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Susanne Frank*, Marcin Spyra, Christine Fürst

Requirements for cross-border spatial planning technologies in the European context

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Abstract: This communication paper investigates requirements for cross-border spatial planning technologies. We refer to European cross-border regions, which are located in the European Baltic Sea Region. We hypothesize that there is no efficient cross-border spatial planning without engagement from various stakeholders, supported by novel spatial planning technologies. This study presents the results from a survey that identifies the requirements for spatial planning technologies adequate for cross - border regions. On the basis of this survey, carried out within the INTECRE project partners coming from the Baltic Sea Region, the study provides general recommendations about cross - border spatial planning technologies. Addressed in the survey are the following central issues: definition of the scope of such technologies, the data base and international planning data provision, features and properties of planning technologies, and stakeholder involvement. The research findings are transferable to wider European and extra-European contexts.

Keywords: Cross-border spatial planning, spatial planning technologies, cross-border regions, Baltic Sea Region

1 Introduction

This communication paper intends to showcase and discuss recommendations for technology requirements and approaches to improved natural resources governance in the context of cross-border spatial planning and is based on experiences made in the Baltic Sea Region (BSR). **Spatial planning** is a generic term that subsumes a complex field within policy and administration. In general, spatial planning concerns complex landscape systems, which are characterized by a large variety of natural assets (e.g. land uses, physical elements), stakeholders, and energy and matter fluxes [2]. It deals with "the problem of coordination or integration of the spatial dimension of sectoral policies through a territorially-based strategy" [5: 91]. More specifically, we address regions that are divided by the national border. Therefore, we use the term **cross-border spatial planning**.

Spatial planning manages the balancing of demands made by manifold stakeholders regarding an integrative re-organization of land-uses [37, 3]. Planners have to consider changes in natural processes and societal demands, i.e. they need to shift from "end-state design" to collaborative processes and iterative decision making [35]. Consequently, spatial plans need to be constantly monitored and updated. Such adaptive planning raises important requirements in regard to **spatial planning technologies**, particularly in cross-border contexts. With spatial planning technologies, we refer to digital tools and instruments that provide spatially explicit planning support by enabling knowledge-based participatory development, assessment of scenarios, and consensus building. Most of the tools and instruments are GIS-based, thus they require good quality, reliable, detailed, thematically adequate, spatially explicit data. Moreover, spatial planning technologies have theoretical bases in different methodological approaches (e.g. ecosystem services, sustainability, green infrastructure). It also means that while performing spatial planning with such technologies, the planner (user) should have a good understanding of specific approaches, and the spatial planning technology allows for assessments of different issues related to these approaches (e.g. assessments of ecosystem services provision / demand). Approaches that are often used in spatial planning were discussed in our research.

***Corresponding author Susanne Frank,** GICON - Großmann Ingenieur Consult GmbH, Department for regional planning and project development, Tiergartenstr. 48, 01219 Dresden, Germany, E-Mail: S.Frank@gicon.de
Marcin Spyra, Faculty of Civil Engineering and Architecture, Opole University of Technology, ul Katowicka 48, 45-061 Opole, Poland
Marcin Spyra, Christine Fürst, Martin-Luther University Halle Institute for Geosciences and Geography, 06099 Halle, Germany

Cross-border cooperation concerning spatial planning in Europe is rising in importance and gaining more attention among various actors [32]. A process of "debordering" has been described, which refers to increasing interactions across (European) borders, since the original function of the border as a barrier has diminished and the economic and cultural exchanges have increased due to globalization effects and, in particular, European Union cohesion policies. According to Sohn and Giffinger [32], a heterogeneous network of actors is the basis for functioning cross-border spatial planning. It is characterized by a large number of various stakeholders, who act across the national border and struggle to overcome different problems associated with difficulties due to language, cultural and legal differences and technology barriers, i.e. internet and other infrastructure access [11,38]. Strengthening the cross-border networks of various stakeholders is an important requirement for sustainability in spatial planning in general and for the European Integration in particular [14,41].

The study was conducted in the context of a network project called INTECRE - Innovative Technologies for Multi-dimensional Integrated Spatial Development (INTECRE) and refers to Baltic Sea Region (BSR) states. Our communication paper presents a survey among INTECRE experts from the BSR states, which we perceived to be a highly representative area for the need to harmonize cross-border collaboration on energy, transport, nature protection, and the sustainable use of natural resources [7, 17]. Our study aimed to **identify requirements** for suitable spatial planning technologies and to **provide and discuss recommendations** for their future development and implementation.

2 Method

INTECRE project objective was to surmount unsustainable resource and infrastructure management issues by identifying requirements for technologies that particularly facilitate the governance of participatory planning and natural resources that are complementary to national regulations. The INTECRE project consisted of 17 partner institutions from six BSR states (DE, DK, EST, FI, PL, and SE).

The experts in our consortium acted as focus group for the derivation of technology requirements, and an online one-time survey was conducted using LimeSurvey 2.x. 59 % of the survey participants were connected with research institutions and 41 % answered the questions from a practical perspective, being SME members (Figure 1).

The survey consisted of seven questions, structured into the following four thematic groups:

A. Regional differences in requirements and usability
B. Data requirements for technologies and instruments
C. Methodological approaches for spatial planning technologies
D. Users

Regarding (A.), the participants were asked whether different support mechanisms are needed for different regions regarding cross-border regional planning. Alternatively, flexible spatial planning technologies (tools and instruments) which can be applied for various regions were suggested.

In part (B.), open lists of data sets which reflect the real needs of stakeholders in the context of regional planning were suggested for selection. CORINE[1], Large Urban Zones (LUZ)[2], and INSPIRE data (Infrastructure for Spatial Information in the European Community[3], based on an INSPIRE regulation) were suggested. Additionally, the participants were asked to select spatial data which are required as a minimum for cross-border regional planning. The open list of answers comprised protected areas, regional planning restrictions (e.g. priority areas for certain land use), infrastructure plans, climate data, soil data, land tenure types and location, demographic data, hydrological data, economic data, and "other" (to be specified by the participant).

The aim of question block (C.) was to figure out which methodological approaches are predominantly applied in the context of spatial planning by which user. Methodological approaches to spatial planning simultaneously address different issues (e.g. green systems, ecosystems, landscape design). It was requested that the following matrix be filled in (Table 1). The core aim of the concept has been explained within the survey.

Part (D.) consisted of two questions. From a user's point of view, the participants were asked to select the most important peculiarities (D1) of spatial tools and instruments in order to be relevant for practice and asked about the biggest challenge in the context of cross-border regional planning and respective support tools and instruments (D2).

3 Results

In part (A.), 75 % of the participants indicated that flexible tools are needed which are applicable to different regional

1 http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-3
2 http://ec.europa.eu/eurostat/web/cities/statistics-illustrated
3 http://inspire.ec.europa.eu/index.cfm/pageid/3

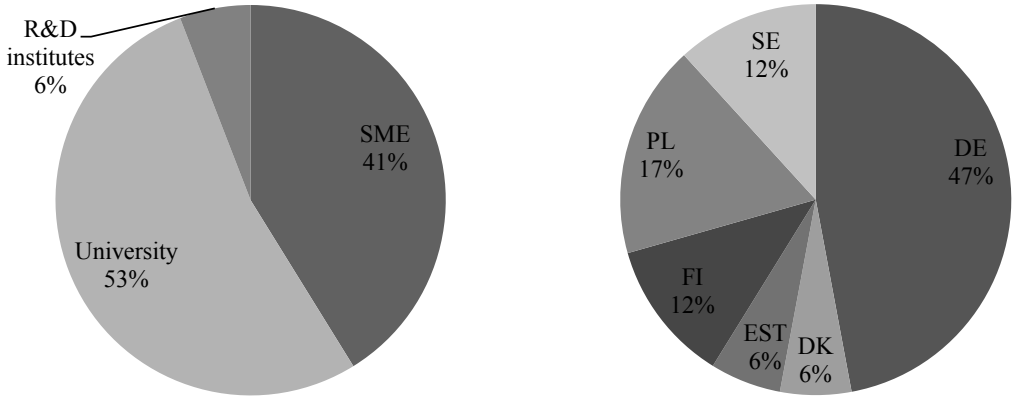

Figure 1: Participants according to their institution (left, clockwise: small & medium enterprises [SME], universities, and research & development [R&D] institutes) and nationality (right, clockwise: Germany, Denmark, Estonia, Finland, Poland, Sweden); n=14

Table 1: Answer matrix for question C (question not mandatory; to be rated on a Likert scale including 1 = Always, 2 = Very Often, 3 = Sometimes, 4 = Rarely, or 5 = Never)

Concepts: / Application:	Ecosystem services	Sustainability	Multi-functionality	Environmental accounting	Geo-design	Green infrastructure
In science						
In politics						
In planning						
In education						

contexts, temporal and spatial scales, (Table 2). 17 % stated that specific tools according to regional conditions are needed. One participant additionally indicated: "if smaller regions are addressed, I suggest that specific tools are needed; if large cross national regions are addressed, a generic tool might work".

Regarding the usability of land use data sets, the results from (**B.)** indicated that some participants found several data sets appropriate for stakeholder's needs in a cross-border planning context (Table 3). INSPIRE data were rated best (89 %). However, also Large Urban Zones (LUZ) were considered to be useful according to the votes by 56 % of the participants. CORINE land cover received the fewest votes. Still, 44 % of the participants considered it to be a reflection of stakeholder's needs. No further data were suggested (Table 3, "other").

Figure 2 illustrates data that are required as a minimum for cross-border regional planning from the perspective of the consortium (question in block B.). Although the participants of the survey covered mainly ecology-related experts, demographic and economic data were chosen as most meaningful in addition to the land use data. 90 % of the participants rated climate and 80 % rated hydrological/ infrastructure-related/ planning-related/ and protection-related data to be essential for regional cross-border planning. Soil data and the location of land tenure types were mentioned by 55 % of the participants.

Results obtained from question block (C.) give

Table 2: Answers in Block (A.) regarding the regional differences in requirements and usability

Answer	Count	Percentage
A tool which supports cross-border regional planning should be applicable for various types of regions, because the conditions (e.g. the degree of marginalization) can vary a lot beyond (administrative) borders.	9	75.00%
Specific tools are needed according to regional conditions (e.g. for rural regions, metropolitan regions, and marginalized regions).	2	16.67%
Other	1	8.33%

Table 3: Answers for the first question in block (B.), regarding the usability of land use data sets.

Answer	Count	Percentage
CORINE	4	44.44%
Large Urban Zones (LUZ)	5	55.56%
INSPIRE data – based on an INSPIRE regulation	8	88.89%
Other	0	0.00%

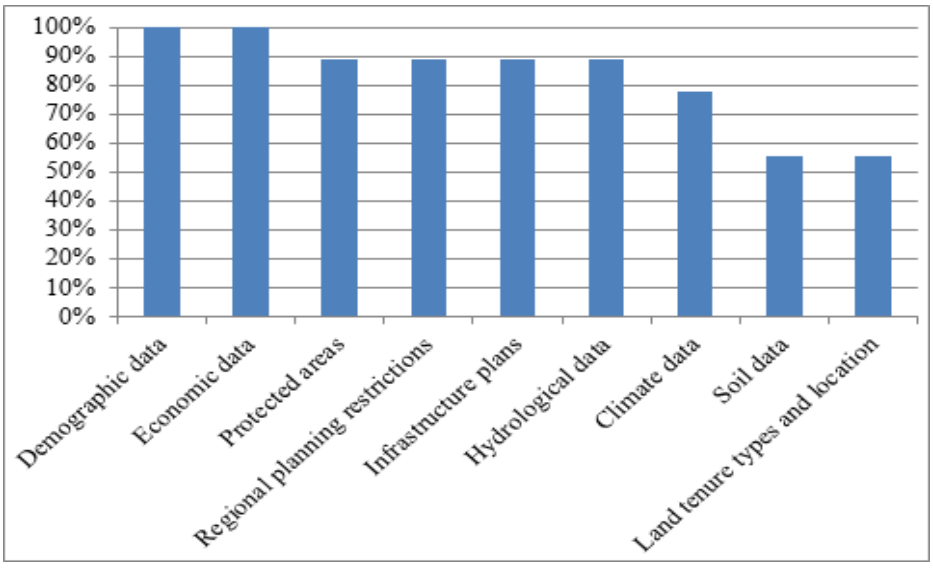

Figure 2: Answers from block (B.) regarding spatial data, which are required as a minimum for cross-border regional planning. Multiple answers were possible.

an overview of methodological approaches of spatial planning and its users (Figure 3). The experts were asked to indicate which approach is rarely, sometimes, or often used by four different user groups. The most important approach for politicians and planners is the green infrastructure. But for planners, as well as for scientists and teachers, especially the well-established sustainability approach is often applied. In science and education also the ecosystem services based approaches play an important role. Although not most often applied, multi-functionality is a widely used approach (in science, planning, and education). The very specific approach of geo-design is equally of wide use; however, it is noteworthy that it is rarely used by policy-makers.

Essential peculiarities of spatial planning technologies are indicated in Figure 4 (**questions D2**). None of the proposed peculiarities was considered to be unimportant. Most features were voted as "very important" or "important". Most votes had the features "data harmonization", "mapping", and "impact assessment". Moreover, two characteristics were emphasized by the survey participants, namely transparency and transdisciplinarity.

Answers for the open **question D2**, which asked for the biggest challenge related to cross-border planning and planning technologies, could be classified into two key issues – namely, "data and modeling" (six answers) and "stakeholders and laws" (five answers) (Table 4). Under "stakeholders and laws", two related aspects are concluded. First, the willingness of stakeholders to participate in the planning process was pointed out as a challenge. However, funding for cooperation activities was mentioned as a prerequisite for such collaborations. Hence, a legal basis is required to ensure financial support and therefore resilient cross-border networks. Under "data and modeling" the challenge of data comparability was raised. As long as data definitions and data processing routines are not harmonized in a transparent way, cross-border modeling for decision-support remains difficult.

Application field	Science			Politics		
Frequency	often	sometimes	rarely	often	sometimes	rarely
Ecosystem services	6	2		1	4	3
Sustainability	8			4	4	
Multi-functionality	5	3		3	3	3
Environmental accounting	4	4		4	2	2
Geo-design	5	3			1	7
Green infrastructure	3	4	1	5	2	1

Application field	Planning			Education		
Frequency	often	sometimes	rarely	often	sometimes	rarely
Ecosystem services	4	3	1	5	2	
Sustainability	6	2		8		
Multi-functionality	5	3		5	2	1
Environmental accounting	2	2	4	2	5	1
Geo-design	4	4		4	2	2
Green infrastructure	6	2		4	4	

Figure 3: Answers for the question C1. Frequency of ratings (1 = always/very often; 2 = sometimes; 3 = rarely/never) are indicated as blue bars.

Features	very important	important	moderately important	of little importance	un-important
Data harmonization of different data sets and processing routines	7	1			
Mapping of functions, goods, services, demand and supply, etc.	1	7			
Simulation of spatially explicit land use alternatives	2	4	2		
Impact assessment to reveal synergies and trade-offs	2	6			
Multi-user sensitivity: adaptive routines, user profiles	1	3	4		
Knowledge management system to maintain existing knowledge	3	3	2		
Examples as showcases for the purpose of learning	2	3	2	1	
Language: easy adaptation to a multi-language context	2	4	2		
Properties	**very important**	**important**	**moderately important**	**of little importance**	**un-important**
Transparency: methods explained, replicable; sources are provided	2	5	1		
Transdisciplinary: Participation options for stakeholders	3	5			
Interdisciplinary: different scientific disciplines integrated	3	3	2		
Open source: the tool or approach is available for free		4	2	2	
Online-solution: option of inter-regional exchange in the internet		5	1	2	

Figure 4: Answers for the question D1 and D2. The number of ratings is indicated by a blue bar.

Table 4: Answers for the question D3, categorized according to socio-economic and methodological/technical issues.

Stakeholders and laws (socio-economic dimension)	**Data and modeling (methodological and technical dimension)**
The honest will of different **stakeholders** to conduct the **planning process** and then to implement it in everyday life. Lack of **funding** for this kind of rather applied research and development. To bring all participants to a **common table** and to develop operational solutions [...], the challenge of cross-border planning requires that stakeholders are willing to commit to the process and enter into the process with an **understanding of the benefits of planning at a scale larger than administrative boundaries**. The use of support tools is simply a **method of enhancing communication** between stakeholders - so any tool which is developed must have a **linguistically correct translation**.	National **modeling standards** (every country should have their own set of models, meaning that you cannot pool resources to create powerful tools together). **Definitions of data** (supporting the national models, but not those across the border). **Data** harmonization and Harmonization of different **processing routines** [...] meeting the two demands 1) making the tool as simple as possible to ensure **applicability** for the user and 2) make the data processing and methods scientifically detailed enough to support **sound and reliable decision-making**. **Transparency**

4 Discussion and conclusion

The sample of stakeholders was limited to the participants of the INTECRE project. Since the INTECRE stakeholders come from various contexts and different BSR countries, we argue that our results are generalizable to the BSR region and can also be interesting to other actors working on planning issues of cross-border regions.

Recently developed planning support technologies predominantly focus on very specific and individual case studies, e.g. on integrated beach planning [1] nature conservation [29] or water management [21]. For regional and especially cross-border spatial planning, **generic tools are needed** which are able to handle heterogeneous regions.

A crucial factor for the successful application of planning support tools is the **data basis**. In addition to this scope, data quality strongly affects the evaluation outcome [20,10]. The survey revealed that the harmonization of data and modeling approaches for cross-border spatial planning is required firstly at the national and secondly at the international level (cf. Table 4, Figure 3). In this context, higher **thematic resolution** of the harmonized European land use data sets is preferred. In contrast, the CORINE data are not useful for working with urban scale, since the area of patches provided in this data set do not reflect the complexity of urban systems. Also LUZ data do not contain detailed data about buildings, for instance, which are the main anthropogenic elements creating the technotope of urban system. Such a shortcoming represents the key obstacle when assessing the cross-border landscape asymmetries, thus making planning in such contexts more difficult. In contrast to CORINE and LUZ data bases, INSPIRE-based data have a wider scope and more detailed thematic resolution (cf. Table 3). This allows more detailed assessments, and the data could also form the basis for the monitoring of landscape changes. The INSPIRE Directive (Directive 2007/2/EC) is an instrument for sharing spatial planning data within the European community. For each member state, publishing data and metadata concerning the subject of spatial planning is mandatory. Therefore, this data classification scheme is recommended for application in spatial planning [19]. Besides the considered data sets in the survey, satellite imageries can also serve as a basis for land use / land cover information. Examples for moderate and high resolution imageries that are widely used are MODIS[4] (MODerate Resolution Imaging Spectroradiometer), Quick Bird[5] (high resolution), or Rapid Eye[6] data. Further promising data are for instance LiDAR[7] (Light Detection and Ranging) data, which examine the surface of the Earth based on a remote sensing method. However, these data sources are not classified according to planning-relevant themes – as are INSPIRE data.

Our research provided insights regarding required features and properties, respectively. Results showed that most of the suggested criteria were considered important (Figure 4). In accordance with the literature, most important for cross-border spatial planning is the **harmonization and transparency of data sets** and processing routines [27,30,4]. These issues were also raised in other BSR studies [40]. According to the authors, not only harmonized data, but especially the data exchange

4 http://modis.gsfc.nasa.gov/

5 http://www.satimagingcorp.com/satellite-sensors/quickbird/

6 http://www.dlr.de/rd/en/desktopdefault.aspx/tabid-2440/3586_read-5336/

7 http://www.lidarmap.org/international/

among countries is essential for effective cooperation. Less importance was assigned to the properties "open-source" and "online-solution". Hence, case-by-case, also desktop software and/or licensed software might be suitable. However, online approaches already play an important role in qualitative scenario planning. According to Raford [28] such online approaches

- enhance participation (amount and diversity),
- increase volume and speed of data collected and analyzed,
- increase transparency, and
- decrease costs of project administration.

In accordance with our results, the importance of transdisciplinarity and interdisciplinarity was also stated in the literature, e.g. by McCall and Dunn (2012).

Although the survey actually focused on the technological requirements for planning support tools, the open questions revealed that the social component plays a key role in this field (cf. Table 4). In addition to the availability and application of planning support technology, a central issue is the **willingness of the stakeholders to participate** [34]

According to the outcomes regarding the four survey categories (A-D) and finalizing discussions within the expert group of INTECRE, we derive the following **general recommendations** about cross-border spatial planning technologies in the European context:

A. *Regional differences in requirements and usability:* A tool which supports cross-border regional planning should be applicable for various types of regions, because the conditions (e.g. the degree of marginalization or urbanization) can vary considerably beyond (administrative) borders.
B. *Data requirements for technologies and instruments:* Cross-border spatial planning requires the integration of cross-sectoral data in order to take all main issues into account. For this purpose (i) a multitude of data are needed, which (ii) should meet the specific regional planning issues.
C. *Methodological approaches of planning technologies and instruments:* Crosscutting concepts that are used by all considered user groups (politicians, planners, teaches, scientists) are sustainability and green infrastructure. Despite the fact that more modern approaches, such as the ecosystem services concept, are perceived and used by some user groups (in science and education), an interdisciplinary communication concept cannot yet be guaranteed.
D. *Users:* Essential features and properties of spatial planning technologies, rendered from a user-perspective, cover a multitude of aspects. Most important is data harmonization, as well as the realization of transdisciplinarity through the involvement of various stakeholders. Main challenges can be classified into (i) socio-economic and (ii) methodological/technical issues, whereas, for example, the willingness of stakeholders to participate, and data harmonization have been identified as challenges, respectively.

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