

Crossborder Interoperability of Land-Use Information

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SUMMARY

In the context of Spatial Information Management information produced by spatial planning, by land registry and by real estate cadastre plays an important role. To guarantee for easy seamless access this information has to be interlinked not only within national borders but also cross-border. From the sharing of heterogeneous data in the context of cross-border SDI, new value creating insights are gained. However, information management within small-scale administrative structures often led to the uncoordinated definition of features and, consequently, to heterogeneous databases. Such heterogeneity substantially hinders inter-administrational cooperation at the operational level as well as information exchange between the different levels of public administration, may it be at the local, the national or the supranational scale. Interoperability, therefore, is a central concept in dealing with spatial data. The paper presents a study analysing spatial information interoperability in the field of planned land-use information. Special emphasis is given to the aspects of semantic interoperability. A case study addressing the in depth analysis of planned land-use documents will demonstrate in which way a conceptual transformation process can be developed to pave the way for cross-border interoperability. Semantic interoperability between two different land-use data systems will be achieved by formulating adequate transformation rules between the two systems' specifications. Such rules provide an indispensable and highly valuable base for the development of Web Map Services (WMS), as well as for download services which are able to process comprehensive spatial data based on different, even municipal, spatial data themes. Integrated data concepts and data models can help to guarantee for the smooth cooperation even in a heterogeneous environment of organization units.

Zusammenfassung

Im Zusammenhang des Geoinformationsmanagements spielt Information aus der Raumplanung, aus Landregistern und Eigentumskatastern eine wichtige Rolle. Um einfachen nahtlosen Zugang zu garantieren muss diese Information nicht nur innerhalb nationaler Grenzen sondern auch grenzüberschreitend verknüpft werden. Das Informationsmanagement in kleinteiligen Verwaltungsstrukturen hat in vielen Fällen zur unkoordinierten Definition von Objekten und damit zu heterogenen Datenbanken geführt. Diese Heterogenität behindert stark die Kooperation zwischen Verwaltungen auf der operationellen Ebene und den Informationsaustausch zwischen den verschiedenen Ebenen der öffentlichen Verwaltung, sei es im lokalen, im regionalen oder im supranationalen Maßstab. Die Studie analysiert die Interoperabilität von Geoinformation im Bereich der raumbezogenen Planungsinformation. Exemplarisch werden aus der Analyse zweier unterschiedlicher Systeme Transformationsregeln entwickelt, die den Weg bereiten für die grenzüberschreitende Interoperabilität. Auf diesen Regeln können webbasierte Dienste aufgebaut werden, über die standardbasiert auf umfangreiche räumliche Datenbestände zugegriffen werden kann.

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1. INTRODUCTION

Interoperability is a central concept in dealing with spatial data. Existing spatial data are collected, analyzed and managed in various distributed systems. It obviously makes much more sense to share existing records rather than to acquire new data for each application separately. The need to use heterogeneous and distributed data becomes evident particularly in current developments of Spatial Data Infrastructures (SDI) and already existing geo-portals on the Internet. From the sharing of heterogeneous data in the context of cross-border SDI, new value creating insights are gained. Concepts such as metadata description of spatial data for geo-services according to ISO 19115 and ISO 19119 offer users a feasible tool to describe the contents of administrative records both in technically and administratively correct way.

The provinces and municipalities in Germany are required to implement the legal framework and rules of the European INSPIRE directive which seeks to establish an infrastructure for spatial information in Europe [1]. A considerable share of land-use information is maintained at the level of local government. Annex III of the INSPIRE Directive addresses the theme Land-use. Local government, therefore, is responsible at large to provide local level spatial data sets and services as well as metadata to meet the requirements of Annex III of the INSPIRE Directive.

At present, however, there is hardly any realization of a comprehensive management and deployment system available to provide capabilities of interoperable spatial data handling within a local administrative environment. Small-scale administrative structures resulted in many specific features and, consequently, in heterogeneous databases. This heterogeneity substantially hinders inter-municipal cooperation at the operational level as well as information exchange between the different levels of public administration both at the national German and at the European scale. Particularly needed are agreed rules for the provision of Web Map Services (WMS), as well as for download services which are able to process comprehensive spatial data based on different, even municipal, spatial data themes. Integrated data concepts and data models can help to guarantee for the smooth cooperation even in a heterogeneous environment of organization units. In depth analysis of data structures, therefore, is imperative.

2. THE CASE STUDY OF INTEROPERABILITY

In the following section issues of crossborder interoperability will be discussed. As an example to highlight problems and solutions the exchange of land-use information between the national level and the European level of the European region will be used.

The Open Geospatial Consortium OGC continuously has developed a comprehensive framework of spatial standards which builds part of the European INSPIRE specification base. In Germany the e-government project X-PLANUNG [20] was initiated which resulted in the OGC compliant application schema XPlanGML of the Geography Markup Language (GML) standard.

In the pilot study we created a local development plan 'Brühl' for a small municipality in Germany called 'Gau-Algesheim' in compliance with the XPlanGML standard (Fig. 1). Based on the planning standard 'XPlanGML' it will be shown, that by using GML-based models which are integrated into a spatial data infrastructure, crossborder interoperability from national SDI to INSPIRE can be achieved.

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<!-- erzeugt mit WS LANDCAD XPlanGML-Export Version 3.0 -->
<!-- am Dienstag, dem 11. September 2012, 13:10:41 Uhr -->
- <XPlanAuszug xsi:schemaLocation="http://www.xplanung.de/xplangml/3/0
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xmlns:xplan="http://www.xplanung.de/xplangml/3/0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
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- <gml:Envelope srsName="EPSG:31467">
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</gml:Envelope>
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- <gml:featureMember>
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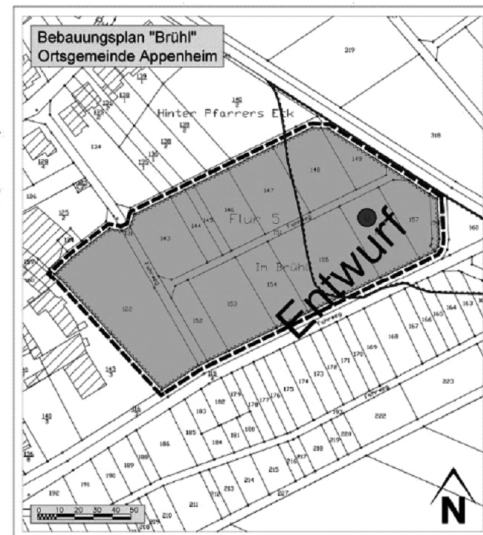


Fig. 1. Local development plan 'Brühl' in German XPlanGML standard

The ultimate goal of the pilot study is to show if and how the XPlanGML schema is compatible with the current INSPIRE Data specifications. At the semantic level the correspondence between the two semantic data models XPlanGML and INSPIRE PLU has to be identified as precisely as possible for all elements to be included in the transformation rules.

2.1 Conceptual Transformation Process for Planned Land-Use Values

Planned Land-use is regulated by spatial planning documents elaborated at various levels of administration. The documentation of Land-use regulation for a geographical area is composed of an overall strategic orientation, a textual regulation and a cartographic representation. Finally adopted spatial planning documents result from a well-defined spatial planning process, with a number of stakeholders being involved. The INSPIRE Land Use Data Specification is an example on how the exact spatial dimension of all elements a spatial plan may consist of can be defined.

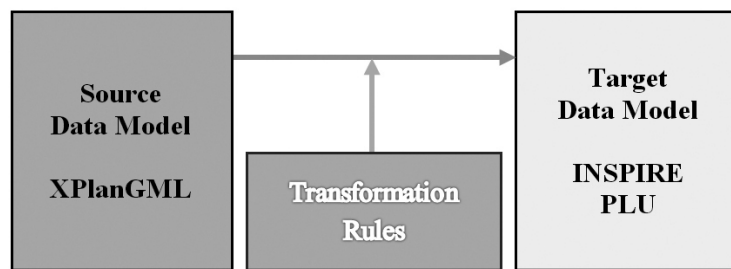


Fig. 2. Conceptual Transformation Process between a defined Source Data Model (XPlanGML) and a Target Data Model (INSPIRE PLU Planned Land Use)

To achieve interoperability between the INSPIRE Land Use Data Specification on the one hand and the implementation of existing German Land-Use Data Models on the other hand adequate transformation rules have to be formulated (Fig. 2). The goal is to show if and how the XPlanGML schema is compatible with the current INSPIRE Data specifications.

2.2 Mapping and Transformation Rules XPlanGML to INSPIRE Land Use Classification

A data model mapping step is assumed as a pre-requisite towards integration and is dealt with as a separate problem. The needed mapping and transformation rules are those between any local source data model and the common target data model, like INSPIRE. Analyzing of all feature types of the local level source data model and the target data model is necessary to fulfill the requirements of INSPIRE.

In Fig. 3 a simplified presentation of X-Planung and INSPIRE data types is given. From the Figure it becomes evident that the data models are different at 'featureType' level. A simple example shall illustrate the consequences. The German XPlanGML schema allows for a spatial plan (<<featureType>>XP_Plan) comprising several areas (<<featureType>>XP_Bereich) whereas in the European INSPIRE specification a spatial plan is a single feature (<<featureType>>SpatialPlan).

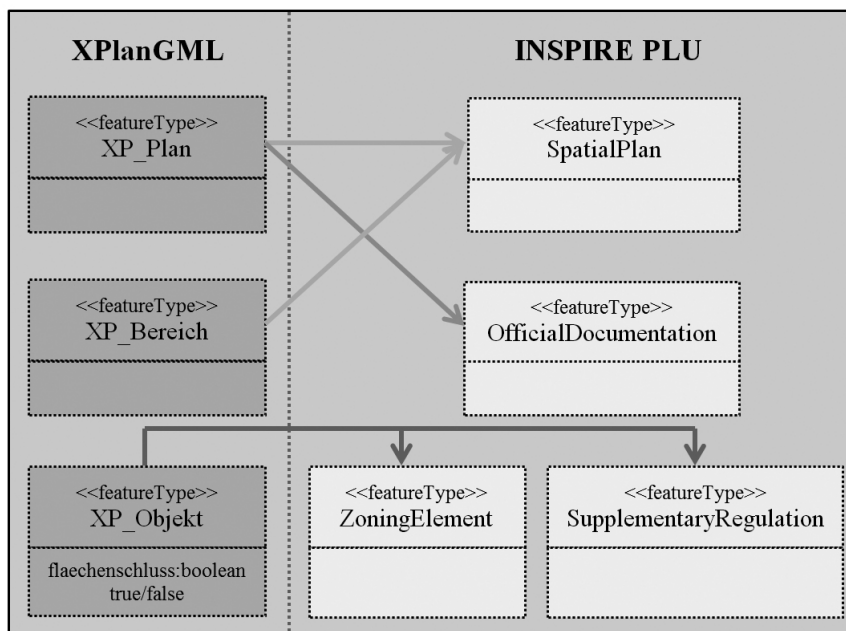


Fig. 3 One-way Transformation Concept from XPlanGML (left) to INSPIRE Planned Land-use Feature Types (right)

To transfer data from the German standard to the European standard the relation in the German data set must be dissolved. The capability of the German standard to manage spatial plans by updating only parts of it while maintaining the relation to the complete ‘XP_Plan’ is often used. As a consequence data transfer of one German plan will generate a more or less huge number of European Spatial Plan features, whilst the link to the original plan even might get lost. Another issue of concern in this context is the geometric property of spatial features. In the German standard features of <<featureType>>XP_Objekt obtain their geometric feature type from the attribute value flaechenschluss true/false. If the attribute value of a feature is ‘true’ this feature is a closed polygon. If the attribute value is ‘false’, the considered feature may be a point or line feature, instead. The transformation rules have to handle such cases. There are other differences between both models which are not critical. To give an example for that, in INSPIRE all official documents of a spatial plan will be recorded in a feature (<<featureType>>OfficialDocumentation) rather than in X-Planung XPlanGML where such information is recorded as an attribute of a plan (<<featureType>>XP_Plan). With formulating the corresponding transformation rules, like shown in Table 2, can easily solve this problem.

2.3 Interoperability Problems and Solutions

Our first attempts to create a set of transformation rules in order to create a framework of one-way transformation from the German X-PLANUNG XPlanGML to the European INSPIRE were based on versions XPlanGML 3.0 and INSPIRE data specifications 2.0. In this initial phase several problems occurred. Certain types of areas being part of plans in compliance with the German standard could not be transferred into the European model; transfer of attribute values was not possible in a number of cases due to semantic inconsistencies which

could not be managed within the given standards, and so on. As a consequence of such shortcomings the German Working group which links the German and the European level for the theme Planned Land-use insisted on an update of the German and the European standards alike. As a result of these activities updated versions XPlanGML 4.0 and INSPIRE data specifications 3.0 were generated.

Again processing the already mentioned legally binding land-use plan ‘Brühl’ of Gau-Algesheim by using the updated standards versions we succeeded in establishing the one-way transformation from German land-use information to the European level. The whole framework of transformation rules results in a large table consisting of all XPlanGML objects with attribute values which correspond to INSPIRE PLU elements.

Table 1. Extract of Transformation Rules for a ‘Regulated Water Management Area’ and an ‘Area of Agricultural Use’; Overlay Object in XPlanGML and INSPIRE PLU

| XPlanGML | | INSPIRE PLU |
|---|----------------------------|---------------------------------------|
| BP_Wasserwirtschafts Flaeche | flächen schluss | Supplementary Regulation Value |
| Hochwasser Rueckhaltebecken | false | 2_RiskExposure |
| Ueberschwemmungsgebiet | false | 2_1_FloodRisk |
| Versickerungsflaeche | false | 2_RiskExposure |
| Entwaesserungsgraben | false | 2_RiskExposure |
| Sonstiges | false | 2_RiskExposure |
| BP_Landwirtschaft | | Zoning Element Value |
| LandwirtschaftAllgemein | true | 1_1_agriculture |
| Ackerbau | true | 1_1_1 CommercialAgricultureProduction |
| WiesenWeidewirtschaft | true | 1_1_1 CommercialAgricultureProduction |
| GartenbaulicheErzeugung | true | 1_1_1 CommercialAgricultureProduction |
| Obstbau | true | 1_1_1 CommercialAgricultureProduction |
| Weinbau | true | 1_1_1 CommercialAgricultureProduction |
| Imkerei | true | 1_1_1 CommercialAgricultureProduction |
| Binnenfischerei | true | 1_4_2 ProfessionalFishing |

Table 1 shows an extract of transformation rules for a ‘Regulated Water Management Area’ and an ‘Area of Agricultural Use’, with attributes of the land-use plan ‘Brühl’ in bold. As can be seen from the list, the German Land-use classification schema shows a more detailed resolution of planned land-use than does the INSPIRE schema. Four different German land-use classes will be transferred to the one Supplementary Regulation Value ‘2_RiskExposure’. In future, INSPIRE will hold so-called national code lists which will give the opportunity to the national level administrations to map their national land-use classifications schemas to INSPIRE in a more sophisticated way than what they can do today. The code lists will be part of <<featureType>>SupplementaryRegulation. In that way mandatory and optional INSPIRE Planned Land-use elements will be kept separately in a clear way.

Another issue of concern is the cartographic visualization of spatial plans. For INSPIRE visualization purposes, simple rules for default portrayal are given by specifying a single color value attached to each class of the ‘Hierarchical INSPIRE Land Use Classification System’ HILUCS. The Spatial plan extent is drawn by a black line of 2 pixel size. In contrary to the simple INSPIRE cartographic presentation model, the German planning law sets a detailed regulation framework called ‘PlanzV90’ which defines symbolisms, signatures and surface representations of legal plans in a very sophisticated way. This issue will have to be subject of future work.

In this study we restrict our considerations to the INSPIRE theme Planned Land-use solely. In practice single national spatial data sets often provide information not only for one but also for other INSPIRE themes. Reversely requirements at the European level for one theme may request national data not only from one but from several national data sets. More work will have to be done to develop feasible solutions for these problems.

3. CONCLUSIONS

Spatial planning has taken place in European countries for a long time. The national spatial planning systems are reflected in corresponding regulations and, consequently, databases. At the European level the INSPIRE directive sets the framework to establish a European wide Planned Land-use schema. Unavoidably such a situation will generate problems of interoperability of the different systems. Common standards are needed to ensure smooth data exchange within a spatial data infrastructure at all levels of public administration. Standards guarantee for sustainable data exchange between different administration bodies. Technical standards are requested to implement the semantic data requirements of all administration levels. Large scale land-use planning essentially takes place at the level of local administration.

The case study focuses on the development of a strategy for national local authorities in Germany how to build up local spatial data models to meet not only national requirements but also the specific requirements as given by INSPIRE. As a result of the efforts many administration units now create spatial datasets of their own public information by using the German standard ‘XPlanGML’. In that way they are able to meet the future INSPIRE requirements without having to spend additional resources.

The municipalities in Germany take practical benefit from that capability by avoiding to re-enter the plan for INSPIRE reporting tasks rather than to transfer the output data set in XPlanGML automatically to the INSPIRE classification. It can be stated that the technical and semantic provision of digital development plans with XPlanGML also supports fulfilling the legal requirements of INSPIRE in Germany.

Land-use covers only a small piece of European spatial information as defined by INSPIRE. To give some examples, in the context of Spatial Information Management the fields of spatial planning, of land registry and of real estate cadastre play a major role and have to be interlinked to INSPIRE in practice. Currently in Germany several initiatives seek to support

the integration of spatial information management including spatial data processing in the named fields. Many local IT standards were developed and meanwhile were adopted by many institutions. The adoption of existing local IT standards will continue to be a driving force for the need to establish semantic interoperability at and between different levels of public and private administration.

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BIOGRAPHICAL NOTES

Hartmut Müller got his diploma and doctoral degree at Karlsruhe University, Germany. After 8 years of research he turned into the marketing and software development departments of international enterprises for 6 years. Since 1991 he is a professor at Mainz University of Applied sciences. Since 1998 he is director of i3mainz, Institute for Spatial Information and Surveying Technology. In the DVW – German Association of Geodesy, Geoinformation and Land Management he was the chair of working group 2 – Spatial Information and Spatial Data Management until 2010. **Falk Würriehausen** holds a diploma in Geodesy. Since 2008 he is a research associate at the i3mainz Institute for Spatial Information and Surveying Technology of Mainz University of Applied Sciences.

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