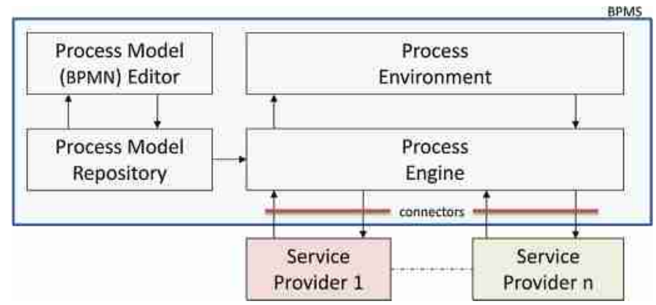

Fig. 1. Architecture of a Business Process Management System.

Recent advances in information systems design are fostering the shift from object to process orientation. A number of Business Process Management Systems or Suites (BPMS) are starting to populate the IT market accordingly. Major IT market leaders including Oracle, IBM, Microsoft to name only few, are starting to offer their BPMS with different approaches (Richardson & Miers, 2013) based on different models being some more “human-centric” and other more “integration-centric” or “case-centred”. In general, a BPMS should both enable all the actors involved in designing and enacting a process to clearly understand the process and to collaborate to its improvement, and at the same time to ease as much as possible technology leveraging in those parts of the process where its use may add value. As such BPMS may become a reliable support tool both in metaplanning and in 2nd generation PSS design in an integrated way. According to the model shown in Fig. 1, the general architecture of a BPMS allows to instantiate and control the execution of a business process through a process engine on the base of an explicit process model representation developed in a process modelling editor and stored in a repository. When a process is instantiated (i.e. a planning process starts) the process engine starts to control the execution of the activities according to the workflow constraints given in the process models and calls external entities (i.e. IT service providers) to supply the required functionalities. An example of such a model will be adapted to the Geodesign domain in the next section.

Many BPM tools rely on the standard graphical notation called Business Process Model and Notation (BPMN) for representing business processes in form of diagrams. The rich semantic of this language allows representing actors and activities and a variety of executions constraints, including simple and complex gateways which support the representation of cycles, loops, and conditional splitting and joining of sequence flows. Tasks can be manual, automatic or mixed, representing possible diverse situations found in real-world processes: automatic and mixed tasks are those which are supported by the execution of distributed data or processing services. In the next section some examples of a generic Geodesign process modelled in BPMN are presented.

5. Modelling Geodesign with BPMN

In the last decade, BPMN has been developed and maintained by the Object Management Group as a standard graphical notation for representing business processes in form of diagrams. The rich

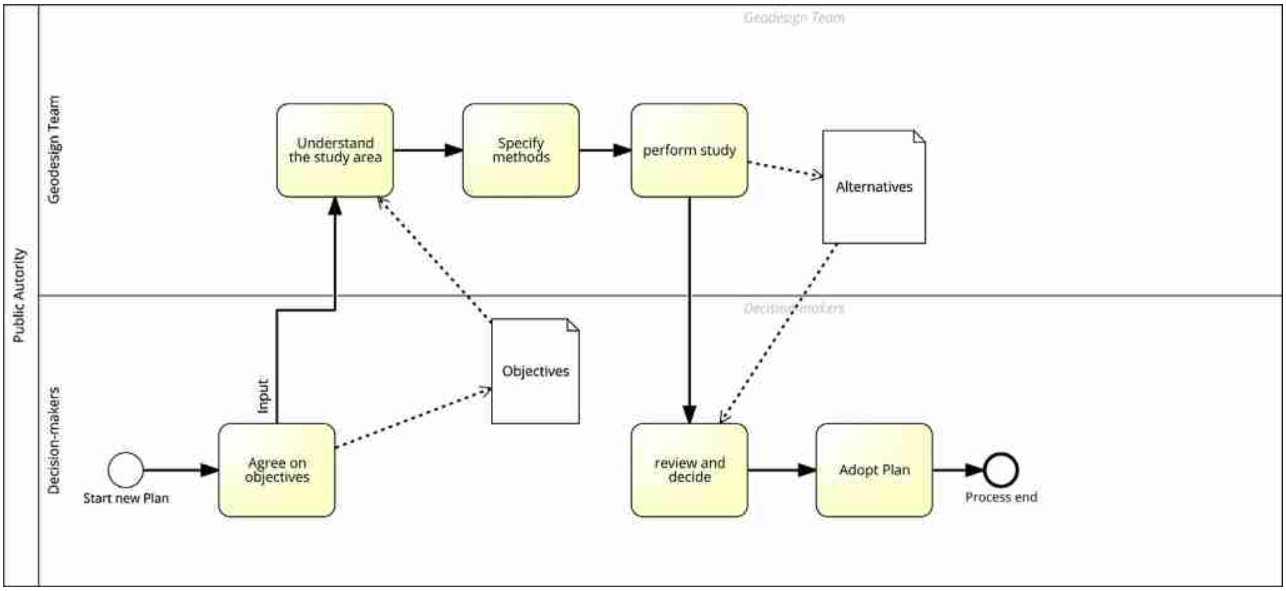

Fig. 2. High level BPMN Geodesign Process Model.

semantic of this language allows representing actors (i.e. pool and lanes) and activities (i.e. tasks or sub-process), a variety of process executions constraints (i.e. events and gateways), and data objects and services to be used along the process.

An example of the creation of a Planning Process Model is discussed below outlining some of the basic features of the BPMN language and the possible advantages of using it to support metaplanning. In its application, PPMs may be used to describe either existing processes (i.e. *as-is*) or possible templates (i.e. *may-be*) for analysis, before consensus is reached on a final PPM (i.e. *to-be*) which is then applied prescriptively in the enactment of the actual process. PPM can be also modified along the process implementation if needed.

Below the Steinitz's Geodesign framework (2012, p. 25–34) is chosen as sample process in order to demonstrate the logic of metaplanning in action using BPMN. It should be noted that any other theoretical or real-world process could be used for this purpose. In a Geodesign study (i.e. the process) two main classes of actors are identified: the Stakeholders and the Geodesign Team which are represented as horizontal *lanes* of a *pool* (Fig. 2). In BPMN, a pool represents an organisation and the lanes represent different roles participating to a process and contributing to achieve a common goal. In metaplanning, the pool may thus represent the public authority responsible for planning, the lanes the decision-makers and the professional specialists, or other participating actors, and the final goal may be the adoption of a spatial plan.

In the process example, the adoption of a rational comprehensive planning style (Khakee, 1998) is assumed; accordingly the Stakeholders give input to the Geodesign Team which proposes alternative optimised scenarios, which in turn are reviewed and evaluated back by the Stakeholders who take the final decision. The diagram in Fig. 2 shows a possible unfolding of the activities to implement this process use-case scenario. The Geodesign Team work is organised according three main (set of) activities which, in this example, correspond to the three iterations of the Steinitz's framework. While the iterations may in practice not follow a strictly linear sequence of implementation due to iterative adjustments, the PPM may evolve accordingly along the study.

Moreover, BPMN supports the definition of gateways and backloops. In Fig. 2, a high level PPM model of the Steinitz's Geodesign Framework (adapted from Steinitz, 2012, p. 28) is given. However the simple model in Fig. 2 shows a linear process, while in reality the process may develop along several cycles. The example PPM in Fig. 3 relying on the BPMN rich semantics shows that after the specialists of the Geodesign Team (represented in the top lane of the diagram) complete their work and send the outcomes to the stakeholders (bottom lane), they may accept or not; in the latter case a new cycle is activated and the loop continues until the consensus is reached on the design products.

Looking at the model at a closer scale, the three (macro) activities (i.e. the three framework iterations) performed by the Geodesign Team are in facts complex processes themselves (i.e. note the cross symbol within the activity frame). The three Geodesign framework iterations may be interpreted respectively as planning process scoping, metaplanning, and implementation. BPMN supports the modelling of sub-processes of complex activities. In Fig. 4, a sub process of the PPM in Fig. 2 is shown: the main steps of the third framework iteration (i.e. *perform study*) are represented, each of which in turn may be expressed as a nested sub-process. Hence, a full PPM will be represented by the hierarchy of the planning sub-process models. The decomposition of the process may continue down to the desired granularity; if the PPM is to be used for services orchestration the final scale should be detailed enough to clearly define how the single tasks are to be implemented.

Focusing on the *design-changes* activity in the PPM in Fig. 4, a new sub-process should be defined. Let us assume, for the sake of the example, the activity *design-changes* is to be implemented by a Land Suitability Analysis (Hopkins, 1977; Malczewski, 2004), on the base of which a planner in the Geodesign Team will define a set of possible change scenarios. The planner may be supported in the Land Suitability Analysis (LSA) by a number of domain experts – e.g. a geologist, an agronomist, a biologist, and an archaeologist represented by the lane *expert* in the PPM – who will prepare a number of criterion maps. The PPMs in Fig. 5a–c, shows the process with three alternative use-case processes. In the first LSA case the weights of the criteria are set by the planner own judgement (Fig. 5a), in the second case they will be asked to decision-makers (Fig. 5b), and in the last case they are simulated through automatic uncertainty and sensitivity analysis (Ligmann-Zielinska, Jankowski, & Watkins, 2012) as shown in Fig. 5c.

The three alternative PPM show how in BPMN tasks can be manual (i.e. rectangle with the human symbol), automatic (i.e. rectangle with the script symbol) or mixed, representing diverse situations

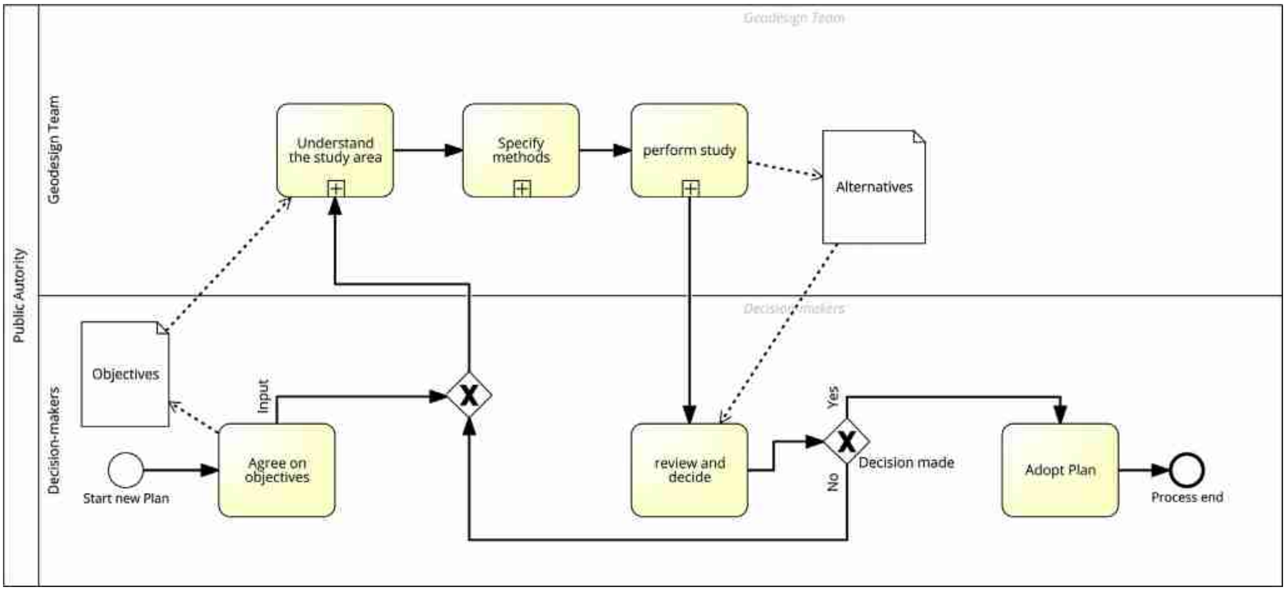

Fig. 3. High level BPMN Geodesign Process Model with cycles.

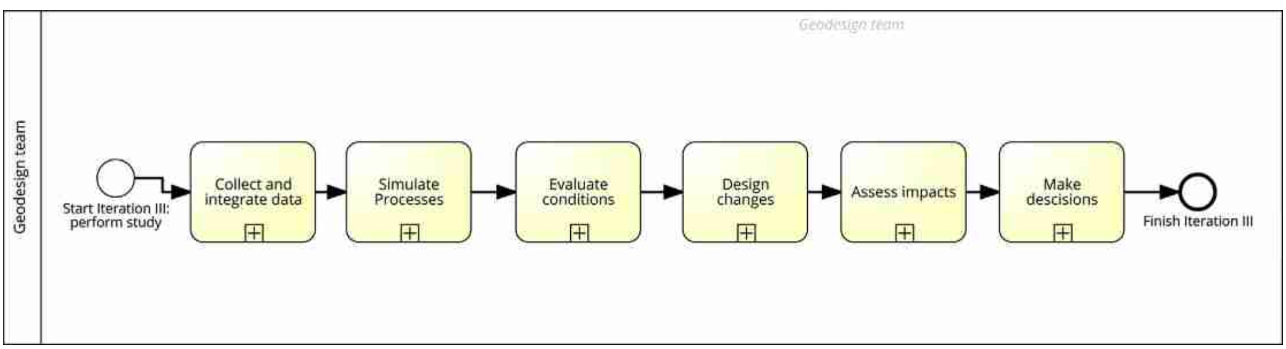

Fig. 4. High Level BPMN Planning Process Model of the III Iteration of the Geodesign framework.

of real world processes: manual task are those executed by humans without the support of digital technology (e.g. a suitability analysis carried on with paper and pencils); automatic and mixed tasks are those which are supported by the execution of ICT tools (i.e. information systems or services) without or with human intervention respectively. As Geodesign is by definition generally thought as a digitally supported activity, mixed activities will be most likely concerned in a planning process management exercise. It should be noted however that BPMN does not support explicit process configuration. The latter phase is done using the BPMS and its connectors, or interfaces between the BPMS and the external data and processing services needed to perform each task of the process.

When the representation of the process to implement is completed and configured (i.e. the III iteration of the Geodesign framework is ready to start), it is possible to run an instance of the process in the BPMS. A start event triggers the enactment of the workflow and all the activities are enabled one by one according to the execution constraints given in the PPM. When an activity is enabled, the actors associated to that activity are invited to join the work (e.g. by email or by a pop-up window in a web interface), and they are supplied with the applications needed to perform the activity tasks. This way, through the BPMS it is possible to orchestrate the technology integration required for planning support. As an example, an actor may be presented a web form to fill-up for data input, and that input may be used by GIS functions to perform the analysis. The level of activity decomposition may vary flexibly and GIS functions can be served as full-featured GIS application to be used with extensive human involvement, or as a chain of web processing services to be executed in more automatic way when appropriate.

Thanks to BPMN, it is possible to model all the complexity of the processes down to the details of single tasks carried on by specific actors. BPMN models can be understood from both humans and machines, becoming the core of planning process life-cycle management. In facts, many off-the-shelf BPMS feature a BPMN model editor for design and analysis, a repository where models are collected, and a process engine which orchestrates the integrated execution of services supporting a variety of tasks including high level applications (e.g. GIS) and/or (spatial) web services. To summarise, after the modelling exercise is completed, the configuration phase in the BPMS enables to select and set-up all the necessary digital tools which then will be served to the relevant process actors run-time to implement Geodesign methods.

While the BPMS configuration phase is not the focus of this paper, it should be noted that recent research advances clearly demonstrated its feasibility in the spatial decision support system domain. Jayavarapu (2007) discussed the advantages of introducing a BPM approach to enterprise GIS, which often constitute the technology platform for PSS development, for orchestrating spatial data management, spatial analysis and software functional testing and acceptance. More recently Horita and de Albuquerque (2013) proposed a Spatial Decision Support System (SDSS) integrating authoritative and volunteered geographic information resources to support disaster management based on a BPM-based service

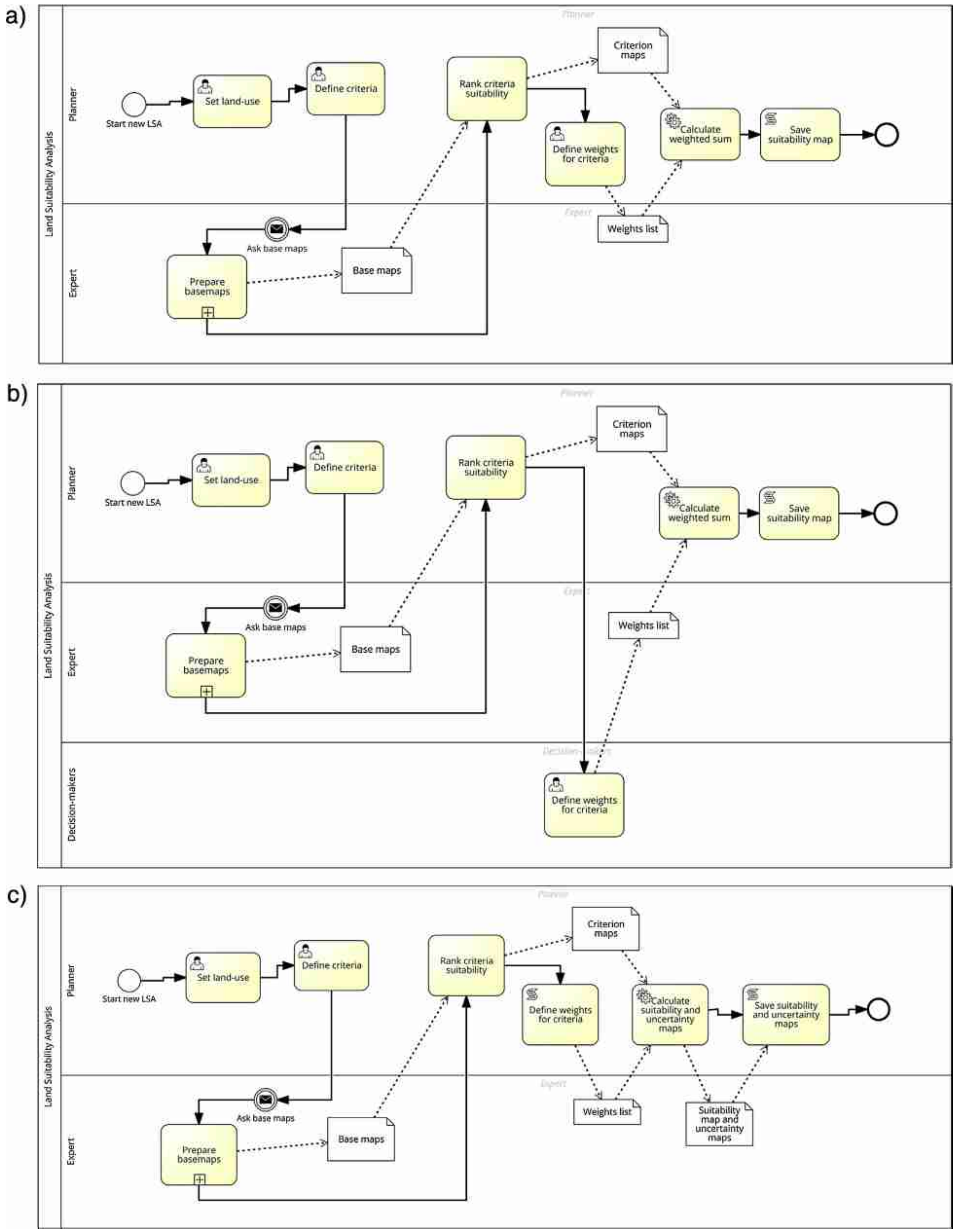

Fig. 5. (a) BaPMN Planning Process Model of an expert-driven land suitability analysis. (b) BbPMN Planning Process Model of a collaborative land suitability analysis. (c) BcPMN Planning Process Model of a land suitability with uncertainty analysis.

oriented architecture, while Campagna, Ivanov, and Massa (2014) demonstrated the possibility to orchestrate both GIS and other desktop applications, as well as chains of spatial (and not spatial) web services with a BPMS.

The PPM examples in this section show how BPMN can be used to design a planning process with iterative shifts from high level general models to the low level detailed description of each subpart. Real world processes are far more complex than the simple example proposed here as it is further discussed in the next section. Anyway, the planning process representation and scale is functional here to explain the overall metaplanning logic within the BPMN language, while in the real world it would be functional to support collaboration and mediation among the actors (i.e. enhancing the understanding of the process among professional planners and decision-makers), to share the knowledge about the process, and/or to support the development of a custom PSS. The BPMN language syntax far exceeds what was shown in the simple examples here. While a complete description of the richness of the BPMN language is out of the scope of this paper, it should be noted that it can express all the metaplanning elements as discussed earlier including actors, activities, information resources and products, and a variety of sequence flows, rules, and objectives related to the actual planning or metaplanning knowledge. An overview of the BPMN constructs can be downloaded at http://www.bpmb.de/images/BPMN2_0_Poster_EN.pdf and the complete specification at http://www.omg.org/spec/BPMN/.

Summarizing, the metaplanning study starts with the definition of the actors and of the main steps of the planning process. Then, relationships should be defined in order to explain which actors participate in which phase, with which role or responsibility. Accordingly, the methods and the tools to be used in each phase are defined as well as the required input data. As shown in the simple examples above, the metaplanning exercise can be efficiently supported by BPMS which then enable the instantiation of the process execution.

6. Discussion

The metaplanning operationalization scenario presented above shows several advantages can be achieved by its application. Firstly, the use of BPM in metaplanning appears appropriate to be applied to spatial planning as a process in general. Thanks to its semantic richness, BPMN clearly expresses the relationships between actors, activities and their sequence, data input, and output products. The documentation of the process through BPMN may therefore improve the understanding among the involved actors and the accountability of the process with regards to the wider community. At any stage, it is possible to understand by whom a decision is taken and on the base of what decision model. In facts, in a BPMS the PPM not only documents the process but it also represents the instructions blueprint for execution. Moreover, current BPMS support the collaboration of different specialists and stakeholders in process modelling, opening the possibility for metaplanning to become a social or participatory task if needed. It should be noted that BPMN is not necessarily to fully replace more traditional forms of process documentation such as texts, but to integrate them for enhancing common understanding and collaboration, as well as for technology orchestration.

More evidence should be generated to fully demonstrate the implementation of BPM-based metaplanning to complex real world planning process. However in general, although BPM is a relatively young discipline, its influence on businesses and industries can be already considered consistent. The introduction of BPMS in the IT sector less than a decade ago has been defined as “the next big thing” (Sinur, 2005) fostering a paradigm shift from object- to process-orientation in order to offer agile IT development tools to dynamic business demand. This trend is slowly expanding from manufacture and services to other sectors including urban management and planning. While literature is still scarce on the latter domain, recent research findings are starting to demonstrate the use of BPMN in urban and territorial governance: Kim, Choi, Son, and Ryu (2011) reported recently on a study to model and analyse urban and environmental maintenance project; Latre et al. (2013) used BPMN to analyse existing territorial government services and to design new territorial e-government services based on the orchestration of spatial web-services from regional and national Spatial Data Infrastructures. These results started to disclose a huge potential for BPM in urban and territorial government and possibly to spatial planning and Geodesign too. Pilot experiments carried on by the author already demonstrated that modelling in BPMN existing (textual) regulations and guidelines for local land-use planning and Strategic Environmental Assessment helps to understand the process and to identify deficiencies, omissions, gaps, bottlenecks in regulations which risk to undermine the correct planning procedural workflow. Furthermore in a very similar fashion to the metaplanning approach to spatial planning and Geodesign proposed in this paper, within the European FP7 project OCOPOMO on collaborative policy modelling using ICT, Butka, Furdik, Sabol, and Mach (2010) used BPMN to model as-is existing policy creation workflows with the purpose to identify those activities and task in the process where ICT support tools could be used, so demonstrating the value of the approach in a complex real world case study.

With more specific regards to Geodesign, the capability of BPMS to enact the process workflows expressed in a PPM and to orchestrate the technology integration open new alleys for the development of process-oriented 2nd generation PSS and their diffusion in the practice. With BPMS, the technology orchestration is process-oriented, meaning that anytime changes in the process model (e.g. during the plan implementation) are admitted and the technology architecture will be updated accordingly, limiting integration efforts to configuration settings, thus reducing substantially the integration resources demand in the PSS life-cycle.

In BPM-based metaplanning both the process (and subprocesses) models and their configuration interfaces and settings can be stored in archives and shared for re-use. While it is not likely that a metaplan would be reused in its entirety, it may be modified, re-adapted in full or in parts to be plugged-in new metaplanning exercises. PPM relating to successful or unsuccessful planning processes, including their configuration settings, can be used for education or research purposes. Catalogues can be used to find existing PPM relevant to the contextual settings at hand. Mining tools could be developed, thanks to the machine-readability of BPMN, to extract knowledge by rich PPM repositories.

While research on BPM application to spatial metaplanning is still in its infancy a number of research questions make it promising in order to address the complexity of planning processes, improving its management, the mutual understanding among actors, making the processes more transparent and accountable, and easing the technology integration.

In order to improve processes and make them more cost-effective the possibility to improve the sequence and concurrency of activities in the hierarchical decomposition of the planning process should be investigated. Is it possible to devise a universal hierarchical structure for planning process or categories of them? Process workflows can be simulated in BPMS in order to detect bottlenecks, to assess costs and duration of the process and its subprocesses. Moreover, recent research findings (Cho & Lee, 2011) demonstrated that having a repository of business process models it is possible to apply evaluation methods to support the selection of reliable models for the contextual settings at hand. Applying these

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approaches to planning process models, the search may be supported for relevant PPM to be seamlessly customised and readapted to the contextual planning conditions.

From a strict Geodesign perspective, it should be further investigated what the possible methods or tools which can be associated to each activity in a PPM are. Knowledge bases such as the ontology of SDSS and/or of Geodesign may give some hints to this respect, and they might be further extended with BPM tools to be used in a metaplanning exercise. Expressing the methods in BPMN would help to integrate them in wider PPM.

Last, but not least, if the final target is the technology integration, an issue of granularity may arise between the use of full featured applications (e.g. a GIS desktop application to solve an activity) or the decomposition of the activity in atomic task each of which to be executed with the support of simple or complex web processing service chains.

7. Conclusions

Geodesign may represent an innovative approach to spatial planning and a possible solution to some of its major pitfalls in the practice. While the current academic disciplinary debate as well as experiences from the practice on Geodesign are already demonstrating its potential in order to exploit the unprecedented wealth of digital data resources and tools to inform design and decision-making in spatial planning, still it only partially addresses the issues of analysing, managing, and documenting the process workflow. Hence, the metaplanning concept is proposed here as a core element in Geodesign.

As the design of the Geodesign workflows, metaplanning is aimed firstly at supporting process management and improvement, and secondly to setting requirements for the supporting technology integration, or in other words for the supporting system architecture design and implementation. An operational approach to metaplanning based on Business Process Management methods, techniques and tools is proposed with the aim of improving the planning process analysis and management, and of easing the implementation of 2nd generation process-oriented Planning Support Systems.

According to this approach, metaplanning should help to design and execute the Geodesign process, and to share and re-use its relevant knowledge. If metaplanning is based on the process representation with BPMN, a language which enables both humans and machines to understand the process, it may enact their respective contributions to put this knowledge into action.

While the BPM-based metaplanning may be considered still in its early conception and its applicability to the complexity of real world planning process is still to be fully demonstrated, early results on spatial metaplanning research are promising, and partial results can be already considered achieved both in planning process analysis and in PSS implementation. By enforcing stronger ties between actors, roles, activities, territorial knowledge, methods, decisions, and tools, and contributing to sharing knowledge about them, may metaplanning eventually help to enrich poor planning.

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