Digitalisation of General Drainage Planning

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Key words: digitalisation, drainage planning, digital data, spatially enabled society, standardisation, spatial data infrastructure

SUMMARY

Urban drainage is an important component in protecting the environment from harmful influences. Urban drainage in Switzerland is in the responsibility of the municipality.
In many places, the operation of wastewater treatment plants is jointly regulated by several municipalities in an association. Important tasks in the planning, operation and maintenance of urban drainage must therefore be better handled at association level than at municipal level.
The tool called "General Drainage Planning" is used for strategic planning, action planning for maintenance and controlling of compliance with water protection regulations. This planning is revised every 10 to 15 years.
The municipalities and associations elaborate the general drainage plans for their respective territories, which are then approved by the canton as the supervisory authority.

The municipalities are faced with different challenges in their infrastructure management. Many actors with different tasks collect different information for the documentation of existing infrastructures, planning and measures. Until the early 2000s, general drainage planning was an "analogue" matter, with very limited digital structured data.
With the emerging of digitisation, a wide variety of information in historically evolved structures was captured digitally but uncoordinatedly by different organisations.
It soon became apparent that the lack of agreements on the form and content of the data made it very difficult for involved organisations to exchange and share information. The lack of regulations on responsibility has meant that data from different sources were not consistent with one another and that it was therefore not possible to make reliable statements by aggregating data on larger areas.

The following paper describes which approaches were chosen in the canton of Aargau to improve the situation. We will show which challenges of decentralised data collection and management combined with a central use have to be mastered and at the same time so that the content consistency (data quality and integrity) can be guaranteed. Organisational, legal, formal, financial and technical aspects are highlighted.

SUMMARY (IN GERMAN)

Siedlungsentwässerung ist ein wichtiger Bestandteil für den Schutz der Umwelt vor schädigenden Einflüssen. Die Siedlungsentwässerung ist in der Schweiz Aufgabe der Gemeinde. Der Betrieb der Abwasserreinigungsanlagen ist vielerorts durch mehrere Gemeinden gemeinsam in einem Verband geregelt. Wichtige Aufgabenstellung der Siedlungsentwässerung können von daher besser auf Stufe ARA / Verband geregelt werden, als auf Stufe Gemeinde. Der Kanton hat basierend auf der Umweltschutzgesetzgebung die Aufsicht über die Gemeinden und Verbände.
Mit dem Werkzeug «Generelle Entwässerungsplanung» erfolgt die strategische Planung, die Massnahmenplanung für den Unterhalt und das Controlling über die Einhaltung der Vorschriften über den Gewässerschutz. Diese Planung wird alle 10 bis 15 Jahre überarbeitet. Die Gemeinden und Verbände erarbeiten die Generelle Entwässerungsplanung, die anschliessend vom Kanton genehmigt wird.

Vielen Akteure mit unterschiedlichen Aufgaben tragen unterschiedliche Informationen für die Dokumentation der bestehenden Infrastrukturen, der Planungen und Massnahmen zusammen. Bis anfangs der 2000-er Jahre waren die Generellen Entwässerungsplanungen eine "analoge" Angelegenheit, mit nur vereinzelten, digitalen, strukturierten Daten. Mit dem Aufkommen der Digitalisierung wurden in den historisch gewachsenen Strukturen verschiedenste Informationen durch unterschiedliche Organisationen unkoordiniert digital erhoben.
Es hat sich bald gezeigt, dass durch die fehlenden Vereinbarungen zu Form und Inhalt der Daten, der Austausch unter den Beteiligten sehr schwierig ist bzw. die mehrfache Nutzung der Daten verunmöglicht ist. Fehlende Regelungen über die Zuständigkeit haben dazu geführt, dass Daten aus verschiedenen Quellen nicht zueinander konsistent sind und deshalb mit einem Zusammenzug der Daten über grössere Gebiete keine zuverlässigen Aussagen möglich sind.

Im folgenden Papier wird beschrieben, welche Ansätze im Kanton Aargau gewählt wurden, welche Herausforderungen einer dezentralen Datenerfassung und -verwaltung und eine zentrale Nutzung bewältigt werden müssen und gleichzeitig die inhaltliche Konsistenz gewährleistet werden kann. Dabei werden organisatorische, rechtliche, formale, finanzielle und technische Aspekte aufgezeigt.

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1. INTRODUCTION - URBAN DRAINAGE IN SWITZERLAND

1.1 Development of planning for urban drainage

For centuries, the main task of urban drainage was to improve hygiene in the cities by discharging the polluted wastewater away from the construction areas. Until the end of the 19th century, the problem was mainly confined to the cities due to the distribution of population and the possibility of recycling wastewater in agriculture. With increasing industrialisation, the population density also increased outside the cities and villages were also confronted with the challenges of urban drainage.

The initial plans for a systematic approach to urban drainage included the coordinated discharge of wastewater through pipes. The wastewater was often directed into the nearest water body (lake or river). This approach soon reached its limits, however, as the water bodies collapsed. Thus, the purification of wastewater became the focus of planning. As a result of increasing building development and the associated sealing of the soil surface, the run-off of rainwater during precipitation became an increasing problem and had to be included in the planning. Agricultural drainage systems influenced the run-off capacity of water bodies and thus also shaped the entire drainage system.

In Switzerland, the municipalities are primarily responsible for the drainage of settlements. However, as water does not respect political and administrative boundaries and many urban drainage tasks can only be carried out economically in a larger alliance, municipalities form associations.

Integrated urban drainage includes the specification of policies, strategic planning of necessary developments, management and control of the implementation of policies and developments, and the operation and maintenance of all necessary facilities with the aim of protecting the environment in a sustainable manner.

1.2 General drainage planning

In order to ensure this holistic view, the tool called "General Drainage Planning" (GDP) was developed. It is used for strategic planning, action planning for maintenance and controlling of compliance with water protection regulations.

Drainage planning takes place at various levels. A region comprises one or more water catchment areas and several wastewater systems. An association area includes one wastewater system. The municipality is defined by the administrative boundaries and issues the mandatory guidelines for the drainage of settlements on the municipal territory.

All three planning levels are interconnected and must complement each other on a subsidiary basis. This means that the higher level only regulates what is necessary for the purposeful coordination of the lower level.

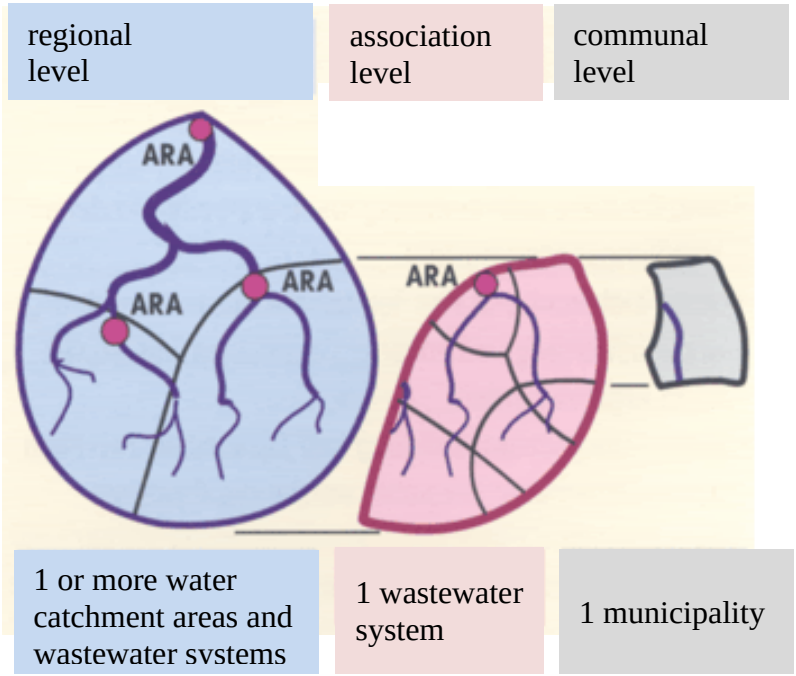

Figure 1 The three levels involved in Drainage Planning (ARA means Wastewater treatment plant)

General Drainage Planning is based on interval of 10 to 15 years. This means that the plans must be periodically reviewed and further developed. The procedure described can be compared with land use planning in Switzerland. This also takes place over several, more conceptual levels and the mandatory specification is made in the municipality. Land use planning is also subject to be reviewed in periods of about 15 years. Since the planning of urban drainage must be oriented towards the objectives of settlement development, the contents of these plans are coordinated with each other.

1.3 Historical evolution of documentation and digitalisation

The effectively built facilities were quite well documented in (paper) plans of the built infrastructure. In the case of wastewater pipes, a plan usually covered one construction stage. These plans also include many construction details of the plants. This type of documentation had two major disadvantages. On the one hand, these plans were never updated in the case of later changes. For the modification, there was simply another plan of the built infrastructure. On the other hand, this documentation did not provide a complete overview of the drainage system.

For a better general view, therefore, an additional documentation was first created as an overview plan on a smaller scale. These plans on a scale of 1:2000 / 1:2500 contained very little technical information about the individual parts. Updating is often only carried out periodically after major adjustments to the drainage network.
In order to improve the updating of the documentation of the buildings, analogous cadastre plans on a scale of 1:250 or 1:500 were created. This means that the information from the various plans of the built infrastructure has been compiled and documented in a coherent manner and, as a rule, also updated.
From about 1990 on, the first cadastre plans were transformed to digital data in a land information system. These developments also led to the first standardisations for digital infrastructure information (as conceptual data model and portrayal rules). Unfortunately, in many cases digitisation has been driven to the point of converting a cadastral plan into a digital CAD-plan in order to be able to update the plans more easily. This meant that important technical information on the objects was not available in digital form, and topological relationships between the nodes and the edges (pipes) were also missing. This cadastral documentation was usually created and updated by surveyors.
The first GDP's were also established with exclusively analogue documentation. Often additional overview network plans were also created which regularly led to contradictions between the various plans. Since the year 2000, various documents of the general planning were drawn with CAD systems. Even though the first efforts to use GIS systems were made more than 25 years ago (and, for example, the pipe network could be taken over in the hydraulic calculation software via an interface), it was not until about 2010 that a broader community began to use GIS for GDP. The standardisation of information on the GDP made very slow progress. This planning documentation was usually prepared and updated by wastewater experts. In these professional circles the knowledge and interest in structured (geographical) information was very low and digital drawing with CAD was already a significant improvement. For technical and organisational reasons, a connection between the documentation of the built infrastructure in the cadastre and the information in the GDP was therefore almost non-existent for a long time.
This means that different documents with overlying contents exist next to each other, both for the documentation of built infrastructure and for the GDP information. This means that the same information must be kept in several documentations. Updating is only rarely guaranteed. The digitalisation of the documentation is not complete in terms of content and space and is also implemented inconsistently in CAD and GIS Systems.
At the municipal level, this situation is not only evident in the field of wastewater, but also in all other topics of municipal infrastructure management.

1.4 Challenges

Over the last years it became apparent that the lack of agreements on the form and content of the data made it very difficult for involved organisations to exchange and share information. The lack of regulations on responsibility has meant that data from different sources were not consistent with one another and that it was therefore not possible to make reliable statements by aggregating data on larger areas.
Particularly when planning across several levels (see Figure 1), however, these aspects are of key importance for efficient and effective processes. In addition, technical progress today

enables continuous digital documentation from the level of the building to the regional overview without multiple data management. This means a fundamental change from traditional plan-oriented methods to work with digital information without reference to scale. On the one hand, this requires a legal framework established in Switzerland by the Law on Geoinformation and on the other hand, it also requires the will and conviction of those responsible to consciously develop a comprehensive digital management of urban drainage. The Canton of Aargau has taken up this challenge and has set the goal of continuous digital processing and documentation for the second generation of General Drainage Plans (GEP). Digital processing also means that the information from one system can be transferred to other systems via agreed formats and structures and that these systems can continue to use the data and information without further manual interaction.
Thanks to the great commitment of the Canton of Aargau, GIS-supported GEP management has become increasingly widespread throughout Switzerland in recent years.

2. HARMONISATION OF BASIC GEODATA IN SWITZERLAND

For efficient and sustainable use of geodata, there was a lack of a common policy and of uniform standards and technologies at federal, cantonal and municipal level. The Federal Government recognized this development in 2001and adopted the Federal Strategy for Geoinformation. The implementation concept then proposed the establishment of a National Spatial Data Infrastructure (NSDI), in order to meet the needs of modern society.
The new Law on Geoinformation (GeoIG) then was put in force in 2008 mainly to ensure that such an NSDI is incorporated into the legal framework and that it corresponds to the political and administrative conditions in Switzerland. The aim of the GeoIG is to "make geodata on the territory of the Swiss Confederation available to the federal, cantonal and municipal authorities, as well as to the business community, society and science, for broad use, in a sustainable, up-to-date, rapid and simple manner, in the required quality and at reasonable cost." (Swiss Federal Assembly, 2007). The law describes that "qualitative and technical requirements for spatial and geometrical data shall be defined in such a way as to allow easy exchange and wide use, and that internationally or nationally recognized standards for geodata and geometadata shall be taken into account in the implementing provisions of geoinformation law to the extent possible and technically reasonable" (cf. Steudler 2019).
The cantons then had 3 years to adapt their cantonal legislation in the field of geoinformation. Appendix1 of the Federal Ordinance on Geoinformation lists the "Catalogue of basic geodata under federal law". Regional and communal drainage planning is identified as basic geodata under federal law in the jurisdiction of the canton with access authorisation level "publicly accessible basic geodata". This means that the responsible federal agency must establish a minimum data model for these GEP issues. The cantons then have 5 years to adapt their existing data to the specified model and, if necessary, to extend the federal model to meet cantonal requirements. Even though it could be assumed that the federal model would be based on the standards of the professional association, the time requirement of several years was too long for the Canton of Aargau.

3. PROCEDURE IN THE CANTON OF AARGAU FOR THE DIGITALISATION OF GDP INFORMATION

3.1 Initial situation with regards to data resources

In 2008, the cantonal authority has ordered a study on the digitisation of GDP information. The situation analysis (cf Kaul et. al 2009) identified various shortcomings. At this time, the canton alone had more than 15 data sets in which information was managed that was relevant for the processing and approval of the GDP or even contained the main statements of the GDP. These data sets were not sufficiently coordinated with each other. The municipal GDP were also often inconsistent with this cantonal data.

The most important basis for the preparation of a GDP is the cadastre of the built drainage infrastructure. At the time of the study only about 25 % of the cadastre were held in digital and structured form. The municipal datasets were therefore not available in a form that met the requirements for broad use of the data beyond the system boundaries. This meant that the data could not be exchanged between different institutions. In many cases it was not even possible to re-use the data outside the system in a structured form due to the lack of interfaces.

3.2 Objectives

Due to the initial situation and the upcoming revisions of the GDPs in many municipalities of the canton, there was an urgent need for improvement. The following benefits were to be achieved with a digitisation project:

- Cantonal supervision:
  - Retrieval in GIS as a basis for project approvals.
  - Integration of different data sets - which will continue to be operated in a separate environment - in a central information system.
  - Periodically updated data, in particular on the measures agreed in a GDP to improve water protection – which measure is implemented when, where are the tasks unnecessarily delayed? The progress made in implementing the measures can thus be monitored "continuously".
  - The updating of the GDP paper documentation is no longer necessary.
- Other cantonal authorities:
  - Access to current data on the cadastre of the built infrastructure and the GDP in connection with the granting of permits under water protection law.
- Municipal authorities:
  - Drainage projects are automatically based on current planning bases.
  - Simplified access to up-to-date information on drainage concepts (target situation) and the actual situation, especially in connection with the assessment of building applications.
  - Simplification of the revision of a GDP thanks to up-to-date, complete and correct information.
  - Use of own data and integration of cantonal information in the municipal GIS.
- Use for the citizens:
  - Supplementing the cantonal geoportal (AGIS) with the desired content. Data distribution directly from AGIS possible (analogous to data from the official cadastral survey).

- Use for engineers:
  - Access to a wide range of information via Web Services instead of physical data acquisition.
  - Reduction of data maintenance costs by eliminating redundancies.

The initial situation described above, and the initial experiences of other cantons showed that there are many different relationships between data (and the products derived from it) - roles - organisations - responsibilities - technical possibilities - etc. This management information must be documented and updated just as carefully as the technical information and actual urban drainage data. In addition to the specific requirements for the use of GDP data, the study also identified a broad range of uses for drainage data in general. In the context of the replacement of analogue by digital information sets, not only the explicitly affected processes should benefit from a simplification, but also upstream and downstream tasks.
The work and considerations carried out in the course of the study have confirmed the older experience that digitisation projects involve 80% organisational issues and only 20% technical challenges need to be addressed.

Based on the tasks of cantonal supervision, the following goal was formulated for the digitisation of the GDP data: "The drainage information in the Canton of Aargau with a declared need for use is available online".

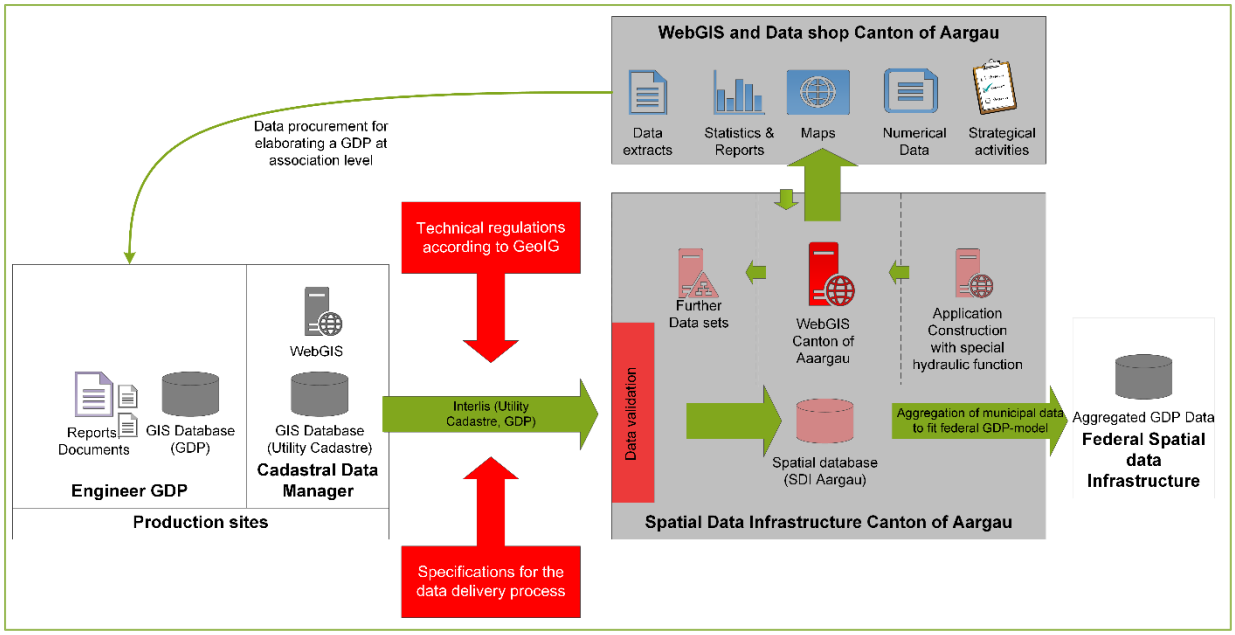

Figure 2 Architecture of the Drainage Information Hub Aargau DIHAG (modified from Kaul et. al. 2009)

A Drainage Information Hub Aargau (DIHAG) was defined as the technical solution as part of the spatial data infrastructure of the canton (SDI). The architecture of DIHAG is shown in the figure above. On the left side, the production environment is located at the municipalities

or the engineering offices commissioned by them (typically one organisation for the network cadastre and another one for the GDP data). These offices periodically supply the data to the canton in a defined exchange model and format. In the cantonal SDI, these data are validated and integrated into the inventory. Various visualisations (maps), reports and lists should be made available from the SDI. It should also be possible to receive data from the SDI. Since the data are also of interest at the national level, the transfer of GDP data to the federal government (national SDI) should also be supported (listed on the right-hand side).

3.3 Constraints for implementation

During implementation, various constraints had to be taken into consideration in order to achieve the objectives, whereby a distinction was made between organisation, legal basis, financing and technical requirements.
Regarding the organisation, it had to be ensured in a suitable way that all GDP actors were aware of their obligations and rights and that they would implement them. This meant concretely:

- Municipal authorities:
  - Ensure that the data management of GIS data meets the requirements of DIHAG.
- Municipal data managers:
  - Record and manage the data in accordance with DIHAG requirements.
  - Periodic export of data and delivery to the canton.
- Cantonal authorities:
  - Ensure a periodical transfer of the municipality data with incoming inspection.
  - Integrate the municipality data into the cantonal GIS portal.
  - Maintain its own data sets in accordance with the harmonised data model
  - Manage and maintain the infrastructure for DIHAG.
- GEP engineers:
  - Establish the GDP according to DIHAG's requirements, i.e. in particular that the data must be recorded and managed in accordance with the conceptual data model.
  - Deliver the data in the prescribed data model and according to the qualitative specifications.

There was hardly any need for further action at the level of the legal basis. On the one hand, technical legislation has long required that municipalities are obliged to maintain a cadastre of drainage infrastructure. They are also obliged to periodically revise a GDP. On the other hand, in addition to these general requirements, the GeoIG (see section 2) provides the framework for concrete technical implementation regarding (geo)data.

There was also little need for action in the area of financing. The GeoIG stipulates that the provision of data among the authorities must be free of charge. Furthermore, the regulations in the technical laws make it clear that the municipalities (or associations) must bear the costs. Since the canton has a great interest in advancing digitisation rapidly, it was decided that the cantonal contributions to the preparation of a GDP (20% of the total costs) should also cover the preparation of the cadastre. This co-financing represents a clear commitment to the project.

At the technical level, although in principle not dependent on a digitisation strategy, various improvements in the procedure for GDP processing were sought with standardisation of GDP products (data and analyses):

- Clear, uniform specifications regarding spatial data simplify the work on GDP's,
- Simpler and better control options increase the formal quality of GDPs,
- Formally unified GDPs (strict portrayal rules) improve the comparability of drainage planning in the various municipalities.

In order to achieve these goals, investments should be made above all in standardization in the spirit of a Data Product Specification. However, due to the planned changes in various respects, it was also clear that information, appropriate training and constant communication are indispensable in addition to a technical manual.

4. APPROACH AND ACHIEVEMENTS

As a solution approach for the various digitisation projects, the formula "4-P" has proven itself. The four "P" represent: Policies, Processes, People and Platform. As already recognized in the situation analysis in chapter 3, the technical solution contributes only about 20% to the success of the project, the far more important aspects are the organizational framework. Based on the concept study, the canton has decided to implement the solution, whereby the components to be provided by the canton for the introduction of the DIHAG should be set up within 2 years. In the following sectionswe describe the main challenges and the approach.

4.1 Policies

As mentioned in the previous chapter, the legal basis for implementing the concept was already sufficiently in existence. For the concrete technical implementation, above all questions regarding the data product specifications had to be clarified (see also Lüthy 2019). To ensure semantic interoperability between the many organisations involved, clear regulation of the following aspects was essential:

- Data model
- Feature capture rules
- Exchange format
- Portrayal
- Quality requirements

Since various technical specifications for GDP processing in the canton of Aargau had already been regulated in a manual, it was obvious that the policies relating to data management should also be included in this manual, which would be binding for all parties involved. Ideally, already available standards should be used for such harmonisation tasks. At the time of the start of the project work, no data product specifications for urban drainage were available in Switzerland. Although a data model (referred to as VSA-DSS) existed on the part of the national professional association, it was not widely used in practice due to its overly complex structures. In order to make the change to a common model as simple as possible, it was therefore decided to develop a conceptual model which, on the one hand, should be designed to be as minimal as possible in scope and, on the other hand, should not contain any

structural contradiction to the standard model. In addition to the data structures, rules for data collection were worked out, a presentation model was developed, and initial quality requirements were developed.
The decision to develop an own conceptual model faced some resistance in the industry, as the engineers feared that additional work would be required. However, since the professional association also recognized that its own data model VSA-DSS was too complex to use and was either not used at all or the data was not structured in conformity with the model, it decided (after the completion of the our project) to develop a simplified version (called VSA-DSS Mini). After some minor adjustments on both parties over the last years, nowadays the two models are practically identical. In retrospect, the chosen procedure proved to be ideal.

4.2 Procedures

4.2.1 Organization of data management at the municipalities

One of the process regulations concerned data management by the municipality. In the many rural communities in the canton, such tasks are not carried out by the administration itself but are outsourced to external partners (engineering offices). In many cases, it was found that in the end several organisations were responsible for some part of the information. Without regulated data management, it was in fact not possible for all information on urban drainage - held in different systems - to be consistent with each other. These inconsistencies often led to considerable effort when it had to be clarified which information was now correct. In the worst cases, decisions were made based on incorrect or outdated data, which usually resulted in additional costs.
For the development of a data management concept at municipal level, a template from the professional association is now available, so that it is clear which regulations typically must be made.

4.2.2 Delivery of data to the canton

Due to large number of actors in the management and use of the drainage data, with very different professional qualifications, the regulation of the processes was of great importance. It was necessary to define the procedures for when which data had to be supplied by a municipality to the canton. In the case of the data on the cadastre of drainage infrastructure, it was clear that this data set would have to be updated on an on-going basis, in line with construction activities. It was therefore specified that a municipality must deliver an up-to-date database to the canton at least once a year after an initial delivery. In comparison, a GDP is only revised every 10 - 15 years, and the implementation of the defined measures is reviewed about every 3 years. It was therefore decided that the GDP dataset should be delivered to the canton when the revision is completed. It is obvious that the approval of a GDP by the canton requires that the delivered data set has the required quality characteristics. Only then can it be guaranteed that the cartographic visualisation in the cantonal WebGIS corresponds to the plans of the project engineers. Homogeneity of data and uniformity of portrayal is important in that - as mentioned in Chapter 1 - the GDP is mandatory for the authorities. A contradictory presentation (or contradictory planning) due to different data can therefore not be tolerated.

4.3 People - Common awareness

As written in Chapter 1.2, the responsibility for the elaboration of GDPs lies with the municipalities. Experience shows that the invisible drainage infrastructure is less significant for the municipalities than, for example, the roads (clearly visible) or the water supply (important as nutrition). As a result, the implementation of the measures defined in a GDP, as well as the daily operation, is not tackled with the necessary resources. The intended digitisation of the GDPs and the harmonisation of the data sets was not at the top of the priority list of the municipalities, as these are rather abstract tasks. Furthermore, the engineers also saw digitisation as a threat to their market position: the simpler exchange of information between the systems put their previous position as knowledge carriers at risk. Even though most engineering firms were familiar with the trustee-like position as data managers of municipal data (especially regarding land administration), much resistance was encountered. In implementing the DIHAG concept, therefore, much emphasis had to be placed on information and communication. The aim was to sensitise the responsible authorities to the topic and to provide the necessary resources. People as central success factors were therefore addressed at various levels:

- Information of the engineering offices regarding the upcoming changes – this ensured that the engineers could continue to be positioned as technical specialists. Furthermore, it was shown that an active participation in the digitalization could offer a market advantage. The information was mainly provided within the scope of two training courses
- In order to raise general awareness among the municipalities, the canton has held an annual GDP conference since the late 1990s. Since the digitalisation project was initiated, the digitisation of the cadastres of drainage infrastructure and the GDP are on the conference programme. By providing constant information on current issues relating to digitisation and showing the first concrete results, it has been possible to carry out the necessary work to improve the data basis in many communities.
- About one third of the municipalities are represented at the above-mentioned conferences. To ensure that the less interested communities also take up the topic, the communities were sensitised through letters and flyers. In addition, the advantages of digitisation were regularly pointed out in bilateral contacts.

In addition to this mostly general information, the canton has also provided concrete support to the municipalities and engineers in individual cases. For example, each municipality was able to have the cadastral data checked by a specialist. This made it possible to compile the need for action from a neutral point of view. Moreover, the close contact between the inspection body and the engineers involved in updating the cadastre ensured that criticism was not presented as a deficiency in the organisation, but rather in a value-free manner as support for achieving the objective. The cooperative attitude has led to the fact that the necessary work could be carried out - despite sometimes considerable costs - and that both the scope of data and the data quality have improved massively over the years.

4.4 Platform - Handling of drainage data in the SDI

With regard to the technical platform for the consolidation and provision of information from urban drainage, it was possible to build on the existing infrastructure for data from the land administration. The task - different land administrators deliver data to one platform, data is

automatically validated and read into a system, old data from the municipality is overwritten - is practically identical and therefore the processes only had to be re-parameterised. The architecture of the infrastructure is shown in Figure 2.
Some important data bases such as the action plans from the 1st generation GDP were prepared by the canton as a raster data set. Today, the cantonal GIS portal provides access to a wide variety of data sets. Since the revision of the GDP is closely linked to the revision of the land use plan (see section 1.2), it is clear that the GDP data will not be available in its full scope via the canton for about 10 years. However, it can be assumed that the cadastre will already be available in complete form and in the expected quality within the next 5 years.

A major objective of the entire project was the provision of GDP data for cross-municipal tasks and the exchange of data between the participants. This objective can be achieved on the one hand by ensuring that all participants supply data to the cantonal platform in the same model and format (INTERLIS). These exchange formats can of course also be used among the engineering offices. On the other hand, engineers who, for example, carry out processing of a GDP at association level can obtain the data basis from the cantonal GDI from all municipalities in the association's catchment area. Typically 10 - 20 municipalities are affiliated to an association: it is therefore obvious that it is much easier to obtain the data once via the cantonal platform in a uniform model than to make bilateral agreements with the individual municipalities for obtaining data in various formats.
In addition to the map-oriented use of data via the cantonal GDI, some separate applications continue to play an important role. In particular, the "Application Construction with special hydraulic function" should be mentioned here. Of these objects - although they can be found as network elements in the cadastre - a wide variety of information must be managed, which is collected by the GDP engineer. For this reason, the application, which dates to the 1990s, was modernized as part of the overall project. Now the data from this application can also be exchanged via INTERLIS (in accordance with the standardised model) or can also be retrieved from the cantonal GDI via web services.

5. CONCLUSION AND OUTLOOK

Today, interested parties have access to a platform on GDP information, which is optimally positioned for the delivery of data from the municipalities to the canton, the retrieval of information and the submission of data from the canton. The functioning of the platform requires that different policies define the framework for interoperability and that the processes for the transfer of information between the various stakeholders are regulated in a transparent manner. Finally, the parties involved have understood the purpose of the entire project and are making their contribution to its success. In comparison to the difficulties in other countries in exchanging data across organisations, it can be said that these obstacles have been eliminated in Switzerland in general and specifically regarding GDP data in the Canton Aargau.

The establishment of the DIHAG has once again confirmed that digitisation is only supposedly a technical matter, in fact it is rather a people business. The paper showed that a paradigm shift from the original documentation of relevant information in analogue plans to the provision of GDP data as an Open Government Data set was necessary. Therefore, in the

implementation of the project, a lot of resources were invested in clarifying organisational issues and in communicating the goals and benefits of the project.

During the implementation of the project it has been further shown that the way the Land Administration Cadastre has been digitized has proven itself. The tools and processes that were developed in this context could be applied to another topic without large investments. In this context, the following technical aspects should be emphasized: Use of a generally understandable language for the conceptual data model and for the system-neutral exchange of data (INTERLIS), acquisition guidelines, and the automated validation of data (not only due to the federal environment).

Many organisations are planning to convert their processes for the planning and design of civil engineering facilities to the BIM method in the coming years. This will mean that in the future, urban drainage facilities will be produced as high-resolution 3D models and will therefore be available in a much higher level of detail than is necessary today. The experience gained in recent years in building up structured, semantically correct and interoperable databases is very valuable for the incomparably more complex tasks associated with BIM data.

Since the tasks in urban drainage are not only dependent on geographical information, but many of the data are numerical in nature, considerations are currently being made as to whether the cantonal GDI ideally supports the requirements. A cockpit on urban drainage data, as presented by Hofer et. al. (2015) is being implemented by other cantons in a comparable manner. If this cockpit proves to be advantageous compared to the current provision, the technical solution of the canton Aargau should develop in the same direction.

REFERENCES

Hofer, Simon, et al. "Infrastructure management in Swiss municipalities–Development of a modern, spatially enabled management cockpit." *FIG Working Week*. 2015.

Kaul, C. and Baenninger, P. (2009). GEP-AGIS – Konzeptstudie. Kanton Aargau, Departement Bau, Verkehr und Umwelt, Abteilung für Umwelt.

Lüthy J. H. (2019). 10 Years of "Law on Geoinformation" in Switzerland – Core Features of a Successful National Spatial Data Infrastructure. FIG Working week 2019.

Steudler, D. (2019). 10 Years of "Law on Geoinformation" in Switzerland – The International Context. FIG Working week 2019.

BIOGRAPHICAL NOTES

Dr. Jürg H. Lüthy is member of the Management Board at Acht Grad Ost AG, one of the largest geomatics companies in Switzerland. He obtained a master's degree in 1996 from Federal Institute of Technology Zurich (Switzerland) in Rural Engineering and Survey. From the same institution he holds a PhD (2007). He has many years of experience in spatial data management, transition from paper maps to data centric systems and the operation of Spatial Data Infrastructures. His current focus lies in the provision of holistic information using modern web-technologies like designing information management platforms or building the technical infrastructure for Cadastre of Public-law Restrictions on landownership. He is the Swiss delegate to FIG Commission 3. Since 2016 he is president of SLM Swiss Landmanagement Foundation.

Christian Kaul is also a member of the Management Board at Acht Grad Ost AG. He obtained a master's degree in 1992 from Federal Institute of Technology Zurich (Switzerland) in Rural Engineering and Survey and three years later the certificate for a licensed surveyor. After ten years of experience in different domains like communal infrastructure, land management and SDI-Projects he worked as a consultant in cadastral issues and procurement processes. Back in an engineering company he completed his experience in land use planning and spatial development. From 2013 until 2020 he focused as head of Department for Geoinformation in Canton of Zurich (Switzerland) on building modern cadaster systems and holistic spatial information infrastructures.

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