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Linz Pilot Definition Plan

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1. Management summary

This document contains the definition plan for the SUDPLAN Linz pilot (phase 3). It is a required reading for the pilot development participants and might be of interest for the WP2 and WP3 participants. This document is an advancement of the Pilot Definition plan V2. The document supplements the pilot scope, describes the used sensor network and devices, revises all former tasks and use-cases based on implementation phase 2 and describes all intended new tasks and use-cases. In WP7 the Pilot software will be developed based on the descriptions within the current document.

Within the Linz pilot three main tasks are carried out:

(1) Develop and set up an information system based on WP3 and WP4 results that incorporates common services and local model components to:

(2) Estimate the overall combined sewer overflow efficiency rates for dissolved pollutants and for particulate pollutants in the catchment area of the waste water treatment plant (WWTP) of Linz, based on long-term simulations with historical and predicted rain data provided by the Common Services of the SUDPLAN project (Phase 1 and Phase 2).

(3) Estimate the sedimentation efficiency rate for the primary clarifiers of the treatment plant in Linz by the installation and operation of a novel sensor network in the inflow and outflow of the primary clarifiers in order to quantify the total suspended solid and chemical oxygen demand retention efficiency under different storm water flow regimes. The sedimentation efficiency rate of these primary clarifiers is crucial for calculating the overall efficiency rate of the combined sewer overflows for particulate pollutants of the whole catchment area (Phase 2 and Phase 3).

2. Pilot Status

The Linz pilot focuses on the development and set up an information system based on WP3 and WP4 results that incorporate common services and local model components to include the aspects of climate change into the problem of combined sewer overflows into receiving waters. Since it can be assumed that during more frequent and heavier rainfalls the overflow duration of these facilities and the spilled out pollution loads to receiving waters will also increase, possible climate changes might have crucial impacts to the aquatic environment. By comparing the results of today's and of future scenarios possible effects and changes can be recognised and located and proper strategic adaptations can be developed within the catchment area in time.

During phase 1 of the SUDPLAN project preparatory work has been carried out

- to screen all available catchment and measurement data in the area of the Linz pilot,
- to decide on historical rainfall data which are used by Common Services for regional downscaling and for future scenarios and
- to select a proper simulation model for the calculation of CSO efficiency rates based on long term simulation runs.

From the two simulation models available for the Linz catchment area the SWMM model was selected.

During phase 2 the following tasks have been carried out successfully:

- An instance of the scenario management system was set up integrating the SWMM model configuration (basic Linz Pilot Application).
- The SWMM model was wrapped in a OGC compliant Service Implementation (Sensor Observation Service, Sensor Planning Service) to control and access results.
- The OGC compliant service was integrated into the Linz Pilot Application.
- Subsequently the model was analysed and calibrated using state-of-the art global sensitivity analysis methods and optimisation algorithms.
- Scripts were developed to automatically calculate the actual and required efficiency rates defined in the Austrian ÖWAV Regelblatt 19 (2007) guideline from any given rainfall time series and SWMM model output.
- With these prerequisites fulfilled a first evaluation and comparison of historical time series and one future predicted scenario was carried out.
- Recently the sensor network at Linz WWTP was installed and is now in full operation.

First implementation of the Linz Pilot Application on the basis of the Scenario Management System is now available, integrating the SWMM model with geographic referencing, the downscaled rainfall time series and the required additional information e.g. for sedimentation efficiency. SWMM model and scripts for evaluation run on servers and results are transferred.

Although a first integration of the essential elements (CS, SMS, SWMM) into the Linz Pilot Application has been achieved that can be the basis for the upcoming validation work, the current system is only in alpha state and need a considerable number of improvements to be applicable in the foreseen real word context. These improvements are the focus of year 3 work and will include: refactoring of the service implementation, stable service communication, consideration of frequency changes for downscaled time series, integration of the sensor network, and enhanced visualisation and use case support. This document however, focuses on updates of tasks and use cases to be support by the pilot application.

3. Methodology

In this document a methodology developed by WP2 was used to define users, tasks and use cases that are the basis for user requirements recorded in D3.1.x (Requirement Specification). The software developed on the basis of tasks, use cases and derived requirements is validated against the requirements in the Pilot Validation Report (D7.3.x) which results are used as a feedback to the development WPs. This document defines the users, tasks and use cases (pilot definition) that are that initiate each of the three development cycles.

The first step towards the pilot definition was conducting interviews with the people involved in the WP7 pilot, assessing and documenting relevant aspects of the expected pilot application. The documentation of the interviews has been accomplished according to aspects like: users involved in the decision process (direct or indirect users of the system), decisions the pilot application shall support, information and data related aspects (amount, representation, etc.), visualization/interaction capabilities, and available subsystems.

The second step consisted in the identification of the main tasks (the user of the Pilot Application shall be able to perform) and definition of use-cases. The identified tasks undergo a recursive decomposition process (sub-tasks) and together with the use-cases are used as basis for the Scenario Management System (SMS) requirements extraction in WP3.

3.1. Task Analysis

Formal method called “hierarchical task analysis” is used to describe the tasks and decisions the user has in general (what is his duty). These are somewhat more abstract than the use cases (higher level). The main idea of the task analysis is to better understand the application domain, what are the goals of the pilots on a system independent level.

3.2. Use-Case Analysis

Use Case Analysis is a common method heavily used in the fields of software engineering (among others) to specify the system (SUDPLAN) behaviour through single use-cases of the system. A single use-case describes the interaction of the system with the different actors for a particular purpose (e.g. downscale climate data). Whereas an actor not necessarily has to be a human person it could also be another system. So the idea is to pick the most important and the right amount to specify the system appropriately.

4. Pilot Definition

4.1. Pilot Site

Linz is the capital of the Austrian Federal State of Upper Austria. With about 185,000 inhabitants it is the 3rd largest city in Austria. The economy is driven by iron & steel industry, chemical industry, pulp industry and small to middle-scale manufacturing. The sewage network is managed by the city authority's operational company "LINZ AG" (http://www.linzag.at). The network covers the city of Linz plus 39 suburban municipalities, thus serving about 400,000 people. The sewer network also serves the chemical, iron/steel and pulp industry. The overall services area covers about 900 km^2. LINZ AG runs a network in Linz of 660 km sewage lines and a modern treatment plant with a capacity of 950,000 PE. The value of the urban drainage infrastructure (only sewer system) is about 600 Mio €.

The Linz pilot explores the suitability and applicability of an innovative sensor, communication and information system for the improved operation of the sewerage system under possible climate change conditions.

The SUDPLAN pilot of Linz will develop planning tools for dimensioning of water sewer systems, to mitigate future spill behaviour of combined sewer overflows (CSO). The Linz pilot study focuses on the problem of combined sewer overflows into receiving waters. Proper strategic adaptations (planning measures) can be developed within the catchment area, by comparing the results of today's and of future scenarios possible effects and changes.

Mainly because of historical aspects most European cities are operating combined sewer systems which mean that waste water and storm water is drained in one sewerage system. Due to the hydraulic limitation of waste water treatment plants it is not possible to treat the whole amount of the drained water during heavy rainfalls. Therefore, the storm water runoff in combined sewer systems has to be either spilled out at combined sewer overflows into receiving waters or stored temporarily in reservoirs.

Since it can be assumed that during more frequent and heavier rainfalls the overflow duration of these facilities and the spilled out pollution loads to receiving waters will also increase, possible climate changes might have crucial impacts to the aquatic environment.

4.2. Pilot Scope

4.2.1 Main Pilot Objectives

One of the critical issues in storm water management is within a waste water treatment plant (WWTP). Due to the hydraulic limitation of WWTPs it is not possible to treat the whole amount of drained water at WWTPs; thus the runoff in combined sewer systems has to be either discharged at combined sewer overflows (CSO) into receiving waters or temporarily stored in reservoirs. CSO facilities can be designed with a retention volume ("CSO tank") in order to mitigate overflow events during heavy rains. CSO tanks also show considerable capacities to hold back the TSS (Total Suspended Solids) and COD (Chemical Oxygen Demand) concentrations in waste and storm water which are the key parameters to describe and quantify the transported pollution loads in sewer systems.

To limit the spilled out pollution loads from combined sewer systems into receiving waters a new standard, the so called ÖWAV Regelblatt 19 (2007), was introduced in Austria in 2007 (Kleidorfer and Rauch, 2010). The ÖWAV-Regelblatt 19 (2007) defines the efficiency η of combined sewer overflows (CSO efficiency η) as an indicator for CSO pollution.

The overall objective of the LINZ AG as the actual end user of the software developed in WP7 is to fulfil the prescriptive limits for the CSO efficiency and other legal regulations. To achieve this

- the CSO efficiencies have to be computed using long term simulation based on rainfall-runoff transport modelling
- the so far unknown sedimentation efficiency of the primary clarifiers of the wastewater treatment plant (WWTP) which work similar to CSO tanks have to be determined with the help of a sensor network
- the impact of the CSO on the ambient water quality has to be analysed by simulating heavy single rainfall events.

A more detailed description of this can be found in *Annex 1: ÖWAV Regelblatt 19*.

4.2.2 Relevance with respect to Climate Change Issues

Due to the fact that one can assume that the spilled out pollution loads from the sewerage into receiving waters are directly linked with rain pattern and that possible climatic changes with more frequent and heavier rainfalls will directly lead to more frequent overflows with more spilled out pollution loads. Therefore adaptation and mitigation strategies are from crucial importance to prevent environment from combined sewer overflows. The LINZ AG is operating CSO tanks and they are interested in the retention efficiency of these tanks to fulfil the Austrian regulations. One of the CSO tanks – the special primary clarifier and its downstream CSO at the WWTP – should be observed and monitored in detail within the Linz pilot by novel sensors to estimate the discharged pollution loads in the inflow to the tank and the spilled out loads in the overflow.

It can be assumed that during more frequent and heavier rainfalls the overflow duration of these CSO tank and the spilled out pollution loads will also increase. Therefore, climate change scenarios should be conducted to estimate these impacts to the aquatic environment. Climate change impacts are considered to be a threat to urban infrastructure with a potential increase of heavy rainfall and accompanying sewerage flooding. The urban infrastructure has been built according to historic standards of frequencies and extents of flood events. With climate change these historic standards need to be re-written or be adapted, respectively.

The Linz case study is an example of the applicability of some of the SUDPLAN innovations for an urban infrastructure operation company, which ensures their practicability and applicability under a tight economic conditions. It will not be financially feasible to re-build all the sewerage systems to be prepared for future climate variability. What is possible, however, is to counteract the potential climate impacts with a better and smarter operation of the sewerage system, using advanced ICT solutions. Monitoring of the waste water system and scenario simulation of potential climate change impacts are essential for the optimization of sewage flow control in order to ensure the smooth operation of existing infrastructure, to prevent environmental damages and to extend the operational lifetime of the urban infrastructure.

The Linz case study will explore the suitability and applicability of an innovative communication and information system for the improved operation of the sewerage system under possible climate change conditions. Special emphasis will be given for using information from different sensor types to ensure an early response to flood events and to an appropriate management. Such innovative systems can be applied to the combination and integration of information from sensors of any kind (e.g. rainfall in sewerage catchments, wastewater qualities, extent of free primary and secondary sewer capacities in different networks, extent of suitable zones for planned emergency spill flows).

Climate Change Issues	Pilot Consideration
More frequent and heavier future rainfalls will directly lead to more frequent overflows with more spilled out CSO pollution loads into the receiving waters.	(1) By calculation an overall CSO efficiency rate for dissolved pollutants (η_d) and for particulate pollutants (η_p) based on an existing model for Linz and based on future long-time periods of at least 10 years provided by the common services the influence of possible climate change scenarios will be assessed.
	(2) The sedimentation efficiency rate of the primary clarifiers in combination with the downstream CSO of the WWTP of Linz will be monitored by a new novel sensor network to gain estimation for this rate under different flow conditions. The sedimentation efficiency rate of these clarifiers is crucial for calculating the overall CSO efficiency rate for particulate pollutants (η_p).

4.3. Local models and data sources used

LINZ AG maintains a geographic information system (Smallworld GIS) as a network information system that covers the sewer network and their total service area. To simulate the hydraulic behaviour of the sewer network and to estimate the spilled out pollution loads during wet weather conditions different models are used by LINZ AG: Mike Urban from Danish Hydraulic Institute (DHI), City Drain from University of Innsbruck and SWWM 5 from the US Environmental Protection agency EPA. Since the simulation tools need rain data with high frequency as input data LINZ AG has started to operate further rain gauges in the catchment area. In total 9 rain gauges are operated and first investigations concerning the possible combination with radar data have been analysed. Besides the on-line rain data of their own rain gauges the rain data from the local hydrological services of the federal government of Upper Austria can also be used for free since they are sharing the measured rain data. At the most relevant CSO structures in the catchment area measurement systems are installed to measure the frequency and duration of overflow events to receiving water. At the primary clarifier site at the WWTP Linz where the sensor network will be installed and operated within the Linz pilot some flow meters and ultrasonic probes to measure flow rates and water levels are already installed and can be used for the pilot to measure the inflow and overflow rates. All installed and already available sensors are directly linked to a continuously operated central data storage system.

4.3.1 SWMM 5 catchment model

Within the SUDPLAN project, the aggregated SWMM 5 model of the Linz catchment is used. It appeared to be the fastest in terms of computational speed and can be easily integrated into the SUDPLAN platform as SWMM platform independent and open source. Additionally it can be directly linked to the open source BlueM.OPT framework (Bach et al. 2009) that allows performing global sensitivity analysis and automated model calibration by optimisation algorithms and has already been successfully applied at TU Graz in several studies (e.g. Gamerith et al., 2011a and 2011b).

An overview of the catchment model as set up in SWMM 5 is shown in **Fel! Hittar inte referenskälla.**. The highly urbanised areas of downtown Linz is and the 39 neighbour communes covering a total area of approximately 900 km² are aggregated to about 190 subcatchments and only the main sewer conduits are explicitly modelled. All relevant hydraulic structures as CSOs, CSO tanks, pumping stations and culverts are modelled and all relevant information for assessment according to the ÖWAV Regelblatt 19 guideline is included in the model. Evaluation of the efficiency rates is done as post processing from the output results.

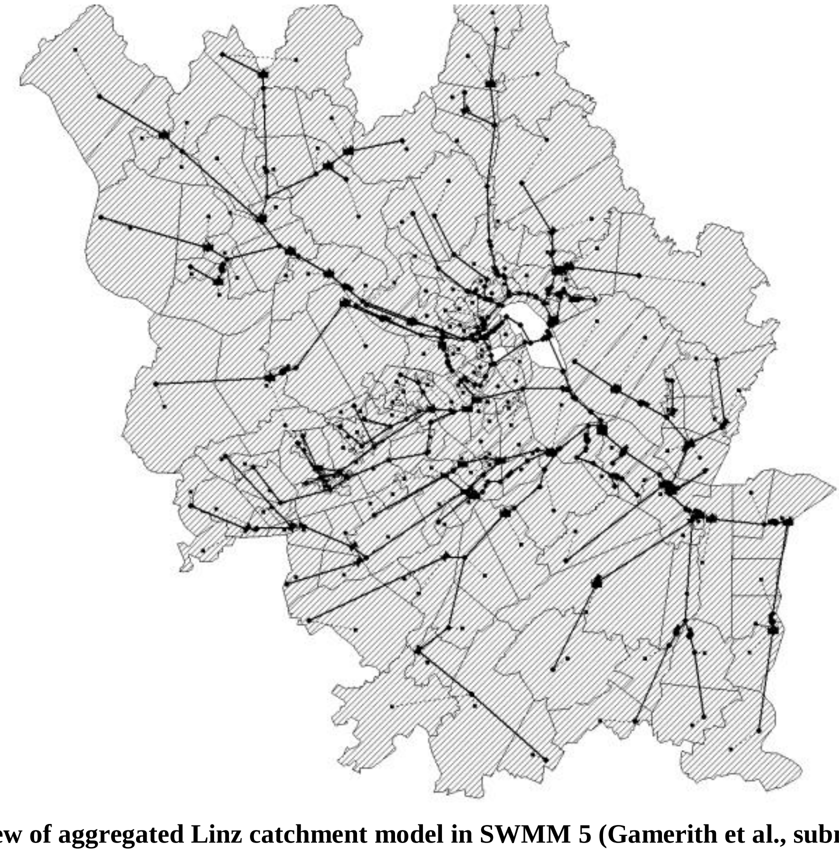

Figure 1: Overview of aggregated Linz catchment model in SWMM 5 (Gamerith et al., submitted)

4.3.2 Sensor network at WWTP

Preliminary model runs identified the primary clarifiers that also function as CSO tanks during rainfall events to have a major influence on the efficiency rates as defined in the ÖWAV Regelblatt 19. Especially the assumption of the sedimentation efficiency has an important impact on the overall efficiency for particulate pollutants. Therefore, an assessment of the actual sedimentation efficiency is crucial in order to evaluate the whole systems performance.
In order to address this question a sensor network will be installed at the primary clarifiers of the WWTP, measuring hydraulic and water quality variables. An overview of the local situation at the WWTP is given in Figure 2, Figure 3 and Figure 4.

Within the SUDPLAN project the measured variables (hydro- and pollutographs) shall be visualised in the SMS. In addition an event-detection algorithm will be implemented that allows automatically detecting overflow events from the measured data. Based on these events, the sedimentation efficiency of the structure during storm events can be determined.

Figure 2: Map of WWTP Linz with the two primary clarifiers in green and indicated with No. 14

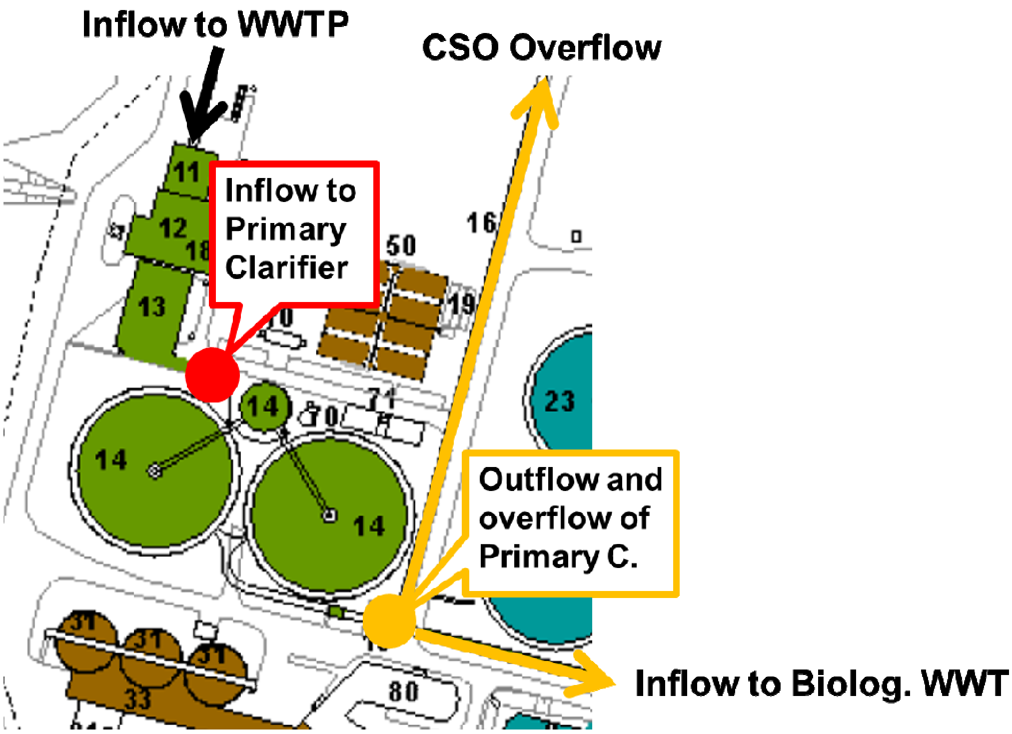

Figure 3: Overview of primary clarifiers at WWTP with inflow, overflow and outflow situation

Figure 4: Photos of primary clarifiers indication inflow, overflow and outflow situation

4.3.2.1 Measured and provided variables

Both discharge and pollutant concentrations have to be measured in the inflow and in the outflow in order to determine the sedimentation efficiency of a structure. An overview of the measured variables and measurement devices is given in Table 1 and Table 2. In order to provide a valid mass balance for the pollutants in the primary clarifiers not only the inflow and outflow concentrations have to be determined but also the primary sludge removal has to be taken into account.

Table 1: Variables measured by the SUDPLAN sensor network

Variables measured by SUDPLAN sensor network			
Location	**Variable**	**Unit**	**Sensor**
Inflow	COD_{eq}, TSS_{eq}	mg/L	UV/VIS spectrometer probe
	Temperature	°C	UV/VIS spectrometer probe
	Water level	m	Ultrasonic water level meter
Outflow	COD_{eq}, TSS_{eq}	mg/L	UV/VIS spectrometer probe
	Temperature	°C	UV/VIS spectrometer probe
	Water level	m	Ultrasonic water level meter

Table 2: Variables provided by LINZ AG from sensors already installed at the WWTP

Variables provided by LINZ AG			
Location	**Variable**	**Unit**	**Sensor**
Inflow	Q_{inflow}	m^3/s	Ultrasonic device
Outflow	$Q_{overflow}$	m^3/s	Ultrasonic device
	$Q_{inflow-bio}$	m^3/s	Ultrasonic device
Primary sludge removal	Q_{PSR}	m^3/s	Ultrasonic water level
	TSS_{PSR}	mg/L	unknown

Special attention has to be given to the choice, installation and operation of the sensors as compared to other measurement tasks, several specific challenges result from measuring in sewer systems (Bertrand-Krajewski et al., 2000):

- In combined systems high dynamics in runoff and pollution concentrations are encountered. This means that i) a high measurement range has to be covered and ii) the measurement device must be robust to withstand possible physical stress.
- The environment is very humid and aggressive. This can lead to corrosion problems for both mechanical and electronic components.
- As the environment is explosive, installed devices have to be explosion proofed.
- The measured medium is inhomogeneous; solids are transported with the water. This means that measurement devices installed in the medium i) risk being damaged and ii) can pose a serious problem due to clogging.
- Trained personal for installation and maintenance is indispensable.

The probes and installation as well as operation procedure used within the SUDPLAN sensor network were all chosen so that they meet the above requirements.

Concerning the **hydraulic measurements**, measurement devices for sewer systems are used in general practice since the 1980s and their use is well established and documented.

For the **water quality measurements** the core of the sensor network is a UV/VIS spectrometer probe. The basic principle of UV/VIS spectrometry is to measure light absorption in different wavelengths in the visible and ultra-violet range and to derive target parameters based on the measured absorptions. These probes were first used in the sewer systems in early 2000 and became more common in the last few years. TU Graz has operational experiences with this device in sewer systems for over 10 years (see e.g. Gruber et al., 2005). For more details see *Annex 2: UV-VIS Probe*.

4.4. Common Services Used

Downscaling of precipitation is the most interesting and important common services for the Linz pilot to get future precipitation pattern for the scenario analysis. One of the most important determining factors for the operation of the CSO tanks at the WWTP is the forecast of regional rainfall in the sewerage catchment. The Linz pilot will use the Common Services (WP4) to achieve downscaled characteristics of future intense rainfall, input to the estimation of the overall CSO efficiency rates for dissolved pollutants (η_d) and for particulate pollutants (η_p) in the total catchment area of the WWTP of Linz.

For phase 2 only the so called Delta Change Method was provided by the Common Services (CS) for long term rain time series downscaling where generally frequency changes are not considered. Since sometimes frequency changes are significant an extended downscaling procedure is planned for phase 3 by CS where the user should be able to select if frequency changes could additionally be considered or not for the used downscaled rain time series. Therefore the Linz pilot application will be a suitable example for testing if the developed frequency change algorithm of CS will influence the future overflow volumes in the Linz catchment area or not.

LINZ AG will contribute the already existing urban runoff model in SWMM 5 set up by University of Innsbruck that will – using the rainfall data provided by SMHI – allow to model and visualize the spatial and temporal dimension of impacts of rainfall events. This will be used to identify vulnerable areas that have high priority for measures to prevent negative environmental and economic effects from potential climate change impacts. For the operation of the sensor network at the primary clarifiers the Linz pilot will also utilize plug and measure concepts of the SANY (“Sensors Anywhere”) architecture developed in the FP6 SANY[1] Integrated Project which focuses on interoperability of in-situ sensors and sensor networks (see SANY - an open service architecture for sensor networks[2]).

[1] (Contract No 0033564, www.sany-ip.eu)
[2] http://www.sany-ip.eu/publications/3317

4.5. Main Pilot Activities

The Linz pilot focuses on the problem of combined sewer overflows (CSO) into receiving waters. In scope of the SUDPLAN project, three main tasks will be carried out within the Linz pilot:

(1) Develop and set up an information system based on WP3 and WP4 results that incorporates common services and local model components to:

(2) Estimate the overall CSO efficiency rates η for dissolved pollutants (η_d) and for particulate pollutants (η_p) in the total catchment area of the WWTP of Linz based on long-term simulations and future rain data provided by the common services (Phase 1). By comparing the results of today's and of future scenarios possible effects and changes can be recognised and located and proper strategic adaptions can be developed within the catchment area in time.

(3) Estimate the sedimentation efficiency rate η_{sed} for the primary clarifiers of the WWTP in Linz by the installation and operation of a novel sensor network in the inflow and outflow of the clarifiers in order to quantify the TSS and COD retention efficiency under different rainwater flow regimes (Phase 3). With an innovative combination of data from traditional and new sensors (such as UV/VIS spectrometers) pollution levels and loads will be measured in the inflow to the very special primary clarifiers and in the overflow channel to receiving water.

This knowledge is of crucial importance to assess the retention efficiency of thus CSO structures under a climatic change scenario, and to plan ahead for adaptation strategies. The results of this estimation can directly be used in (1) and will improve the simulation certainty since the sedimentation efficiency rate of the primary clarifiers is crucial for the overall CSO efficiency rate for particulate pollutants (η_p).

4.6. Decisions/Analyses to be supported by the DSS

The Linz pilot will allow an analyst to detect critical CSO structures within the Linz catchment area under climatic change behaviour

- by comparing today's with future scenarios the overflow behaviour of the sewer system and therefore also the emitted pollution loads to receiving waters can be estimated and necessary strategic adaption work can be developed within the required time,
- by comparing the simulated data with available measured data at CSO structure (e.g. frequency and duration of overflow events) the calibration quality of the used model City Drain can by assessed year by year and also possible changes in the catchment area can be detected and
- by operating a novel sensor network at the WWTP of Linz in phase 3 a tool will be developed to estimate the retention efficiency of the primary clarifiers which are the crucial contributor in the whole sewer system regarding to the total emitted pollution loads.

These tasks have as their primary goal the integrated protection of the aquatic environment from emitted pollution loads from urban drainage systems. Both should support LINZ AG to optimize their whole system and to find proper adaption measures within the required time. Furthermore, the result will be basis for future conceptual design and operation strategies of sewer real time control. These tasks will be described in more detail in the following subsections, including a hierarchical decomposition into subtasks.

4.7. Expected Added Value

It is expected that the Linz case study will lead to substantial added value for the project, for the city of Linz and for European wastewater industry:

- The Linz pilot will lead to practical experiences of the systems developed within the SUDPLAN project that will provide essential feedback for further development.
- The climate change vulnerability analysis of the wastewater system will lead to new knowledge about an optimal operation of CSO tanks in Linz, and in other EU cities with a similar situation.
- The intended monitoring program at the primary clarifiers at WWTP Linz with novel sensors will lead to a better knowledge and understanding of the retention efficiency of pollution loads in CSO tanks.
- The planned innovative CSO sensor network will provide a basis for the development of new monitoring technology.
- The SUDPLAN project will provide decision support for operation and re-design of the already existing sewer system considering future precipitation scenarios.

5. User Analysis Results

5.1. Primary Users

There are three types of users who will make regular and direct use of the Linz Pilot system: Technical staff, Technical Consultants and System Administrators.

5.1.1 Internal Technical Staff of LINZ AG

Linz's sewer system analysis is carried out by internal technical staff and external technical consultants. The internal technical staff is in general familiar with the application of urban run-off modelling (hydrological and hydrodynamic models) and GIS systems and are comfortable with computers. They may also have some familiarity with precipitation models. However, they will likely have little to no experience with global climate models. Some of their analyses are done internal to support the managers of LINZ AG by strategic or operational decisions or are carried out collaboratively with external technical consultants. German language may be required.

5.1.2 External Technical Consultants

These individuals are very comfortable with computers. As modellers they will want to interact with the hydrological models used in the pilot and to adapt the model if there is a need for. They may also have some familiarity with precipitation models. However, they will likely have little to no experience with global climate models. They may or may not have sophisticated GIS experience. Their analyses are carried out collaboratively and the German language may be required.

5.1.3 System Administrators

The System Administrator for the Linz pilot will be an autonomous IT department associated to the LINZ AG company who is comfortable with computers and software installation. They may not be sophisticated GIS users. In general they have no domain knowledge regarding climate, precipitation, or urban run-off modelling.

5.2. Secondary Users

The sole type of secondary user envisioned for the Linz pilot consists of managers and engineers from the LINZ AG wastewater department.

5.2.1 Managers/Engineers

Managers and engineers in Linz will be shown results by the users with modelling background (4.1.1 and 4.1.2) and may sit with them at the system itself to engage in “what if” scenario sessions. They may or may not have technical backgrounds. German language may be required.

5.3. Tertiary Users

There are four types of tertiary users of the Linz pilot: city politicians/managers, plant and sewer operators, regulators, and the public. All of these will interact with the system only in the sense that they will be shown results/reports whose content was produced by the system.

5.3.1 City Politician/CEOs/Manager

The politician/CEO/manager will be the recipient of reports generated by primary users of the pilot system. While the content of these reports will in part come from the system, other content and formatting will generally be the product of other tools. The politician/CEO/manager is generally assumed to have little to no technical training or knowledge, but will be familiar with the general issues of urban drainage and property protection. In general, the German language will be required.

5.3.2 Plant/Sewer Operators

The Plant/Sewer Operators will also receive reports including content from the pilot system. These operators are technically familiar with the operation of the wastewater system. The German language will be required.

5.3.3 Regulators

Regulators will receive reports including content from the pilot system. These regulators are likely familiar with the operation of the wastewater system, and may have technical training. The German language will be required.

5.3.4 General Citizen

The general citizen of Linz may be provided with information resulting from sessions conducted with the Linz pilot, perhaps through publication on the city's web site. While the content of these publications will in part come from the system, other content and formatting will generally be the product of other tools. The general citizen is assumed to have no technical training or knowledge, and they may be only slightly familiar with the general issues of urban drainage and property protection. In general, the German language will be required.

5.4. Stakeholders

5.4.1 State or Federal Funding Agencies

One stakeholder of the Linz pilot might be state or federal agencies which provide public funding to cities for public works projects. While they will likely not have any direct or indirect contact with the system or its products, they will be impacted by the quality of the analyses and resulting decisions supported by the system.

6. Task Analysis Results

The overall Task structure can be divided into:

(1) The System Performance Assessment (SPA) performance is intended to determine the overall CSO efficiency rates for dissolved pollutants (ηd) and for particulate pollutants (ηp) in the total catchment area of the WWTP of Linz by using a combination of precipitation models provided by the common services, CSO efficiency calculations and sensor measurements.

(2) The System Design Improvement is intended to build on the system performance modelling capability of the System Performance Assessment and further allow the analyst to consider the impacts on system performance of certain changes in system design parameters, such as tank capacities.

The following tasks in the context of (1) and (2) have been identified:

6.1. Task 1 Assess the current state of the sewer network

Task	*1*
Description	*Assess the current state of the sewer network*
Actor	*Primary*
Goal	*Assess the current state of the sewer network by* • *Calculating the required CSO efficiency rates* • *Calculating the actual CSO efficiency rates*
Input	*See subtasks*
Output	*Actual and required CSO efficiency rates of the actual sewer network*
Components	
Constraints	

Task	*1.1*
Description	*Calculating required CSO efficiency rates*
Actor	*Primary*
Goal	*Calculate the required CSO efficiency rates based on the available catchment and rainfall data according to the guidelines*
Input	*Catchment and historical rainfall data*
Output	*Required efficiency rates*
Components	*The calculation should be done in the SUDPLAN application (scenario manager):* *To calculate the required CSO efficiency rates for future scenarios the knowledge of the r720,1 value of the used predicted rainfall time series is necessary. These values should be provided by the common services.*
Constraints	

Task	*1.2*
Description	*Calculating actual CSO efficiency rates*
Actor	*Primary*
Goal	*Calculate the actual CSO efficiency rates with the calibrated SWMM 5 model and available historical rainfall time series*
Input	*Calibrated SWMM 5 model configuration, historical rainfall time series > 10*

	years, temporal resolution of rainfall data must be 5 minutes or higher
Output	*Actual CSO efficiency rates*
Components	*Pilot-specific model, controlled by Session Management System*
Constraints	

6.2. Task 2 Validate measurement data

Task	*2*
Description	*Validate measurement data (rainfall, runoff and pollution concentrations) provided by LINZ AG*
Actor	*Primary*
Goal	*Validated data on rainfall, runoff and pollution concentrations provided by LINZ AG*
Input	*Raw measurement data provided by the existing data management system of LINZ AG and by the to be installed new sensor network at the primary clarifiers at WWTP Linz*
Output	*Validated time series for rainfall, runoff and pollution concentrations*
Components	*Unclear in the moment: Done before importing the data into SUDPLAN, done by a local pilot-specific model within SUDPLAN or is there a common service for this?*
Constraints	

6.3. Task 3 Determine local rainfall data for future scenarios

Task	*3*
Description	*Determine local rainfall data for future scenarios based on climate change models (downscaling) provided by common services*
Actor	*Primary*
Goal	*Determine local rainfall data for future scenarios based on climate change models*
Input	*Historical rainfall data provided by Linz AG for calibration the downscaling approaches of common services to get more accurate results and necessary input data to parameterise the common services*
Output	*Predicted future rainfall time series and heavy storm water events (IDF curves)*

Components	*Common Services*
Constraints	

6.4. Task 4 Develop future scenarios for the catchment

Task	*4*
Description	*Develop future scenarios for the catchment & adapting the SWMM model*
Actor	*Primary*
Goal	*Develop future scenarios for the catchment, e.g. based on changed land use, etc. and adapting the SWMM model correspondingly.*
Input	*Expected scenarios*
Output	*Adapted SWMM model for future catchment scenarios*
Components	
Constraints	

Task	*4.1*
Description	*Adapt SWMM model to future catchment data due to changed land use*
Actor	*Primary*
Goal	*Develop future scenarios for the catchment based on changed land use*
Input	*Expected scenario*
Output	*Adapted SWMM model for future catchment scenarios*
Components	
Constraints	

Task	*4.2*
Description	*Adapt SWMM model to future catchment data due to modified sewer system*
Actor	*Primary*
Goal	*Develop future scenarios for the catchment by adjusting the sewer system and CSO structures*
Input	*Expected scenario and changes in the current sewer system*
Output	*Adapted SWMM model for future catchment scenarios*
Components	

Constraints	

6.5. Task 5 Assess possible impacts of climate change scenarios

Task	*5*
Description	*Assess possible impacts of climate change scenarios on the sewer system due to future rainfall time series*
Actor	*Primary*
Goal	*Assess possible impacts of future scenarios on the sewer system based on current guidelines by* • *calculating the required CSO efficiency rates for future scenarios* • *calculating the predicted CSO efficiency rates for future scenarios*
Input	*See subtasks*
Output	
Components	
Constraints	

Task	*5.1*
Description	*Calculate the required CSO efficiency rates for future scenarios*
Actor	*Primary*
Goal	*Calculate the required CSO efficiency rates based on the available catchment [e.g. predicted catchment data] and predicted rainfall data according to the guidelines*
Input	*Predicted future rainfall time series (Task 3), predicted catchment data and sewer system structure (Task 4)*
Output	*Required CSO efficiency rates for predicted future rainfall time series*
Components	
Constraints	

Task	*5.2*
Description	*Calculating predicted CSO efficiency rates for future scenarios.*
Actor	*Primary*
Goal	*Calculate the predicted efficiency rates with the calibrated model and predicted rainfall time series.*

Input	*Calibrated SWMM model, predicted future rainfall time series (Task 3) & SWMM model with predicted catchment data (Task 4)*
Output	*Predicted efficiency rate for future scenarios.*
Components	*Pilot-specific model (SWMM)*
Constraints	

Task	*5.3*
Description	*Comparison of required and predicted efficiency rates for several future rainfall scenarios*
Actor	*Primary*
Goal	*Comparison of required and predicted efficiency rates*
Input	*Output from 5.1 and 5.2*
Output	*Comparison data*
Components	*Pilot-specific model (SWMM)*
Constraints	

6.6. Task 6 Sensor network and data acquisition

Task	*6*
Description	*Sensor network and data acquisition*
Actor	*Primary*
Goal	*Operation of the sensor network at WWTP Linz and gathering additional data from available measurement devices*
Input	*See subtasks*
Output	*See subtasks*
Components	
Constraints	

Task	*6.1*
Description	*Design and installation of the sensor network at WWTP Linz*
Actor	*Primary*
Goal	*Operation of the sensor network at WWTP Linz*

Input	
Output	*The sensor network*
Components	
Constraints	

Task	*6.2*
Description	*Collect additional data by existing or by installed novel measurement devices*
Actor	*Secondary*
Goal	*Collect additional data by novel measurement devices (runoff and pollution concentrations)*
Input	*Output from 6.1*
Output	*Additional data*
Components	
Constraints	

Task	*6.3*
Description	*Integration of the sensor network and data from additional sources into the SUDPLAN platform*
Actor	*Primary*
Goal	*Integration of the sensor network and data from additional sources into the SUDPLAN platform*
Input	*Output from 6.2*
Output	*Data availability in SUDPLAN*
Components	
Constraints	

6.7. Task 7 Event detection at primary clarifiers

Task	*7*
Description	*Event detection at primary clarifiers*
Actor	*Primary*
Goal	*Detect overflow events at primary clarifiers*

Input	*Output from Task 6*
Output	*Detected events*
Components	
Constraints	

6.8. Task 8 Calculation of TSS and COD retention rates

Task	*8*
Description	*Calculation of TSS and COD retention rates of the primary clarifiers at WWTP Linz*
Actor	*Secondary*
Goal	*Estimation of ranges for TSS and COD retention rates of the primary clarifiers at WWTP Linz based on the collected additional data from task 7*
Input	*Collected additional data from task 7*
Output	*Estimated ranges for TSS and COD retention rates of the primary clarifiers at WWTP Linz*
Components	
Constraints	

6.9. Task 9 Assess possible impacts of different sedimentation efficiencies

Task	*9*
Description	*Assess possible impacts of different sedimentation efficiencies for all installed CSO tanks in the catchment area on calculated efficiency rates*
Actor	*Primary*
Goal	*Assess possible impacts of sedimentation efficiencies on the calculated efficiencies according to the ÖWAV Regelblatt 19 guideline*
Input	*Output from task 8*
Output	*Predicted CSO efficiency rate for different selected sedimentation efficiency rates*
Components	
Constraints	

6.10. Task 10 Adapt model calibration

Task	*10*
Description	*Adapt model calibration based on additional measurement data*
Actor	*Primary*
Goal	*Adapt and improve the model calibration based on additional measurement data collected over time*
Input	*Model (Task 1.2) and measurement data (Task 6)*
Output	*Improved calibrated model*
Components	
Constraints	

6.11. Task 11 Visualize measurement data

Task	*11*
Description	*Visualize measurement data and data from additional sources*
Actor	*Primary for secondary*
Goal	*Visualize time series of measurement data and data from additional sources*
Input	*Outputs from task 6.2*
Output	*Graphs and reports*
Components	
Constraints	

6.12. Task 12 Visualize results from event detection

Task	*12*
Description	*Visualize results from event detection*
Actor	*Primary for secondary*
Goal	*Visualize results from event detection*
Input	*Outputs from task 7*
Output	*Graphs and reports*
Components	

Constraints	

6.13. Task 13 Visualize results from SWMM model & generate reports

Task	*13*
Description	*Visualize results from SWMM model & generate reports*
Actor	*Primary for secondary*
Goal	*Visualize the results from SWMM model and create reports extracted from the scenarios*
Input	*Outputs from tasks 1 - 9*
Output	*Graphs and reports*
Components	
Constraints	

6.14. Task 14 Visualize geographical features

Task	*14*
Description	*Visualize geographical features of the SWMM model and relevant parameters*
Actor	*Secondary*
Goal	*Visualization of geographical features of the SWMM model and parameters*
Input	*Output from task 2*
Output	*Interactive map*
Components	
Constraints	

6.15. Task 15 Develop and test mitigation strategies for future scenarios

Task	*15 (Not in the socpe of the project)*
Description	*Develop and test mitigation strategies for future scenarios*
Actor	*Primary for secondary and tertiary*
Goal	*Develop mitigation strategies for future scenarios based on*

	• *results from models for future scenarios and* • *testing mitigation strategies with the adapted model*
Input	*Results from task 4*
Output	*Possible mitigation strategies for future scenarios*
Components	
Constraints	

7. Use-Case Analysis Results

7.1. UC-711 "Upload pilot specific data"

Acronym	
	UC-711
Description	
	The actor wants to upload pilot specific data in preparation for a scenario execution.
Primary actor	
	Primary user.
Stakeholder	
	SUDPLAN System
Goal	
	Successful upload of pilot specific data.
Input	
	Login credentials. Location of the files containing the pilot specific data that has to be uploaded (in a suitable format).
Output	
	Pilot specific data gets stored in a location managed by the SMS.
Components	
	SMS frontend, Authentication and Authorization service, File transfer component.
Preconditions	
	The user identity and rights are previously set using the SMS user and rights management.
Main success scenario	
1	Connect and login to the SMS.
2	Pilot specific data selected.
3	Data uploaded.
4	Logout.
Extensions	

7.2. UC-712 “Start Downscaling”

Acronym	
	UC-712
Description	
	The actor wants to start a downscaling scenario execution.
Primary actor	
	Primary user.
Stakeholder	
	SUDPLAN System
Goal	
	Availability of downscaled data on the Common Services Server
Input	
	Login credentials. Location of the files containing the pilot specific data that has been uploaded (optional, but needed for better results). RCM to use Area to calculate data for
Output	
	Pilot specific results get stored in a location on the Common Services Server.
Components	
	SMS frontend, Authentication and Authorization service, Common Services
Preconditions	
	The user identity and rights are previously set using the SMS user and rights management.
Main success scenario	
1	Connect and login to the SMS.
2	Select needed feature (rain). Selection from different models.
3	Selection of RCM from list of available RCMs (includes description of GCM the RCM is based on).
4	Select if frequency changes should be considered or not
5	Open map, zoom to Linz, select AOI (Area of Interest)
6	Select pilot specific dataset(s). (See UC-711 “Upload pilot specific data”)
7	Execute downscaling.
Extensions	

7.3. UC-713 “Download downscaling results”

Acronym	
	UC-713
Description	
	The actor wants to download some of the downscaling results.
Primary actor	
	Primary user.
Stakeholder	
	SUDPLAN System
Goal	
	Get data needed for later processing or visualization to local SMS managed storage.
Input	
	Login credentials. Location of the files containing the pilot specific results.
Output	
	Pilot specific downscaling results get stored in a location managed by the SMS.
Components	
	SMS frontend, Authentication and Authorization service, Common Services Server, File transfer component.
Preconditions	
	The user identity and rights are previously set using the SMS user and rights management.
Main success scenario	
1	Connect and login to the SMS.
2	Select from the results from previous downscaling.
3	Narrow to specific phenomena (optional)
4	Narrow Area of Interest (optional)
5	Download data
Extensions	

7.4. UC-714 “run local model”

Acronym	
	UC-714
Description	
	The actor wants to start a local model execution.
Primary actor	
	Primary or secondary user.
Stakeholder	
	SUDPLAN System
Goal	
	Results from local model run
Input	
	Login credentials. Input data, Model version and parameters.
Output	
	Local model results get stored in a location managed by the SMS.
Components	
	SMS frontend, Authentication and Authorization service, Service allowing to run local models
Preconditions	
	Availability of input data in a location managed by SMS. Optional: Availability of downscaled rainfall in a location managed by the SMS. Maybe transparent download from the Common Services Server.
Main success scenario	
1	Connect and login to the SMS.
2	Select model and model version
3	Select input data (see UC-711 “Upload pilot specific data”, historical or downscaled rainfall)
4	Define names for results (current scenario)
5	Execute local model.
Extensions	

7.5. UC-715 “calculate CSO efficiency rates”

Acronym	
	UC-715
Description	
	The actor wants to calculate the required and the actual CSO efficiency rates
Primary actor	
	Primary or secondary user.
Stakeholder	
	SUDPLAN System
Goal	
	Required and actual CSO efficiency rates for a given scenario
Input	
	Login credentials, Data selection (Location managed by SMS or on the common services server)
Output	
	The required and actual CSO efficiency rates for a given scenario get stored in a location managed by the SMS.
Components	
	Service that allows the calculation of the efficiency rates, SMS
Preconditions	
	Availability of the results of a local model execution (see UC-714) in a location managed by SMS. Availability of the downscaling results (see UC-713) in a location managed by SMS
Main success scenario	
1	Connect and login to the SMS.
2	Select model results (see UC-714) and the corresponding downscaled rainfall (see UC-713)
3	Calculate CSO efficiency rates
Extensions	

7.6. UC-716 “export data”

Acronym	
	UC-716
Description	
	The actor wants to export data from SUDPLAN into local files
Primary actor	
	Primary or secondary user.
Stakeholder	
	SUDPLAN System
Goal	
	Local files in suitable file format
Input	
	Login credentials. Data selection (Location managed by SMS or on the common services server), Wanted format. Wanted reference system
Output	
	File in the local file system
Components	
	SMS frontend, Authentication and Authorization service, Format / Reference conversion services?
Preconditions	
	The user identity and rights are previously set using the SMS user and rights management.
Main success scenario	
1	Connect and login to the SMS.
2	Open map, zoom to Linz, select AOI (Area of Interest)
3	Select data to be exported (downscaled rainfall – see UC-712, results from the local model – see UC-714 or efficiency rates – see UC-715)
4	Select suitable file format
5	Export data
Extensions	

7.7. UC-717 “Standard visualisations”

Acronym	
	UC-717
Description	
	The actor wants to visualize rainfall, local model results or CSO efficiency rates
Primary actor	
	Primary, secondary and tertiary user.
Stakeholder	
	SUDPLAN System
Goal	
	View data managed by SMS as map layer, graph or table
Input	
	Login credentials. Background map data
Output	
	Visualisation on the screen, hardcopy
Components	
	SMS frontend, Authentication and Authorization service, Already existing WMS to get background map layers
Preconditions	
	Pilot specific input data, downscaling results, local model results in a suitable format for visualization Availability of WMS for background data
Main success scenario	
1	Connect and login to the SMS.
2	Open map, zoom to Linz, select AOI (Area of Interest)
2	Select data to be visualized (input data – see UC-711, downscaled rainfall – see UC-712, results from the local model – see UC-714 or CSO efficiency rates – see UC-715)
3	Select type of visualization (screen, hardcopy)
4	Visualize
Extensions	

7.8. UC-721 Visualize geographical features of the SWMM Model

Acronym	
	UC-721
Description	
	The actor wants to visualize the geographical features and relevant parameters of the SWMM model
Primary actor	
	Primary, secondary and tertiary user.
Stakeholder	
	SUDPLAN System
Goal	
	View data managed by SMS as map layer, graph or table
Input	
	Login credentials. Background map data, SWMM model input
Output	
	Visualisation on the screen
Components	
	SMS frontend, Authentication and Authorization service, Already existing WMS to get background map layers SWMM Model component
Preconditions	
	SWMM model input Availability of WMS for background data
Main success scenario	
1	Connect and login to the SMS.
2	Open map, zoom to Linz, select AOI (Area of Interest)
3	Select SWMM model input
4	Visualize
5	Select geographical features
6	Show relevant parameters of the selected feature
Extensions	

7.9. UC-722 Export Measurement data

Acronym	
	UC-722
Description	
	The actor wants to export time-series data delivered by the sensor network or data from external sources
Primary actor	
	Primary user, Secondary user
Stakeholder	
	SUDPLAN System
Goal	
	Export time-series data delivered by the sensor network or data from external sources.
Input	
	Login credentials. Data delivered by the sensor network or data from external sources.
Output	
	Exported data
Components	
	SMS frontend, Authentication and Authorization service, Export routines
Preconditions	
	Availability of sensor network data and data from external sources in the SMS
Main success scenario	
1	Login to the SMS
2	Select measurement station in the tree
3	Select time-period and variable(s)
4	Click on export in the context-menu
5	Choose data format
6	Export
Extensions	

7.10. UC-723 Visualize Measurement data

Acronym	
	UC-723
Description	
	The actor wants to visualize data from the sensor network or external sources
Primary actor	
	Primary, secondary and tertiary user.
Stakeholder	
	SUDPLAN System
Goal	
	View data managed by SMS as time series graph
Input	
	Login credentials. Data from the sensor network or external sources
Output	
	Visualisation on the screen
Components	
	SMS frontend, Authentication and Authorization service, sensor network
Preconditions	
	Availability of sensor network data and data from external sources in the SMS
Main success scenario	
1	Connect and login to the SMS.
2	Open Tree and select measurement station
3	Select variable and period of interest
4	Visualize
Extensions	

7.11. UC-724 Event detection

Acronym	
	UC-724
Description	
	The actor wants to detect events in the data delivered by the sensor network
Primary actor	
	Primary user
Stakeholder	
	SUDPLAN System
Goal	
	Detection of overflow events in the data delivered by the sensor network
Input	
	Login credentials. Event detection data
Output	
	Event detection data
Components	
	Event detection routines
Preconditions	
	Availability of sensor network data to the event detection routines
Main success scenario	
1	Start event detection routines on the data delivered by the sensor network
2	Event detection data
Extensions	

7.12. UC-725 Visualize Event detection data

Acronym	
	UC-725
Description	
	The actor wants to visualize the data which was produced by the event detection routine
Primary actor	
	Primary, secondary and tertiary user.
Stakeholder	
	SUDPLAN System
Goal	
	View data generated from the event detection routine
Input	
	Login credentials. Event detection data
Output	
	Visualisation on the screen
Components	
	SMS frontend, Authentication and Authorization service, Event detection data
Preconditions	
	Availability of event detection data in the SMS
Main success scenario	
1	Connect and login to the SMS.
2	Select event detection dataset in the tree view.
3	Visualize
Extensions	

7.13. UC-731 Estimation of sedimentation efficiency of primary clarifiers

Acronym	
	UC-731
Description	
	The actor wants to estimate the sedimentation efficiency for the primary clarifiers at the WWTP from the event detection measurement data
Primary actor	
	Primary, secondary and tertiary user.
Stakeholder	
	SUDPLAN System
Goal	
	Provide sedimentation efficiencies for primary clarifiers for each event
Input	
	Login credentials. Event detection data
Output	
	Value for sedimentation efficiency and visualisation for each event
Components	
	SMS frontend, Authentication and Authorization service, Event detection data
Preconditions	
	Availability of event detection data in the SMS
Main success scenario	
1	Connect and login to the SMS.
2	Select event detection dataset in the tree view.
3	Calculate the sedimentation efficiencies for each CSO event of the event detection dataset
4	Visualize results
Extensions	

7.14. UC-732 Set individual sedimentation efficiencies for each CSO tank

Acronym	
	UC-732
Description	
	The actor wants to set individual sedimentation efficiencies for the modelled CSO tanks for the calculation of CSO efficiency rates
Primary actor	
	Primary, secondary and tertiary user.
Stakeholder	
	SUDPLAN System
Goal	
	Set sedimentation efficiencies for calculation of the efficiency rates
Input	
	Login credentials. Event detection data
Output	
	CSO Efficiency rates
Components	
	SMS frontend, Authentication and Authorization service, Event detection data
Preconditions	
	Availability of input data in a location managed by SMS.
Main success scenario	
1	Connect and login to the SMS.
2	Set individual sedimentation efficiency rates for each modelled CSO tank
3	Start model run
4	Visualize results
Extensions	

7.15. UC-733 Select if frequency change for the rainfall downscaling procedure

Acronym	
	UC-733
Description	
	The actor wants to select if the frequency change algorithm for rainfall downscaling provided by CS should be considered or not
Primary actor	
	Primary, secondary and tertiary user.
Stakeholder	
	SUDPLAN System
Goal	
	Downscaled rainfall time series where a future frequency change is considered or not
Input	
	Login credentials. Historical rainfall time series
Output	
	Downscaled future rainfall time series
Components	
	SMS frontend, Authentication and Authorization service, CS
Preconditions	
	Availability of event detection data in the SMS
Main success scenario	
1	Connect and login to the SMS.
2	Select existing historical rainfall time series in SMS for future downscaling
3	Select a provided climatic model approach provided by CS
4	Select the future time period for downscaling
5	Select if the frequency chance algorithm should by applied or not for downscaling
6	Start downscaling
Extensions	

8. Conclusion

During the first year of the project the main focus of the Linz pilot work was on the selection of a proper simulation model for the calculation of CSO efficiency rates. The focus of second year was on integration of the whole chain of components involved in the Linz pilot scenario and the setup of a sensor network. For the 3rd Period (2012) we have planned to add more data to the Pilot Application, to support and implement a larger number of the defined use cases and to enhance model parameterization and visualization capabilities of the software.

The primary objective of this document is to define and specify the plan for the Linz pilot site regarding the tasks and use cases supported by the developed software. All versions of this document describe the background and goals of the pilot in detail. Relations between the Linz pilot and climate change issues are explained. The usage of the Common Services is examined and the potential decisions supported by the SMS are analysed. The main pilot activities are derived from the insights won through the single steps of the pilot definition process.

The methodology developed by WP2 was followed throughout the creation of this document. In the scope of this methodology a user analysis was performed to define the user groups of the later system. In this process skills and properties of the single user groups were identified. Independent from the later system, tasks necessary to fulfil the pilot objectives were analysed and described in detail. This step has been undertaken to give all partners the possibility to understand the background and motives of the pilot. This would be rather difficult to understand only by the description of the system functionality without the system independent task definitions. Particular emphasis was laid on the use case analysis and description in the document. The use cases define the boundary of the system and the interface to the user. As a whole, the use cases draft the behaviour of the system and are essential for the design and implementation of the Scenario Management System (WP3) because the use cases represent the system functionality expected by the user.

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10. Acronyms and Abbreviations

AOI	Area of Interest
CCTV	Closed Circuit Television
COD	Chemical Oxygen Demand
CS	Common Services
CSO	Combined Sewer Overflows
DSS	Decision Support System
DTM	Digital Terrain Model
GCM	Global Climate Model
η	CSO efficiency rate
η_d	CSO efficiency rate η for dissolved pollutants
η_p	CSO efficiency rate η for particulate pollutants
η_{sed}	CSO efficiency rate η for particulate pollutants
PE	Population Equivalent
r720,1	Statistical rainfall intensity with a duration of 12 hours and return period once per year
RCM	Regional Climate Model
SPA	System Performance Assessment
SDI	The System Design Improvement
SMS	Scenario Management System
TSS	Total Suspended Solids
UC	Use Case
WP	Work Package
WWTP	Waste Water Treatment Plant

11. Annex 1: ÖWAV Regelblatt 19

The ÖWAV Regelblatt 19 distinguishes between two different kinds of CSO efficiency: one for dissolved pollutants (η_d) and one for particulate pollutants (η_p).
Thereby η is the part of the surface runoff which has to be treated at the WWTP and is expressed in percentage. Consequently the CSO efficiency can be calculated after equation 1

$$\eta = \frac{(VQ_c - VQ_d)\cdot C_C - VQ_O \cdot C_O}{(VQ_c - VQ_d)\cdot C_C}\cdot 100 = \frac{VQ_R \cdot C_C - VQ_O \cdot C_O}{VQ_R \cdot C_C}\cdot 100 \qquad [1]$$

with

η	CSO efficiency	[%]
VQ_c	Total volume of the combined sewage	[m^3/a]
VQ_d	Total volume of dry weather flow	[m^3/a]
VQ_R	Total volume of surface runoff	[m^3/a]
VQ_O	Total volume of overflow discharge	[m^3/a]
C_C	Pollutant concentration in combined sewage	[m^3/a]
C_O	Pollutant concentration in overflow discharge	[m^3/a]

The required values for η_d and η_p depend on the design basis of the WWTP in population equivalents (PE) and the statistical rainfall intensity with a duration of 12 hours and return period once per year (r720,1) for the investigated catchment. The requirements for η_d are shown in Table 3 and the requirements for η_p are shown in Table 4. Linear interpolation should be used for in-between values.

Table 3 Required CSO efficiency η_d for dissolved pollutants

	Design basis of the WWTP (PE)	
Rainfall intensity	≤ 5 000	≥ 50 000
r720,1 ≤ 30 mm / 12h	50 %	60 %
r720,1 ≥ 50 mm / 12h	40 %	50 %

Table 4 Required CSO efficiency η_p for particulate pollutants

	Design basis of the WWTP (PE)	
Rainfall intensity	≤ 5 000	≥ 50 000
r720,1 ≤ 30 mm / 12h	65 %	75 %
r720,1 ≥ 50 mm / 12h	55 %	65 %

The calculation is based on the assumption of constant pollutant concentration in time and along the sewer system. Furthermore a perfect mixture of wastewater and stormwater is assumed for the calculation of η_d. Hence the concentrations C_C and C_O from equation 1 are the same and η_d can be calculated as

$$\eta_d = \frac{VQ_R - VQ_o}{VQ_R}\cdot 100 \qquad [2]$$

For the calculation of η_d the removal of sediments is expressed by a mean sedimentation efficiency η_{sed} which can be calculated after

$$\eta_{sed} = \frac{C_{C,CSO} - C_O}{C_{C,CSO}} \qquad [3]$$

Consequently η_p is calculated from η_d, VQ_O and η_{sed} for each CSO j after

$$\eta_p = \eta_d + \frac{\sum_j VQ_{o,j} \cdot \eta_{sed,j}}{VQ_R} \qquad [4]$$

As η_{sed} is difficult to determine the ÖWAV-Regelblatt 19 (2007) presents typical values for sedimentation efficiency depending on the specific volume and type of the CSO structure (see Table 5).

Table 5 Sedimentation efficiency after ÖWAV-Regelblatt 19 (2007)

Hydrodynamic separator	Basin	In-pipe storage with overflow downstream	η [%]
	Specific volume [m³/ha]		
0	0	0	0
3	5	10	20
7	10	20	35
>10	>15	>30	50

Due to the lack of knowledge of the actual sedimentation efficiency of pollutants in CSO structures LINZ AG is interesting in monitoring its primary clarifiers and the downstream CSO - these structures work similar to a CSO tank - within the SUDPLAN project. The aim is to quantify the TSS and COD retention efficiency of the tanks under different rainwater flood regimes.

With an innovative combination of data from traditional and new sensors - such as UV/VIS (ultraviolet/visible) spectrometers - pollution levels and loads will be measured in the inflow to the primary clarifiers and in the spilled overflow after the clarifiers where the maximum hydraulic load is adjusted for the further biological treatment. (for details on the sensor network see also section 4.3.2) The knowledge about the sedimentation efficiency of the primary clarifier is of crucial importance to reach the required CSO efficiency η_p according to the ÖWAV Regelblatt 19 (2007) as well as to assess the potential environmental and economic damage due to increased precipitation under a climatic change scenario and to plan ahead for adaptation strategies. Such measures might include for example increased storage capacities, new floodwater management systems and regulations.

Based on the measurements the inflow and outflow loads for TSS and COD can be determined according to equations 5 and 6

$$B_{\text{poll, inflow}} = \sum_T C_{\text{poll, inflow}} \cdot Q_{\text{inflow}} \qquad [5]$$

$$B_{\text{poll, outflow}} = \sum_{T} C_{\text{poll, ouflow}} \cdot Q_{\text{outflow}} \qquad [6]$$

with

B_{poll}	Pollutant load	(MT^{-1})
C_{poll}	Pollutant concentration	(ML^{-3})
Q	discharge	(L^3T^{-1})
T	time	(T)

Besides the two continuously measurable pollutant loads of the equations [5] and [6] the primary sludge removal $B_{\text{poll, primary sludge removal}}$ from the primary clarifier has also to be taken into account. These removed loads could be estimated by the continuously removed volume of primary sludge and the corresponding TSS concentration.
Finally the sedimentation efficiency η_{sed} can then be determined by equation 7

$$\eta_{\text{sed}} = \frac{B_{\text{poll, inflow}} - B_{\text{poll, outflow}} - B_{\text{poll, primary sludge removal}}}{B_{\text{poll, inflow}}} \qquad [7]$$

The calculation of the CSO efficiency η should be done as an average over a long-time period of at least 10 years. Hence this requires long-term simulation by either hydrological or hydrodynamic rainfall-runoff transport models. Temporal resolution of rainfall data should be 5 minutes or higher.

Taking into account the complexity of hydrodynamic calculations, computation time can reach extreme amounts of several weeks for a given system. In contrast, a hydrological model of the same sewer system is calculated in some minutes (De Toffol et al., 2006). This can be explained by (i) the solution of the underlying equations and (ii) the level of modelled detail of the sewer system that is in general reduced in hydrological models. Therefore, the use of a hydrological model is reasonable choice for determining the CSO efficiency, if it can be set up in comparatively short time and can be calibrated accurately.

For the Linz pilot catchment area two aggregated models were available: a hydrological model was set up with the software City Drain © (Achleitner et al., 2006) and a hydrodynamic model in the software SWMM 5 (Rossmann, 2007). Both models contain all existing CSO structures. SWMM 5 was chosen as modelling platform in the SUDPLAN project as (i) test runs showed that the SWMM 5 model was slightly faster in terms of computational speed and (ii) SWMM 5 is platform independent and open source.

Apart from that emission based requirements in ÖWAV-Regelblatt 19 (2007) also criteria for the ambient water quality are defined, which comprehend six kinds of impacts:

- Hydraulic impact
- Acute ammonia toxicity
- Oxygen concentration
- Solids
- Hygienic impact
- Aesthetics

While the calculation of η is based on the modelling results and should be done as an average over a long-time period of at least 10 years with a temporal resolution of rainfall data of 5 minutes or higher the risk for the ambient water quality has to be assessed by single rainfall event analysis taking into account the actual immission based situation in the receiving water and the spilled out loads at each CSO structure driven by heavy thunderstorms.

Further description of the requirements of ÖWAV-Regelblatt 19 (2007) is available from De Toffol (2009), who also compares legislation and technical guidelines of 17 different countries.

12. Annex 2: UV-VIS Probe

Compared to the other methods one major advantage of UV/VIS spectrometry is that a spectrum with a wide range of wavelengths is recorded allowing to deduce concentrations of several waste water compounds with one probe at the same time. In addition, compared to e.g. turbidity, absorption at several wavelengths can be used to deduce the concentration for one target parameter.

The probe installed in the SUDPLAN sensor network is a *spectro::lyser* from the company *s::can*. A schematic design of the probe is shown in **Fel! Hittar inte referenskälla.**. It measures the light attenuation (absorption and scattering) in the ultra-violet and visible range between 200 nm and 750 nm. A reference beam compensates effects from aging of the lamp and the detector. The width of the measurement window is 5 mm. A typical absorption spectrum is shown in **Fel! Hittar inte referenskälla.**.

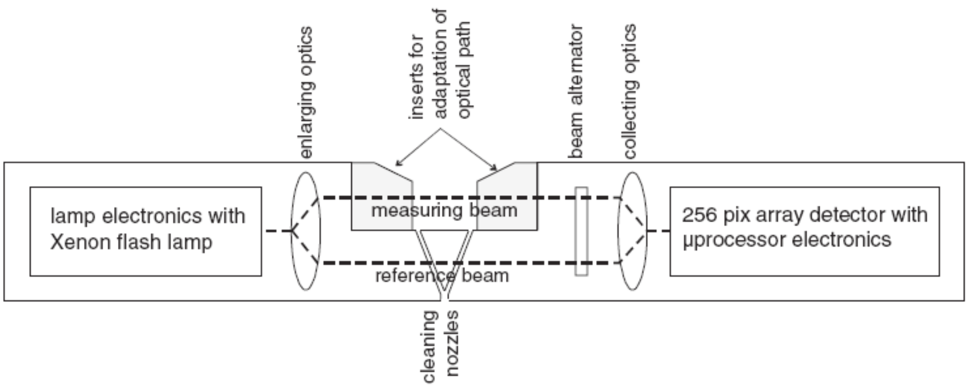

Figure 5: Schematic design of UV-VIS probe (Langergraber et al., 2003)

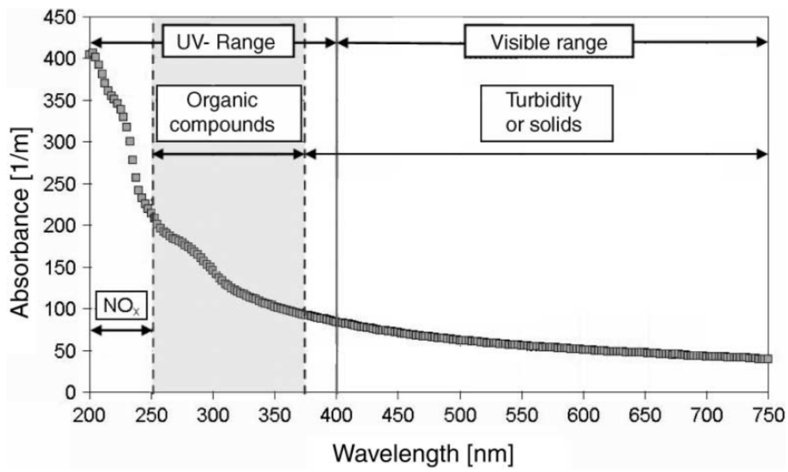

Figure 6: Absorption spectrum and ranges for parameters (Hochedlinger et al. 2006)

Based on the measured attenuation in different wavelength ranges, so-called equivalent concentrations can be calculated for: i) organic matter, as chemical oxygen demand (COD_{eq}) and total organic carbon (TOC_{eq}), ii) total suspended solids (TSS_{eq}) and iii) nitrate ($NO_{3,eq}$). The target parameter concentration is calculated by equation 8.

$$C_{eq} = \sum_{i=1}^{n} w_i \cdot A_i + K \qquad [8]$$

with

C_{eq}	equivalent concentration	(mg/L)
w_i	factor for wavelength *i*,	
A_i	measured absorption for wavelength *i*	(1/m)
K	offset	

The probe measures at a temporal resolution of one minute. This makes the probe especially apt to understand the dynamics of pollutants in the investigated system and assess phenomena linked to pollution transport. Effectively this is only possible with high resolution measurements.

A comprehensive overview of measurement programs in Europe using UV/VIS spectrometry including a synopsis of the results and experiences is given in Hochedlinger (2005), and Rouault (2009).