Dichtung of Standards and *Wahrheit* of GIS Data for Spatial Planning: Cross-Border Case

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1 REASONS LEADING TO STANDARDISATION

After information technology has enabled developing huge data storages and their remote providing and sharing, the value of informatisation consists increasingly in networking hitherto individual, *ad-hoc* data sets in multiple information systems. The economic aspects of data development and maintenance make data managers think about sharing and providing data sets for secondary use. In fact, most data sets are built secondarily upon another data; only minor part of data is entirely "purely primary" ones. However, the secondary and, more generally, multiple data use by numerous users emphasises the need for their transferability from original, primary manager and user to other subjects: secondary users of primary data, those who use the primary data for creating secondary data, "tertiary" users of the secondary data, etc. This ultimately leads to effort to establish and to enforce standards for data. Decision-making is a special case of use of GIS data. Here the accuracy, updateness and reliability are the pre-requisites for correct decisions. Procuring, management and dissemination of such data needs special standards and special procedures to prevent damages. In the public domain, this is the case of the data entering the legal decisionmaking process. This all requests for legal instruments to enforce the specific standards on the part of those who originate / procure the data. Thus, the state can develop the environment for intragovernmental standardisation and transfer of GIS data relevant for planning and subsequent decision-making. Outside the public domain, data producers are not subjected to the standardisation imposed by law. However, their standards may be driven by demand, discipline and technology. As such, the standards will be part of a company strategy to retain its market share and to guarantee to their clients the continuity of their products use.

1.1 Dichtung of data standardisation

Multiple sharing of data supported by information technologies will improve the economy of data acquisition, updating and management. This will motivate data managers to keep their datasets updated and thus improve the quality of information for all users. In the field of management, the continuously updated databases may change the very system of planning and decision-making towards continuously updated strategies supporting operative decisionmaking. In the domain of data procured within public sector, the assumption is that those public data that are designated to be distributed will be certified concerning their quality and conformity with the standards. These data will be considered and treated as public goods and therefore it will be convenient when the public authority will systematically maintain its quality and stability. The high quality of public data will be transferred into derived datasets. That kind of standardisation is top-down, administration driven. On the technology side, market forces will make virtually all GIS technology producers offer similar functionality. The only way how to increase the use of their technology is to lower the transaction costs of data use by agreement to standards. Both for non-public data producers and technology producer, this will be market forces that will make them standardise their production in bottom-up manner. As it happened with railways in the 19th century and electricity networks and telephones in the 20th century, numerous formats of GIS data will merge in a single standard or a single transferable format.

1.2 Benefits and perspectives of GIS data standardization

A deeper analysis of reasons for GIS data standardisation may reveal several streams of benefit:

- interoperability by technical homogeneity of data – standardized exchange format is the precondition for building up distributed data stores
- interoperability through common structure (syntax) of data – topological as well as attribute description
- retaining semantic value of the entering and outcoming data by common ontology, e.g. using unified terminology The data standardisation has twofold perspective: syntax and semantics.
- The syntax perspective focuses on interoperability of various information systems (exchange of data between various systems) and the processing of different data by one information system. The main stress is placed on the formal grammar of information that would enable streamlined machine processing of data and the automatic interoperability

  of GIS. As most operations of GIS are automated, one needs to be sure that the data sets of different origins entering the process are logically compatible. The logic consistency of the data processing is the necessary prerequisite for receiving meaningful results at the end of the processing.
- The data semantics is always closely linked to the ontology of particular disciplines. It cannot be detached / separated from the assumptions, missions and practices of those disciplines independently from the other perspective, which is the semantics of data.

While the syntax perspective is central for IT and GIS experts, it is the semantics that is very important for secondary professional data users.

1.3 Potentials, constraints and bottlenecks

The process of standardization in general brings various potentials and constraints:

Potentials:

- standards enable to apply the information technology in solving real problems by standardised problem situations with standard solutions.
- standards rationalise the behaviour of individuals so that they do not interfere each with other in their effort to solve the problem; in this way, the standards are a prerequisite for the effectiveness in attaining pre-defined, shared aims.

Constraints:

- standardisation tends to reduce the description of the problem into limited set of standard elements; consequently, only a selection of "standard", i.e. pre-defined and well-known problems is solved, which could further prevent from identifying "non-standard" problems and/or "hidden" sources of problems.
- sanctions for not respecting standards may hinder the creativity in solving problems.

Standards are efficient as long as the problem is "clearly-cut" and its solution can be attained by a pre-defined procedure. Within these constraints, the following "standard" pattern of problems and their relevant "standard" approaches for solutions can be summarised:

problem	„standard" approach for solution
users lack orientation in the information environment	• common data patterns, formats or their description procedures of their creation
automatic processing of data is impossible because of incompatibility of input data and the program that process them	• interoperability by technical homogeneity of data • common exchange format (XML)
data cannot be compared because of different procedures of their creation	• standardised procedure for data creation •common ontology and unified terminology for retaining semantic value of the data
normative knowledge that directly influence our behaviour is missing.	• coordination of the behaviour of individual actors • standards based on agreement and/or enforcement

1.4 Wahrheit of GIS data standardisation

The nature of GIS data makes their syntax standardisation economically constrained. The various aspects of their geographic and topologic quality, etc. and diverse GIS formats / software of origin are extremely costly to be transformed to a unique standard. Secondly, the need for GIS data standardisation itself can hardly bridge the gaps between particular disciplines, their professional concepts, viewpoints and foci.

2 METADATA STANDARDISATION

2.1 Dichtung of metadata standardisation

As there is not and obviously cannot be a kind of general uniform quality format of GIS data, the effort for standardisation has focused to metadata. Metadata seems more productive and, consequently, effective to provide potential data user a most complete, relevant, comprehensible and true information on the data comprised in a particular GIS data set. General, standardised metadata can describe the data syntax. The accessibility of metadata by users should be quick and user friendly. To attain this objective it is helpful to create stable pattern between the expectations on the user side and the metadata content and structure on the producer side. The metadata standards therefore specify the obligatory and mandatory issues that cover all aspects of described data. When the metadatabases are restructured and their content completed according to those standards, the positive effects in terms of decreasing costs of metadata creation and maintenance and increased rate of their usage arrive.

2.2 Goals and efforts

The standardisation of metadata should lead to following goals:

- to neutralise technical problems – the main objective is to ensure the interoperability of numerous data stores; the metadata creation and maintenance can be partly automated
- to guide the search for information – the standards will ensure that user will know in advance what data characteristics the metadata covers. In this case the metadata specify mostly technical information. The information on the data semantic is represented only by category "keywords".

Unlike the data syntax, the data semantics cannot be fully reflected by general metadata standards. In effect this is not their task, ISO standards build up general, universal platform for data exchange. ISO standards on the other hand are not the closed system, it is rather system of rules that enable to extend their extend so, that the standards would cover also the issues of more specific domains.

The ISO/DIS standard distinguishes the core metadata that offer the information crucial for technical exchange and automatic processing of data, and community profiles that should serve particular communities of professional users of GIS data. There are several efforts to develop an international standard for metadata, e.g European EU CEN 12657 and world-wide ISO/DIS 19115 Geographic Information – Metadata: the latter seems to be a groundwork for the future unification even in Europe as the process of acquiring has started as European standard. The ISO metadata standards offer description of geographic data generally but it also enables to build community profiles with information for specific users. The general metadata descriptions relates to the techniques of GIS data production and use. They are for biggest part technical specification of datasets. The rest of the general standard of metadata addresses the accessibility and management of data. However, the approach is generalist for the information on the data content.

2.3 Wahrheit of metadata standardisation

However precise the standards of metadata aim to be, no one has been approved and accepted as binding standard yet. Instead, national standards have been developed here and there, making the issue of future shift to a uniform international standard even trickier. The presently existing metadata obviously do not comply with the formal requirements of the ISO metadata standard as well as any other generally acceptable standard for the description of geographic data. It would require a lot of time and resources to achieve any kind of such standard for the existing data. The cost-benefit ratio can be very disadvantageous for the primary producers of standardised metadata as they will not be immediate receivers of the benefit. Positive externalities will not arrive as long as the standards will not be broadly accepted and implemented. Obviously, the full scope of the standard may prove to be achievable only for the metadata on basic geographic GIS data, while the secondary data created on the background of the basic data may make reference to their “parent” data set. With different pace of updating of the “parent” and secondary data, the value of metadata cannot be overestimated but it will be difficult (and costly) to achieve the appropriate standard generally. Probably this will be only a fragment of GIS data that will be described by standardised metadata even in future. This may be the case of statutory, legally defined registered data sets of information systems for public administration, for which the fully standardised metadata will be provided, based on a legal enforcement. In this respect, this is mainly the task for public sector to start the implementation of metadata standards. Beside the statutory, legally registered authoritarian data, a wide scope of privately created information systems is emerging, designated for market. Here the market laws on demand and supply enter the scene. The competition for customers may make the data managers / providers / suppliers to comply with metadata standards, but only in the case of data designated for wider market, and in rich informational communities where costs of primary data acquisition will be low and quality information based on the data will be highly priced, frequently needed data will be worth describing by standardised metadata. But wherever the information market is weak and imperfect, monopolist behaviour of suppliers can be expected and, consequently, the data description by metadata will be weak and incomplete.

3 THE CASE OF INFORMATISED SPATIAL PLANNING

3.1 Dichtung of informatisation of spatial planning

With help of information technology, spatial planning can easily make available data created in the domains of demography, general statistics, environmental protection, monument conservation, transport, water management, energetic, etc. This will save a lot of tedious hunting for particular data and make the saved time available for analyses that will improve the quality of planning process. Information technology can also disseminate the information elaborated by planning to all stakeholders and to general public. Internet can make access to the data instant and easy. It has also potential to establish a two-way communication on planning and development issues between planners and stakeholders. Thus, information technology can contribute to a more democratic, responsive planning.

3.2 Specifics of spatial planning in the respect of information

The Royal Institute of Town Planning defines spatial planning as “management of environmental change”. To be able to manage, planners need information in a broadest sense of the word. Information science distinguishes several levels of items in information management (Laurini 2001):

- data – strings of digits, letters or any other symbols without any semantic connotation
- information – the data that have a meaning for their user
- knowledge – the application of information that supports reasonable decision-making.

Only data and information is the concern of this paper. While data can be transferred and processed again and again, information is rather specific to the individual data user and to the intended use of knowledge. John Zeisel (Zeisel 1981) recognises two types of information in planning:

- information that describes planning proposals – in the form of written guidelines or more physical and concrete plans.
- information used to test and to choose the right choice / solution.

Spatial planning discipline is analytical as well as design discipline and the use of data and information in planning is twofold:

- Planners collect various data, mostly from other fields of enquiry (geography, sociology, environmental sciences...) and they analyse their relevance to the problem in their hands. The outcome of the analyses is planning information and as such it should help stakeholders of development to make proper individual decisions.

• On the other hand, planners propose solutions of the problems in the form of plans. This is the act of design, which is a kind of outgoing data produced by planning.

The table below confronts the nature of data with their testing in the process of planning:

nature of data	**information to test with**	**nature of test**	**information to be tested (alternative proposals)**
GIS objects – their geometry and topology, their geographic referencing	existing physical objects and phenomena that are possible to represent by points, lines, polygons or that are sampled into raster geographical data	existing physical objects and phenomena that are possible to represent by points, lines, polygons or that are sampled into raster geographical data	depiction of the proposal in the form of GIS objects
depiction of the proposal in the form of GIS objects	depiction of the proposal in the form of GIS objects	GIS methods of spatial analysis plus non-spatial analysis	the properties of proposal
non-geographical data	properties of abstract objects that are not possible to represent as GIS objects. Some of those properties can have spatial impact related to GIS objects	non-spatial analysis and human judgement	• proposed image of future state • qualitative aspects of proposal • written record only

Planners use all the above stated information to propose solutions for problems. GISs offer variety of spatial analysis tools. They are centred to analyse spatial relations between objects. The GIS can be also very well combined with other kinds of models that represent non-spatial aspects (economy or demography). On the other hand GISs are based on the assumption that we are explicit in the spatial extent and impact of described or prescribed phenomena. Quite frequently planners are not capable to express these aspects clearly enough, to make them operational so that they can be used in GIS analysis. Then non-rational kind of test must persuade about the rightness of the proposal. Mostly subjective human judgement based on experience is used, or confrontation of the proposal with existing standards, guidelines and specifications. It is obvious that the judgement cannot be reduced just to the information that is possible to represent by means of GIS.

3.3 The nature of the information that spatial planners use

For the application of general concepts of data, metadata and their standardisation in the environment of spatial planning, analysis was made of the kinds of information spatial planners need, seek and use. The analysis showed that the data entering spatial planning convey various quality of information with different prospects of validation. Most incoming data can be comfortably placed in one of the following categories:

character	**the reality presented**	**origins of data**	**validation**
hard	physical reality	modelling physical reality	easy to validate by eyewitnessed confronting the model with the reality
	legal reality	derive from law	confronting the data with relevant legal instruments
soft	values, opinions and judgments	enquiry or other sociological research, informal interviews, studying media issues, etc.	depends on the method but it is always restricted to certain space and time
	Intentions – declarations of intented change	Plans, strategies, projects	If the intentions are projected into material form (plan) than they can be tested on the backround of other information

Outgoing data and information

character	The reality presented	Data	validation
Hard	Analyses as outcomes of research	Obsberbation and/or by experimental manipulation with the objects or logical inference	Scientific tests and proved analyses
soft	Planned (future) physical reality: it can span from the edge of “hardness” to mere vision	(statutory) plans, projects strategies, prognoses visions	Belief that plans will come true; the risk that they may not be “true” in future depends on the power of those who are expected to implement the plan in question

In fact, only the "hard", quantifiable data and logic transformation has been the domain of GIS. The other information has had to be supported by other techniques and technology so far. This existing shortcoming of GIS data should be taken in consideration in every effort to conceptualise a GIS-based planning process. The "hard" data can be subject of formal standardisation. Here, metadata can be a great help to classify the data. For the data on physical reality, the main focus of the metadata is in general, i.e. discipline-free, description of the GIS data (topology, geometry, time relevance). For the data on legal reality, one needs to understand their meaning for decision-making. The "soft" data, however they can be geo-referenced, can hardly be somehow standardised. Their metadata can be reduced to the description of their origin, showing also their nature / reliability) and use for planning and the description on the incoming data processing.

3.4 The information and power environment planners face

In the relation to information presented and decision to be taken, spatial planners can run into following scenarios:

- hard data + rational analysis – syntax of the outcome can be standardised; the syntax quality of data produced by secondary analysis derives from the poorest quality of the entry / incoming data sets; the data semantics can be derived from the incoming / entry data
- hybrid or soft data + rational analysis – syntax of the outcome is unclear, semantics varied
- lack of data – rational analysis is incomplete or impossible; the outcomes are intuitive

In most planning assignments, the entry data are of varied syntax, some of them may be outdated or otherwise imperfect. Often, planners cannot rely on "hard" data only. Consequently, the syntax perspective of the outcoming planning information can be hardly standardised by rational, scientific analysis only. Moreover, any case of planning is challenged by limited power to implement the outcoming knowledge. Even the fully standardised outputs will not make "reliable" planning product. The essence of planners' skill is to recognise and distinguish the category of data s/he deals with and to understand how much power is available to implement the plan.

3.5 Transfer for secondary analysis and use of data in planning

Spatial planning is a typical secondary user of the data made for another use. It frequently uses the GIS data originally developed for cartography, environmental monitoring and protection, transportation, etc. The background data transferred from other disciplines make the base and background for planning analyses and then for the outcoming planning information. Sometimes the background data serve as containers that are filled by additional factual data needed for the planning analyses. As such, meta-information on the transferred data and standard transfer of them are the prerequisite for the estimation of the quality of analyses made upon them. The issue of standardisation that would support the data transfer by creating transparent mechanism of it emerges as another dimension of the standardisation. In the inter-territorial transfer the relevance of planning-relevant data to particular tiers (national, regional, local) of planning is important. Each of the tiers places own priority on different particular issues.: The national and regional tiers emphasise inter-regional or, respectively, intra-regional balance, economical competitiveness, and higher-level infrastructure. The local tier is more focused on attributes of physical environment, visual aspects of environment and social interaction in the space. As it was with the data standardisation in general, also the standardisation of data transfer has syntax and semantic perspective. More to that, the transfer from one discipline to another and the transfer between different (legally) institutional and national (language) territories can be distinguished. The following morphological table combining the perspectives and transfers stated above implies four different limits to the use of data:

	syntax perspective	semantic perspective
inter-disciplinary transfer	narrow focus of standards on general geographic use	barriers / gaps between professional concepts
inter-territorial transfer	diverse regional / national standards different scales of the tiers of planning documents	language barriers between territories

4 WAHRHEIT OF INTERDISCIPLINARY TRANSFER OF DATA

Interdisciplinary transfer of information is a crucial problem for spatial planning not only in syntax and semantic perspectives as described above but also in terms of a (dis)balance between information coming in the system of spatial planning and information provided by spatial planning for the use of other disciplines and users. What is critical is not the interdisciplinary nature of the discipline alone, but the need of data supplied from other disciplines. The discipline is a "net importer" of GIS data: spatial planners need a lot of "hard" GIS data from outside than endogenous "hard" data created by the discipline itself. Also the application of spatial planning-born GIS data outside the discipline is much less than the "import" of them by planning. This makes the position of spatial planning on the "GIS data market" extremely weak.

4.1 From "hard" metadata to "soft" metadata?

Most effort in the hitherto informatisation of planning has revolved around the technology of data accessing and transfer. We showed that increasing concern concentrates around the elaboration and providing of data on the data through metadata. However, the standardisation of metadata has definite limits both in the standardisation of their context and the extent of data sets that can be reasonably equipped by metadata. The exploding number of data and the diversification of their origin and shape bring another problem on the scene: how to get oriented in the maze of data to reach the data relevant to the individual case of planning problem.

Here, portals seem to be certain help, by enabling link to data providers. The problem rests in the selection (and selectiveness) of the information provided by portals, partly reasoned by certain quality criteria that may be applied for the placement of the link on providers and on data. As planners need and also have to use also non-standard, “soft” and fuzzy data (usually not equipped with relevant metadata), this data may be disqualified from the portals. On the other hand, if admitted, they may be misleading as for their (not indicated) quality. Accepting that not only standard, “hard” data is acceptable in the community of planning, also not only standardised metadata should be accepted. They should be communityspecific. They may not provide full scope of information needed by data users but they should convey the basic information on to what kind of risk a user is exposed by using them as a model of reality.

4.2 Community profile: The way how to cope with the specifics of planning in its informatisation (?)

A great deal of GIS data relevant to spatial planning was originally produced for a specific use and for a single specific “primary” user who ordered for the making of the data. The primary user of the data needed a certain scope of meta-information, and this is what the primary user as a client ordered from the data producer. As long as the data was not offered to a secondary user, no standardised metadata was required. Therefore planning needs a lot of additional meta-information of semantic character, specific for the use within the discipline. Using the ISO/DIS metadata standard, the Community profile of metadata should facilitate the interpretation of data by community of users to get the discipline-specific metainformation. In the description of the syntax perspective, it should be focused on the import of data from the domains of other disciplines. For the specific case of spatial planning as a receiver of data of heterogeneous quality and relevance from diverse disciplines, the semantics of the transferred data to fit to the spatial planning discipline ontology and the methods that spatial planners use is a major issue. It remains a matter to be disputed whether or not, or to which extent the community metadata profile should provide that kind of meta-information. Maybe it should just guide the users to get the information by themselves. Unlike the general metadata description, the community profile should be developed and managed by planners, no matter where the data may originate. In the syntax perspective of the data description, the community profile of planning will include mostly the items already included in the general ISO/DIS metadata core or standard (Maier, Čtyroký, Vorel 2003): title, alternate title, category of topic, geographic extent, scale of resolution, data description with attribute structure, type of spatial representation, time relevance, date of data acquisition, data quality (completeness, semantic correctness), spatial reference system, data language, format, management of and access to data, lineage of origin, source lineage, date of metadata updating, and some more, less important for planning use. Problems emerge when non-standardised data, mostly not equipped with metadata are to be used by planning community. Here probably a certain basic set of metadata would be helpful to describe the potential use for planning but there is no standard way how to develop, verify and manage it. The interest in metadata is on the part of planning community but the major part of the needed information remains in the domain of the data originator. The semantic perspective deserves special attention in the respect of the planning community metadata profile. However, it is doubtful to which extent the semantics-oriented metadata should be developed, not to interfere with case-specific and user-specific matters.

4.3 From metadata to meta-knowledge?

Metadata describe the properties of data but the properties of data plus data is not information yet. In order to get information, the ontology, i.e. the meaning of the objects that are represented by data is necessary: the way the objects are conceptualised, the constraints for their interpretations, and the definition of concepts that are represented by data. There is a debate whether the ontology should be part of metadata or if this is the role of meta-information. The ontology is usually at least partly included in the metadata as key words that define thematic area to which the data make reference. The definitions of the vocabulary terms that create ontology cannot be in metadata as they are specific to various uses of data. These definitions should be in the meta-information. To use the information and data in solving our problems we need knowledge. The knowledge consists of assumptions, theoretical statements and normative guidelines (methods). The knowledge is necessary for the use of data and information, but it is not the property of any of these. The sources of knowledge are different. The knowledge is proper to each person and is shared in domains of specific disciplines.

A knowledge base that would guide the use of data and information could consists of (Turban and Aronson in Laurini 2001):

- Behaviour descriptors and beliefs
- Vocabulary definitions
- Objects and relationships
- Procedures for problem solving
- Heuristics and decision rules
- Typical situations
- Hypothesis (theories)
- General knowledge of the world
- Facts
- Constraints
- Processes

The description of the knowledge base would be the role of meta-knowledge. The metaknowledge cannot be part of metadata or meta-information. The knowledge base as well as meta-knowledge should be built by community that share the knowledge and it should evaluate the theory and methodology in relation to the problems to be solved. The following table summarises the previous discussion.

nominal level	meta-level	the role of meta-level	who creates meta-level
data	metadata	Proconditions for data storage, transfer and automatic processing	Producers of data describe the properties of data
Information	Meta-information	Precondition for understanding the meaning of data	Users of specific ontology domain
Knowledge	Meta-knowledge	Describing the effectiveness of the knowledge use when solving the problem	Problem solvers evaluate the knowledge base

The metadata are created by data producers as only producers are knowledgeable of data properties they create. The meta-information is created by users that share the common ontology. Every ontology conceptualizes the perception of problems. The symptoms of the problem are confined into categories that serve our decision-making. The knowledge bases and meta-knowledge guide the ontology users in connecting the named symptoms with specific action. Once the ontology is established, it is the independent, objective, categorical system of concepts that can be made public. It can guide the data producers in the creation of data and organizing their meanings in reference to chosen ontology. The meta-information is more general and less abstract than the meta-knowledge. Several disciplines (or knowledge bases) can use shared ontology defined by meta-information. The meta-knowledge is created by users of knowledge: the professionals and scholars. Only users of the knowledge base can evaluate the efficiency of knowledge base in guiding them to the right solutions. Every new or updated knowledge creates new ontology and therefore inform the meta-information level. All three levels: metadata, meta-information and meta-knowledge play different roles, they are created for different purposes and often by different communities of experts. The community profile of planning should focus on the meta-information level. It should be created by planners with regards to other ontology.

5 CONCLUSIONS

The reality of GIS data diverts from the wishful thinking of GIS standards. This makes the challenge of the muddling through in the GIS not temporal but constant issue. This is not an unknown situation for planners who got used to incomplete, heterogeneous and outdated data in their everyday practice but is difficult to swallow by more "technically perfectionist" GIS experts. Also the general standardisation of the description of data by metadata has own limits. It does not fit to non-standard, imperfect data. On the other hand, planners need certain orientation in the maze of data, even on the imperfect data. A flexible description of these data, open and relevant both to the data and their users, could be a part of the community profile of metadata. The ultimate use of data is to develop the relevant and useful information and knowledge from them. The exchange of data, information and mainly knowledge needs support by structured descriptions, each related to one of the mentioned levels: data, information and knowledge. Standards can never cure our world of the chaos that is connected to the usage of data. In the planning profession, managing incomplete information environment is an everyday business.

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