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Summarized survey

OF THE EXISTING EQUIPMENT IN DUPNITSA MUNICIPALITY - BULGARIA AND TRGOVISTE MUNICIPALITY - SERBIA. MEASURES FOR SUSTAINABLE DRAINAGE SYSTEM

STRATEGIC PLAN FOR DEVELOPMENT OF SUSTAINABLE SYSTEMS FOR URBAN DRAINAGE OF DUPNITSA MUNICIPALITY AND TARGOVISHTE MUNICIPALITY

Project CB007.2.32.142 Preservation and restoration of CBC ecosystems through improvement of the quality of river waters and soils

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1. Municipality of Dupnitsa

1.1. Infrastructure risks

- All hydropower systems in the country are designed, built and operated as complex hydrotechnical facilities that meet the non-energy needs of all water users and water users (irrigation, drinking, domestic and industrial water supply, recreation, fish farming) according to the capacity of each system.
- The comparison of the projected water consumption (excluding hydropower and NPP) for The period of the Strategy with the total flooded volume of the dams shows that in Bulgaria there are enough dams built. Identified needs for several small region of the country can be covered by the construction of several new dams, for 3 of which have been signed a financing agreement with the World Bank, and others are with construction started but stopped due to financial reasons.
- The predominant part of the existing water supply assets (water intake facilities, water supply network, pumps, hydrophores, water meters, etc.) have been introduced in operation before 1980 and are made of materials (predominantly asbestos cement and steel pipes) whose expiration date has expired.
- In much of the water supply network the level of corrosion or accumulation of deposits is significant, which poses risks to water quality.
- The identified water losses are extremely large and are mainly due to physical leaks - both visible and hidden, both from the water supply network, as well as on cranes, connections and in various shafts. Large volumes of water are also lost for emptying and filling the water supply network in case of accidents due to the fact that it is poorly constructed and / or oversized, and the limit valves between the hydraulic zones do not work well enough.
- A serious problem is the presence of uneven hydraulic pressure (high or low) in separate areas of the water supply network. Causes of high blood pressure are: large displacement between the tanks and the supply area; direct connections (water supply) to high-pressure transit pipelines; lack of pressure reducing regulators; oversized pumping stations, hydrophores and respectively the water supply network. Low pressure is obtained due to smaller diameters or oversized grids feeding a lot consumers, leading to large pressure losses, especially in suburban villa areas; construction near the tanks, where due to lack of displacement cannot provide the required static pressure; numerous leaks on water supply network.
- All DWTPs built and in operation (46% of the population are connected to DWTPs) are obsolete equipment and urgently need reconstruction and modernization (especially of the filter housings) and introduction of automated control for the residue of the supplied reagents (chlorine and aluminum) in the purified drinking water.
- The predominant number of surface water sources used for drinking and domestic water supply are without water treatment facilities, according to its category, in accordance with the requirements of Ordinance № 12 for the quality requirements for surface waters intended for drinking and domestic use water supply. There are no treatment facilities for underground water sources, where there are deviations in certain indicators (manganese, iron, chromium, etc.).
- No new water sources are being built and there are no water connections between different water supply areas to enable the supply of water. drinking water that meets the requirements in areas where there are deviations in water quality and the problem cannot be solved in any other way.
- The percentage of construction of the sewerage network is low (60.56%) it has expired depreciation and a high rate of infiltration of foreign waters (leaks from water losses, groundwater and drainage water). This fact has been established in all pre - investment studies and in the prepared Master Plans of big cities.
- Almost everywhere in the country the sewerage system is of a mixed type, which too leads to problems, especially in heavy rainfall.
- The level of construction of the WWTP is low. Almost all built and put into operation of WWTPs at the end of the last century need reconstruction and modernization of both the mechanical and biological stage, as well as the sludge

stage. economy. In most stations there is a need to update the structural, mechanical, electrical elements and automatic control systems for processes.

- In many cases there is a lack of correspondence between the degree of construction of the sewerage network and the conductivity of the main collectors and the capacity and construction of WWTP.
- The information security regarding the status, events and monitoring is too low for the preparation of complete analyzes of the assets in the water sector (water quantities, length and pressure in the network, infiltration in sewerage and many other data needed for analysis, design, construction and operation).
- Most of the hydro-ameliorative facilities are old and depreciated, as the latter were built in the early 1990s, and most of them - in the 60s and 70s, but there are systems from the 50s of last century, which is why they cannot do their job normally. The reasons for this are:
  - ❖ the low heights of the dikes, which do not correspond to the changing profile
  - ○ of river beds - the presence of torn dikes due to formed high waves of intense snowmelt and precipitation and poorly cleaned rivers troughs;
  - ❖ uncontrolled and unregulated seizure of aggregates at
  - ○ corrections of rivers, causing a change in the levels of the bottom of rivers; demolition of bottom thresholds, built dams at water catchments; berms, locks and safety dikes, longitudinal and transverse shore protection facilities; undermining the foundations of bridges from the national road network and others.

➢ The capacity of hydropower systems meets the complex needs of water users and water users (irrigation, drinking and industrial water supply, recreation, fish farming), as well as energy. The big ones hydropower facilities are maintained in very good condition.

➢ The comparison of the projected water consumption (excluding hydropower and NPP) for the period of the Strategy with the total flooded volume of the dams shows that Bulgaria is high coverage of constructed dams. Identified needs for several small areas of the country can be solved by building several new dams or upgrading of existing.

➢ The predominant part of the operating water supply assets (water abstraction equipment, water supply network, pumps, hydrophores, water meters, etc.) have been introduced in operation before 1980 and are made of materials (predominantly asbestos cement and steel pipes) whose expiry date has expired.

➢ In much of the water supply network the level of corrosion or accumulation of deposits is significant, which poses risks to water quality.

➢ The identified water losses are extremely large and are mainly due to physical leaks - both visible and hidden, both from the water supply network and on cranes, connections, tanks and in various shafts. Large volumes of water are also lost for emptying and filling the water supply network in case of accidents due to the fact that it is poorly constructed and / or oversized, and the boundary cranes between hydraulic zones do not work well enough.

➢ A serious problem is the presence of uneven hydraulic pressure (high or low) in separate areas of the water supply network. Causes of high blood pressure are large displacement between the tanks and the supply area; direct connections (water supply) to high-pressure transit pipelines; lack of pressure reducing regulators; oversized pumping stations, hydrophores and respectively the water supply network. Low pressure results from more small diameters or oversized grids feeding many users, leading to to large pressure losses, especially in suburban villa areas; construction in proximity to tanks, where due to lack of displacement can not be provided the required static pressure; numerous leaks in the water supply network.

➢ Almost all DWTPs built and in operation (46% of the population are connected to DWTPs) have obsolete equipment and urgently need reconstruction and modernization (especially of the filter housings) and introduction of automated control for residue of the supplied reagents (chlorine and aluminum) in the purified ones drinking water.

➢ The percentage of construction of the sewerage network is relatively low (61%).

➢ The network depreciation period has expired and there is a high infiltration rate foreign waters (leaks from water losses, groundwater and drainage water). These facts have been established in all pre-investment studies and already prepared General plans of the big cities.

➢ Almost everywhere in the country the sewerage system is of mixed type, which also leads to problems, especially in heavy rainfall.

➢ The level of construction of the WWTP is relatively low. Almost all built and put into operation WWTPs at the end of last century need reconstruction and modernization.

- In many cases there is a lack of correspondence between the degree of construction of the sewerage network and the conductivity of the main collectors with the capacity and the construction of the WWTP.
- Most of the hydro-ameliorative facilities are old and depreciated, as the latter were built in the early 1990s, most in the 1960s and 1970s years, but there are systems from the 50s of last century, so they can not perform their work normally.
- The usability of the capacity of the hydro-ameliorative systems for the last ten years is below 10%, which is due to the drastic reduction of sown irrigation cultures and change their structure.
- No maintenance operators have been designated for some of the facilities in the water sector, but some also have unidentified property.
- Many of the facilities for protection against the harmful effects of water need repair and prevention.
- The information security regarding the condition (both in quantitative, both in qualitative terms), events and monitoring is too low for the preparation of full analyzes of the infrastructure in the water sector and for taking relevant ones management decisions. The available information is scattered in a large number of institutions and commercial companies, in many cases unsystematized.
- Estimates of the funds needed for investments in water management infrastructure, show amounts in the order of over BGN 12 billion to cover minimum needs of over BGN 43 billion to bring it closer to European standards.

1.2. Risks to the general state of the environment

The quality of the components of the environment in the municipality of Dupnitsa is good, if we summarize the conclusions and data from the annual reports on the state of the environment, prepared by the Regional Inspectorate of Environment and Water - Pernik. This is a summary that takes into account the lack of a system of stationary points and long time intervals in monitoring the quality of ambient air in the municipality, the annual base for monitoring water quality, and the only point for monitoring the quality of soils in the village of Yahinovo, which does not monitor soil salinity indicators. The Regional Inspectorate for Environment and Water does not perform measurements and monitoring for potential radiation pollution. Industry and road transport are a factor which leads to episodic exceedances of the PM10 pollutant in some of the months and for hydrogen sulfide (H2S) for the months of August to November in the ambient air. Seasonal air pollution with dust, soot and gases due to the use of fossil fuels in the city and large villages is observed. The territory of Dupnitsa municipality has significant anthropogenic pressure. The soils in the area have good ecological indicators. There are no productions in the Municipality of Dupnitsa that pollute the soils with heavy metals (lead, copper, zinc, arsenic, cadmium, nickel, chromium) and oil products. The main sources of water pollution on the territory of the municipality are the settlements without built sewerage or discharging their sewerage into the rivers and pollution with household waste.

Environmental protection in Dupnitsa municipality is a key priority for all local stakeholders. Environmental experts point out as key problems in the sector the lack of sufficient financial resources for activities in this area, the need to attract young local staff, insufficient infrastructure related to the protection of environmental components - treatment plants, modern installations. for storage, treatment and processing of non-hazardous waste, as well as the emphasized weak public culture in this area. Logically, the priorities in the socio-economic development of the community of this stakeholder are related to the protection of the environment and the improvement of the water supply and sewerage infrastructure.

Indisputable local wealth are forests and waters - all actions related to their protection, but also sustainable use in support of local development must be supported.

Addressing the issue with wastewater treatment, water management program, protection and support for biodiversity in the municipality, reduction of noise pollution and air pollution. These are the priorities in environmental protection. The main risk for the territory of the municipality are the floods - in this sense, the experts offer regular cleaning and maintenance of the riverbeds and afforestation of the deforested terrains, especially the steep slopes. The production facilities of Actavis AD are also perceived as a source of risks for the population of the municipality. Potential areas of common interest with other municipalities and regions are the construction of installations for disposal, processing and treatment of non-hazardous waste, treatment plants, water control and management systems in the Struma River basin,

1.3. Risks of natural disasters

1.4. Flood risk:According to the Flood Risk Management Plan of the West Aegean Basin Management Region, adopted by Decision

№ 1105 / 29.12.2016, on the territory of Dupnitsa Municipality there are two regions with significant and potential flood risk (APSFR):

- **BG4_APSFR_ST_06** - Struma River and tributaries near the village of Nevestino, the valley of the Struma River, water body: BG4ST700R021. The degree of risk is high.

The section is located in the upper reaches of the Struma River. It covers the main course of the river and parts of the left and right tributaries of the Struma in this area, as well as the village of Nevestino. The main reason for its designation as an APSFR is the likelihood of affecting "Kadin Bridge", which has been declared an architectural monument of national importance. The PURN proposes a measure for the construction of barriers by filling a large rock and earth mass on the left bank of the Struma River before and after Kadin Bridge. The Municipality of Nevestino has an investment proposal, providing for rehabilitation and conservation of "Kadin Bridge" by cleaning and restoring the bridge in its almost original form.

- **BG4_APSFR_ST_07** - German river and tributaries from the town of Dupnitsa to the village of Yahinovo. The risk of floods is from water bodies: BG4ST600R032, BG4ST600R034, BG4ST600R035, BG4ST600R036. The degree of risk is high. The section covers the middle course of the German River and the lower parts of the left and right tributaries of the river in this area, as well as the town of Dupnitsa. Due to heavy rainfall and rising water levels of the German River, in 2010 a state of emergency was declared in the municipality of Dupnitsa. Critical points of the international transport network are affected. The RMP provides for measures for prevention and protection against floods, such as cleaning and management of river beds within the urban area and upgrading of dikes. The valley of the German river and its tributaries in the regions of the town of Dupnitsa, the village of Yahinovo and the village of Samoranovo are identified as one of the areas with significant potential flood risk in the Struma River basin. This is done with Order RD-05-91 from 15.08.2013. of the Director of the Basin Directorate "West Aegean Region" for determining the areas with significant potential risk of floods in the West Aegean region for basin management and Order RD-746 of 01.10.2013. of the Minister of Environment and Water for approval of the areas with significant risk of floods in the West Aegean region for basin management.

1.5. Risk of landslides

On the territory of Dupnitsa municipality there are a total of 5 active landslides, 4 pcs. stabilized landslides and 5 pcs. potential landslides

Two of the active landslides are above the Struma Motorway, on a mountain slope or on an artificial slope to the highway.

Active landslide KNL 48.24791-01 is on the land of the village of Dyakovo, mach. "Buchalata", on a mountain slope above the third class road III-6232 - Dyakovo - Kremenik.

Active landslide KNL 48.80491-01 is on a mountain slope in the northern part of the village of Cherven Bryag.

Active landslide KNL 48.55230-01 is on a mountain slope in the northeastern part of the village of Palatovo.

Three of the potential landslides are located on a mountain slope above the Struma Motorway.

Potential landslides KNL 48.02350-01 and KNL 48.02350-02 are on a mountain slope in the land of the village of Balanovo, next to the route of a transit gas pipeline to Greece.

1.6. Risk of drought

A study on the spatial distribution of the soil drought in Bulgaria (V. Alexandrov, Sofia, 2006) of the annual precipitation amounts defines as arid the municipalities along the Struma, including the municipality of Dupnitsa. The amount of winter precipitation defines the municipality of Dupnitsa as an area with a potential risk of atmospheric drought this season. In general, the risk of atmospheric drought in the municipality is defined as low. Based on the FAO classification of soils, in case of water deficit, the municipality of Dupnitsa is among the municipalities with a significant risk of soil drought. It is also among the municipalities in Bulgaria, with potential conditions (in case of water deficit) for drought indthe arable layer (0-25 cm) of deep soils at a stable transition above 10 degrees Celsius, in the one-meter layer of deep soils during the eruption of wheat, the sweeping of corn and the waxy maturity of wheat. In general, the risk of soil and atmospheric drought in the municipality of Dupnitsa is defined as low to

medium. With average summer precipitation in the modern climate of 177 mm, the respective percentages of reduction in a realistic and pessimistic scenario for 2038 are 22.60% and 40.68%. The territory of the municipality falls into the critical zones for atmospheric and soil drought as a result of climate change, which requires theadoption of measures related to monitoring of phenomena and those that limit and mitigate the impact of processes on agriculture and water supply. and manufacturing plants,

1.7. Risks from legislation and sources of funding for environmental protection

Although the legislation related to sustainable land management is largely in place and Bulgarian legislation offers a wide range of legal mechanisms for land protection and management, there is still no clearly regulated relationship between the objectives and specific provisions of these laws. One of the main weaknesses observed in this regard is related to the insufficient regulation of the requirements for prevention and control, as well as for the early warning systems. Another deficit observed in the existing legislation is related to the lack of adequate preventive measures for lands that are not affected by degradation processes or have undergone insignificant degradation. In our country the application of norms is about to start, harmonized with those of the EU in the field of requirements for early prevention and monitoring of desertification processes. In the Bulgarian legislation, with the exception of the Regional Development Act, there is no legal obligation for certain bodies to carry out the activities for management, organization and coordination of all issues of sustainable management of land resources of national importance. With our accession to the EU, the application of norms harmonized with those of the EU in the field of requirements for early prevention and monitoring of desertification processes has begun. Most drainage systems are completely depreciated or in need of there is no legal obligation for certain bodies to carry out the activities for management, organization and coordination of all issues of sustainable management of land resources of national importance. With our accession to the EU, the application of norms harmonized with those of the EU in the field of requirements for early prevention and monitoring of desertification processes has begun. 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The main problem in the implementation of the program budget is the lack of financial experts responsible for each policy in the line directorates, in order to ensure quality planning and subsequent implementation of the budget. The collection of the receivables of the water supply and sewerage operators is pointed out as an obstacle in their activity; the introduction of fast-track proceedings or the application of a simplified procedure for the recovery of receivables is a possible legislative measure. The legislation does not allow the allocation of budget funds to commercial companies for maintenance and construction of hydro-ameliorative sites, nor subsidizing the service "water supply for irrigation", as this is a form of unregulated state aid for these companies. The issue of depreciation and deductions from the operation of hydropower infrastructure is to be resolved. There is no regulation of prices taking into account the "water" factor. Support is needed for the hydrological cycle and participation in the financing of water and water body protection. The main issues of financing the hydromelioration system are unresolved. The financing of the hydro-ameliorative fund and the maintenance of the facilities should be supported with funds from the state budget and the EU funds due to the nature of the public state property. The reimbursement of a large part of the costs for the provided hydromelioration services can be solved by introducing hydromelioration fees and paying regulated prices for irrigation and drainage services. Support is needed for the hydrological cycle and participation in the financing of water and water body protection. The main issues of financing the hydromelioration system are unresolved. The financing of the hydro-ameliorative fund and the maintenance of the facilities should be supported with funds from the state budget and the EU funds due to the nature of the public state property. 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2. Targovishte Municipality

2.1. Risks from infrastructure and the general state of the environment

Insufficiently developed environmental infrastructure leads to excessive air, water and soil pollution. There are no facilities for management of household and hazardous waste, for treatment of domestic and domestic wastewater, as well as technological procedures and devices for reducing air pollution in the industrial and energy sector. Targovishte Municipality does not boast a developed modern infrastructure. The state roads of the first order do not pass through the territory of Targovishte municipality. The main road is the route of the state road of the second row № 125, which passes through the center of the village Targovishte. The length of the categorized road network is 451 km, of which 87 km are state roads II and 364 km municipal roads. The entire network of municipal roads, except for only 2 km, consists of dirt roads. The water supply in the municipality is not at an enviable level. About 30% of households have safe access to adequate drinking water. The largest water supply system is built in the municipal center of Targovishte, which is for drinking needs, supplied by groundwater sources, but is not reliable. The water supply network is in very poor condition, which leads to large losses of drinking water. Centers for the supply of other types of drinking water rely mainly on smaller local springs, groundwater, separate wells, fountains and reservoirs that act by gravity, and water companies distribute water to consumers. These local water mains are not under the jurisdiction of the local JKP Komunalac and the quality of this water is not monitored. Of the total number of households (2133 according to the 2002 census), only 640 households are connected to the sewerage network in the administrative center of Targovishte. The other settlements in the municipality do not have sewerage systems. There is not even a wastewater treatment plant in the municipality, only design and technical documentation has been prepared. Power supply is provided for all settlements, but there are frequent power outages due to damage and overloads, so it is necessary to reconstruct the low-voltage network and increase the installed capacity. For the Republic of Serbia, the share of households connected to the public sewerage network in 2002 was 33%, and in 2008 it was 35.03%. It is estimated that only 13% of all domestic wastewater is treated. The percentage of households connected to the sewerage network, which have an appropriate system for treatment of domestic wastewater in 2002 was 5.3%, and in 2008 was 4.8%. Only 28 cities in the Republic of Serbia have a wastewater treatment plant, while in 2006 only 5 were in operation. The country's largest cities, Belgrade, Novi Sad and Nis, do not have a common treatment plant. Some of the existing treatment plants are neglected, many of them provide only primary (mechanical) treatment and most do not work continuously. Currently, 152 industrial sites have wastewater treatment, of which 20 are large industries. However, a very small number of industrial treatment plants (13%) operate efficiently. The percentage of households connected to the public water supply network in 2002 was 69%, and in 2008 it was 78.31%. Although the water supply coverage is very high, many of these systems do not function properly, leading to large physical water losses and low, inadequate service levels. The average network loss in the Republic of Serbia is 28.4%. The share of households covered by organized collection of household waste in 2006 was 55%, and in 2008 it was 60%. The collection of household waste is organized by public utility companies in the cities, while the collection in rural areas does not exist. The equipment of the utility companies is insufficient, outdated and inadequately maintained. Containers intended only for household waste are also used for certain types of hazardous waste (medical waste, fluorescent lamps, used batteries, oils, paints and solvents, etc.). In rural areas, waste is dumped in illegal landfills or incinerated, which endangers the environment. Existing landfills usually do not meet the prescribed requirements of national legislation. Numerous places are located on the banks of rivers and often in areas where the possibility of groundwater pollution is high. Landfills with the highest risk to the environment and

human health are those located at a distance of less than 100 m from settlements (12 landfills) or less than 50 m from the banks of rivers, streams, lakes or reservoirs (25 depots, out of 14 depots are located on the very bank of the watercourse). There are large amounts of ash (about 5.5 million tons per year) generated by burning coal to operate thermal power plants. The ash deposited in existing landfills endangers the environment. There are no facilities for treatment and disposal of hazardous waste, which leads to a constant increase in improperly stored hazardous waste in industrial sites. Very few companies have temporary storage facilities equipped to prevent the spread of toxic components or their spillage into soil or groundwater. There is no EU-compliant animal waste management system.

2.2. Risk of floods and erosive processes

Regarding the threat to the environment from the consequences of natural disasters and accidents, the main danger is the appearance of high waters on the rivers Pchinya, Tripushnitsa and Kozhedolska rivers, ie. flooding of the surrounding agricultural and built-up areas (usually during the spring months). Numerous smaller water bodies overflow during the flood period, but also threaten erosion processes. It is estimated that about 70% of the municipality is attacked by erosion processes - excessive, strong and moderate (especially in the areas of settlements in the valleys of Pchinya, Trypushnitsa and Kozhedolska and in areas along the state border with the Republic of Macedonia). According to the available data, the Pcinja River Basin is the most endangered area of the Republic of Serbia in terms of the intensity of erosion processes (20% of the basin is under excessive erosion), which is largely a consequence of uncontrolled logging and deforestation. In recent years, Serbia and Macedonia have been threatened by floods caused by small currents, ie. torrential floods, and this is directly related to the intensity of the erosion process. Villages, roads, industry, agricultural areas, tourist centers are endangered. It should be emphasized that in Serbia, according to the torrential flood cadastre prepared in the 1950s and 1960s, there are more than 12,500 registered torrential watercourses (excluding Vojvodina). This means that virtually all of Serbia south of the Sava and Danube (the mountainous part of Serbia) is threatened. However, it should be noted that the most vulnerable areas are in the border area: the gorges and gorges of Grdelica Vranska, the basin of the Binachke Morava River in Kosovo and Metohija. In Macedonia, most of the rivers are floodplains and this also applies to the Pcinja catchment area. Until the seventies of the twentieth century, floods threatened the settlements in the entire catchment area of Pchinya, especially in the catchments of the Kumanovska and Kriva rivers. In parallel with the construction of the hydraulic systems, the regulation of the currents is applied and in this way most of the currents are regulated. However, today there are also torrential floods, but they are much rarer. Potential flood zones in the Pchinya River Basin cover an area of 184.41 km2, or 6.41% of its total area, and in recent decades, the largest flood in the Pchinya River catchment area occurred on 19 and 20 November 1979. ., when the peak flow is 350 m3 \ sec. On this date, an increased transport of retained sludge through the river profile Katlanovo was registered, by 2800 kg \ sec. The situation is similar with the frequent floods of the Kumanovo River, which until recently threatened the lower parts of Kumanovo around the river. Anthropogenic factors have an indirect impact by reducing the discharge capacity of riverbeds and canals, and reducing the wet profile and faster flooding.

2.3. Risk of drought

In addition to hail, drought is an atmospheric hazard with the greatest consequences in Serbia and Macedonia. The main problem is the creation of criteria for determining the natural hazards caused by drought. Drought monitoring pays special attention to drought indices, using a number of humidity indicators: standardized precipitation index for the period from 1 to 24 months, which for operational purposes can be calculated daily, productive moisture reserves in the water balance calculations of soil, Palmer Z index, Palmer land weight index, etc. from the main indicators and parameters (annual rainfall, precipitation regime, analysis of temperature and humidity during the growing season, lack of water in the soil) to determine the duration and intensity of droughts. The longest absolute duration of the drought is observed in Vranje and lasts 61 days. This extreme drought began on June 22 and ended on August 21, 1928. In Macedonia, droughts are more noticeable. Typically, in recent decades, the frequency and duration of droughts have been longer, due to the effect of global warming.

2.4. Risks related to legislation and financing of environmental protection

Legislation related to the monitoring of soil condition and the limit value of soil pollutants is not sufficiently developed in the Republic of Serbia. The concept of cleaner production, which is a proactive approach to saving raw materials, water and energy, replacing high-risk chemicals where the risk is not adequately controlled with their

lower-risk alternatives, and reducing waste and emissions into water and air is not widely used in industry. Industries have not implemented an environmental management system, the concept of best available techniques has not been applied as a basis for obtaining an integrated permit. Land monitoring as a systematic and permanent activity is not organized on the entire territory of the Republic of Serbia. The monitoring of water quality in the Republic of Serbia is within the competence of the Republican Hydrometeorological Institute, which is carried out in accordance with the Program for Systematic Control of Water Quality, adopted by the government for a period of one year. The core network of stations formed in the late 1960s has expanded over time, both in terms of the number and location of measurement points and in terms of the frequency of sampling and the number of parameters analyzed. In the Republic of Serbia, there is a legal obligation to systematically monitor wastewater discharges, which has not been fully implemented in practice. The number of measured parameters is minimal and without hydrological measurements. Pollutants are required to measure the amount of wastewater discharged, but often do not. Monitoring compliance with wastewater regulations is not possible due to the lack of wastewater standards. Biodiversity monitoring is inadequate. Apart from the cumulative area of protected areas, other data on biological diversity, monitoring of protective effects and population dynamics in both protected and other areas are not available or are incomplete. At the national level, there is no state monitoring of protected species, except for traffic reporting. A new list of strictly protected and protected species is being prepared. Waste monitoring was launched in 2005 as part of the activities of the Environmental Protection Agency to establish an information subsystem for waste management based on the Rules for the methodology for developing an integrated cadastre of pollutants. The Waste Management Act gives the Environmental Protection Agency new powers related to the collection of data on the management of all types of waste, in the first place, industrial waste, packaging and packaging waste, special waste streams, etc. In the Republic of Serbia, there is no systematic monitoring of trade and use of chemicals and the implementation of risk mitigation measures, as well as adequate determination of whether it is necessary to introduce risk mitigation measures. There is no chemical information system to be used for the chemical management system as well as for inspections. Also, a significant problem is that no conditions have been created for laboratories in Serbia to be certified to operate in accordance with the principles of. The Environmental Protection Agency has the obligation to establish an Integrated Cadastre of Pollutants in accordance with the Law on Ministries and the Law on Environmental Protection. In September 2007, with the adoption of the Regulations on the Methodology for the Development of an Integrated Pollutant Cadastre, this register was established, harmonized with the PRTR Protocol of the Aarhus Convention and the E-PRTR Directive. In 2009 the information system of the Integrated Pollutant Cadastre was completed. In addition to the National Register of Pollution Sources, local registers of pollution sources are being prepared, which will be established with the adoption of the Ordinance. Within the framework of the Environmental Protection Agency, activities related to the establishment of an integrated environmental information system are carried out. This applies primarily to the adoption of the necessary by-laws, as well as to the implementation of a number of projects that have the common goal of forming a network of institutions involved in monitoring environmental aspects. The system for financing environmental protection in the Republic of Serbia is decentralized and relies on earmarked funds, own revenues and budget funds. Other sources of funding include municipal budgets, industry funding, public utility (PUC) funding, and foreign financial assistance. A common feature of the environmental financing system is the lack of earmarked funds and decentralized sources of financing, especially from the private sector, as well as the lack of financial instruments such as long-term loans, securities, public-private partnerships or capital investments. Limited revenues collected from pollution charges are not usually spent on reducing pollution. The weaknesses of the environmental financing system stem from the limited coverage of the application of resource charges, the high dependence on the national budget, the incomplete harmonization of the legal framework with EU legislation and the limited application of incentive instruments. The economic situation and the weaknesses in the existing financial system lead to a long-standing insufficient amount of funds intended for environmental protection. Local government invests in environmental protection on the basis of annual financial plans and local environmental action plans. The investments are financed on an annual basis depending on the availability of financial resources in the budget of the local self-government unit. Loans are rarely taken due to the lack of targeted available funds, due to high interest rates on trade loans and administrative bans. The financial resources of public utilities (PUCs) dedicated to environmental protection cover neither operating costs nor maintenance costs. The infrastructure is in very poor condition. PUC revenues come from service pricing. Price levels in the PUC are different and are significantly lower than the prices paid by economic operators. The level of

fees that are not yet on the market is approved by the municipal assembly. Therefore, utilities are allocated funds for investments from the regular municipal budget or special budget lines for environmental protection, as well as from the national budget. This significantly limits the ability of PUCs to manage their business and minimize costs. PUCs are still state-owned and their operations are managed by municipalities. PUC privatization, public-private partnership agreements or concession agreements have not been implemented. The economy's investment in pollution reduction and cleaner technologies is insufficient. Companies are not obliged to report investments to government agencies, which is why there is a lack of adequate data on the types of investments of the economy in environmental protection. Lack of incentives for industry and energy to reduce pollution (fines and charges are very low and enforcement is low), the existing high level of taxation and the poor financial condition of many companies make it difficult to increase investment in environmental protection. Serbia has not yet implemented the instrument of compensation for environmental damage and the obligation to insure facilities or activities that pose a high degree of danger to human health and the environment in the event of damage caused to third countries as a result of an accident.

II. An effective risk management model for a sustainable drainage system and ecosystems in the cross-border region and improved soil, air and water quality

1. Risk Management

In order to assess the impact of selected indicators on the project implementation, a risk assessment is performed. The impacts on the project implementation are assessed on the following indicators:

- Change of legislation in the water sector,
- Non-performance of part of the contract by the beneficiary,
- Improper selection of technologies for implementation,
- Wrong budgeting,
- Leaving employees of the project team,
- Incorrect team selection,
- Failure to comply with the project implementation deadline,
- Delay in the key stages of the project,
- Ineffective communication,
- Insufficient information security,
- Inefficient allocation of project resources,
- Delay in project payments by the managing authority,
- Environmental risk,
- Climate risk.

1.1. Methodology for risk response strategies

According to the applied risk assessment methodology, risk management strategies are defined, and a specific strategy is proposed for each type of risk.

The classification of the types of risk according to the assessed indicators shows that the delay of the project payments by the managing authority, non-compliance with the project implementation deadline and the delay of the key stages in the project are identified as critical risks. These three indicators are assessed with a high degree of impact and a high probability of occurrence, which requires special attention in risk management. Improper selection of technologies for project implementation and incorrect budgeting fall into the quadrant of unexpected risk and have a large impact, but a relatively small probability of occurrence.

The non-performance of part of the contract by the beneficiaries is assessed as an indicator with medium impact and low probability of occurrence and falls on the border between unexpected and insignificant risk.

Insufficient provision of information, risk to the environment and climate, ineffective communication and leaving staff are insignificant risks, as they are unlikely to occur and have a low impact. Inefficient allocation of project resources and improper team selection also fall into the quadrant with minor risks, but they are determined by the average probability of occurrence and average impact. One of the indicators is defined as systemic risk and that is the

change of the legislation in the water sector. The indicator is characterized by a medium probability of occurrence and a low degree of impact.

Risk rating calculations show that no high rated indicators have been identified (Table 1).

Indicators	Risk rating
Change of legislation in the water sector	3
Non-performance of part of the contract by the beneficiary	3
Incorrect selection of technologies for implementation	4
Wrong budgeting	4
Leaving employees of the project team	2
Wrong choice of team	3
Failure to comply with the project implementation deadline	5
Delay in the key stages of the project	5
Ineffective communication	3
Insufficient information security	3
Inefficient allocation of project resources	3
Delay in project payments by the managing authority	5
Environmental risk	2
Climate risk	3

Table 1. Rating of the indicators with impact on the realization of the project

Indicators such as Change in the legislation in the water sector, Non-fulfillment of part of the contract by the beneficiary, Leaving employees of the project team, Improper selection of team, Ineffective communication, Insufficient information security, Inefficient allocation of project resources, Environmental risk and Climate risk are low rated. The other indicators: Incorrect selection of technologies for implementation, Wrong preparation of the budget, Non-compliance with the deadline for project implementation, Delay of the key stages of the project, Delay of the project payments by the managing authority have an average rating.

1.2. Risk response strategies

Avoidance / exploitation strategies must be applied to the indicators Delay in project payments by the managing authority; Failure to comply with the project implementation deadline; Delay in the key stages of the project. As these indicators are defined as critical risk, immediate attention and monitoring of risk management activities is required. With regard to these indicators, the risk can be avoided by eliminating the cause of the risk or by implementing the project in a different way. This type of risk can be managed by clarifying requirements, gaining information, improving communication or by gaining experience.

The risk acceptance strategy must be applied to the indicators Insufficient information security; Environmental and climate risk; Ineffective communication; Leaving employees of the project team; Inefficient allocation of resources; Wrong choice of team. These indicators are defined as an insignificant risk and this type of risks can be matched by identifying those that will be relevant to the success of the project in accordance with the available resources and stakeholder requirements (Stoyanova, 2017).

	Unexpected risk		Critical risk
Decrease / Increase	• Incorrect selection of technologies for implementation • Wrong budgeting	Avoid / Exploitation	• Delay in project payments by the managing authority • Failure to comply with the project implementation deadline • Delay in the key stages of the project
	Minor risk		Systemic risk
Acceptance	• Insufficient information security • Environmental risk • Climate risk • Leaving employees of the project team • Ineffective communication • Inefficient allocation of project resources • Wrong choice of team	Transfer / Sharing	• Change of legislation in the water sector

Table 2. Risk response strategies

2. Effective models for assessing the environmental benefits of SUDS

Environmental benefit assessments from WSUD projects can be expressed through monitoring or modeling of hydrological results, water quality results and environmental results. Estimates can be performed on a variety of scales, from evaluations of the performance of a single GI device during a single rainfall event to a response from multiple events at a receiving water body to GI interventions throughout the catchment. Monitoring from a single device usually involves measuring flows and sampling the water quality at the inlet and outlet of a SUDS system (rain garden, wetland or green roof). This type of approach provides information that allows to determine the efficiency of the system in terms of maximum flow and determine the load of pollutants. Although, monitoring on this scale provides precise specific information on the effectiveness of the integrated GI system, it does not assess whether the larger environmental objectives have been met. These targets may reflect some of the "non-aquatic" benefits, such as the terrestrial value of the system's biodiversity. Additional observations and studies are needed to assess this type of benefit. To achieve water objectives, assessing whether WSUD achieves environmental results in the catchment requires monitoring in water-receiving environments. This may include setting up points to monitor hydrological, water or sedimentation indicators and conducting environmental studies (eg microbiology sampling and / or flow habitat studies) in rivers. Monitoring may be required for long periods of time (years to decades), to determine whether there are improvements in water quality trends or in biological parameters. The design of the monitoring should aim to compare water bodies with and without WSUD and / or before and after the implementation of WSUD in order to reduce uncertainty about the interpretation of the results. Other factors may need to be taken into account, such as changes in rainfall patterns or coverage of rural (non-urbanized) areas.

Adopting a monitoring approach is often not feasible. Comprehensive monitoring can be too costly, logistically challenging, and require a long-term (perhaps several decades) commitment of resources. In other situations, the benefits of WSUD should be assessed as part of the project planning and design of its individual phases. Modeling provides a way to evaluate WSUD projects on a number of different scales and in a relatively fast way. Different designs or scenarios can be evaluated under a number of environmental conditions to provide management with detailed information on the pros and cons of adopting such alternative environmental approaches. As with monitoring assessment, different modeling approaches are appropriate in answering different questions and information needs. The design of SUDS rainwater runoff systems can provide information through relatively simple

precipitation / runoff volume calculations that provide estimates of (e.g.) peak rainwater flows predicted to occur with a given recurrence interval. These types of calculations help designers to scale their SUDS projects to provide the expected level of efficiency for the quantity and quality of treated water. Pollutant load models are another relatively simple type of model that estimates the amount of different pollutants generated in a watershed or the project area, based solely on the characteristics of the ground cover and the type of impact of rainwater. Reservoir models that simulate continuous periods of rainwater monitoring, river flow and water quality over time are more complex and resource intensive to implement. This type of model may require a wide range of data, usually characterizing the land cover, soils and topography and requiring climatic data for a period of several years. Where possible, they shall be calibrated against observations of river hydrology and water quality to provide confidence that they provide a realistic assessment. The models can then be used to assess hydrology results and water quality in changing conditions, such as with additional urbanization or increased rainfall intensity. Model builders can test alternative configurations of ground cover and rainwater control devices, to compare how SUDS solutions are presented against conventional approaches in designing an individual drainage project or planning future growth in urbanization of the city. Reservoir models can also be used in combination with other models to provide assessments of the results of water and sediment quality in coastal water bodies. This may include taking the results of catchment models (eg flows and concentrations of pollutants) to model the transport and deposition of pollutants in the port during a storm using hydrodynamic models or in the long term. Reservoir models can also be used in combination with other models to provide assessments of water and sediment quality outcomes in coastal water bodies. This may include taking the results of catchment models (eg flows and concentrations of pollutants) to model the transport and deposition of pollutants in the port during a storm using hydrodynamic models or in the long term. Reservoir models can also be used in combination with other models to provide assessments of the results of water and sediment quality in coastal water bodies. This may include taking the results of catchment models (eg flows and concentrations of pollutants) to model the transport and deposition of pollutants in the port during a storm using hydrodynamic models or in the long term.

III. SWOT / LOED analysis

1. Targovishte Municipality

STRENGTHS	BUILDING STRENGTHS
• Geographical location near Corridor 10 and border crossings • Proximity to Vrane as the main pole of development and functional center of Pchinya district; • Existing transport network and infrastructure resources; • Relatively good road connection of the landscape units with the settlements; • Quality agricultural land in the Pchinya valley; • Quality forest fund; • Richness of natural and mineral resources; • Satisfactory preservation of the quality characteristics of the natural resources; • Variety of specific geomorphological forms; • Preserved air quality; • Absence of significant industrial facilities and sources of air pollution; • Satisfactory quality of water bodies • Satisfactory level of sanitary protection of the main water sources of the regional town; • Preserved biodiversity;	• Creating conditions for investing capital of investors and donors; • The spring of Bela Voda on Golemi Vrah as a potential center for winter tourism; • The river sediment of the river Pchinya is a suitable soil for agriculture (agriculture, vegetables, viticulture, animal husbandry) and development of organic farming; • Naturally preserved landscapes represent a special potential for development of various types of tourism and recreation;
OPPORTUNITIES	**USE OF OPPORTUNITIES**
• New environmental law • Commitment of local self-government to work actively to improve the environment • Cooperation with the municipalities in the region • Support from the relevant ministry • Development of animal husbandry, fruit growing and vegetable production • Integrated waste management of • Regional level. • Cross border cooperation. • Determining local government for • Support for economic development. • Strengthening the capacity of local self-government • Possibility for organized drainage of wastewater from 12 coastal settlements on the river Pchinya, with the construction of smaller standard packages of facilities for • Wastewater treatment (WWTP); • Opportunity to build a larger number of mini hydropower plants on rivers;	• Development of rural infrastructure with the support of the state budget and EU funds • Construction of a border crossing with FYR Macedonia as the main potential • Development of cross-border cooperation; • The possibility of forming an organized water supply system and • Realization of the Prohor tank;
WEAKNESSES	**OVERCOMING WEAKNESSES**

THREATS	PROTECTION AGAINST THREATS
• Traffic position outside the main transit corridors; • Distance from the regional centers • Negative natural growth; • Unfavorable educational structure and high percentage of illiterate people (6%); • Unfavorable demographic trends in most settlements (large number of workers - daily migrants, large percentage of elderly population over 60 years, depopulation of villages, etc.); • High unemployment and poverty • Insufficient information on the possibilities for using financial resources - loans, grants • Outdated technology (factories and economic operators as pollutants) • Insufficient number of professional staff at the level of local administration • Insufficiently effective work of the inspection and control services • Lack of programs and plans for environmental protection • Poor solid waste management • Illegal logging; • Seismicity of the area; • Large number of polluting septic tanks in rural areas; • Lack of infrastructure equipment in most settlements (sewerage network, which does not cover most of the municipality); • Lack of wastewater treatment plants; • Ecologically unconditional location of the municipal landfills for household waste • Polluted landfills in settlements and on river banks; • Unregulated landfills and dangerous dumps • A large number of torrents that threaten agricultural areas and built-up land in rural areas; • Large percentage of areas threatened by excessive and strong erosion and initiated processes of soil erosion on deforested terrains; • Vulnerability to natural disasters during the winter period of the year;	• Integrating environmental policy with economic and other sectors; • Participation in the preparation and implementation of sectoral strategies in the fields related to the environment; • Integration of the principles of environmental protection and energy efficiency in spatial and urban planning; • Strengthening the institutional capacity for creation and implementation of sectoral and environmental policies in general and creation of an emergency response system; • Improving the quality control system of the environment through accreditation of authorized laboratories, application of norms and regulations, mandatory quality control of environmental factors and analytical methods, own monitoring of pollutants, development of a cadastre of pollutants, development of an inventory of greenhouse gases, creation of a unified information system; • Introduction of effective financial mechanisms for promotion of investments in the environment and provision of secure sources of financing; • Increasing the level of investment in the environment to cover the costs of operation, maintenance and modernization / expansion of existing infrastructure in the field of environmental protection technologies and pollution reduction. Promoting competition and private sector participation in the provision of services, especially in the waste and water management sectors; • Improving formal and non-formal education in environmental protection and energy efficiency; • Raising awareness through better information and communication with the public and developing mechanisms for their participation in the decision-making process in the field of environment;

• Uneven regional development • Natural disasters (hail, fires, floods, snowstorms, etc.) • Danger of ecological catastrophe • Soil erosion processes • A large number of torrential rains • Uneven regional development • Continuation of the negative demographic trend • Lack of investor interest • Outflow of expert staff • Increasing the number of adult households • Leaving the young people from the villages • High unemployment rate among the population and lagging behind private entrepreneurship, especially in settlements with extremely unfavorable demographic trends; • Insufficient funds to support rural development of MAFWM and the EU due to weak financial capacity • Increasingly strict regulations regarding security and environmental protection • Occurrence of torrential floods and negative processes due to intensified erosion processes • Lack of financial resources • Deterioration of the distribution of the water supply network in the municipal center; • Discharge of untreated domestic wastewater into natural receivers without prior treatment; • Unplanned conversion of agricultural land into construction land, which damages ecosystems;	• Expanding and improving infrastructure in the field of environmental protection, nature conservation and biodiversity with a focus on endangered sites, including wastewater treatment plants, sanitary landfills, technologies to reduce air pollution, improve traffic and others; • Development of modern biological monitoring; • Development of a register of water pollution sources; • Improving the quality of data on pollutant emissions into water; • Improving the self-reporting of waste generating; • Modeling the effects of stationary and large point sources; • Conducting own monitoring of pollutants; • improving the monitoring of biodiversity components, endangered species, ecosystems and protected areas; • Establishing monitoring of the sustainable use of natural resources (hunting, fishing, forestry); • Establishment of biomonitoring of certain aquatic ecosystems • Establishment of systematic monitoring of lands with precisely defined sampling sites and standardized methods for collection and analysis of samples; • Determination of specific parameters and monitoring of factors of soil degradation, erosion, reduction of organic matter, pollution, salinization, compaction, loss of biodiversity, land conversion, floods and landslides; • Defining criteria for determining areas at risk of land degradation; • Development of action plans • Development of a database of contaminated sites • Increasing the percentage of households connected to the public sewerage network • Increasing the percentage of households covered by organized collection of municipal waste • Introduction of composting of green waste

2. Municipality of Dupnitsa

STRENGTHS	BUILDING STRENGTHS
• Favorable geographical location as a crossroads of transport and communication corridors in national and transnational terms. • Favorable climate and relatively good water resources for the development of intensive modern agriculture. • IPGVR approved. • Rise in the development of agriculture in the municipality of Dupnitsa, with opportunities for irrigated agriculture due to the preserved irrigation system. • High share of micro and small enterprises and relatively good indicators. • High share of the economically active and able-bodied population. • Relatively high proportions of the youth population and families with children up to 18 years. • Lower rate of demographic aging against the background of the average levels for the district and the country. • Good quantitative indicators for the education of the population of the municipality. • An active and well-capacity non-governmental sector that creates and manages social services in the community and carries out youth activities. • Built and working system for collection of household waste, including separately. • Large mineral water resources. • Good quality of the components of the environment in the municipality of Dupnitsa according to the observed maximum permissible norms of indicators for the quality of air, water and soils. ▪ Good ecological indicators of the soils in the municipality. Increased values of the acidity indicator were reported. ▪ There is no data on groundwater pollution in the municipality of Dupnitsa.	• Establishing cooperation with municipalities and non-governmental organizations from the country and abroad. • Preparation and implementation of projects and initiatives funded by the EU, including local businesses. • Construction of the necessary infrastructure, including • On dams, allowing in an extremely dry year the negative consequences to be within the limits of tolerance for the economy and the population of the municipality • Development of planning documents to identify • Existing problems and frame future actions at different levels • Management and territorial level. • Building an institutional framework and capacity covering all areas of water sector management. • Strengthening the role of the basin principle of water management, including in • Functions related to planning future activities through the RBMP. • Establishing practices for enforcing the legislation through effective control of the fulfillment of the conditions in the permit and concession contracts. • Legally regulate the process of transfer of part of the property of • The water management infrastructure of the state and the municipalities. • Creating preconditions for a lasting tendency to increase the share of treated wastewater. • Building prerequisites to allow public participation in making • On decisions related to the water sector - basin councils, public discussions of regulatory changes, provision of information through various media and the Internet. • The acquis communautaire to be transposed into Bulgarian legislation.
OPPORTUNITIES	**USE OF OPPORTUNITIES**

• Increasing environmental spending in the public and private sectors, especially through investments to prevent natural disasters and improve energy efficiency. • Careful assessment of the priority environmental investments in the municipality from the point of view of the limited local and national financial resources and the dominance of the investments through the operational programs. • Promoting self-employment and job creation. • Implementation of integrated water resources management of Dupnitsa municipality. • Environmental investments • Providing complex administrative services and those electronically. • Favorable conditions for the development of CBC. • Use of EU financial instruments to solve the problems	• Opportunities for sustainable development of the municipality by using the opportunities of the EF for the development of the regions, economic activity, human resources and environmental protection. • Adopted by the community vision and plan for integrated rehabilitation and development of Dupnitsa. • Opportunities for development of grain production, production of technical crops, vegetable and fruit growing, oilseeds, dairy and meat farming. • Normative regulation of the principle of reimbursement of the costs for water services (the costs for resources, for the environment and the costs for operation of the infrastructure sites), through the final price paid by the consumer.
related to the efficient, rational and economical use of water and their protection. • Coincidence of national water priorities with the priorities of the international communities, for which sustainable water use and protection is a priority. • Willingness among a large part of the population to accept an increase in the price of water under certain conditions. • An ongoing process of changing public attitudes in support of water conservation and conservation efforts.	
WEAKNESSES	**OVERCOMING WEAKNESSES**

• Only over 7% of the territory of Dupnitsa municipality is included in protected areas under the Habitats Directive and the Birds Directive, as well as in the Rila National Park. • High share of the territories with anthropogenic pressure in the municipality of Dupnitsa against the background of the indicator for the country, the district and the region • Insufficient coverage of the territory with systems for monitoring and control of pollution, especially with regard to air, soil, radiation background, noise pollution. This is a prerequisite for severely limited opportunities to manage the risks of environmental pollution. • Seasonal air pollution with dust, soot and gases due to the use of fossil fuels in the city and large villages. • There is no policy to attract young local staff • Insufficient infrastructure related to the protection of the components of the environment - treatment plants, modern installations for storage, treatment and processing of non-hazardous waste, as well as the emphasized weak public culture in this area. • Dupnitsa Municipality is "aging" and is dynamically losing its ability to reproduce the able-bodied, active population. • Depopulating rural periphery. • Strong competitive pressure from the nearby large urban centers - Sofia and Blagoevgrad. • High levels of anthropogenic pressure on the territory. • Low productivity, added value and extensiveness of the local economy. • Relatively sustainable share of the workforce without education and qualifications. • Depreciated water supply and sewerage systems, high water losses in the city and in the villages. • There is no treatment plant for drinking and wastewater. • Outdated zoning plans of the villages in the municipality and the general development plan of the town of Dupnitsa. • River currents polluted with domestic and industrial wastewater - German, Dzhubrena, Otovitsa, Topolnitsa. and river terraces with household waste from unregulated landfills. • Insufficient participation of citizens in the processes of making management decisions and implementing policies at the local level.	• The expansion and reconstruction of the wastewater treatment plant near the village of Dzherman, the connection of the city collectors with it, as well as the implementation of the projects for local treatment plants in the large villages of the municipality. • business must be supported in its efforts not only to improve energy efficiency, but also to improve the environmental management of its own production • application of modern monitoring and control systems, as well as early notification of the population; • continuation of actions for strengthening and management of riverbeds; • active involvement of the local population in prevention activities, provision of the necessary equipment, gear and training for the action groups; • development of systems for efficient irrigation of agricultural areas • minimizing losses of drinking water and irrigation water, limiting infiltrations and improving wastewater treatment, afforestation and restoration of green areas

• There are disparities in the distribution of water resources in territorial, seasonal and annual aspects. • The frequent changes in the regulatory framework and the sectoral approach in the legislation are led to contradictions, ambiguities, omissions and lack of good codification in regulations. • There are significant problems and delays in the implementation of measures related to changes in the management of the water sector - the establishment of water associations, transfer of assets from companies to the state and municipalities and others. • There is a delay in the deadlines for fulfilling the country's commitments, arising from the application of EU legislation, basic wastewater treatment and drinking water quality. • There is a chronic financial shortage, causing a lack of adequate investment in water infrastructure, which is insufficient or to a very large extent physically and morally degraded and with deteriorating functional parameters. • The regulation of the activity of the main water users - Water and Sewerage, Irrigation Systems and NEK EAD - and the existing practice create obstacles for the complex, efficient and rational use of water. • No social assistance has been introduced for the socially disadvantaged, which limits price increases and funding in the water sector. • The monitoring of the quantity and condition of the waters is not performed in full and with the required quality. • There is insufficient strategic management and coordination between institutions with functions in the water sector. • The number of settlements in which a water supply regime is introduced, especially in "dry" years, is large. • There are no indicators for water efficiency and price incentives to promote efficient water use by consumers	
THREATS	**PROTECTION AGAINST THREATS**

• High risk of floods in the area of Dupnitsa - Samoranovo - Yahinovo. • The municipality falls into the critical areas for atmospheric and soil drought as a result of climate change, which creates a risk in the process of providing water for the population and the economy of the municipality • The landslide nature of some of the terrains in the municipality increases the risk of disasters and accidents • Over 91% of the territory of the municipality is exposed to erosion risk • Transport accessibility and proximity to larger urban and economic centers encourages migration processes, supported by the inability of the local economy to generate sufficient and sustainable jobs. • Deepening demographic crisis. • Shrinking the investment activity of local and regional entrepreneurs.	• An integrated local flood risk management program through a system of investment, reorganization and information measures is needed. • Urgent adoption and implementation of integrated local policies for efficient water management and development of modern irrigated agriculture • Need for the introduction of modern monitoring and signaling systems, along with regular preventive and strengthening works • Careful planning and implementation of all types of activities that would trigger erosion processes, especially work related to the implementation of major infrastructure projects and logging.
• Slower renewal and modernization of the technical infrastructure in the municipality. • The Tourist Climate Index of the European Union indicates the territory of the municipality as part of the territory of Bulgaria, as exposed to significant negative consequences for the tourism industry related to reducing the number of days with snow cover and reducing water flow. • The investment needed to improve the water sector is huge, including implementing the requirements of EU directives. • Available old technologies in industry and energy and inability of some enterprises to set aside funds for the introduction of the best techniques and water-saving technologies, as well as for the construction of facilities for optimal wastewater treatment. • Weak purchasing power of some households and difficulty for low-income groups to allocate additional funds for services and products related to supply, drainage and water purification. • The higher education system does not "produce" a sufficient number of specialists needed to manage the water sector.	

IV. Strategic plan for development of sustainable systems for urban drainage of Dupnitsa municipality and Targovishte municipality. Objectives and mission for the protection and restoration of the ecosystem through the implementation of sustainable urban drainage systems

Name of the specific activities	*period of execution*	
	Municipality of Dupnitsa	***Municipality of Trgovishte***
Activities for structuring a set of design criteria		
Defining a scheme for surface water drainage		
Construction of a scale plan on a small scale of the existing site and information on existing drainage systems of the site	JANUARY 2022 - MARCH 2023	JANUARY 2022 - MARCH 2023
Construction of a dimensioned scalar topographic level of the studied area in meters above sea level		
Creating dimensional plans and drawings of the proposed layout of the site, identifying the area to be drained		
Formation of a proposed controlled release rate for 1 precipitation event per 1 year and 1 precipitation event per 100 years		
A set of geological information including drilling records, depth to water level and / or infiltration test results and a report interpreting and describing the suitability of the infiltration site		
Formation of detailed design drawings for floods and drainage		
Performing hydraulic calculations for the proposed drainage project		
A set of evidence of consent of the third and the countries and drainage runoff to run its sewer system		
A set of details on land flows in excess of drainage capacity		
Assessment of the expected service life of the development when the development proposal is non-residential		
Development of a management plan for future maintenance and acceptance of the drainage system for the entire service life of the development		
Formulate a plan for phased construction demonstrates dollars access to / from interdependent phases		
Estimation of capacity and discharge rate of the current drainage system		
Defining completed elevations of the proposed buildings		

Name of the specific activities	***period of execution***	
	Municipality of Dupnitsa	***Municipality of Trgovishte***
Perform calculations of SuDS outflow before and after development		
Building a model "Conceptual design of SuDS"		
Evaluation activities		
Perform analysis of the existing flow route for the site	OCTOBER 2022 - APRIL 2023	OCTOBER 2022 - APRIL 2023
Performing a modified flow route analysis for a proposed development		
Activities related to the formation of a project model		
Evaluation of the runoff collection model	APRIL 2023 - FEBRUARY 2024	APRIL 2023 - FEBRUARY 2024
Formation of a characteristic		
Formulation of source control activities		
Formulation of control composition (SuDS-related components and drain storage functions)		
Identification of catchments		
Formulation of technological-economic model for maintenance		
Flow route analysis • functionality analysis of a specific object • identifying the presence / absence of historical drainages • identification of discharge sites and associated (and overall flow) pollution problems • assessing existing these landscape features and characteristics of the habitats		
Performing a topographic survey, expressed as: point level and outline. Assessment of the possibilities for specific sites for which there is a natural infiltration, for its violation after the development of SUDS		
Activity related to SuDS planning		
Physical data set for drainage plan development	MARCH 2024 - JUNE 2024	MARCH 2024 - JUNE 2024
Public survey to identify the sites with the greatest drainage problems *(if necessary, including to supplement the available data).*		
Building a model (including information and publicity activities) related to ensuring the participation of community members in the implementation of urban drainage projects is direct employment in construction activities *(if necessary)*	JULY 2024 - OCTOBER 2024	JULY 2024 - OCTOBER 2024

Name of the specific activities	***period of execution***	
	Municipality of Dupnitsa	***Municipality of Trgovishte***
Involve community members in monitoring the quality of construction *(if necessary)*	OCTOBER 2024 - SEPTEMBER 2027	OCTOBER 2024 - SEPTEMBER 2027
Involvement of community members in monitoring the quality of construction in the cases of hired private contractors *(in case of need and interest of the community)*		
Activities related to the individual stages in the design process		
Stakeholder discussion before applying:		
Achievement of clarity for comprehensive information on the development plan	FEBRUARY 2023 - MAY 2023	FEBRUARY 2023 - MA J 2023
Ensuring effective lines of communication		
Identifying design criteria and site opportunities / constraints		
Assess the capabilities and ensure the integration of SuDS with the rest of the infrastructure		
Formulation of approaches for the acceptance of SuDS in the public space		
Activities to outline the planned application and the drainage proposal		
Activities for the development of common drainage proposals through initial discussions that will determine the approaches for integrating the SuDS scheme into the landscape : • use of the principles for overall management of SuDS ; • initial calculations of water runoff ; • scope of the SuDS scheme with mapped current routes ; • Demonstrating that the original design of the scheme takes into account climate change ; • agreement for maintenance and operation of the systems ; • compliance with the principles of sustainable development ; • initial estimates of the amount of runoff to be controlled; • Demonstration that the principles for sustainable drainage and the functioning of the system, taken into account in the general design parameters, have been applied	MARCH 2024 - JUNE 2024	MARCH 2024 - JUNE 2024
Activities for formulation of a complete application plan and detailed assessment of drainage, design and consultation *(Preparation of a detailed drainage project for submission with a full planning application)*		
Assessment of drainage with the following scope : • land set aside for SuDS • SuDS designs that are integrated into the overall	MAY 2024 - SEPTEMBER 2024	MAY 2024 - SEPTEMBER 2024

Name of the specific activities	*period of execution*	
	Municipality of Dupnitsa	*Municipality of Trgovishte*
concept and layout of the seats • calculations showing peak flow rates before and after development • an indication of the flow paths and that the overflow has been taken into account • an indication that the possibilities for providing SuDS are maximized • calculations showing that the flow and volume of the outflow can be properly controlled and managed • the need to investigate and further remediate contaminated land • a statement of the method on how surface water will be controlled during construction • adoption of an agreement for maintenance and operation of the systems • the need for long-term monitoring.		
Building a framework of activities related to the planning of flood prevention measures		
Flood risk design and assessment activities ***(objective of the specific activities - ensuring safe for the whole operational life of areas with direct impact from climate change, leading to increased risk of floods for people and property)***		
Building a basic development to prevent the risks of floods	JULY 2023 - SEPTEMBER 2024	JULY 2023 - SEPTEMBER 2024
Establishment of a zonal development for assessment and management of the areas at risk of flooding		
Building a development for residual risk management		
Activities to achieve the strategic goals related to the quantity and quality of water, use of its useful functions and protection of biodiversity		
Activities aimed at the implementation of the overall activity for controlling the amount of water ***(activities to control the effect of urbanization on water intakes and in order to reduce the risk of floods)***		
Water quantity activities		
Reduce the increasing flow of natural development to "greenfield" condition (based on a control value to 1 critically rainfed event of 100 years)	MAY 2023 - APRIL 2026	MAY 2023 - APRIL 2026
Inspection and establishment of safe surface runoff channels for events (based on a control value of at least 1 critical precipitation event per 100 years)		
Water quality assurance activities *(activities for protection of water flows from diffuse and accidental pollution and pollution from point sources)*		
Ensuring waste treatment according to the SUDS manual (CIRIA C697)	JUNE 2026 - SEPTEMBER 2027	JUNE 2026 - SEPTEMBER 2027
Inclusion of proven SUDS techniques for protection of water		

Name of the specific activities	***period of execution***	
	Municipality of Dupnitsa	***Municipality of Trgovishte***
flows from diffuse and accidental pollution and from point sources of pollution		
Activities for integration of the drainage scheme with the general strategies for protection of the habitats, environment and landscape		
Providing permanent SUDS elements and landscape buffer zones	MARCH 2023 - DECEMBER 2027	MARCH 2023 - DECEMBER 2027
Establishment of "green corridors" connecting the main SUDS elements		
Planning of footpaths and bike lanes to promote safe public access		
Activities related to the formulation and implementation of operational capabilities of the built infrastructure facilities and elements		
Formulation and implementation of entertainment opportunities	JANUARY 2027 - DECEMBER 2027	JANUARY 2027 - DECEMBER 2027
Formulation and implementation of opportunities for conservation of water resources		
Formulation and implementation of opportunities for approval of habitats / biodiversity		
Formulation and implementation of opportunities for traffic management		
Formulation and implementation of opportunities for car parking		
Formulation and implementation of training / explanation opportunities for citizens		
Formulation and implementation of opportunities for impact of air temperature / urban warming and to mitigate "the effects of the island"		
Formulation and implementation of opportunities for reduced energy use		
Formulation and implementation of possibilities for approval of air quality		
Formulation and implementation of aesthetic appeal , character and distinctiveness of the local and urban landscape		
Formulation and implementation of opportunities related to health benefits		

	Step	basic activities	Necessary information		Results	
Citywide	Defining goals, planning framework and local requirements	Conducting seminars	Local requirements		• Goals • Obstacles to project implementation	
	1. Defining priority and strategic watersheds	Designation of a unit for the management of urban drainage	Urban drainage catchments		Spatial analysis unit	
		Conducting spatial analysis	Water quality	Rivers	Water quality index	Priority catchments
				Wetlands		
				Other water bodies		
			Amount of water	Floodplains	Water quantity index	
				Capacity of storm sewer systems		
				Wetlands		
				Critical points		
			Social and environmental information	Air quality	Socio-ecological index	
				Parks		
				Plantations		
				Buildings		
				Vulnerable group of the population		
				Socio-economic level of the population		
			Green corridors		Index of green and blue-green corridors	Strategic catchments
			Blue-green corridors			
			Plans for urban redevelopment and new infrastructure		Planned index	
Local	2. Identification of candidate sites for SUDS projects, applicability and potential constraints	Analysis of public and private spaces according to the available information	Physical restrictions according to the type of SUDS		Potential areas for SUDS	
			Land use			
			Slope			
			Groundwater level			
			Degree of infiltration (geological or geotechnical data)			
			Buildings			
			Parking lots			
			Public space			
Micro	3. Selection of the SUDS type for the proposed area and composition for overall processing	Use of selection matrices	Possible number of SUDS for the area		Recommended SUDS	
		Determining the possible processes for rainwater control in the area			Recommended composition for complete processing	

Table 3: Multi-stage methodology for planning sustainable urban drainage systems (Source: A Multicriteria Planning Framework to Locate and Select Sustainable Urban Drainage Systems (SUDS) in Consolidated Urban Areas Ariza et. Al, 2019)

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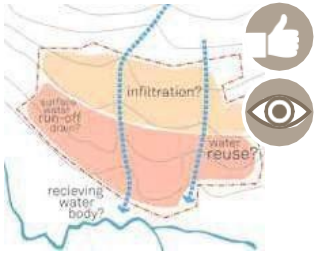
Master planning process		Design process for SuDS	
B. Define		SuDS baseline analysis Conduct a baseline appraisal of the possible benefits of SuDS and the site conditions that could affect design. See chapters 3 and 4 for benefits and site conditions that should be considered. Identify desired benefits and challenging site conditions that will be considered in the design process.	
	SPATIAL FRAMEWORK opportunities and constraints	Identify flow paths and low points Existing drainage patterns and natural flow paths should be mimicked. Examine the existing topography (and note any substantial required changes to topography through development) to identify natural flow paths. Identify areas at the lowest points where water will naturally gather. This will help to maintain natural processes and eliminate the need for additional infrastructure or pumping. Identify discharge options Work through a hierarchy of options to determine where water should be directed: 1. water reuse - is there a local need for non-potable water? 2. infiltration - are ground conditions suitable for infiltration in some areas? 3. discharge to water body - is there a watercourse or water body on-site or near the site which could receive water? 4. discharge to surface water runoff drain - is there an above ground or below ground conveyance network for surface water only on-site or near the site? Could one be created? discharge to combined drain - as a last resort, find connections to a nearby combined drain that carries both runoff and wastewater. On some sites there may be multiple discharge points and discharge types. SuDS opportunities and constraints diagram Include a high-level spatial diagram that identifies the possible benefits and constraining conditions for SuDS as part of the suite of baseline diagrams that make up the spatial framework for the site.	 
	ASSEMBLE THE MASTER PLANNING TEAM the right range of skills for the team	Bring together the right skills Identify skills that are needed in the master planning team to develop the best SuDS options. These should relate to the desired benefits to be developed and the site conditions that need to be addressed. A specialist with water management skills should be part of every team.	

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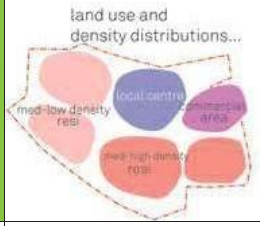
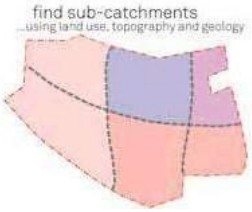
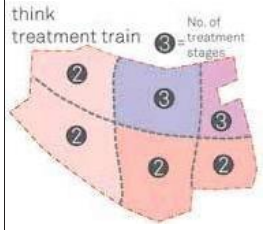
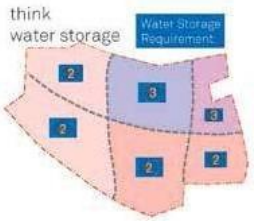
Master planning process		Design process for SuDS	
C. Design - Initial Testing	INITIAL TESTING	Explore water movement Design begins with an exploration of the relationship between the developed area and water. The placement and size of development will influence runoff rates and pollution risk and layout will influence the availability of opportunities for the introduction of sustainable drainage systems for amenity and biodiversity benefits.	
	LAND USE & DESTINATION Outline distributions and relationships 	Identification of catchments (where applicable) As the outline land use plan develops, a series of sub-catches may evolve where distinct sets of SuDS treatment trains will be required. For example, on large developments which will be phased (built-out at different times) SuDS should similarly be phased to ensure each area is functional in itself. Also, there may be varying land uses on a site that give rise to different contamination risks, eg an industrial area within a wider residential development. SuDS in sub-catchments can join regional SuDS systems downstream.	
		Allocate number of treatment stages All rainwater that falls on the site should generally be passed through at least two SuDS treatment stages to improve water quality before it is infiltrated into the ground or discharged (see chapter 3). The number of treatment stages should be scoped at this stage for each distinct drainage area or sub-catchment. Estimate outline attenuation volumes From the types of land use and density of development, a general assumption can be made about the percentage of the area which is impermeable and will generate runoff. Using the local runoff-rate requirements this can be used to calculate a volume of runoff that needs to be attenuated for the site (and its component sub-catchments). This can be calculated manually or using modeling tools. A specialist member of the design team should be consulted at this time. The amount of source control (management where rain falls to prevent runoff such as rainwater harvesting, permeable surfaces and green roofs) should be estimated here through discussions with the design team to give a realistic estimate of runoff. The volume calculated does not need to be delivered as one storage area,	 

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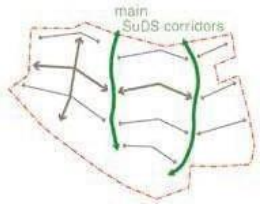
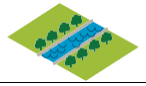
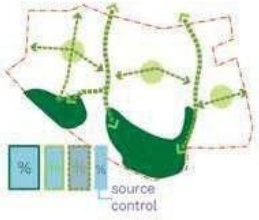
Master planning process	Design process for SuDS	
KEY CONNECTIONS Strategic connections between destinations	Structure conveyance paths At this stage of master planning, key routes and connections for vehicles and pedestrians will be established. Natural flow paths and 'man-made' connection routes (roads, green corridors) should be examined at this point to establish a structuring grid for surface water conveyance to storage areas and discharge points. Conveyance paths should work with topography to safely and effectively direct surface water to the desired location. Water should be kept above ground (not in pipes) where possible.	
OPEN SPACES Connected green infrastructure 	Identify green space and public space locations Most development types will include some form of open space, be it an urban park or a more informal public square. One of the key benefits of SuDS is their ability to be multi-functional - integrating into these spaces in an obvious or more subtle way. eg SuDS built into play spaces to prevent flooding. The master planning process may identify key locations for these spaces at this stage, which should be considered as locations for SuDS.	
MASTER PLAN OPTION TESTING	Outline water management diagram As early options for land use distribution are tested in the master plan, the location of SuDS conveyance paths, storage and treatment areas should also be outlined spatially and discussed with the design team and any relevant stakeholders who are involved with the overall master plan. Initial ideas for types of SuDS may be suggested at this stage.	

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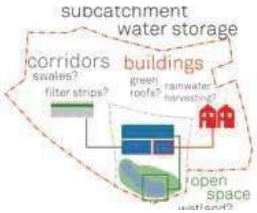
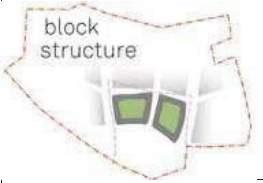
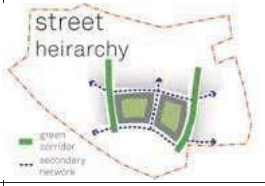
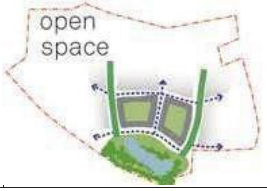
	Master planning process	Design process for SuDS	
D. Design - Preferred Strategy	PREFERRED STRATEGY	Selection of SuDS portfolio After the initial land use and spatial testing options, a preferred master plan option will be chosen for further detailing. At this stage, there is **the opportu**nity for the design team to work together to develop the SuDS proposals to concept stage, selecting the possible types of SuDS and creating a SuDS network for the site. In any one area, several types of SuDS could be identified to provid**e flexibility for the**developer in detailed design stage. SuDS components should be threaded together with the urban design vision to ensure they complement the development context and that they act as a treatment train, where water is conveyed from one SuDS component to another. Refer to the SuDS selection tables in chapters 3 and 4 to understand the relationship between site conditions, benefits and the various SuDS types and discuss options with the specialist in the team. Identify possible SuDS which can be used to make up the attenuation and treatment train requirements identified in the previous stage. It is often helpful to identify SuDS components that will be used in and around buildings (blocks), in roadways and in open spaces as described below. Solutions may vary by sub-catchment.	
	BLOCK STRUCTURE patterns of blocks and densities	SuDS portfolio - blocks SuDS in these areas will predominantly take water from roofs and paved areas surrounding buildings. A general selection of suitable SuDS and source control measures should be identified at this stage that can be included on or around the building.	
	MOVEMENT FRAMEWORK street hierarchy and character of routes	SuDS portfolio - streets At this stage, the width of major and minor routes (including green corridors) is likely to be decided. SuDS opportunities should be considered in tandem with the requirements of the Highway Authority to allocate space that could also be used as verges, parking areas, or tree pits which could include a SuDS function.	
	OPEN SPACE NETWORK function and character of open space 	SuDS portfolio - open space A portfolio of possible SuDS components and their likely storage requirements can be defined at this stage.	

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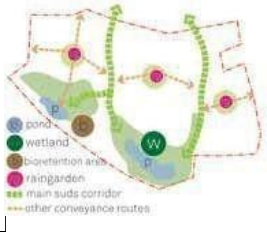
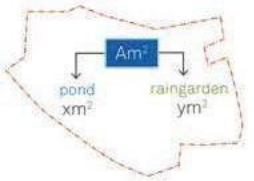
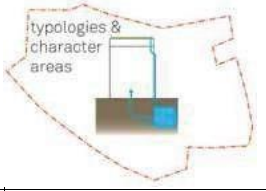
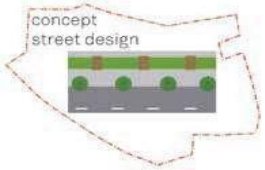
	BUSINESS CASE	Create SuDS Concept Plan As the preferred option is finalized, a business case for the master plan will be developed in more detail to underpin viability by estimating the number of units / floor area of development and the corresponding cost-benefit of the master plan proposals. At this stage, the portfolio of SuDS to be integrated into the development, and the general conveyance mechanisms between them should be decided. The outline amounts of attenuation for each sub-catchment should be indicated. This level of detail is appropriate for pre-application discussions or for a surface water management strategy submitted with an outline planning application. This is a good time to discuss adoption and maintenance and the target benefits to be delivered with stakeholders.	

Master planning process		Design process for SuDS	
E. Design - Design Refinement	DESIGN REFINEMENT	SuDS concept design and optimization At this final stage of master planning, the SuDS proposals can be developed to a concept level of design. Detailed design at a development plot scale will be completed at a later stage. This content will begin to build the detail required for a site specific surface water management plan. The solutions can be optimized to provide the best cost-benefit.	
	CONCEPT ARCHITECTURE character areas and building typologies	SuDS Concept Design - blocks and buildings The final selection and concept design of SuDS should consider the roof type (flat, single slope, dual slope), building surroundings (gardens, forecourts), building uses and water demands. Outline sizing of specific features should be conducted at this stage.	
	CONCEPT STREET DESIGN highways and street	SuDS concept design - streets In tandem with the development of street sections and visualizations the SuDS components should be selected and roughly sized. Overland conveyance such as swales should be given sufficient space here.	

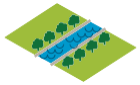
	CONCEPT LANDSCAPES open spaces and public realm 	SuDS concept design - open spaces In tandem with the development of landscape concepts and visualizations the SuDS components should be selected and roughly sized.	
	DEVELOPER BRIEF OR GUIDELINES	Create SuDS Brief The vision for SuDS should now be integrated into the master plan. This vision can be integrated into developer briefs or design guides through the use of example designs and design criteria for SuDS. The SuDS brief should ensure the key benefits and site conditions are recognized as this will form the basis for further design at the plot scale. A selection of SuDS options could be presented if it is desired that more flexibility is provided for those conducting the detailed design stage.	

Table 4. SUDS design process, Source: Water. People. Places. A guide for master planning sustainable drainage into developments Prepared by the Lead Local Flood Authorities of the South East of England, September 2013

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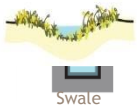
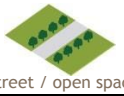
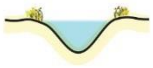
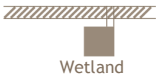
	Description		Required area
 Swale	Swales are vegetated shallow depressions designed to convey and filter water. These can be 'wet' where water gathers above the surface, or 'dry' where water gathers in a gravel layer beneath. Can be lined or unlined to allow infiltration.	 Street / open space	Account for width to allow safe maintenancce typically 2-3 meters wide.
	Hardscape water features can be used to store run-off above ground within a constructed container. Storage features can be integrated into public realm areas with a more urban character.		Could be above or below ground and sized to storage need.
	Ponds can be used to store and treat water. 'Wet' ponds have a constant body of water and run-off is additional, while 'dry' ponds are empty during periods without rainfall. Ponds can be designed to allow infiltration into the ground or to store water for a period of time before discharge.	 Open space	Dependent on runoff volumes and soils.
 Wetland	Wetlands are shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Wetlands can be integrated with a natural or hardscape environment.		Typically 5-15% of drainage area to provide good treatment.
Underground storage	Water can be stored in tanks, gravel or plastic crates beneath the ground to provide attenuation.	Open space	Dependent on runoff volumes and soils.

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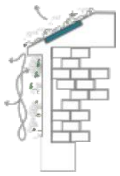
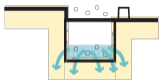
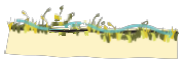
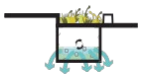
	Description	Setting	Required area
 Green roofs	A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation.	 Building	Building integrated.
 Rainwater harvesting	Rainwater is collected from the roof of a building or from other paved surfaces and stored in an overground or underground tank for treatment and reuse locally. Water could be used for toilet flushing and irrigation.	 Building	Whatis storage (underground or above ground).
 Soakaway	A soakaway is designed to allow water to quickly soak into permeable layers of soil. Constructed like a dry well, an underground pit is dug filled with gravel or rubble. Water can be piped to a soakaway where it will be stored and allowed to gradually seep into the ground.	 Open space	Dependent on runoff volumes and soils.
 Filter Strip	Filter strips are grassed or planted areas that runoff is allowed to run across to promote infiltration and cleansing.	 Open space	nimum length 5 meters.
Permeable paving	Wellving which allows water to soak through. Can be in the form of paving blocks with gaps between solid blocks or porous paving where water filters through the block itself. Water can be stored in the sub-base beneath or allowed to infiltrate into the ground below.	 Street / open space	Can typically drain double its area.
 Bioretention area	A vegetated area with gravel and sand layers below designed to channel, filter and cleanse water vertically. Water can infiltrate into the ground below or drain to a perforated pipe and be conveyed elsewhere. Bioretention systems can be integrated with tree-pits or gardens.	 Street / open space	Typically surface area is 5-10% of drained area with storage below.

Figure 1. Choosing the best solution for SUDS integration, Source:Water. People. Places. A guide for master planning sustainable drainage into developments Prepared by the Lead Local Flood Authorities of the South East of England, September 2013

V. Comparative study and presentation of the best European and international practices. Necessary and more important effective equipment for a sustainable ecosystem and improvement of soil, air and water. Current and applicable model of sustainable drainage system for Dupnitsa municipality and Targovishte municipality

1. Environmental indicators and steps for their improvement

1.1. Denmark

Air quality in Denmark is often considered to be good with a few exceptions. Internal steps to improve urban air quality include low-emission zones in large cities, registration tax exemptions for electric cars, particulate filters for new fossil fuel vehicles and revised emission limit values for domestic radiators. of wood. The Danish government launched a clean air package in October 2018, specifically dedicated to reducing air pollution in major cities and eliminating diesel and petrol vehicles. In addition, the government is committed to meeting the reduction targets under the National Emission Ceilings Directive (NEC). Specific targets include stopping the sale of new diesel or petrol cars by 2030; stopping hybrid cars by 2035; cleaner transport in urban and rural areas; greener shipping at sea and in ports; efficient and modern agricultural sector; more environmentally friendly heating of homes. The ecological status of lakes, rivers and groundwater has improved in eastern Denmark, but problems with meeting the requirements of the EU Water Framework Directive (WFD) remain. Denmark expects to achieve the WFD targets for 50 of its 119 coastal water areas by 2021. To this end, € 830 million, more than half of the RBMP budgets for 2015-21, are earmarked. for the creation of wetlands, afforestation, protection of agricultural land, fast-growing crops and areas with an ecological focus (where agricultural production is prohibited). Another third of the budget goes to wastewater treatment, and the remaining 13% is related to the restoration of lakes and rivers.

1.2. Spain

Air quality in Spain has improved and is usually good in most urban areas. The percentage of urban population exposed to PM10 emissions above the daily limit values set by the EU (50 µg / m3) has decreased significantly since 2006 and has fallen below the EU average in 2010. Exposure to air pollution from urban ozone (O3) has been consistently higher than the EU average since 2009, following some decline and stabilization between 2004-08. Overall, emissions of air pollutants have decreased since 2000, thanks to a combination of factors, including changes in Spain's energy mix (increased use of natural gas and renewable energy sources), better quality fuel (especially lower sulfur content), reduction measures in the industrial and energy sectors (e.g. flue gas desulphurisation, reduced solvent use) and improved vehicle emission standards. Significant progress has been made in reducing SOx emissions, which fell by more than 70% in 2000-12, faster than the OECD average. Surface water quality has improved and is usually better than in many European countries. Spain accounts for about 10% of reported bathing water in the EU. The country has managed to implement the EU directive on bathing water in coastal sites. In 2013, the water quality of 97.1% of coastal bathing waters was satisfactory and 90% of the sites showed excellent quality. In view of the reduction in the natural availability of water and the restrictions on increasing the amount of water abstraction of conventional freshwater resources, reused water and desalination play an increasing role. In 2008, seawater desalination capacity increased significantly, including the construction of Europe's largest plant in Murcia, southeastern Spain.

1.3. The Netherlands

Air quality in the Netherlands has improved significantly in recent decades. Concentrations of emissions of major air pollutants in Dutch traffic have decreased significantly, although some problem areas remain around the main cities and some transport corridors. The number of deaths related to air pollution decreased by 16% between 2005 and 2010. The main factor influencing general trends in air quality since 2000 is the implementation of EU air quality

legislation through the implementation of measures in national policy. The Netherlands achieves very high levels of compliance for drinking water quality and urban wastewater treatment. Water supply for public supply decreased by 7% in 2000-10. and represents only 11% of total freshwater abstraction in 2010. Most of the Dutch drinking water comes from groundwater, while less than 40% comes from surface water. Households account for more than 70% of drinking water consumption, but this share has decreased by 2% since 1990 due to water savings. This represents a significant decoupling from population growth, which increased by 13% over the same period. Over 99% of domestic wastewater is treated before being discharged into surface water bodies. Almost the entire population is connected to wastewater treatment plants that apply tertiary treatment. Households account for more than 70% of drinking water consumption, but this share has decreased by 2% since 1990 due to water savings. This represents a significant decoupling from population growth, which increased by 13% over the same period. Over 99% of domestic wastewater is treated before being discharged into surface water bodies. Almost the entire population is connected to wastewater treatment plants that apply tertiary treatment. Households account for more than 70% of drinking water consumption, but this share has decreased by 2% since 1990 due to water savings. This represents a significant decoupling from population growth, which increased by 13% over the same period. Over 99% of domestic wastewater is treated before being discharged into surface water bodies. Almost the entire population is connected to wastewater treatment plants that apply tertiary treatment.

1.4. New Zealand

New Zealand's air quality is good by international standards. According to OECD estimates, the average annual exposure of New Zealanders to particulate matter (PM2.5) is among the lowest in the community. The improvement in air quality is mainly due to the transition from wood heating to electricity and gas heating; the introduction of national emission standards, improved insulation on buildings; and the introduction of vehicle standards. Urban air quality is generally good compared to many cities in other OECD member countries; average concentrations of fine particulate matter and NOx generally meet national standards or international air quality guidelines.Water is relatively abundant in New Zealand due to the temperate climate and marine weather patterns. The country has more than 425,000 km of rivers and streams, about 4,000 lakes and over 200 underground aquifers. The annual water flow is 145 million liters per person. A reliable supply of good water is an important economic advantage for New Zealand. New Zealand's freshwater resources are vital to the primary sector and tourism, as well as to the country's culture. Agriculture is the dominant land use; Dairy production has grown rapidly in recent decades in response to high global milk prices. Water pollution from the cumulative effects of diffuse runoff from agricultural and urban rainwater is a growing problem for the environment and public health. For the Maori people, freshwater is a "taonga" (culturally valuable resource), ie. it is essential for their lives and identities, and they assert their right to jointly manage water resources and take an active part in decision-making processes.

Soil quality data obtained from 11 regions in New Zealand show that more than 83% of the sites surveyed meet the standards for five of the seven indicators (pH, total algae, total nitrogen, mineralized nitrogen and bulk density.

1.5. Japan

In the field of air quality, Japan is still one of the best performing countries among the OECD members. The country has a system for continuous monitoring of 11 air pollutants: Atmospheric Regional Environmental Monitoring System, "Soramame-kun". The system has two types of monitoring stations: common to the atmosphere (1581 stations in 2016) and roadside air monitoring stations (451 stations in 2016). The system site displays the processed information in near real time on a distribution map, where concentration values are reported through a color coding system. In addition, the system shows warnings about the amount of photochemical oxidants in the last seven days. Overall, water quality in Japan is good, especially in terms of protecting human health. Water quality is monitored at about 9,000 points in public water areas across the country (rivers, lakes and seas) and groundwater. The level of compliance with water quality standards related to human health reached 99.1% in 2005. The level of compliance for closed water bodies (lakes and reservoirs and marine and coastal areas), which often receive more pollutants than terrestrial activities around highly populated areas show less improvement in quality than for rivers.

2. Policies and laws related to environmental protection

2.1. Denmark

Denmark has a well-functioning environmental policy and management system that benefits from high levels of cooperation and consensus. Its strengths include an informal system of inter-party political agreements, strong involvement of civil society in policy-making and high-quality independent advisory bodies. Interagency coordination on environmental policies at the central level is well established.The country has a decentralized environmental management system in which environmental jurisdiction is shared between national, local and, to a lesser extent, regional levels. The national level defines the legal framework and provides guidelines for implementation. It also develops national plans, programs and strategies. Local authorities are responsible for municipal and local planning; implementation of policies, plans and programs; and the issuance of most environmental permits and related inspections. Some domestic measures to help improve air quality include financial support for low-emission fertilizers and regulation of urea-based chemical fertilizers. Other ways to address air quality problems in Denmark include national air quality monitoring and compliance with relevant multilateral environmental agreements. Denmark uses economic instruments to reduce emissions (eg NOX tax) and has been applying emission standards for wood-burning stoves since 2008, as well as supporting international work in this area. In 2013, Parliament adopted the revised Water Planning Act, transposing the EU WFD and establishing the legal framework for river basin management. It provides for the active participation of civil society in the preparation of the RBMP through municipal water councils, including representatives of environmental and agricultural groups. To facilitate their work, the government informs them of the effectiveness of expenditure measures, which can be applied in the catchment. In order to improve water quality in a more targeted (ie risk-based) way, Denmark is implementing a new policy. For each of its 90 river basins, it has been calculated by how much the excess nitrogen in agriculture must be reduced in order for coastal waters to achieve good status according to the WFD. In parallel, the amount of nitrogen retained in the soil downstream from farms to coastal waters was calculated on the basis of 3,000 points. By combining the required reduction in each sub-basin with the degree of retention in the soil, Denmark determines the efforts to be made at each of the 3 000 points. For each of its 90 river basins, it has been calculated by how much the excess nitrogen in agriculture must be reduced in order for coastal waters to achieve good status according to the WFD. In parallel, the amount of nitrogen retained in the soil downstream from farms to coastal waters was calculated on the basis of 3,000 points. By combining the required reduction in each sub-basin with the degree of retention in the soil, Denmark determines the efforts to be made at each of the 3 000 points. For each of its 90 river basins, it has been calculated by how much the excess nitrogen in agriculture must be reduced in order for coastal waters to achieve good status according to the WFD. In parallel, the amount of nitrogen retained in the soil downstream from farms to coastal waters was calculated on the basis of 3,000 points. By combining the required reduction in each sub-basin with the degree of retention in the soil, Denmark determines the efforts to be made at each of the 3 000 points.

Legislation in Denmark on rainwater reuseis very strict and forces companies to focus on optimal design and safety. It must be documented that there is no contact between the rainwater system and the drinking water system.

Copenhagen torrent management plan

Copenhagen has experienced a number of extreme rains since 2010 and these events are expected to recur in the coming years. As extreme rainfall is a huge challenge that varies from region to region, it cannot be solved with one initiative, such as the modernization of the sewerage system. For this reason, the City of Copenhagen has decided on a coordinated and consolidated action, combining solutions appropriate to each area. The result is the launch of a Flood Management Plan in 2012. The plan outlines the methods, priorities and measures recommended in the field of climate adaptation, including extreme rainfall. It covers 7 catchment areas and has led to the development of a catalog of about 300 surface projects that will be completed over the next 20 years.

2.2. Spain

The decentralization of powers and competencies, which began with the approval of the Constitution in 1978, has transformed Spain from one of the most centralized countries in the OECD into a quasi-federal system with a high level of decentralization. Today, all 17 autonomous communities have a strong regional and political identity and are

effectively autonomous in their areas of competence. Spain's regulatory framework for air pollution includes two main measures - the Law on Air Quality and Atmospheric Protection (34/2007) and the National Plan for Air Quality and Atmospheric Protection 2013-16, called Plan Aire. The law requires the AU and cities with more than 100,000 inhabitants to develop and adopt programs to improve air quality and meet the targets set for their territory.Spain has also launched three programs in support of cleaner vehicles: the five-phase program for effective vehicle incentives (PIVE), which aims to modernize the national car fund; The Electric Vehicle Promotion Action Plan 2010-14 (MOVELE), which aims to have 250,000 electric vehicles on Spanish roads by the end of 2014; and the Environmental Promotion Plan (PIMA Aire), which aims to renew the fleet of commercial vehicles with more efficient and less polluting vehicles. Special institutional arrangements apply in the water sector, where the central government manages marine and interregional waters and the AU manages intraregional waters. Spain also emphasizes improved drought management practices, requiring the development of drought management plans at river basin level and drought emergency plans in cities with more than 20,000 inhabitants. The approach has shifted from simply responding to cyclical droughts to proactive management approaches in line with the European Commission's 2007 recommendations on water scarcity and droughts. Spain has introduced a wastewater discharge program to reduce pollution and the negative impact of wastewater on the aquatic environment. According to this program, wastewater must be returned to the natural environment (rivers or aquifers) under the quality conditions prescribed in the discharge permits. These permits, which must be compatible with the host environment, are regulated by a list of "concentration limits" for basic physicochemical parameters. The requirements take into account the best available techniques (BAT) and environmental quality standards (EQS). Discharge permits are registered in the "Wastewater Census" and are subject to a wastewater control fee. In 2012, the Spanish Royal Decree RD 1290/2012 imposed the need to reduce the contribution of new urban developments to the volume of rainwater runoff. In 2013, the approved Spanish Royal Decrees RD 233/2013 and RD 400/2013 encouraged the use of sustainable drainage techniques in the management of rainwater drainage, especially in new urban buildings, which may affect the drainage behavior of the catchment. The requirements take into account the best available techniques (BAT) and environmental quality standards (EQS). Discharge permits are registered in the "Wastewater Census" and are subject to the payment of a wastewater control fee. In 2012, the Spanish Royal Decree RD 1290/2012 imposed the need to reduce the contribution of new urban developments to the volume of rainwater runoff. In 2013, the approved Spanish Royal Decrees RD 233/2013 and RD 400/2013 encouraged the use of sustainable drainage techniques in the management of rainwater drainage, especially in new urban buildings, which may affect the drainage behavior of the catchment. The requirements take into account the best available techniques (BAT) and environmental quality standards (EQS). Discharge permits are registered in the "Wastewater Census" and are subject to a wastewater control fee. In 2012, the Spanish Royal Decree RD 1290/2012 imposed the need to reduce the contribution of new urban developments to the volume of rainwater runoff. In 2013, the approved Spanish Royal Decrees RD 233/2013 and RD 400/2013 encouraged the use of sustainable drainage techniques in the management of rainwater drainage, especially in new urban buildings, which may affect the drainage behavior of the catchment. Discharge permits are registered in the "Wastewater Census" and are subject to the payment of a wastewater control fee. In 2012, the Spanish Royal Decree RD 1290/2012 imposed the need to reduce the contribution of new urban developments to the volume of rainwater runoff. In 2013, the approved Spanish Royal Decrees RD 233/2013 and RD 400/2013 encouraged the use of sustainable drainage techniques in the management of rainwater drainage, especially in new urban buildings, which may affect the drainage behavior of the catchment. Discharge permits are registered in the "Wastewater Census" and are subject to the payment of a wastewater control fee. In 2012, the Spanish Royal Decree RD 1290/2012 imposed the need to reduce the contribution of new urban developments to the volume of rainwater runoff. In 2013, the approved Spanish Royal Decrees RD 233/2013 and RD 400/2013 encouraged the use of sustainable drainage techniques in the management of rainwater drainage, especially in new urban buildings, which may affect the drainage behavior of the catchment.

2.3. The Netherlands

The Netherlands is a pioneer in developing comprehensive environmental plans that set out a long-term, strategic vision. The first plan was developed in the 1980s, while the fourth and most recent (NMP4) was issued in 2001. The

government uses a number of different initiatives to promote environmental goals, focusing on various topics and environmental media. One such major initiative is the Delta Program launched in 2010, which focuses on water management. There is currently a drive to modernize environmental policies. The modernization approach emphasizes more active international cooperation, recognizing both the global nature of environmental issues (such as climate change) and the impact of international fora (in particular the EU) on environmental policy.
The Dutch policy for achieving good air quality has two objectives:

- limiting emissions of harmful substances;
- prevention of long-term exposure of people to pollution

EU limit values for concentrations of air pollutants are incorporated into Dutch law through the Environmental Management Act. The National Air Quality Cooperation Program addresses areas that are expected to exceed air quality limit values. The program was intended to last until August 2014, but was subsequently extended until January 1, 2017. NSL is a cooperation program between the national government and local authorities. Regional Air Quality Cooperation (RSL) programs, under the responsibility of provinces and municipalities, are also part of the NSL. The Dutch government is providing more than 1.55 billion euros to reduce background and peak concentrations of air pollutant emissions. For example, about € 554 million has been used to subsidize the implementation of diesel particulate filters. Water management in the Netherlands has gone through two phases: centralized water management until 2000 and water management, in line with the EU, since 2000. Water regulation in the Netherlands is characterized by a multi-level management system from the European Union to the local level. It is built on a relatively high degree of decentralized model with the motto "decentralized when possible, centralized when necessary". According to the 2009 Water Act, the central government, provinces, municipalities and water councils have joint responsibility for water resources management. and water management, in line with the EU, since 2000. Water regulation in the Netherlands is characterized by a multi-level management system from the European Union to the local level. It is built on a relatively high degree of decentralized model with the motto "decentralized when possible, centralized when necessary". According to the 2009 Water Act, the central government, provinces, municipalities and water councils have joint responsibility for water resources management. and water management, in line with the EU, since 2000. Water regulation in the Netherlands is characterized by a multi-level management system from the European Union to the local level. It is built on a relatively high degree of decentralized model with the motto "decentralized when possible, centralized when necessary". According to the 2009 Water Act, the central government, provinces, municipalities and water councils have joint responsibility for water resources management.
For decades, Dutch water management has relied on major structural solutions and engineering approaches to provide flood protection and meet freshwater needs. A new approach, known as the Place for the River, has recently been developed, combining innovative architecture, urbanization and landscaping to achieve environmentally friendly goals. An important change in Dutch water management has been achieved at local, national and regional level in the EU since the beginning of the twenty-first century. Governments are moving towards integrated water resources management (IWRM), which is defined as “a process that promotes the coordinated development and management of water, land and related resources in order to achieve the most effective economic and social well-being in a fair way,

2.4. New Zealand

New Zealand's environmental management system is unique in many ways. Although a unitary state, the country has largely decentralized functions of regulating and ensuring compliance with regional and territorial authorities; national environmental standards and regulations cover only a limited number of issues. Most environmental impacts are managed through a single piece of legislation - the Resource Management Act 1991 (RMA), which closely integrates land use planning and environmental regulation. Since 2007, New Zealand has made significant progress in strengthening cooperation and stakeholder engagement with Maori communities at national and regional level and implementing the recommendations of the OECD reports in the field of environmental information and education. Regional councils and unitary bodies are responsible for air quality management under the Resource Management Act. They are required to identify and monitor areas where air quality is likely or known to exceed national environmental air quality standards (NESAQ). These areas are known as "airsheds". 'Airshed' is a geographical

boundary defined by the regional council or the single air quality management body, where part of the atmosphere is considered to behave uniformly, especially with regard to the distribution of emissions. Monitoring is performed in airsheds that are at risk of violating NESAQ for one or more pollutants. The number of monitoring sites within an airshed varies. "Airsheds" may have more than one monitoring point, as individual sites are often not representative of the entire airshed and can monitor for different sources of pollutants. RMA 1991 regulates the environmental responsibilities of regional councils. With regard to freshwater management, the responsibilities of the councils include managing water risks - drought, floods, water pollution and degradation of freshwater ecosystems - and land use activities that address these risks. The areas of jurisdiction of the regional council are based on the boundaries of the catchment, which allow water management at the catchment level, controlled by one regional council. More specifically, this includes regulation of: water abstractions, diversions, storage and minimum and maximum flows; direct and indirect discharges of pollutants into water bodies; avoidance or mitigation of natural hazards, including protection against floods and water restrictions during drought; and freshwater ecosystems and local biodiversity.Recognizing the need for restrictions on water resources distribution and water quality, the Ministry of Environment (ISA) issued a National Freshwater Management Declaration (NPS-FM) in 2011. NPS-FM directs all regional councils to set targets and norms and introduces methods to achieve the desired results in terms of water quality and quantity in all water bodies. In addition to addressing water quantity and quality issues, in addition, the objectives and requirements of the NPS-FM cover: (i) integrated management (for land development and use, provision of infrastructure and coastal waters); (ii) monitoring plans; (iii) reporting on freshwater intake and pollutants; (iv) Tangata Whenua roles and interests; and v) progressive implementation.

Water pollution is against the law. The Resource Management Act 1991 (RMA) is New Zealand's environmental legislation. Section 15 of this law prohibits the unauthorized discharge of pollutants into land and water. Simply put, this means that only clean rainwater can be discharged into external rainwater channels or into streams, rivers, lakes or the sea. It is illegal to cause pollution and the fine is up to $ 750 for minor incidents of pollution.

2.5. Japan

Policies in Japan are well supported by laws and regulations, and monitoring and enforcement are properly implemented. Air quality management, as in other key areas of the environment, is still largely based on the legal framework developed in the 1970s and in the Basic Law on the Environment, adopted in 1993. Following the relatively centralized structure of the Japanese government, most of the responsibilities for environmental policy remain at the central level. The Ministry of the Environment has exclusive jurisdiction over several issues related to air pollution. These include the setting of both ambient air quality standards and emission limit values, formulating policies to reduce total emissions and defining regulatory facilities. The ISA's annual budget has almost tripled in the last decade, without - however - having a major impact on air quality resources. Prefectures, the lower level of government, have limited decision-making power over air quality and are primarily responsible for monitoring and enforcement. They can set stricter emission standards than those set by the central government, as in several other OECD countries, and they are also responsible for monitoring and enforcing air quality regulations and operating the permit system. In this context, they also have a responsibility to warn the public when the concentration of selected pollutants (SOx, SPM, CO, NOx, OX) reach levels considered dangerous to human health. The desired status of environmental water quality is defined as the water quality standard (WQES), as defined by the basic environmental law. Two types of WQES are set: one is for the protection of human health with 26 parameters related to hazardous substances such as cadmium, cyanide and fluoride; the other is WQES for environmental protection with parameters and values differentiated by water bodies and purpose for water use. The parameters and values of WQES are reviewed and revised, where necessary, in accordance with new scientific discoveries and emerging social requirements for water quality (Article 16 of the Basic Law on the Environment). The government of the capital in Tokyo introduced its main policy for heavy rainfall in August 2007. The policy has three main objectives: to protect life during flood disasters, to provide the necessary urban functions during floods and to reduce property damage caused by floods. The policy strikes a balance between implementing measures to protect against heavy rainfall in recent years and maintaining compatibility with previous plans. The long-term (30-year) plan for the entire Tokyo region is to:

- Eliminate flood damage during rainfall up to 60 mm / h.
- Protect as much as possible against surface and underground floods during rainfall up to 75 mm / h.
- Safe life and safety compared to the latest maximum rainfall levels.

The following measures will be implemented in priority zones / zones over the next 10 years: Protect as much as possible from surface and underground floods during rainfall up to 55 mm / h.

- Safe life and safety compared to the latest maximum rainfall levels.

3. Application of effective and applicable models for sustainable management of urban rainwater. Cases

Sustainable drainage systems are designed to maximize the opportunities and benefits we can provide from surface water management. There are four main categories of benefits that can be achieved by SUDS: good water quality and quantity, benefit from its useful functions and biodiversity. These are the four main pillars in the design of SUDS systems. SUDS systems can be built in a variety of forms both above and below ground. It is generally considered that SUDS projects, which aim to manage and use rainwater close to the source and, built on the surface and involving greenery, provide the greatest benefits. Most SUDS projects use a combination of individual SUDS components to achieve common site design objectives.

Efforts to create more climate-resilient cities in Denmark are under way with a national action plan for climate-resilient. Denmark has many good examples of green, innovative solutions. Just a decade ago, most cities in Denmark saw rainwater as something to get rid of and hide in the sewers - not as a valuable resource as it really is. Today, the situation is quite different, as water is again sees it as an asset with huge potential to improve the daily lives of people living in cities. More and more Danish cities and water companies are trying to manage rainwater as close as possible to the source and divert it from sewage systems and treatment plants, thus reducing the risk of combined sewage overflow.

"Water in urban areas" (established in 2010) is an innovation network consisting of 150 training institutions, government agencies and municipalities, utilities and private companies (tetra-spiral structure). The aim of Water in Urban Areas is to develop, document and present climate adaptation technologies and related planning tools for the transformation of existing urban areas in Denmark. All information and experience with SUDS systems in Denmark is collected on the website: www.sudsindenmark.dk

Over the last 20 years, great efforts have been made to increase knowledge of SuDS techniques and their presentation. In this sense, the contribution of various research centers such as the universities of Cantabria, Madrid, La Coruna and Zaragoza; and the polytechnics of Catalonia and Valencia are very remarkable. Over the last 50 years, the huge economic growth observed in Spain has led to massive migrations from rural to urban areas, causing rapid growth in urban centers. The uncontrolled expansion of cities, especially in the tourist regions of the Mediterranean, has led to the waterproofing of the natural soil in the urban environment, increasing the problems associated with the management of urban rainwater. In addition, due to the geographical location of Spain, there are different climate models, which leads to different problems related to urban water management depending on the specific geographical area of the country. While in northern Spain large amounts of rainfall, which spread throughout the year, can lead to flood problems, in some regions of southern Spain it is normal to find periodic droughts during the summer. Another case is the eastern coast of the Mediterranean region, which suffers from the effects of reduced flow levels in the autumn, followed by torrential rains, creating flood problems.

SuDS solutions can be included in the design of both newly built sites and converted in the diverse Mediterranean climate in Spain, from the rainy north to the areas of the south, where droughts are a problem at certain times of the year. In keeping with the Dutch proverb that "God created the world and the Dutch created the Netherlands", the country is largely an engineered landscape project created by swamps and marshes. One third of the Netherlands is below sea level and two thirds are vulnerable to floods. Dutch identity and society arose from the common need to push the sea away from the lands.

According to climatologists, in 100 years the climate in the Netherlands will be the same as in the south of France, and Amsterdam will be like Venice in the north. Traditional infrastructure in Dutch cities, such as canals and

sewerage systems, does not have the capacity to cope with the increase in rainwater. One of the key concepts of Dutch water management is a three-step approach that involves capturing, storing and draining water - similar to the function of a sponge. This means that rainwater must be kept as long as possible in the catchment area, close to the source. Where this is no longer possible, storage facilities set up for this purpose must temporarily store water. Excess water should only be drained when the first options have already been used to their full capacity.

Dutch water management concept. Climate-resistant cities

In recent years, the Netherlands has been working to create Climate proof cities, a project related to sustainable water management. For example, the national initiative "Space for rivers" in 2007 and other similar practices, such as "Building together with nature", give an idea of a unique combination of land, water and environmental management. Urban water retention aims to deal with torrential rains for a short period of time by using a small amount of water buffer space in urban areas (Gemeente Rotterdam, 2007). In 2014, the OECD described the Dutch water management as a "world example" and praised the country for having a stable and regulated institutional and policy framework. The Netherlands is an example in which the specific objectives of the adoption of the LID or WSUD are determined by local geographical circumstances. Much of the Netherlands includes polders that have been reclaimed from the sea and whose surfaces are below sea level, protected by dikes. In recent years, many Dutch cities have combined an integrated future vision for urban development and habitability with strategies for drainage, water management and climate adaptation. Technical measures taken can be seen in the plans of cities such as Rotterdam and Amsterdam, which include the implementation of SUDS such as bio-drainage ditches, green roofs, water retention areas and increasing the capacity of water retention facilities. which have been recaptured from the sea and whose surfaces are below sea level, protected by dikes. In recent years, many Dutch cities have combined an integrated future vision for urban development and habitability with strategies for drainage, water management and climate adaptation. Technical measures taken can be seen in the plans of cities such as Rotterdam and Amsterdam, which include the implementation of SUDS such as bio-drainage ditches, green roofs, water retention areas and increasing the capacity of water retention facilities. which have been recaptured from the sea and whose surfaces are below sea level, protected by dikes. In recent years, many Dutch cities have combined an integrated future vision for urban development and habitability with strategies for drainage, water management and climate adaptation. Technical measures taken can be seen in the plans of cities such as Rotterdam and Amsterdam, which include the implementation of SUDS such as bio-drainage ditches, green roofs, water retention areas and increasing the capacity of water retention facilities.

Amsterdam

Amsterdam aims to cope with rainfall of 60 mm / h by 2020, without damaging buildings and urban infrastructure, and to be a fully "waterproof" city by 2050. The public company Waternet, which is the water company for Amsterdam and the surrounding area has developed its strategy for adapting to climate change, creating its "Amsterdam Rainproof" program, which contains several measures to deal with increasing rainfall. In order to comply with its service level agreement, the company chooses soft policy instruments such as encouraging and informing local residents, business owners and government officials to work on the design of roofs, streets, gardens, parks and squares that can be cope better with heavy rainfall. Amsterdam has identified 1, EUR 75 million from a total budget of EUR 70-77 million for the period 2016-2021 to launch the Amsterdam Rainproof policy. This amount does not include the costs of the actual implementation of the project, but only the costs of salaries, research and workshop costs.

Eiburg

Eiburg is a newly created island near Amsterdam, with houses designed by various architects. Water management is done in three ways: rainwater collected from roofs is filtered before it enters the soil, wastewater and rainwater are separated, rainwater is treated before it is returned to the environment, and sewage receives domestic wastewater. Some houses even have the option of processing gray water, which the owners may request from the builder.**SUDS solutions can be used even in the smallest spaces**- the apparent lack of space should never be a reason for not using SUDS. Designing SUDS so that the space performs many functions is especially important in dense urban areas where free space is a luxury.

Utrecht

The Utrecht Service Level Agreement provides for the municipality to prevent flooding of streets and to ensure that public infrastructure remains usable in case of rainfall below 20 mm / h.
In 2015 and 2016, the municipality invested EUR 6 million each to improve and replace parts of the sewerage system and EUR 1 million to replace the asphalt with green areas and to separate the sewerage system from the rainwater drainage system.To the west of Utrecht, in the area formerly known as De Meern, is Leidsche Rijn. Leidsche Rijn was built by merging three former villages and is a series of individually designed neighborhoods that were not planned in advance. In this project, water plays an important role in recreation, decoration and the environment. In the center of Leidsche Rijn there is a green area of 300 ha, which connects the individual autonomous districts. In this "natural" area, rainwater is collected and stored for future use. As surface waters are of great importance, goals have been set to keep them clean. Due to population density, pets and unexpectedly high car use, a pilot plant has been set up consisting of 13 processing sections using sand, iron and calcium carbonate, with reed layers to provide vertical runoff to help filter out contaminants such as phosphorus. The water in Leidsche Rijn comes from two main places; 80% of rainwater and 20% of seepage groundwater. Much of the green area allows rainwater to seep slowly into the soil and thus allows its natural purification. Leidsche Rijn also has an underground system for sustainable waste collection, which keeps the streets clean of rubbish, which can potentially affect the quality of groundwater and runoff. Also, the hot water used in the district heating network can also be used for household appliances (dishwashers and washing machines), which allows this water to perform more than one function without the energy-intensive process to make it drinkable. to help filter out pollutants such as phosphorus. 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Rotterdam

Due to the fact that Rotterdam is located 2 meters below sea level, the city is surrounded by dikes and has a complex pumping system that protects the city from floods. Most security systems around Rotterdam are designed to withstand a storm that is expected to occur once every 10,000 years. Until now, water management strategies have seen water primarily as an invasive threat, focusing on safety, quantity and quality issues. That changed in 2007, when it became increasingly clear that Rotterdam would be severely affected by climate change. In response, Rotterdam is developing Waterplan 2, a comprehensive collaborative approach to spatial planning and water management. As a city at the mouth of an estuary, Rotterdam has long considered water to be one of its main attractions and now, with the second water plan, the city uses water as an opportunity, focusing on management strategies that ensure safety while improving the urban landscape and promoting interaction with water. One of the most innovative solutions used by the city of Rotterdam is the water plaza. This solution contributes to the quality of the public space and uses technical rainwater management systems. During periods of drought, the square is used as an open public space, while during heavy rains the square is used for temporary storage of rainwater. The design of the pilot water square type includes a sports field and a playground. The site is located about one meter below the level of its surroundings and surrounded on all sides by steps where people can sit. The playgrounds are located on different levels. For 90% of the year the space is dry and used for recreation. The square changes its function only during heavy rain: Then the rainwater floods the square - starting from the playground area, filling the carefully arranged depressions in the ground gradually creating streams, streams and small ponds. If the rain lasts longer, the sports field also fills up. When completely filled, the water area can hold a maximum of 1000 m3. After the rains are over, the rainwater is retained for several hours, after which it is slowly drained into Rotterdam's sewage systems. Then the rainwater floods the square - starting from the area of the playground, filling the carefully arranged depressions in the ground, gradually creating streams, streams and small ponds. If the rain lasts longer, the sports field also fills up. When completely filled, the water area can hold a maximum of 1000 m3. After the rains are over, the rainwater is retained for several hours, after which it is slowly drained into Rotterdam's sewage systems. Then the rainwater floods the square - starting from the area of the playground, filling the carefully arranged depressions in the ground, gradually creating streams, streams and small ponds. If the rain lasts longer, the sports field also fills up. When completely filled, the water area can hold a maximum of 1000 m3. After the rains are over, the rainwater is retained for several hours, after which it is slowly drained into Rotterdam's sewage systems.

Water-sensitive design in urban environments has been implemented in New Zealand, with a concentration in Auckland - the fastest growing city in Australia. In many places, stand-alone rainwater treatment devices are used, such as rain gardens or drainage ditches. Sequences of multiple rainwater treatment methods, combined with retention in sensitive areas, reduction of impermeable surfaces, and avoidance of highly polluting building materials, are increasingly common solutions, especially for larger, project or urban plans. Such solutions show that WSD can fulfill its main goal of increasing the resilience of aquatic and terrestrial ecosystems to the intensive impacts of urban rainwater runoff. Maori values emphasize the importance of water, seen as a living being with a unique "mauri" (life force or spiritual health) and as part of the people, expressed in the proverb "I am the river and the river is me." The passage of urban runoff through the soil can restore the "mauri" of rainwater.In New Zealand, there is usually great potential for implementing WSD in ways that not only restore matauranga mauri to water, but also to promote maori (traditional knowledge). Increasingly, WSD projects are based on 'Maori' in consultation with the 'Tanga Uenua' - Maori with traditional links to an area. This approach also informs landscape design, which enhances the local 'sense of place' through the use of native plants, materials, models and sculptures. WSUD is also included in the national

highway design guidelines published (in 2014) by the New Zealand Transport Agency, as one of the ten design principles that must be applied to all major transport projects. Common WSD systems, used in state highway projects to improve New Zealand's environmental and social well-being are bio-drainage ditches and wetlands. In 2010, New Zealand's Transport Agency updated its design specifications to include SUDS systems and devices. The specifications recommend the use of wetlands where peak control or flow erosion protection is a priority if the catchment area and size are appropriate. The LIUDD program is one of New Zealand's current research efforts for WSUD, focusing on the cities of Auckland, Taupo and Christchurch. New Zealand's LIUDD innovations are mainly focused on finding environmentally sensitive approaches to urban rainwater management (introduction of rain gardens, green roofs, drainage ditches, retention lakes and use of environmentally friendly permeable surfaces). LIUDD innovations call for alternative, cost-effective urban design and development that includes designing and working with nature - creating a society that respects, preserves and enhances natural processes. Compared to many countries, New Zealand's LIUDD program has additional imperatives, as New Zealand's landscape has changed dramatically over the past 150 years. Thousands of species of plants and animals have been introduced into their primary environment. Exotic trees, shrubs and herbaceous species from Europe, Australia, North and South America, South Africa and Asia have traditionally favored less productive native species. The term "low impact" introduces the idea of reducing the impact of human activities on natural processes,

WSUD systems and solutions in Auckland: Engines of design

Auckland, Tamaki Macaurau ("Lovers' Tamaki") and the "city of ships", home to 1.66 million people, is located on a narrow isthmus between two ports. Rainwater runoff is recognized as a major factor in water quality and the health of coastal and river ecosystems. In the older areas of the city there are combined overflows in the sewerage. To cope with population growth, Auckland local authorities plan capital investments of around NZD 490 million per year in the coming years (2017-26), significantly more than investments in the 2000s (around NZD 100 million on average per year) and the first half. since 2010 (approximately NZD 200 million).Moving towards a sustainable approach to water management and infrastructure investment, the Auckland Council initiated the Greenways program, which encourages government action and investment in a number of planning and operational units to achieve multiple objectives of the same investment. These goals include solutions related to rainwater management, drinking water, biodiversity, and transportation. The Auckland Council 2013 set a vision to become the best city to live in. The city is always at the forefront of international surveys of the best cities to live in. The Auckland environment supports its viability. Environmental protection has been identified as the number one priority for residents of the North Shore, one of the five areas that make up Auckland.

In recent years, more and more municipalities in Japan are using rainwater. Blessed with high rainfall compared to other countries, as the post-war period of urban development, Japan tends to cope with this abundance by "throwing away" rainwater. Over the years, however, this thinking has gradually shifted to using the benefits of rainwater as a natural resource.

The earthquake and tsunami that hit northern Japan in March 2011 caused a sudden increase in the number of households installing rainwater storage tanks for emergencies. The size and type of these tanks vary widely, from a small storage capacity of 100 liters to a large storage capacity of 1000 liters, including tanks used as terracotta garden furniture. Installation costs range from a few thousand yen to several tens of thousands of yen. The number of municipalities offering subsidies for the installation of rainwater tanks is also increasing. In April 2014, the Japanese government passed the Rainwater Improvement Act, which will take effect in May next year. According to the law, municipalities must make every effort to define and work to achieve the goals of rainwater use, and the national government must provide financial support for subsidy programs. With these new responsibilities provided for the national government, local authorities and businesses, a national move to promote rainwater use can be expected.

4. Examples of sustainable drainage systems applicable to the municipality of Dupnitsa and the municipality of Targovishte

4.1. Rainwater collection

Sumo Wrestling Arena, Sumida, Japan

The sumo wrestling arena in the city of Sumida makes extensive use of rainwater. The 8,400 m2 roof of this arena serves as a catchment area for the rainwater recovery system. The system drains the collected rainwater into an underground storage tank of 1000 m3 and uses it for washing toilets and air conditioning. Following this example, many new public facilities, including the town hall, have begun to implement rainwater recovery systems.

Dome of Fukuoka, Fukuoka, Japan

Fukuoka Dome is one of the largest gyms in Japan with a capacity of 50,000 seats. The large roof of the building (32,000 m2) is suitable for collecting rainwater. The collection and use of rainwater is carried out through a system consisting of roof catchments, collector pipes, a sedimentation tank and a rainwater storage tank with a volume of 2900 m3. Before being used for washing toilets, rainwater is treated by sand filtration and chlorination. When water needs exceed the available quantity, regenerated water is purchased. According to the management of the hall, the installed equipment contributes to reducing water consumption by 10%. 40% of the total annual water consumption in the hall is covered by the collected and regenerated water. Given the annual rainfall of 1600 mm in the Fukuoka region,

Rojison, Mukojima, Japan

At the Community level, a simple and unique Rojison rainwater recovery facility has been set up by locals in Tokyo's Mukojima district to recover rainwater collected from the roofs of private gardens for watering gardens, putting out fires and drinking water in critical areas. situations. To date, about 750 private and public buildings in Tokyo have introduced rainwater collection and utilization systems. The use of rainwater is now thriving on both the public and private levels.

G-cans, Tokyo, Japan

Tokyo is focused on structural and non-structural measures to control rainwater runoff. For example, the city is investing in and building huge tunnels, such as the G-cans, and at the same time the local government is encouraging residents to use BMP and groundwater infiltration systems. To address the fears of floods and the adverse effects of rainwater runoff and torrential rains, Tokyo is investing in underground infrastructure using five silos and culverts to transport water outside the city; This is called the Metropolitan Area Outer Underground Discharge Channel or G-Cans Project and is the largest underground rainwater diversion facility in the world.

4.2. Impermeable flooring

Dealing with rainwater in densely populated areas with impermeable pavement

With regard to infiltration from permeable areas, the experience from Denmark shows that it is possible to build permeable pavement with and without infiltration. If, for example, the municipality is concerned about the water quality of the runoff from a larger car park, it is possible to build a permeable pavement with a membrane underneath and divert the runoff through pipes to a collection well. When taking samples with a certain frequency determined by the municipality, it becomes possible to document the quality of the runoff from the parking lot and to assess whether it is possible or not to allow infiltration of the runoff in the long run.

Japan is struggling with the heat island effect

Street water retention is used in many cities in Japan, such as to counteract the effects of the heat island. As a weakness of this pavement, however, it is observed that the effect of reducing the temperature of the road disappears within 2 or 3 days if there is no precipitation. As a solution to this problem, a new type of flooring has been developed for water retention with water supply from a rainwater storage tank. An example is the Minato neighborhood, which installed a water retention unit in a public square called SL Square (Steam Locomotive). The water spray pipe (10 mm with inner diameter and 15 mm with outer diameter) is installed under the water retention block made of ceramic, and the water flowing out of the pipe is fed to the whole block. The fallen rainwater on the

square is collected from the side ditch and stored in a tank (155 mm3), which is installed under the square. After filtering the rainwater, it is fed to the water retention unit by a pump, which is automatically controlled by a sensor. So far, the monitoring database confirms that compared to the conventional asphalt pavement, a decrease in surface temperature of 13 ° C or less has been observed.

In the town of Mitaka, in front of the Mitaka railway station, a "small park" is planned in accordance with the project for reconstruction of the area. A water retention unit with water supply is introduced in the park, under which a rainwater storage tank (100 m3) is built. Filtered rainwater is fed to the pavement of the water retention unit. There is an effect of reducing the temperature by approximately 19 ° C. In this case, the water is delivered eight times a day for 15 minutes.

The city of Kyoto is implementing a project to bury communal lines on Ogawa-dori, a street that runs from north to south in the central part of the city. The street is paved with stone-like water-retaining asphalt as part of this project, which improves the street landscape and strengthens disaster preparedness. This pavement is created by pouring liquid cement (cement milk) on porous asphalt, then the surface layer is removed and finally a decorative element is cut into the surface with a cutter. The water-retaining properties of the pavement are improved by adding a mineral material that allows the water to be easily absorbed and evaporated. The pavement absorbs rainwater and water sprayed directly on it on hot days, and keeps the street surface temperature low by evaporation.

4.3. Green roofs

Green roofs in Bagswerd, Denmark

In a dense industrial area, the global healthcare company Novo Nordisk A / S decided to transform more than 15,000 m2 into one large green roof, creating a landscape on an underground car park. Instead of using the traditional seven-story roof, a variety of grasses and meadow species have been selected - all of which are wild native plants. Green roofs extend all the way to the ground and combine the roofs and the ground perfectly, thus creating a spectacular starting point for increasing biodiversity. At the same time, the solution allows the company to handle all rainwater locally. A combination of steep roofs and a large roof area requires an individual solution.

Rainwater reuse systems from green roofs serve a dual purpose, Copenhagen, Denmark

Rainwater can be collected from roofs and reused for many purposes. In an office building called the House of Energy in Copenhagen, rainwater is collected and reused to irrigate green areas in the building's reception and car park. A drainage system redirects rainwater to four tanks in the basement (1,500 liters each) placed in the parking area. An automatic water system is installed to ensure irrigation of the green roofs. This type of rainwater solution reduces the volume of rainwater runoff and reduces the stress on sewer systems. The amount of energy needed to achieve a moderate temperature in the building is reduced by green areas due to the cycle of condensation and evaporation.

Green roofs in Hativa, Spain

Gozalbes Vera State School is located in the center of Hativa and was selected during the AQUAVAL project to raise awareness of SuDS among students from an early age. The green roof has been upgraded to assess its ability to manage runoff in Mediterranean climates. Due to budget constraints, only part of the former stone, conventional roof has been modernized. This provides an opportunity to compare in one place the effectiveness of storm attenuation in both modernized green areas and stone areas. Monitoring activities include measurements of the quantity and quality of water (October 2012 to September 2013) from a section of the modernized green roof (218 m2) as well as from the intact conventional roof (107 m2). Leaks from both roofs are monitored with bucket tilting manometers mounted on the two gutters. In addition, two sample bottles were connected to each flow meter to take water samples for quality testing. Although the green roof is watered periodically during the initial period to ensure proper vegetation development, a volumetric efficiency (retained runoff on precipitation volume) of 52–100% was achieved during the monitoring period. The total rainfall is 88 mm and the maximum intensity for 10 minutes is 11 mm / h. Only 31% of the rainwater volume is retained by the conventional roof, while for the green roof 80% efficiency is achieved. The reduction in peak flow is also significant,

4.4. SUDS techniques for biodiversity enhancement

Bringing nature back to the cities, Denmark

In Denmark, a series of governments have worked to reverse the trend of reducing the country's diversity of nature by creating connected and sustainable natural areas with improved living conditions for native animal and plant species. It is possible to choose a strategy for selected plants in the SUDS elements to support certain insects (ie bees, butterflies) and thus the life of birds, amphibians and / or native plants. Denmark has experience with strategies to support native plants that serve as habitats for certain species - such as "salt marsh" or "meadow". The concept is called 'Urban Green', where the plants are selected to ensure that their composition is maintained as a 'symbiosis' between wild plants.

4.5. Infiltration systems

Costa Hermita Park, Benaguasil, Spain

In the Costa Hermita Park, located in the high topographic region of Benaguasil, under the AQUAVAL project, three interconnected overgrown pools have been modernized to reduce the runoff of surface water and sediment emitted by the hill. The main goal is to reduce the amount of runoff flowing through the streets, causing flood damage to garages and houses in the lower part of the city, as well as reducing the sludge accumulated in the combined network. An old wall at the entrance to the park has been removed to allow runoff to enter the park, and footpaths have been erected to divert water into infiltration pools. They are formed by digging the existing flat soil between the trees and providing further reduced volume underground. In the upper pools, one on each side of the path, the runoff is filtered through the top layer of soil and temporarily stored in a gravel layer before penetrating the ground and / or channeled by connecting pipes to the third basin, which uses a buried geocellular tank (formed by polypropylene drainage boxes with a storage volume). 18 m3). An overflow device located in this lower infiltration basin transmits the excess flow to the municipal combined sewerage system. The sludge is deposited mainly at the entrance of the park, where it is easily accessible for removal if necessary. The total storage volume of these pools is approximately 22 m3 and it is estimated that they will remove (within a short period of time) approximately 1400 m3 of water per year. Of the 19 rain events recorded in Benaguasil during the monitoring period (October 2012 to September 2013),

Setagaya and Koganei, Japan

Many cities in Japan apply rainwater infiltration. The local government of Setagaya, Tokyo, initiated the Setagaya Reservoir Framework in 2009 by beginning to raise public awareness about rainwater collection systems in households to reduce possible overflows from the river. The non-profit organization joins the Setagaya Reseroir Framework by proposing a joint project involving infiltration measures aimed at contributing to the management of Nagowa River waters in Setagaya jurisdiction and avoiding groundwater depletion. 5,000 drainage wells are built annually in Setagoya. In the city of Koganei, a suburb of Tokyo with a population of 110,000 inhabitants and an area of 1,133 ha, as of March 31, 2005, there were about 48,935 drainage wells and drainage ditches with a total length of 38 km, which may be the largest installation in the world. An experimental sewerage system in the western part of Tokyo, Nerima district, has installed a similar system on 1434 ha. More than 34,000 drainage wells, 220 km of drainage ditches, 70 km of infiltration curbs and 500,000 m2 of permeable pavement were built in 13 years between 1982 and 1994.

4.6. Systems integrating multiple SUDS techniques

SUDS cannot always be considered as a single component, such as a filter strip, green roof, drainage well, etc. They may be an interconnected system designed to manage, treat and make the best use of surface water, from the source (precipitation) point to the point where it is discharged into the receiving environment outside the site. The designer can select a number of different SUDS components and adapt the overall SUDS scheme to the local context. The designer can use the sequence of processes to create green corridors, connect habitats and add value for fun, education and comfort. The SUDS approach is described as the use of a sequence of components that together provide the necessary processes to control runoff frequency, low runoff levels and volumes and to reduce pollutant concentrations to acceptable levels. Below are brief summaries of examples with multicomponent SUDS systems.

Las Jamas Park, Santander, Spain

In 2008, an experimental permeable area of 1100 m2 was built in Santander (Cantabria region). In 2006, Santander

City Council began rehabilitating the desolate land of Las Yamas, a degraded urban area near the city's main beaches and university campus. The aim of this restoration action is to build a city park with a green area of 300,000 m2, which includes the principles of sustainability in its design. For the proper management of rainwater in the area, various SuDS techniques have been applied, mainly green infrastructure, a retention lake and an artificial wetland. Experimental permeable pavement of a built parking lot, with 45 fully monitored parking lots, is included in the new Las Yamas City Park. Each parking space has a tank with a capacity of 115.5 l / m2,

La Soreda parking area, Oviedo, Spain

In 2009, Hotel El Castillo de La Zoreda was built in the La Soreda forest on the outskirts of Oviedo, Asturias. The principles of sustainability for rainwater management are integrated in the main project, in particular the inclusion of green infrastructure and high permeability zones to increase water penetration into the soil. As part of the new urban development, three experimental zones with linear drainage with a length of 20 m were built along the road of the parking lot for the hotel. Each diversion corresponds to a different linear drainage system, two SuDS: filter drainage, drainage channel and conventional concrete channel, the most commonly used roadside drainage system in Spain. For three years, common water quality parameters have been observed at the outflow of each range,

Joan Reventis Park, Barcelona, Spain

In 2006, the Barcelona city management company integrated SuDS in Joan Reventis Park. For the management of rainwater runoff, the principles of sustainability have been observed, integrating low-impact development practices that provide emphasized aesthetic value. For the selection of the most suitable SuDS techniques, the area is divided into 16 catchment areas, the hydrological characteristics of each of them have been studied and local solutions for rainwater management have been sought. The selected SuDS techniques are integrated into the management as a SuDS composition for rainwater runoff management in the area. Drainage filters and filter trenches have been used as a source control system to collect runoff from the surrounding impermeable areas and from the park's main pedestrian areas. These systems are connected to various drainage channels, which carry the runoff through the park, transporting it to the main drainage channel, which is built above a common collector for the sewer system. The green areas are designed to transmit the runoff formed in the park to the drainage canals, which act as natural water channels, transporting the water to a retention basin built in the floodplain of the park. With this design, the most heavily polluted water from the surrounding impermeable areas is treated by the entire treatment composition, while the less polluted runoff generated in the park uses only one or two of the systems. In order to limit the contribution of the parking area to the rainwater runoff, a permeable pavement has been applied, which allows water to penetrate into the soil. by transporting it to the main drainage channel, which is built above a common collector for the sewer system. The green areas are designed to transmit the runoff formed in the park to the drainage canals, which act as natural water canals, transporting the water to a retention basin built in the floodplain of the park. With this design, the most heavily polluted water from the surrounding impermeable areas is treated by the entire treatment composition, while the less polluted runoff generated in the park uses only one or two of the systems. In order to limit the contribution of the parking area to the rainwater runoff, a permeable pavement has been applied, which allows water to penetrate into the soil. by transporting it to the main drainage channel, which is built above a common collector for the sewer system. The green areas are designed to transmit the runoff formed in the park to the drainage canals, which act as natural water canals, transporting the water to a retention basin built in the floodplain of the park. With this design, the most heavily polluted water from the surrounding impermeable areas is treated by the entire treatment composition, while the less polluted runoff generated in the park uses only one or two of the systems. In order to limit the contribution of the parking area to the rainwater runoff, a permeable pavement has been applied, which allows water to penetrate into the soil. The green areas are designed to transmit the runoff formed in the park to the drainage canals, which act as natural water canals, transporting the water to a retention basin built in the floodplain of the park. With this design, the most heavily polluted water from the surrounding impermeable areas is treated by the entire treatment composition, while the less polluted runoff generated in the park uses only one or two of the systems. In order to limit the contribution of the parking area to the rainwater runoff, a permeable pavement has been applied, which allows water to penetrate into the soil. The green areas are designed to transmit the runoff formed in the park to the drainage canals, which act as natural water canals, transporting the water to a retention basin built in the floodplain

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Whitangi Park, Wellington, New Zealand

Whitangi Park is an example of one of the best practices in New Zealand, which combines at a high level both WSUD elements and leisure and entertainment goals. The rainwater management system has been built up, including several key steps. Rainwater from drainage pipes is connected by a pump system with sensors to read the level and salinity to turn off the sea water during overflow. The water then enters the subterranean wetland, designed to reduce the turbidity of rainwater to levels suitable for UV disinfection. All oils and solids are removed here. Wetland streams are treated through a process of filtration, absorption and biological / chemical treatment before flowing into Wellington Harbor waters. Finally,

Jellioce Street and Silo Park, Auckland, New Zealand

The extensive rain gardens on Jellicoe Street, along with a series of built-up wetlands, collect and filter rainwater on site before being taken to the port. Rain gardens use waterproof pavements to protect against major contamination and structural cells to make it possible to lay paving and parking lots on the ground. Local plantations create a unique street landscape that encourages pedestrians to cross. Rainwater drains through large concrete stairs made of recycled materials from the site, which also serve as shore protection. The purpose of rain garden design is to apply the latest and best SUDS practices. Specific estimates of the success of the project are the data for reduction by 42% of the volume of rainwater runoff and exceeding the (then) legal requirement for over 75% removal of total suspended solids. The aim of the approach taken to reduce rainwater is to capture and reuse rainwater in buildings (eg for washing toilets) and to purify rainwater runoff in rain gardens. Rain gardens are very large, almost continuous and do not differ from the rest of the landscaping. Continuous simulation of 10-year 6-minute precipitation shows that 78% of the removal of total suspended solids can be achieved; huge rain gardens help to compensate for areas that will not be treated. The aim of the approach taken to reduce rainwater is to capture and reuse rainwater in buildings (eg for washing toilets) and to purify rainwater runoff in rain gardens. Rain gardens are very large, almost continuous and do not differ from the rest of the landscaping. Continuous simulation of 10-year 6-minute precipitation shows that 78% of the removal of total suspended solids can be achieved; huge rain gardens help to compensate for areas that will not be treated. The aim of the approach taken to reduce rainwater is to capture and reuse rainwater in buildings (eg for washing toilets) and to purify rainwater runoff in rain gardens. Rain gardens are very large, almost continuous and do not differ from the rest of the landscaping. Continuous simulation of 10-year 6-minute precipitation shows that 78% of the removal of total suspended solids can be achieved; huge rain gardens help to compensate for areas that will not be treated. Continuous simulation of 10-year 6-minute precipitation shows that 78% of the removal of total suspended solids can be achieved; huge rain gardens help to compensate for areas that will not be treated. Continuous simulation of 10-year 6-minute precipitation shows that 78% of the removal of total suspended solids can be achieved; huge rain gardens help to compensate for areas that will not be treated.

Oranga Community Center, Fergusson Park, New Zealand

The new Oranga Community Center is located along Waitangi Road, Wanghunga, in an area where rainwater is drained by irrigation. The facility is a demonstration project for rainwater irrigation devices, designed in accordance with the new Soakage design manual of the city. The rainwater treatment and disposal system includes a series of bio-drainage canals, rain gardens, drainage wells, and educational signs showing how they work.

Sustainability in redevelopment of the abandoned field in Talbot Park, Tamaki, New Zealand

Between 2002 and 2007, Housing New Zealand Corporation renovated the Talbot Park residential complex. This opens up the possibility of incorporating a wide variety of LIUDD practices into the street landscapes, houses and parks of the neighborhood. Rainwater infiltration, evaporation and capture of pollutants have been improved through the use of street rain gardens, the planting of large trees and the construction of a permeable pavement in some properties. In some residential areas, the installation of solar hot water systems and rainwater tanks has improved the quality of life of residents. This renewal was undertaken with the awareness of the need to minimize the effects of housing intensification on the estuary of the Tamaki River and its tributaries, while at the same time providing sustainable and affordable social housing.

Grand Mall Park, Yokohama, Japan

The park at the Grand Mall in Yokohama has been renovated and established as the core of the new urban development. To create a lively space in the park, a large water circulation system has been installed with the help of green infrastructure technologies. Rainwater, infiltrated by water-retaining pavement or side excavations, moves through the rainwater retention, infiltration base and reaches the water-retaining pavers by capillary action. This has the effect of reducing the temperature by evaporating rainwater from the water-retaining pavement and from evapotranspiration from the trees. This helps to create a "cool space" even in summer "not only thanks to the tree shadows, but also by the evaporation of rainwater from the underground layer by capillary action, as well as by evapotranspiration from growing trees. This microclimatic effect was demonstrated and described in a report published in the Journal of the Japanese Society of Revegetation Technology (Volume 42, Issue 3, February 2017). Thus, the park at the Grand Mall in Yokohama becomes an example of the ecological city of the future.

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Applications

Stakeholders	Role	Desired outcomes
Public and communities	They have a vital role in the vibrancy of a development and the acceptance of sustainable drainage.	➢ to live, work and play in attractive surroundings ➢ to be involved in the development and how the SuDS scheme works ➢ to be certain that the design is adequate, and the operation and maintenance of SuDS schemes will be taken into account.
Local authority - planners Upper tier - SuDS approval body Lower tier - planning	They control planning applications and can advise on the effect of regional / local policies. They will consult stakeholders to understand the opportunities, constraints and issues of an application.	➢ to promote development policy ➢ to approve new development ➢ to encourage the inclusion of sustainable drainage.
Local authority - highway engineers	They construct and manage highways and provide standards to developers for the construction and adoption of roads. Managing the quantity and quality of runoff from highways.	➢ to ensure highways drain to sustainable drainage ➢ to be satisfied SuDS components used meet their requirements to be satisfied that SuDS can be adopted.
Building control or approved inspectors	Before construction building control officers need to be satisfied development complies with the Building Regulations and will not affect the integrity of any buildings.	➢ to know location of drainage system in relation to buildings ➢ to ensure it is compliant with Building Regulations.
Environment Agency	They are statutory consultees in the planning process on flood matters covering	➢ to holistically manage runoff rates and volumes to ensure that sustainable drainage principles have been incorporated ➢ to see the SuDS management train delivered.

Stakeholders	Role	Desired outcomes
	regional spatial strategies and strategic flood risk assessments.	
Conservation organizations	They are the statutory advisors on conserving and enhancing the natural environment at a regional and national level.	➢ high quality, sustainable developments ➢ protect sites of special scientific interest, special ➢ protected areas or special areas of conservation.
Sewerage undertakers	They have a duty to provide a public sewer connection and are responsible for surface water drainage from developments.	➢ normally to ensure surface water management systems adhere to Sewers for Adoption ➢ some sewerage undertakers may also adopt SuDS consider capacity of existing drainage systems and where possible use sustainable drainage
Developers	They are ultimately responsible for the type of surface water management system used. To achieve successful SuDS involve them with other important stakeholders early in the planning process.	➢ to meet planning requirements ➢ to comply with the requirements of the Code for Sustainable Homes and National Standards (once introduced) ➢ to provide a cost effective, attractive ➢ development, which will be easily sold.
Internal drainage boards	They are an operating authority in parts of that have permissive powers to manage surface water and water levels within their district.	➢ to be consulted on the development of strategic flood risk assessments ➢ to be consulted on development within their area.

Table 7. Stakeholders involved in the planning process; Source: Stephen Dickie, Planning for SuDS - making it happen, ISBN: 978-0-86017-687-9

Interreg - IPA CBC Bulgaria - Serbia

The project is co-funded by EU through the Interreg-IPA CBC Bulgaria – Serbia Program.

SUDS SELECTION MATRIX FOR BENEFITS

		Rainwater Harvesting	Soakaway	Permeable Paving	Filter Strip	Bioretention area	Swale	Hardscape / Modular Storage	Pond	Wetland	Underground Storage
Attenuation	O	O	●	●	O	●	●	●	●	●	●
Water Treatment	O	O	●	●	●	●	●		●	●	
Infiltration			●	O	●	O	O		O	O	O Geocellular storage system
Water Reuse	O Pre-storage treatment	●		O Pre-storage treatment		O Pre-storage treatment	O Pre-storage treatment	O Storage	O Treatment and / or storage	O Pre-storage treatment	O Storage
Biodiversity and Habitat	●		O		O	●	●		●	●	
Education	●	O	O	O	O	●	●	O If aboveground	●	●	
Amenity	●	O	O	O	O	●	●	O If aboveground	O	●	

● unlikely benefit

O benefit could be achieved in some cases with good design

● likely benefit

Open Space	O			O	O	O	O	O	O	O	
Character	O			O	O	O	O	O If aboveground	O	O	
Microclimate	●			O		●	●	● If aboveground	●	●	

Source: Water. People. Places. A guide for master planning sustainable drainage into developments Prepared by the Lead Local Flood Authorities of the South East of England, September 2013

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		SUDS SELECTION MATRIX FOR SITE CONDITIONS										
		Green Roof	Rainwater Harvesting	Soakaway	Permeable Paving	Filter Strip	Bioretention Area	Swale	Hardscape Storage	Pond	Wetland	Underground Storage
Flood Plain	Located in the floodplain?	✓	✓	✓	✓	✓	✓	✓				
Groundwater	Groundwater less than 3 meters below ground surface?	✓	✓		✓ With liner and underdrain (no treatment)	✓ With liner and underdrain (no treatment)	✓ With liner and underdrain (no treatment)	✓ With liner	✓ If aboveground	✓ With liner	✓	
Topography	Sited on a flat site (<5% gradient)?	✓ Source control	✓ Source control	✓ Source control	✓ Source control	✓ Source control	✓ With short kerb or rill length	✓ Careful to provide some gradient	✓ Try to keep flow above ground to	✓ Try to keep flow above ground to	✓	✓

	Sited on a steep slope (5-15% gradient)?	✓	✓		✓ If terraced		✓ If terraced	✓ If installed along contour	✓ If terraced		✓ If terraced	✓
	Sited on a very steep slope (> 15% gradient)?	✓	✓									✓
Soils and Geology	Impermeable soil type (eg clay-based type)?	✓	✓		✓ With underdrain (no treatment)	✓	✓	✓	✓	✓	✓	✓
Contaminated land	Are there contaminated soils on site?	✓	✓		✓ With underdrain (no treatment)	✓ With liner	✓ With liner and underdrain	✓ With liner	✓ With liner	✓ With liner	✓ With liner	✓ With liner

Existing Infrastructure	Are there underground utilities in the SuDS area?	✓	✓		✓ If possible relocated into a marked corridor for future maintenance	✓	✓ Possible with structural grid in soil					✓
Space constraints	Limited space for SuDS components?	✓	✓	✓	✓		✓	Rill or channel more	✓		✓ Micro-wetland	✓
Runoff characteristics	Suitable for Inclusion in high risk contamination areas?	✓ Source control	✓ Source control		✓ With liner and spill insulation		✓ With liner and spill insulation		✓ With liner and spill insulation		✓ If designed for treatment of predicted wastes	✓ With liner and spill insulation

Protected species or habitat	Proximity to designated sites and Priority habitats?	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Ownership and Maintenance	Can the feature be designed for adoption?	✓ Dependent on design and local adoption policies										

Source: Water. People. Places. A guide for master planning sustainable drainage into developments Prepared by the Lead Local Flood Authorities of the South East of England, September 2013

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Abbreviations used

BMP Best Management Practices

EPI Environmental Performance IndexEQS

Environmental Quality Standards

LIUDD Low impact urban design and developmentNEC

National Emission Ceilings

NESAQ National Environmental Air Quality StandardsPUC

Public Utilities Communal

RBMP River Basin Management Plans

SUDS / SuDS Sustainable urban drainage systemsWFD EU

Water Framework Directive

WQES Water Quality Standard WSUD Water-

sensitive urban designGDP Gross domestic

product

IWUM Integrated water resources managementRMA

Resource Management Act

ME Ministry of Environment BAT Best

available technology

OECD Organization for Economic Co - operation and DevelopmentWWTP

Waste Water treatment plant

SWTP Surface water treatment plantFRMP

Flood risk management plans

ASPFR Areas with significant potential flood riskFAO

Food and Agriculture Organization