

MonPlanGML - GML-based Data Model for Municipal Land Management in Montenegro

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1 ABSTRACT

The Municipal Land Management Project aims to improve legal certainty as well as spatial and urban planning using land as a resource in Montenegro. The project specifically targets municipalities as local self-government units, and cooperates with all 21 Montenegrin municipalities. One of the problems dealt with the project is the lack of legal standards on elaboration and exchange of digital plans. For this, a GML-based data model and object oriented data exchange format MonPlanGML for all types of Montenegrin spatial plans is being developed, adapting the approach of the German standardisation project XPlanung. MonPlanGML supports the exchange of spatial planning data between different IT-systems without loss of information, and enables an easy access to planning information via internet services. After a short introduction into the legal regulations on spatial planning in Montenegro and the general goals of the Municipal Land Management Project, the paper concentrates of data model of the General Urban Plan (GUP).

2 INTRODUCTION

The main task of spatial planning is to coordinate the different requirements on the resource “land” within a certain country, and to balance potential conflicts. Such conflicts exist between different administrative levels (municipality, region, country), and between different aspects of land usage (e. g. traffic, economy, natural environment, population). Efficient spatial planning has to take care of future spatial functions and usages, and must support a sustainable spatial development taking into account social, economical, ecological and legal aspects.

This is of special importance for a young and developing country like Montenegro. Nationalisation, confiscation and expropriation of private land and property in the Socialist era as well as the swift privatization of real estate in the following years, left unclear and often incoherent situation on real estate and land use in this country. The core problem is an inadequate database as well as planning and management competencies for steering strategic spatial development, in all Montenegrin municipalities. This situation shall be improved by the “Municipal Land Management Project”, a bilateral project of the Government of Montenegro and the Government of Germany, implemented by the “Deutsche Gesellschaft für technische Zusammenarbeit” (GTZ). Main partners in realization of the project are the Montenegrin Ministry for Economic Development, the Head Office for Real Estate, and the municipalities. One central topic of this project is the implementation of a Geographic Information System (GIS) in all 21 Montenegrin municipalities and the Sector for Spatial Planning of the Ministry for Economic Development, in order to improve the process of urban planning and support decision making.

According to the Montenegrin Law on Planning and Development (GoM 2005), all new planning documents have to be elaborated and submitted to the municipal / national planning institutions in digital form. The actors of the planning process are using different IT-Systems. For the exchange of digital planning data, as well as for the internet-based provision of planning data to potential users, a data exchange format is needed being supported by all IT-systems in use without the necessity of complicated conversions, and being able to represent every possible spatial plan without loss of information. Existing exchange formats like DXF cannot be used for this purpose, because they mainly describe the graphical representation, and not the semantically content of a plan. A semantically data model, describing the geometrical and logical content of a spatial plan independent from its graphical representation, and an object oriented data exchange format supporting this model are missing.

As one topic of the Municipal Land Management Project, a data model called MonPlanGML, specially adapted to the legal situation in Montenegro, is being developed. The MonPlanGML project adapts the

German project XPlanung (Benner, Krause 2007; Benner, Krause 2007A), where a similar data model and exchange format for German urban, regional, and landscape plans has been developed. Both approaches use international standards like the “Uniform Modelling Language” (UML) for the data model, or the “Geographic Markup Language” (GML) for the exchange format.

After a short introduction into the legal conditions of spatial planning in Montenegro (chapter 3) and the general context of the Municipal Land Management Project (chapter 4), this paper mainly discusses the MonPlanGML model of one type of spatial plan, the *General Urban Plan* (GUP). The general approach in deriving the GUP-model and the corresponding GML-based exchange format, functional range and structure of the model, as well as the strategy for testing and evaluating the specification are described. Finally, a summary and an outlook for extending the model to other types of spatial plans is given.

3 SPATIAL PLANNING IN MONTENEGRO

The different levels of spatial planning with their specific plans are regularised in Article 16 et sqq. of the Montenegrin Law on Planning and Development. Compared to German planning law the different levels of spatial planning in Montenegro are regulated in one single law. In Germany the legal foundation for spatial planning is the regional planning act (ROG), the legal foundation for urban affairs is the building law (BauGB). According to Montenegrin Law on Planning and Development a distinction is drawn between spatial and urban plans:

Spatial plans are:

- spatial plan of the republic (PPR),
- spatial plan of a special purpose area (PPPPN),
- detailed spatial plan (DPP),
- spatial plan of a local self-government unit (PPO).

Urban plans are:

- general urban plan (GUP),
- detailed urban plan (DUP),
- urban project (UP),
- state or local study of location (DSL or LSL).

Municipality overall planning is specified abstract in the spatial plan of a local self-government unit (PPO) for the whole area of a municipality. The general urban plan (GUP) specifies the land use in the settlement area of a municipality. According to the German planning law on the level of a municipality there is one additional planning level. The detailed urban plan (DUP) is comparable to a zoning-plan.

Table 1 shows the main categories and sub-categories of objects occurring in the spatial plans mentioned above

land use / building development	DSL / LSL / UP / DUP / GUP	PPO	PPR
	living area living area smaller density living area medium density living area higher density mixed purpose area village areas working area areas with central activities business area administration area school area	settlement area living area mixed purpose area village areas working area areas with central activities business area administration area school area	settlement area

	health area culture area church area sport area industry area tourism area tourism settlement area hotel area camp areas weekend settlement areas marina areas	health area culture area church area sport area industry area tourism area tourism settlement area	
urban green	urban greenery area urban wood Park other landscape architect object sport recreation traffic green	urban greenery area urban wood Park sport recreation	
infrastructure	infrastructure area air traffic area electro energy infrastructure area railway traffic area road traffic area telecommunication infrastructure area water traffic area	traffic infrastructure area other infrastructure area	infrastructure area
agriculture	agriculture area agriculture high quality cropland vineyard	agriculture area agriculture high quality cropland vineyard	agriculture area agriculture high quality cropland vineyard
wood	wood area economy wood protection wood protected wood special purpose wood	wood area economy wood protection wood protected wood special purpose wood	wood area economy wood protection wood protected Wood special purpose wood
water	area sea lake river reservoir	area	area
	other natural area	other natural area	other natural area
mineral raw materials	area on ground under ground	area on ground Under ground	area
defence	defence protection area	defence protection area	defence protection area
cross border cooperation		between states between municipalities	between states between municipalities
green corridor		linear green corridor	
development corridor			dinaric arc corridor

			green belt corridor costal mountains corridor
settlement network			national special regional municipal important local local

Table 1: Compendium of the regulations in urban plans (GUP, DUP, UP and LSL), in the spatial plan of a local self-government unit (PPO) and the spatial plan of the republic (PPR)

4 MUNICIPAL LAND MANAGEMENT PROJECT

Montenegro is a small, mountainous country at the Adriatic Sea. After breakdown of the Socialist Republic of Yugoslavia and joining a State Union with Serbia Montenegro re-established its independence in June 2006.

Nationalisation, confiscation and expropriation of private land and property in the socialist era as well as swift privatisation of real estate in the subsequent years have led to unclear, often contradictory conditions on real estate in Montenegro. In addition, since mid-1990s, Montenegro faces huge changes in urban development. Different land uses are competing for land resources under primarily economic aspects. Previous industrial centres decay, urban and other areas degrade while uncontrolled development takes place outside areas determined for construction, often occupying valuable landscapes or high quality agricultural land. In particular in the capital Podgorica and the coastal area sub-urbanisation and increasing amount of illegal structures can be observed. Databases and corresponding planning and management competences for strategic steering of regional and urban development are inadequate in all municipalities.

On base of this initial situation a project on land management has been set up by the Government of Montenegro and the Government of Germany, represented by the German Federal Ministry of Economic Cooperation and Development (BMZ). The BMZ commissioned the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) with implementation of this project. The main partners in realization of the project are the Montenegrin Ministry of Economic Development, the Head Office for real Estate, and the Municipalities.

The project “Municipal Land Management” (MLM), Montenegro, started in March 2004. It is designed for a total period of approximately 7 years (March 2004 – December 2010). Its overall objective is that legal certainty as well as spatial and urban planning using land as a resource is improved. The project specifically targets municipalities as local self-government units.

In 2004 the project started cooperating with 6 coastal municipalities. In 2006 cooperation has been expanded. Today, the Municipal Land Management Project cooperates with all 21 Montenegrin municipalities.

By the MLM project elaboration of spatial and urban plans at national as well as at local level is being supported. Legal regulations on planning, development and construction are being amended in order to integrate European standards and modern planning approaches. According to the Montenegrin Law on Planning and Development (GoM 2005), all new planning documents have to be elaborated and submitted to the municipal / national planning institutions in digital form. Due to the lack of legal standards on elaboration of digital plans institutions involved in spatial and urban planning suffer significant problems:

- Each planning company uses different symbols for maps. There is no uniform visualization of spatial and urban plans.
- There are no specifications in which format digital plans shall be submitted to the responsible authority (Ministry for Economic Development or municipality). Thus, planning companies submit there products in the proprietary format of the IT system they apply (CAD-, GIS-formats). Usually the authorities do not have the necessary software applications for using these data.
- Currently, main purpose of the digital plans is to serve as base for analogues plots and print-outs. Therefore, the planners are not familiar with and do not apply rules to create object-structured data sets. Thus structure of the digital plans is not adequate for spatial analyses e.g. in GIS or

implementation into web services. The high potential of digital data in respect of spatial analyses, interactive services etc. is not used.

The Montenegrin Ministry for Economic Development has recognized this problem. With support of the MLM project it enacted a bylaw on elaboration of planning documentation. Amongst others, this bylaw regulates the use of symbols for the different types of spatial and urban plans. The development of the GML-based data model MonPlanGML, together with this bylaw, will form the necessary precondition for a standardized visualization and exchange of digital planning information in Montenegro. Enabling easy exchange of planning data and its internet-based provision will foster the access to relevant spatial information enormously and improves services provided to investors, institutions, and citizens.

Beside its main sector related to spatial and urban planning, the GTZ Municipal Land Management Project provides outputs in the sectors of real estate taxation and real estate cadastre too.

- Real Estate Tax is determined and collected by Montenegrin municipalities since 2002. Revenues by this tax flow completely into the municipal budget. Thus, it is one of the most important revenues for the local self-government units, and the one with the highest potential to be increased. By providing more actual and complete data and improving procedures of determining and collection of the real estate tax the GTZ project contributes to a significant increase of municipal revenues during the past years. By this, the municipalities improve their capability to act, e.g. to up-date municipal planning documentation, improve municipal infrastructure and initiate urban development projects.
- The Real Estate Cadastre of Montenegro is an integral register on ownership rights and other rights on real estate as well as evidence on parcels and objects. Yet, it is established for approximately 60 % of the total area of Montenegro. Priority tasks are finalization of the Real Estate Cadastre and updating the existing records. The project supports establishment of procedures for regular maintenance of the Real Estate Cadastre as well as a faster establishment of the register for the whole country. This is achieved by improvement of the technical capacities of the national authority responsible for survey, establishment and maintenance of the Real Estate Cadastre (Uprava za nekretnine) as well as by establishment of a private sector for licensed surveyors.

5 GML-BASED DATA MODEL FOR SPATIAL PLANNING IN MONTENEGRO

The general regulatory framework for spatial planning in Montenegro (chapter 3) shows a number of similarities to the situation in Germany. It has therefore been decided to adopt the methodology already established in the German national project XPlanung, where a GML based data exchange format for urban planning (XPlanGML) has been developed. For the equivalent schema modelling Montenegrin spatial and urban plans, the name MonPlanGML has been chosen. The central characteristics of the MonPlanGML approach are as follows:

- The GML-based data model realizes the paradigm of „separation of (semantic) content and (graphical) representation“. This means that a digital version of a spatial plan mainly contains information on the semantic content of a plan, i. e. the regulations on possible or impossible land-use in different regions of the planning area. The information how this content is actually presented on a computer display or in a printed plan is specified independently from a concrete plan in a separate stylesheet document. Up to now, the project work concentrated on the specification of the semantic model.
- The MonPlanGML schema has a three-level structure (fig. 1):
 - On the upper level there are GML feature types for plans, representing a spatial plan as a whole. All plan types are derived from the basic class *MOP_Plan*. The basic class has a number of attributes, allowing e.g. the specification of the plan's identifier, name, number and description, of company and person responsible for generating the plan, and of important dates concerning the planning process. The polygonal geometry of the planning area can also be specified. Planning regulations which cannot be formalized or have no spatial reference can be formulated textually (class *MOP_TextClause*).
 - A plan aggregates a number of plan sectors, either corresponding to partial plans (e.g. infrastructure plans, green area plans, ...), or to spatial (horizontal or vertical) partitions of the planning area. The basic class for plan areas is *MOP_PlanSector*.

- A plan sector aggregates an arbitrary number of plan objects, each of them corresponding to a specific regulation. The attributes of the basic class *MOP_PlanObject* support the specification of an arbitrary (textual) comment, of the regulation’s legal basis, and a layer number, indicating the vertical position of the regulation.
- For each type of spatial plan, there corresponds a separate GML applications schema. The classes of the application schema are derived from the basic classes for plans, plan sectors and plan objects mentioned above. Up to now, an application schema for the General Urban Plan has been developed, which is discussed in more detail in chapter 5.1.
- Because the content of a spatial plan like the GUP is not totally preassigned, the GML application schema has to be open and extensible. This is accomplished by a set of „generic“ feature types, by „generic attributes“ extending the set of specific attributes of each feature type (*MOP_GenericAttribute*), and by specific text attributes extending the range of enumeration values.

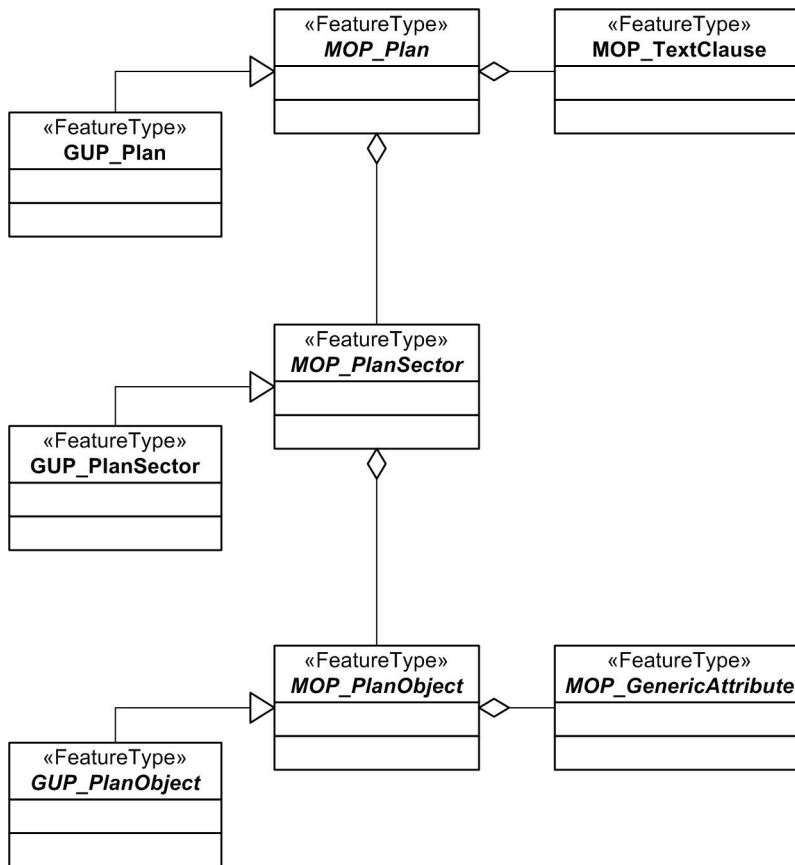


Figure 1: Basic structure of the MonPlanGML data model

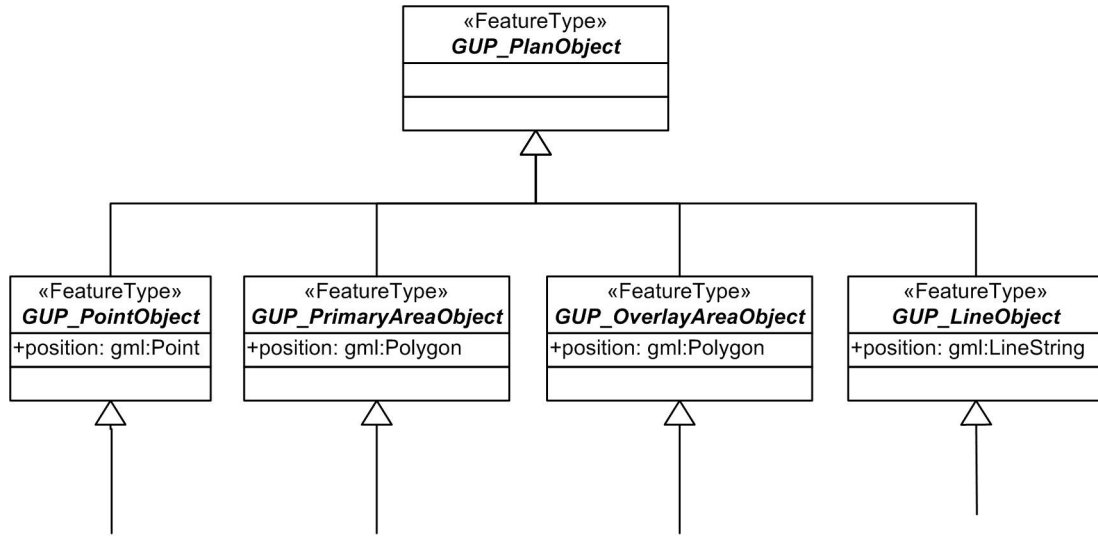
5.1 MonPlanGML data model of the General Urban Plan (GUP)

The definition of the different feature types modeling regulations of a GUP is mainly based on the signature catalogue (Ljeskovic 2007). The design goal was that every spatially referenced regulation relevant for the GUP and explicitly mentioned in the signature catalogue can be represented by a specific plan object and a specific set of attribute values. Under these circumstances, an automatic visualization of the regulation in accordance with the signature catalogue is possible.

Figure 2 shows the inheritance hierarchy of the GML feature types modelling specific regulations of a GUP. Each GUP object is derived from one of the following classes:

- *GUP_PointObject*: Basic class for regulation with point-shaped spatial reference;
- *GUP_LineObject*: Basic class for regulation with line-shaped spatial reference;
- *GUP_PrimaryAreaObject*, *GUP_OvelayAreaObject*: Basic classes for regulations with polygonal-shaped spatial reference.

There are two possibilities for the definition of objects with polygonal-shaped geometry. *PrimaryAreaObjects* (derived from *GUP_PrimaryAreaObject*) cover the whole planning region without overlap. Balancing of areas is possible among these objects. *OverlayObjects* (derived from *GUP_OverlayAreaObject*) superimpose *PrimaryAreaObjects*, and normally are not apt for area balancing.



Classes representing GUP regulations

Figure 2: Structure of the GUP application schema

The classes specifying a certain type of geographic reference are itself derived from the basic class *GUP_Object*.

In the actual version 1.0 of the GUP application schema there are 76 classes representing specific regulations, which are thematically ordered in 9 main packages. Table 2 gives an overview on the available packages and their content.

Package name	Content
<i>GUP_BasicClasses</i>	Basic feature types of the GUP application schema.
<i>GUP_BuildingDevelopment</i>	Feature types modeling regulations for building and development.
<i>GUP_DevelopmentRestoration</i>	Feature types modeling regulations concerning development and restoration of land.
<i>GUP_Infra</i>	Different sub packages concerning infrastructural regulations: <ul style="list-style-type: none"> • Air traffic infrastructure; • Communal infrastructure; • Energetic infrastructure; • General traffic infrastructure; • Hydrologic infrastructure; • Railway traffic infrastructure; • Road traffic infrastructure; • Telecommunication infrastructure; • Water traffic infrastructure.
<i>GUP_LandscapeAndNatureProtection</i>	Feature types modeling regulations concerning protection of landscape and nature.
<i>GUP_NationalHeritage</i>	Feature types modeling regulations concerning the national heritage.
<i>GUP_Nature</i>	Feature types modeling regulations concerning natural areas.
<i>GUP_OtherClasses</i>	Additional Feature classes
<i>GUP_WaterProtection</i>	Feature types modeling regulations concerning water protection.

Table 2: UML packages of the GUP application schema

In this paper it is not possible to present all classes of the GUP application schema in detail. As an example, figure 3 shows the UML diagram of the class GUP_NationalHeritageArea, derived from GUP_OverlayObject. Objects of this type therefore have polygonal geometry and overlap other regulation being defined as PrimaryAreaObjects. They define areas of central importance for the national heritage of Montenegro. The class has two attributes (type and specialType), which enable a more precise specification of the subject of protection. There exists a list GUP_NationalHeritageType of predefined subjects, defining the value range of the attribute type. In the signature catalogue, a specific symbol or signature is assigned to each item of the enumeration. If the actual subject of protection is not covered by the list, the value „9999“ (Other) may be chosen for type, and the subject can be specified as free text with the optional attribute specialType. By this extension mechanism, the data model is able to represent arbitrary types of National Heritage Areas.

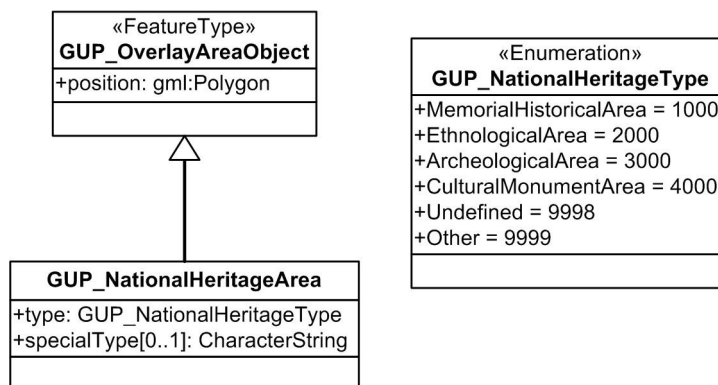


Figure 3: GUP representation of a National Heritage Area

For testing, evaluating and demonstrating the GML-based data model, a „Reference GUP“ has been generated by Montenegrin planning experts. It contains instances of all classes and all relevant attributes occurring in the GUP application schema. Figure 4 shows a section of this plan with various symbols, area- and line signatures.

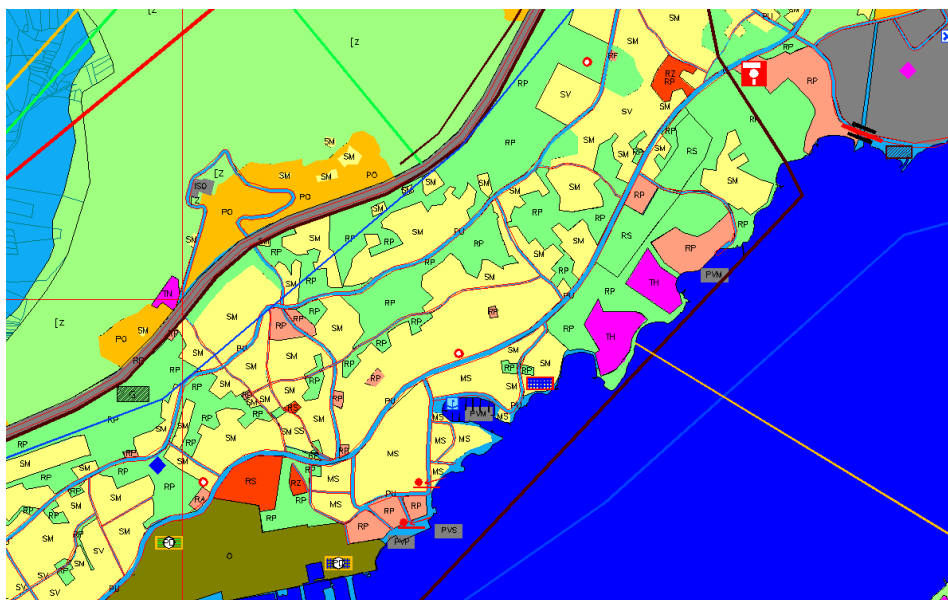


Figure 4: Section of the reference GUP

During the design process of the GML-schema, the reference plan has also been used for resolving open questions concerned with the spatial reference of certain classes. The reference plan was generated with a general purpose CAD system, and successfully converted into MonPlanGML with a specialized version of the XPlanGML-Toolbox software (Benner 2007).

6 SUMMARY AND OUTLOOK

The paper presented the MonPlanGML data model specially designed for the digital exchange of spatial plans in Montenegro. In the final state, this exchange format will be able to handle all plan types mentioned in the Montenegrin planning law. The paper presented derivation strategy and general architecture of the data model, as well as the GML feature types representing the content of a General Urban Plan (GUP). The theoretically derived GUP-model has been successfully evaluated by converting a synthetic „Reference-GUP“.

In the future, the actually existing MonPlanGML data model has to be extended in order to deal with other types of spatial plans. This work will be performed in a close cooperation of foreign experts – actually being involved with the German XPlanung project – and a local working group consisting of representatives of the Ministry of Economic Development, municipal secretariats and private planning institutions. A central challenge will be to organize the transfer of know-how, enabling the local experts to use, enhance and adapt the model without external assistance in the future. Furthermore, the integration of the MonPlanGML data format into the IT-systems used for spatial planning in Montenegro has to be supported, and corresponding import and export filters have to be developed. By the time MonPlanGML supporting software tools are available, planning processes and the access to planning information really can be based of the new data format. At this stage, the benefits of using a standardised and semantically structured data model will become obvious.

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