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Innovative methodology to prevent and mitigate diffuse pollution from urban water runoff

WATERUN

Deliverable D3.1

Modelling database for Santiago and Aarhus CS

Work Package 3

Modelling tools for UWR management

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Executive Summary

Abstract	This report presents the database structure and data collection process for developing modelling tools for urban water runoff (UWR) management component of the WATERUN project. The database was designed to store the spatial and time series datasets required to build and validate UWR models developed for Amman, Santiago de Compostela, and Aarhus. A data requirement list was used to ensure that the necessary datasets were obtained from project collaborators, and a folder-based database system was chosen for its simplicity and ease of use and storage. The report concludes with an outlook that identifies potential areas for expanding the database with new data sets, as well as some risks associated with missing data. Overall, the data collection and database structure provides a solid foundation for the modelling component of the WATERUN project.
Keywords	urban drainage, modelling, data collection, database, WATERUN project

Revision history

Version	Date	Status	Author	Description
0	13 Jan. 23	First Draft	UFZ	Deliverable preparation started
0.1	01 Mar. 23	Second Draft	UFZ	Editing and Formatting
1	28 March	Third Draft	UFZ	Respond to comments

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1 INTRODUCTION

Urban drainage models are important for managing urban water runoff quantity and quality in urban areas. To develop accurate models, it is essential to have well-organized and structured data that can be easily accessed and analyzed. This report briefly describes the database structure developed for the modelling activities of WP3 (Modelling Tools for Urban Water Runoff Management). UFZ GmbH, on behalf of the WATERN Consortium, has provided and developed the common data infrastructure for modelling Tools (T3.2, T3.3 and T3.4). The data collection process entails gathering geospatial regarding the urban layout, time series, and sewer network data for three case studies (CS) in the WATERUN project, i.e., Aarhus, Amman and Santiago de Compostela. The database is structured using a simple folder system with separate folders for sensor-based observations, sewer network data, and urban layout. The data is organized and stored to allow easy access for the model simulation process. We also describe the approach to sharing the database with project partners and highlight important data protection and security issues. In summary, this report aims to outline a structured approach for organizing data to support the development of the planning tools outlined in WP3 and provide a framework to improve the accuracy and reliability of the resulting models.

2 DATA COLLECTION

The data collection phase was a critical and necessary first step in building the urban drainage modelling database. Clear communication was essential to ensure that the requested data was well-received by project partners. A data requirement list was created to facilitate this process, which classified the required data into four categories: spatial data, time series data, existing Stormwater Management Model (SWMM) models, and additional information. The data requirement list assigned a level of importance for each dataset request, ranging from critical (must-have), important, and optional. A detailed list was also created for the sewer network data, which specified the importance level for each data item requested. This information was then sent out to the project partners responsible for gathering the datasets.

In the following sections, we provide a detailed summary of the data provided, along with an overview of the database structure.

2.1 Data Requirement List

The data requirement list is a comprehensive document outlining the data types required for the urban drainage model. The list is divided into several groups: spatial data, time-series data, existing SWMM models, and additional information. For each dataset request, a level of importance is assigned, which can be critical, important, or optional. This helps prioritize the most important data and collect all required data. The definitions of the level of importance assigned to the requested are provided below:

- Critical – a "must-have" for setting up the MUST-B and hydraulic model.
- Important – To provide a relatively accurate representation of the study domain.
- Optional – To provide additional helpful information for the workflow.

The data requirement list serves as a clear and concise communication tool between the project partners responsible for gathering the datasets. Providing a clear and structured list of required data helps minimize confusion and ensure that all necessary data is collected promptly and efficiently.

Spatial Data

Geospatial data is a critical component of urban drainage models, providing information on the physical characteristics of the drainage network and catchment that are necessary for accurate simulation of the system's behavior. It includes data with geographic or spatial components, such as location or extent, and provides details on catchment characteristics in terms of surface types and hydrological and hydraulic connectivity. In short, geospatial data is essential for understanding the spatial layout of the catchment and the connections between different elements of the urban drainage system.

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Table 1: Spatial data requirements for urban water runoff models

Spatial Data	Description	Importance	Format
Sewer Network	Provides the geometry of the drainage network and reveals key geometric parameters such as the location of the drainage inlets and outlets. Preferred data type: Vector data	Critical	SHP; GPKG
Case study boundary	The boundaries of the selected study sites.	Important	SHP
Digital Elevation Model (DEM)	Defines the elevation across the catchment. Use for defining the drainage path. Preferred data type: Raster Data	Optional	GEOTIFF; netCDF; HDF5; GPKG
Urban green	Location of individual trees (maybe also species and age), parks, green areas, green roofs, existing green infrastructures (LIDS)	Important	SHP
Street layout and sealing	Streets including size, number of lanes and traffic amount (heavy, medium, small), parking, pedestrian areas, parking, degree and type of sealing	Important	SHP or raster
Urban soils	Soil map for cities	Important	SHP
Land-use Raster	To identify the various categories of land uses within the drainage area and to determine the degree of perviousness within the drainage area or, in our case, at the block level.	Optional	GEOTIFF; netCDF; HDF5; GPKG

Sewer Network/Urban Drainage Data

The urban drainage and sewer network data are essential for setting up the hydraulic component of the urban drainage model. These datasets reveal important geometric parameters, such as the location of drainage inlets and outlets, pipe lengths, and the elevation of key hydraulic elements, which are necessary for accurately modelling stormwater flow through the drainage system. Without the critical data specified in the data requirement list, it will not be possible to model the drainage system in each case study area accurately. It is important to note that the water utilities in each case study area are responsible for providing the sewer network and urban drainage data. Their consent is required for anyone who intends to use the data apart from the designated users involved in the development of the planning tool.

Table 2: Required network data for the setup of the SWMM hydraulic model.

Required Sewer Network Data	Description	Importance
Drainage inlets	Location (Latitude, Longitude)	Critical
	Invert elevation (the elevation at the inside-bottom of a pipe, culvert etc.)	Critical
	Cross-sectional geometry	Critical
	Type (storm drainage, culvert opening)	Optional
Drainage outlets	Location (Latitude, Longitude)	Critical
	Invert elevation (the elevation at the inside-bottom of a pipe, culvert etc.)	Critical
	Cross-sectional geometry	Critical
	Stage relationship (e.g. stage time series). Required for setting the boundary condition at the outfall.	Important
	Presence of a flap gate to prevent backflow through the outfall	Optional
Conduits (Pipe)	Length	Critical
	Location of the inlet and outlet (Latitude, Longitude)	Critical
	Elevation above the inlet and outlet inverts	Critical
	Material type (For Manning's roughness coefficient)	Important

Manholes	Invert elevation	Critical
	Height to surface ground	Important
	External inflow data, e.g., from connecting combined sewer, sanitary sewer etc.)	Optional
Weirs	Location (Latitude, Longitude)	Critical
	Shape (Type) and geometry	Important
	Crest height	Important
Orifices	Location (Latitude, Longitude)	Critical
	Configuration (bottom or side)	Important
	Shape (circular or rectangular)	Important
	Height	Important
	Time open or closed	Optional
Pumps	Location (Latitude, Longitude)	Critical
	Connecting inlet, outlet points	Critical
	Pump curve	Important
	Startup and shutoff depths	Optional
Storage Units	Location (Latitude, Longitude)	Critical
	Invert elevation	Critical
	Maximum depth	Critical
	Depth-surface area data	Important
	Evaporation potential	Optional

Time series data

The time series data required for the urban drainage modelling project includes sensor-based observations of various parameters obtained from network data, such as sewer flows and water levels, and meteorological data, such as rainfall. These observations are typically taken

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continuously or at specified intervals and are critical for urban drainage modelling. In particular, time series obtained from sewer network monitoring, such as sewer flow measurements, are important for validating urban water runoff models. This data helps to assess the quality of simulation results as well as identify whether the drainage system dynamics are well represented by the model. Overall, time series data obtained from network monitoring are critical for diagnosing the ability of the model to predict the behavior of the urban drainage system under various conditions, as well as changes in water quality and quantity.

Table 3: Time series data required for the model development.

Time Series	Description	Importance	Required Format
Sewer Network Discharge	Discharge(flow) measured at the outlet.	Critical	CSV
Flow Measurement	Flow time series at pump stations. Especially if the pumps are used for diverting excess rainfall	Critical	CSV
Water level at outfall	Time series of water level measurements of CSOs, at pump stations that divert excess water and other outlet points in the network.	Critical	CSV
Rainfall data in high resolution	High-resolution rainfall data in 1min, 5 min or 10min time series in the case study cities and in a radius of ca. 20 km surrounding the cities)	Critical	CSV
Air pollution data	Time series on air pollution (whatever is available)	Critical	CSV
External inflows	Flows in addition to inflows originating from sub-catchment runoff. For example, dry weather inflows (specifically for study sites with combined sewers)	Optional	CSV
Control settings for pumps and flow regulators	Time series regarding the operation of the pumps installed (start and stop times)	Optional	CSV

Additional Information

Data on street cleaning routines and salt application during winter are useful for simulating the build-up and wash-off of pollutants during storm events. By incorporating this information into the modelling process, the model developed can predict the impact of these factors on the pollution of the UWR and develop more effective strategies for managing urban water runoff.

Table 4: Additional Information Required Modelling

Operation/Maintenance Routine	Description	Importance
Street cleaning routines	Information on cleaning routines for streets (wet or dry cleaning, how often per year or month)	Optional
Salt applications during winter.	Information on salt applications during ice/snow conditions (public and private use, in some EU countries, it is forbidden, what about the two case studies cities?)	Optional

2.2 Summary of Data Provided

The summary of the data provided by project partners indicates that the data collection effort was largely successful, with above 70% of the critical data requested returned for the Santiago and Aarhus case studies. Both case studies provided the core data elements necessary for setting up the hydrologic and hydraulic model components. The availability of the core data elements means that we can produce a well-represented model of the urban drainage system in those CS. However, in the case of the Amman case study, no sewer network data was available, making it impossible to set up the hydraulic model component. Despite this, it is still possible to build a model that focuses on the hydrologic aspects of the case study by accessing global open-source data. It is worth noting that even in the Santiago and Aarhus case studies, some data required for the hydraulic model component was not provided, indicating that further communication and collaboration may be needed in order to ensure that the modelling effort is as accurate and effective as possible. Figure 1 shows the critical, important and optional percentages for each case study location. Furthermore, summary tables of the data that project partners returned can be found in ANNEX 1.

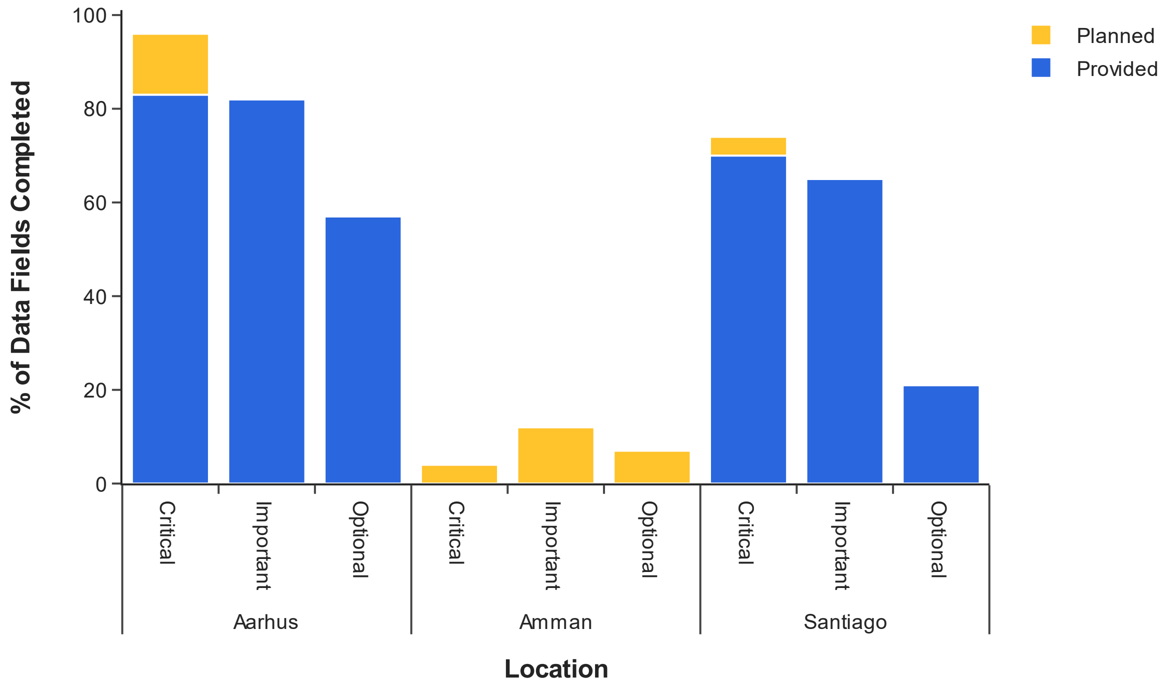

Figure 1: Summary of the data project partners provided in each CS.

Open-source data sets from global sources, such as NASA/Copernicus and OpenStreetMap (OSM) data, can be used to supplement the limited data available for setting up the hydrologic model, especially in the case of Amman, where there is very little data. The global data sets and OSM data can provide details on the urban layout, such as land use and land cover, impervious surface coverage, street/buildings and other necessary data for simulating the urban water runoff. By incorporating this open-source data, we can proceed with setting up a hydrologic model for the Amman case study despite the limited available data.

3 DATABASE STRUCTURE

The structure of a database is a critical component in organizing data for efficient and effective use in urban drainage modelling. For this project, a simple folder system was selected as the database structure to manage the various data types. The folder system is structured into three main categories: sewer network data, urban layout data, and sensor-based observations for time series data. Sewer network data includes information on the physical infrastructure of the drainage system, such as pipes, manholes, and pump stations. Urban layout data describes the characteristics of the catchment, such as street layout, building footprint, and sealing degree. Finally, the sensor-based observation data contains time series data and is organized into separate subfolders for rainfall and network monitoring data. Each of these categories includes subfolders to organize the data further. In the following sections, more details will be provided on the structure of each folder and the types of data contained within the database.

3.1 Outline of the database

As mentioned above, we opted for a simple folder-based system to store the data collected. One of the advantages of using a simple folder-based database is that it is easy to set up and maintain. With this structure, the data is organized into folders and subfolders that can be accessed and managed using standard operating system tools. Additionally, because the data is stored as files within folders, it can be easily shared with project partners or transferred to other systems without the need for special software or data transformation. Further details regarding the database structure are outlined below.

- ***Sewer network data:*** This folder contains data on the sewer network, including pipe diameters, lengths, slopes, manhole location, location of pumps, etc. For each CS, several SHP files store the essential sewer network data: links, manholes, basins, weirs, outlets and pumps SHP files. All relevant data required for setting up the hydraulic network model is included within these SHP files. Note that an SHP file is a standard file format used for storing geospatial data in a vector format.
- ***Sensor-based observations:*** This folder contains time series data collected from sensors installed in the catchment. The data is collected at regular intervals and provides information about rainfall, sewer flows, and water levels. The "rain gauge" sub-folder contains data on rainfall measurements obtained from the nearest rain weather stations within the drainage catchment, while the "network monitoring" sub-folder contains data on sewer flows and water levels. For simplicity and consistency

within the database, each time series is stored as CSV file, a standard format used for storing time series data.

- ***Urban layout:*** This folder contains spatial data related to the urban characteristics of the study area, such as the locations and types of land use, buildings, and road networks. The "land use" sub-folder provides information on the different types of land use in the catchment, such as residential, commercial, or industrial. Ultimately, it provides details on the degree to which the land surface is sealed, which can affect the amount of runoff generated during rainfall events. The "Infrastructure" sub-folder provides information on the location and connectivity of streets, buildings and green space within the urban landscape. Ultimately, the vector data provided by the CS partners or obtained from the global datasets are used to derive the blocks SHP file, a key data input for the MUST-B model.

The general concept of structuring the database is to organize the data attribute (sewer element -e.g., manholes, time series observations – e.g. rainfall measurements) according to the ISO country and IATA city code (ISO 3166-1 alpha-3, IATA). This naming convention makes identifying and locating separate elements in the sewer network easier and supports the workflow in creating the model input files for simulation. Each file would contain information about a specific sewer network element or time series observation for a particular city. For example, the file "DEN_AAR_manholes.shp" is a vector dataset containing key parameters (location, dimensions, invert elevation) of the manholes within the Aarhus CS. **Table 5** shows the naming convention adopted for the WATERUN project.

Table 5: General naming convention of the files stored in the folder database system.

CS Name	ISO Country Code	IATA City Code
Aarhus, Denmark	DEN	AAR
Amman, Jordan	JOR	AMM
Santiago de Compostela, Spain	ESP	SDC

Figure 2 maps the final organization and storage of the data types collected to assemble the modelling database. The database structure follows the approach of that used in an open-access data urban drainage dataset(Nedergaard Pedersen et al., 2021). The data storage directory provides examples of data files using the naming convention described in the previous section. Furthermore, the figure indicates the access rights (private or open-access) of the data files as well as the data source.

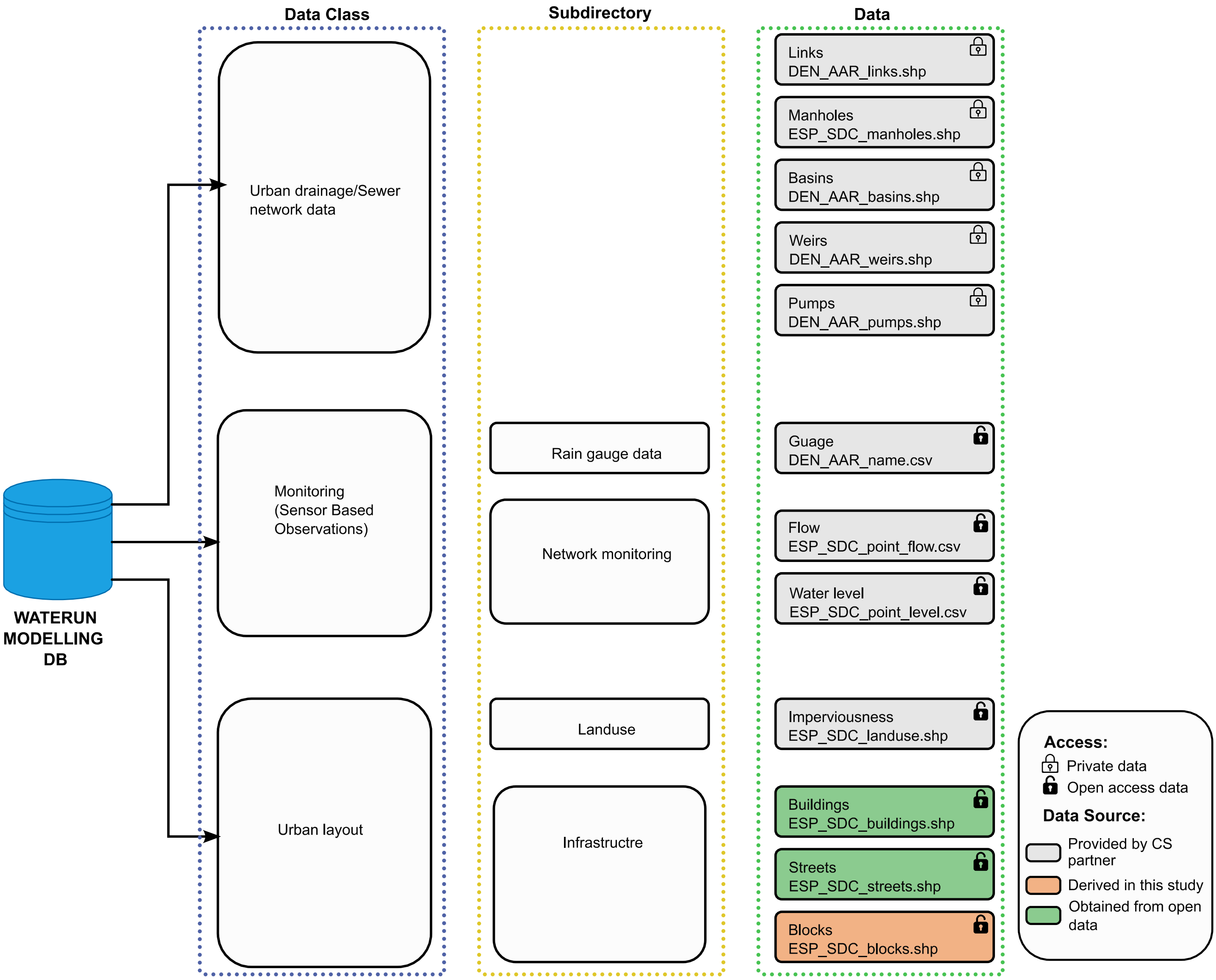

Figure 2. Structure of the Modelling Database

3.2 Data Protection, Security and Sharing Considerations

UFZCloud (UFZ's secure cloud storage, the institute's version of NextCloud) was chosen as the platform for hosting and sharing the modelling database in the WATERUN project. Nextcloud provides several options for sharing files securely, including password-protected links, time-limited shares, and end-to-end encrypted sharing. However, there are several data protection, security, and sharing issues to consider when using Nextcloud to share the database with project collaborators. Here are the restrictions that we enforced when setting up the database:

- ***Access control:*** the database is only accessible to authorized users who have a legitimate need for the data. User role-based access controls (RBAC) are implemented to manage user access and permissions to the database and its contents.
- ***Data encryption:*** Enabled data encryption to protect the data from unauthorized access during transmission and at rest on the Nextcloud server.
- ***Backup and recovery:*** By default, the data research management team of UFZ implement regular backup and recovery procedures to protect against data loss due to hardware failure, software errors, or user mistakes.

The modelling database is available for members involved with tool development WPs of the WATERUN project. Permission to access the database should be requested by contacting the UFZ project collaborators. Finally, it should be noted that the sewer network data obtained from water utilities Aarhus (Aarhus Vand) and Santiago (VIAQUA) conforms to confidentiality established in the Grant Agreement. Therefore, consent from the water utilities must be given to those intending to use the sewer data provided apart from the assigned model developers involved in WP3.

4 OUTLOOK/ RISK

Given that there are varying levels of data availability across the CS, specifically for the Amman CS, a revised modelling approach using open-source datasets should be considered, as sewer network data is not available. Consequently, the accuracy of the model for Amman CS may not be comparable to those developed for the other case studies. This highlights the need for flexibility and adaptability in the modelling approach to account for varying levels of data availability and to ensure the relevance of the results to the local context.

As the project progresses and monitoring campaigns are conducted, it is possible that new data sets could become available for inclusion in the modelling database. These new data sets could potentially provide valuable information for validating the model results. However, it is important to note that the reliability and quality of the data collected during the monitoring phase will determine their usefulness for modelling. As such, continued communication with project collaborators responsible for data collection and quality control is critical for ensuring the accuracy and relevance of the modelling database.

Another potential risk concerning the simple folder database system is limited scalability using this structure. As new data is added and the model becomes more complex, the database may become too large to manage effectively using a simple folder-based system. In this case, one should consider alternative database structures that can handle larger amounts of data and provide more sophisticated querying and analysis capabilities.

Another risk is the potential for unforeseen data inconsistencies or errors. This could be due to issues such as incomplete or missing data, inconsistent data formats, or errors in data entry or processing during the model setup. To minimize this risk, we intend to establish a clear protocol for data quality control and to implement regular data checks and validation procedures during the modelling phase. This protocol will be continuously updated and communicated to project collaborators during the model development phase. Additionally, it is important to maintain clear communication among collaborators to ensure that any data issues are identified and addressed promptly.

To address these potential risks, it's important to have clear communication channels with project collaborators and to ensure that all parties are aware of the project objectives, risks, and mitigation strategies. Finally, we intend to routinely review the database structure to help identify and address any potential issues as they arise.

5 CONCLUSION

In conclusion, this report outlines the data collection and structure of the modelling database for Deliverable WP3.1. The database structure was designed to facilitate easy data retrieval, storage and management, and the use of a simple folder-based system was found to be an effective and practical solution. The report has also highlighted the importance of data protection and security when sharing the database with project collaborators and the suitability of Nextcloud for this purpose.

Two out of three case studies have provided sufficient data for the planned modelling activities, while for the Amman case study, a revised modelling approach using open-source data sets should be considered. It is recommended to continue communication between project partners to ensure accurate modelling.

In summary, the completion of deliverable WP3.1 marks an important milestone for the project, and the developed database will serve as a valuable resource for the planned modelling activities.

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1 ANNEX

Link to the Requirement List Summary Spreadsheet

2 2. REFERENCES

Nedergaard Pedersen, A., Wied Pedersen, J., Vigueras-Rodriguez, A., Brink-Kjær, A., Borup, M., & Steen Mikkelsen, P. (2021). The Bellinge data set: Open data and models for community-wide urban drainage systems research. *Earth System Science Data*, *13*(10), 4779–4798. https://doi.org/10.5194/essd-13-4779-2021

Data Requirements for WP3

General Instructions

- Please provide the data listed in the tables below
- The required data is classified as critical—"a must-have"; important—provides a relatively accurate representation of the study domain, drainage network; optional—provides additional information to support the workflow.

These are indicated in the **"Importance"** column provided in the tables below as:

Critical: "A must-have"
Important
Optional

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1. Spatial Data (Geodata)

Overall, the spatial data collected will be used to discretise the urban landscape and drainage area and to set up the hydraulic model.
The spatial data would also be used for characterising the catchment in terms of the types of roofs, surface types and connectedness in terms of the hydrologic and hydraulic connectivitiy.

Table 1: Spatial data required for building the geo-database of the study sites

Spatial Data	Description	Importance	Preferred Format	Resolution	Projection	Aarhus (ARH)	Amman (AMN)	Santiago de Compostela	Notes
Sewer Network	Provides the geometry of the drainage network and reveals key geometric parameters such as the location of the drainage inlets and outlets. Preferred data type: Vector data	Critical	SHP; GPKG		UTM (local UTM zone) and WGS 84 (e.g. UTM 28N, WGS48)	✓	×	✓	SCO - Network data for city to be uploaded in January ARH - New BGI to be selected, network data of the overall study area already provided AMN - BGI identifided, acutal sewer network not available
Case study boundary	The boundaries of the selected study sites.	Important	SHP		UTM (local UTM zone) and WGS 84 (e.g. UTM 28N, WGS48)	✓	✓	✓	
Digital Elevation Model (DEM)	Defines the elevation across the catchment. Use for defining the drainage path. Preferred data type: Raster Data	Optional	GEOTIFF; netCDF; HDF5; GPKG	< 5m-Resolution	UTM (local UTM zone) and WGS 84 (e.g. UTM 28N, WGS48)	✓	(✓)	✓	
Cadastral Data	Defines data on the building roof and road networks and other critical infrastructure, location of trees etc. Preferred data type: Vector data	Optional	SHP; GPKG		UTM (local UTM zone) and WGS 84 (e.g. UTM 28N, WGS48)	×	×	✓	
Urban green	Location of individual trees (maybe also species and age), parks, green areas, green roofs, existing green infrastructures (LIDS)	Important	SHP	point data		✓	×	✓	
Street layout and sealing	Streets including size, number of lanes and traffic amount (heavy, medium, small), parking, pedestrian areas, parking, degree and type of sealing	Important	SHP or raster			×	×	✓	
Urban soils	Soil map for cities	Important	SHP			×	×	✓	
Buildings	3d model of buildings	Important				×	✓	×	
Land-use Raster	To identify the various categories of land uses within the drainage area and to determine the degree of perviousness within the drainage area or, in our case, at the block level Preferred data type: Raster Data	Optional	GEOTIFF; netCDF; HDF5; GPKG		UTM (local UTM zone) and WGS 84 (e.g. UTM 28N, WGS48)	✓	✓	×	

2. Sewer Network Data

Table 2: Required network data for the setup of the SWMM hydraulic model

Required data	Description	Importance	Aarhus (ARH)	Amman (AMN)	Santiago de Compostela
Drainage inlets	Location (Latitude, Longitude)	Critical	✓	(✓)	✗
	Invert elevation (the elevation at the inside-bottom of a pipe, culvert etc.)	Critical	✓	✗	✗
	Cross-sectional geometry	Critical	✓	✗	✗
	Type (storm drainage, culvert opening)	Optional	✓	✗	✗
Drainage outlets	Location (Latitude, Longitude)	Critical	✓	(✓)	✓
	Invert elevation (the elevation at the inside-bottom of a pipe, culvert etc.)	Critical	✓	✗	✓
	Cross-sectional geometry	Critical	✓	✗	✓
	Stage relationship (e.g. stage time series). Required for setting the boundary condition at the outfall.	Important	✓	✗	✗
	Presence of a flap gate to prevent backflow through the outfall	Optional	✓	✗	✗
Conduits (Pipe)	Length	Critical	✓	✗	✓
	Location of the inlet and outlet (Latitude, Longitude)	Critical	✓	✗	✓
	Elevation above the inlet and outlet inverts	Critical	✓	✗	✓
	Material type (For Manning's roughness coefficient)	Important	✓	✗	✓
Manholes	Invert elevation	Critical	✓	✗	✓
	Height to surface ground	Important	✓	✗	✓
	External inflow data, e.g, from connecting combine sewer, sanitary sewer etc)	Optional	✓	✗	✗
Weirs	Location (Latitude, Longitude)	Critical	✓	✗	✓
	Shape (Type) and geometry	Important	✓	✗	✓
	Crest height	Important	✓	✗	✗
Orifices	Location (Latitude, Longitude)	Critical	✓	✗	✗
	Configuration (bottom or side)	Important	✓	✗	✗
	Shape (circular or rectangular)	Important	✓	✗	✗
	Height	Important	✓	✗	✗
	Time open or closed	Optional	✓	✗	✗
Pumps	Location (Latitude, Longitude)	Critical	✓	✗	✓
	Connecting inlet, outlet points	Critical	✓	✗	✓
	Pump curve	Important	✓	✗	✓
	Startup and shutoff depths	Optional	✓	✗	✓
Storage Units	Location (Latitude, Longitude)	Critical	✓	(✓)	✓
	Invert elevation	Critical	✓	✗	✓
	Maximum depth	Critical	✓	✗	✓
	Depth-surface area data	Important	✓	✗	✓
	Evaporation potential	Optional	✗	✗	✗

3. Time Series Data

Table 3: Required time series for modelling the workflow

Time Series	Description	Importance	Required Format	Aarhus (ARH)	Amman (AMN)	Santiago de Compostela
Sewer Network Discharge	Discharge(flow) measured at the outlet.	Critical	CSV	(✓)	✘	(✓)
	Flow time series at pump stations. Especically if the pumps are used for diverting excess rainfall	Critical	CSV	(✓)	✘	✘
Water level at outfall	Time series of water level meaurements of CSOs, at pump stations used for diverting excess water and at other outlet points in the nextwork.	Critical	CSV	(✓)	✘	✘
Rainfall data in high resolution	High resolution rainfall data in 1min, 5 min oder 10 min time series in the case study cities and in a radius of ca. 20 km surrounding the cities)	Critical		✓	(✓)	✓
Air pollution data	Time series on air pollution (what ever is available)	Critical		✘	✘	✓
Rainfall	• Location (Latitude, Longitude)	Important	CSV	✓	(✓)	✓
	• Measurements corresponding to the discharge	Important		✓	✘	✓
External inflows	Flows in addition to inflows originating from subcatchment runoff. For example, dry weather inflows (specifically for study sites with combined sewers)	Optional	CSV	✘	✘	✘
Control settings for pumps and flow regulators	Time series regarding the operation of the pumps installed (start and stop times)	Optional	CSV	✘	✘	✘

Comments
SCO - Flow measurements from previous by UDC were provided ARH - Flow measurements are planned
Note that we recieved data from the historical studies in SCO conducted by the UDC between 1999-2008. this includes measurements of the flow and water level measurements for 3 sub-catchments in SCO
SCO - 10 min resolution available ARH - 30 years of 1-min resolution are available

4. Exisiting Sewer Models

Table 4: Descrpition of packaging the SWMM models for sharing.

Item	Description	Importance	Required Format	Aarhus (ARH)	Amman (AMN)	Santiago de Compostela
Existing SWMM Model	Existing SWMM model for selected study areas. This should be packaged in a zip file consisting of .ini; .inp; .dat files, and any other relevant data for running the model	Optional	zip	✓	✘	✘

5. Additional Information

Table 5: Additional information required for WP3

Item	Description	Importance	Required Format	Aarhus (ARH)	Amman (AMN)	Santiago de Compostela
Street cleaning routines	Information on cleaning routines for streets (wet or dry cleaning, how often per y	Optional		✘	✘	✘
Salt applications during winter.	Information on salt applications during ice/snow conditions (public and private use, in some EU countries it is forbidden, what about the two case studie cities?)	Optional		✘	✘	✘