Interreg Italy - Croatia STREAM

EUROPEAN UNION

Early warning system (RTC) in the most significant discharge points

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Work Package Number	5
Work Package Title	Pilot projects
Activity Number	5.6
Activity Title	ADSU Pilot project
Partner in Charge	PP10
Partners involved	PP10
Status	Final
Distribution	Public

Summary

1. Introduction

In order to minimize the urban flooding and the environmental impact of combined sewer overflows on water bodies and especially on bathing water quality, ADSU Teramo, with the cooperation of Ruzzo Reti, developed a Real Time Control System able to:

- collect quantitative and quality information on sewage waste
- balance the sewer flow to avoid urban flooding
- minimize the impact of spillways
- predict possible dangerous situations and be able to take action to prevent them

Software, equipment and web platform have been purchased and are managed by Ruzzo Reti as owner of the pilot site.

2. Early warning system (RTC) in the most significant discharge points

Ruzzo Reti, scientific and technical partner of ADSU Teramo, is a water and a wastewater public utilities of the Adriatic coast that manages a combined sewer system, serving roughly 3 hundred agglomeration, ranging from 50 to 90 thousand inhabitant equivalent.

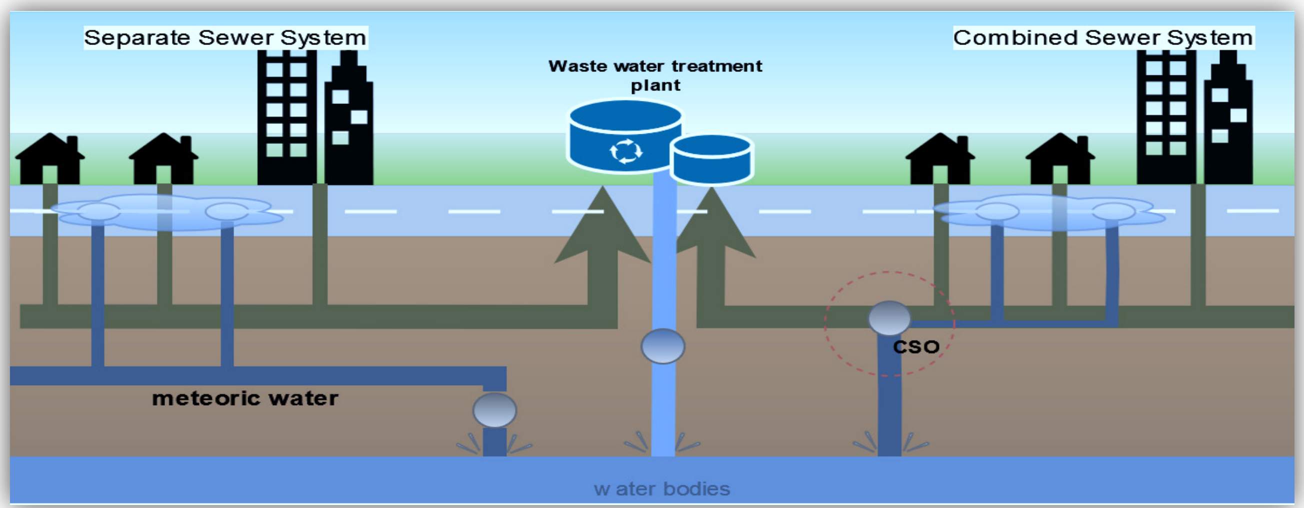
During dry periods combined sewer system transport wastewater to treatment plants where pollutants are removed, and then to water bodies, but when a rain fall occur combined sewer also collect part of the run-off form impervious surface and when the total amount of water exceeds the capacity of the sewer system, combined sewer are designed to discharge the excess of water directly to nearby streams and river through CSO (combined sewer overflow). In the worst-case scenario, we can also have discharges directly from manholes directly in urban area causing an urban flooding.

2.1. Combined Sewer System

Combined Sewer Overflow (CSO) is a component of a combined sewer system designed to prevent flooding of the system during heavy rainfall. During normal conditions , the combined sewer system conveys the wastewater and stormwater to a wastewater treatment plant, where it undergoes treatment before being discharged into a receiving water body. However, during intense rainfall or when the capacity of the sewer system is exceeded, the excess of water volume can overwhelm the system. To prevent the system from becoming overloaded, CSOs are designed to divert the excess flow. Typically, CSOs are equipped with regulators or diversion structures that automatically open when the water level in the system reaches a certain threshold.

When this occurs, a portion of the water is discharged directly into nearby rivers or other water bodies, bypassing the treatment plant.

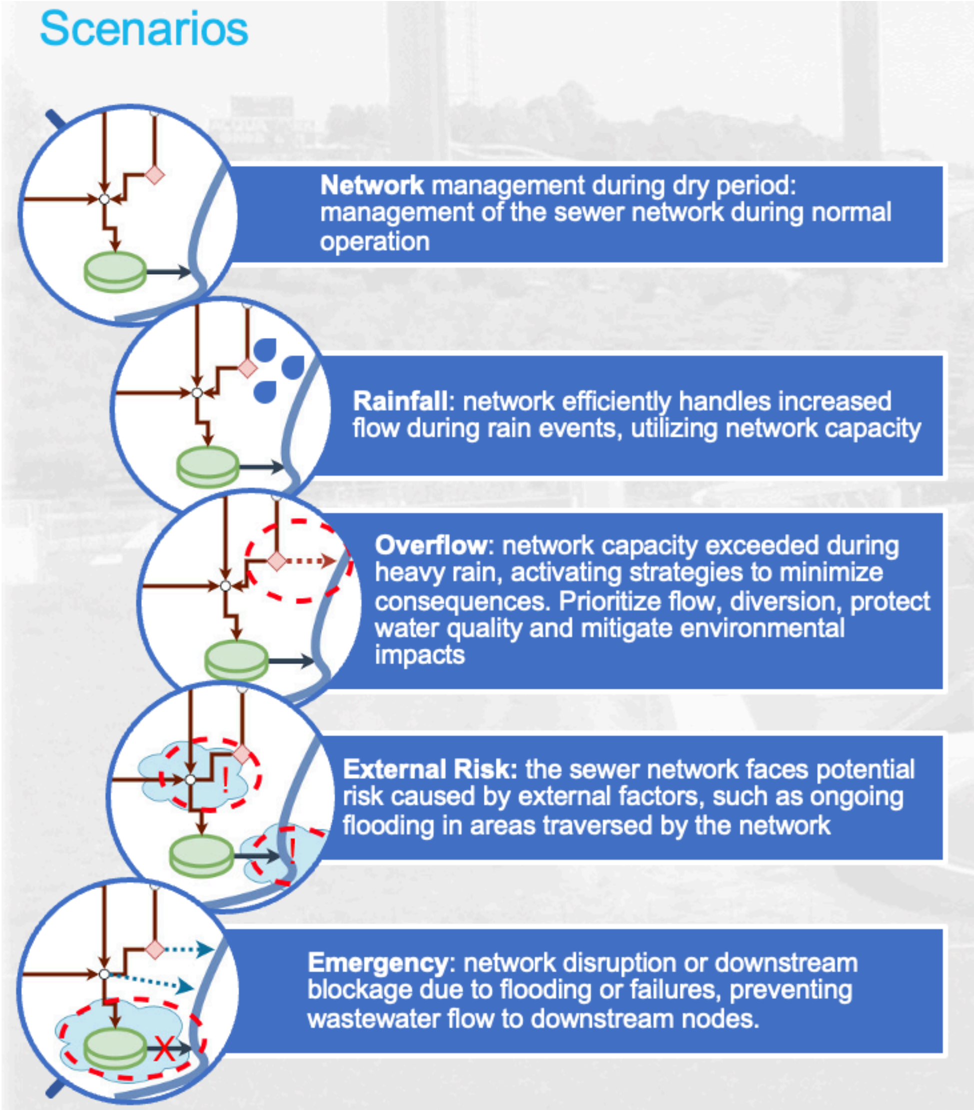
The purpose of CSOs is to protect the integrity of the sewer system and prevent widespread flooding. However, the discharge from CSOs contains pollutants, as it may include untreated wastewater and contaminants from stormwater runoff.

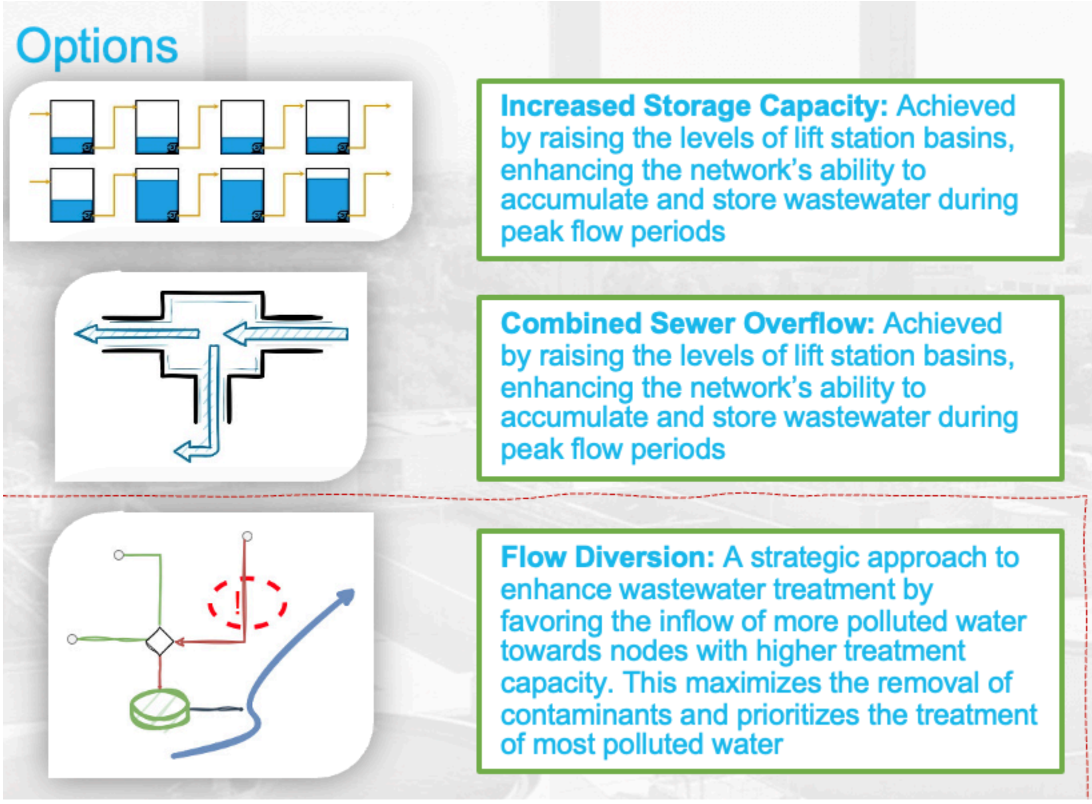


Separate Sewer System: it is a sewer system where domestic wastewater and stormwater are managed separately. There are two distinct pipe networks: one for domestic and industrial wastewater and another for stormwater runoff from street and

Combined Sewer System: it is a sewer system where domestic wastewater and stormwater are collected and conveyed through the same pipe network. Both domestic sewage and rainwater are channeled into a single system and transported to a wastewater treatment plans.

2.2. Combined Sewer Management: Options and Scenarios

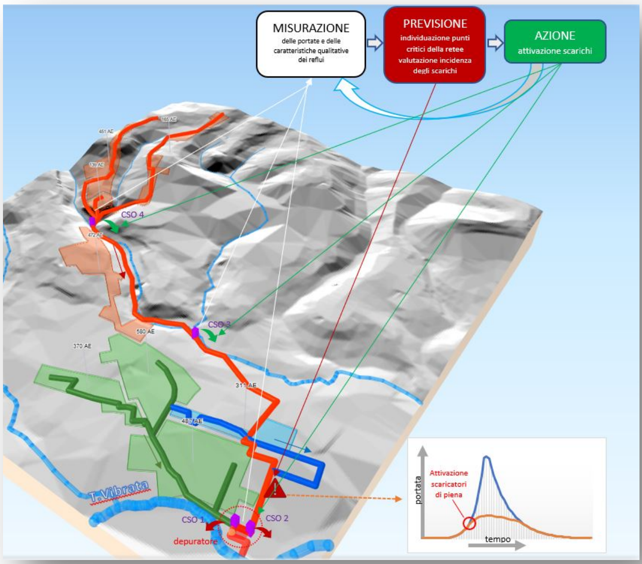

Scenarios
Network management during dry period: management of the sewer network during normal operation
Rainfall: network efficiently handles increased flow during rain events, utilizing network capacity
Overflow: network capacity exceeded during heavy rain, activating strategies to minimize consequences. Prioritize flow, diversion, protect water quality and mitigate environmental impacts
External Risk: the sewer network faces potential risk caused by external factors, such as ongoing flooding in areas traversed by the network
Emergency: network disruption or downstream blockage due to flooding or failures, preventing wastewater flow to downstream nodes.

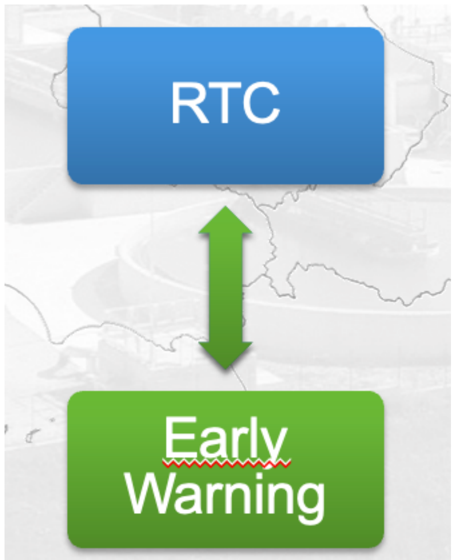


2.3 Inegrated Water Management Solutions

1. **MEASURE**: Real-time measurement of quantitative and qualitative water data in the network. This helps garter accurate data for informed decision-making
2. **OPTIMIZE**: Balancing flow to minimize urban flooding. Implementing strategies that effectively control and manage stormwater, ensuring the drainage system can handle the excess water during heavy rainfall
3. **MAXIMIZE**: Maximizing treatment of highly polluted stormwater at the treatment plant.

- Managing the quantities within the network to limit urban flooding incidents
- Reducing the realis of pollutants in the stormwater runoff
- Balancing the inflow to treatment plants
- Predicting the behavior of the network
- Maximizing the treatment of stormwater with high pollutant concentrations
- Managing the information related o the release of pollutants from overflow outlets based on the environmental qualities of receiving water bodies and potential human health risk
- Managing a flow of information to establish a real-time EARLY WARNING system capable of alerting citizens and/or environmental and safety operators to emergency

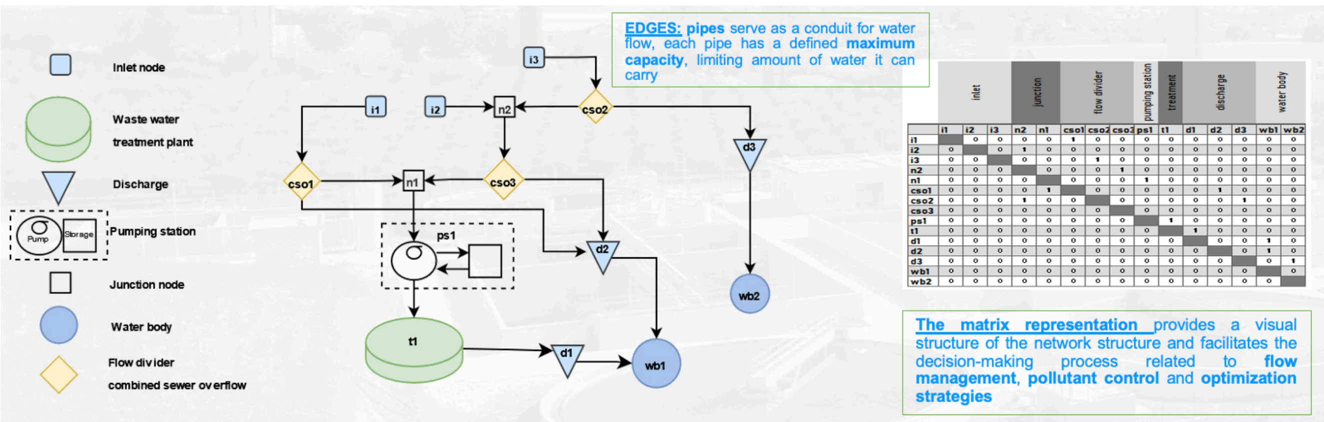




2.4 Network Diagram

The network is characterized by interconnected edges and nodes forming a structure that converges toward a final water bodies.

The network diagram provides a visual representation of the sewer system, illustrating the interconnectedness of edges and nodes. It serve as the basis for analyzing water flow, pollutants distribution and making decision regarding discharge levels, optimization strategies and directing the most polluted water to nodes with higher treatment capacities or storage capacities.



2.5 Decision Making Algorithm

The algorithm considers variables such as pollutant concentration, flow rate and the capacities of storage to optimize the routing of wastewater.

Initializations:

- Set initial values for variables and parameters
- Define the network structure with edge and nodes

Calculate Pollutant concentrations:

- Measure or estimate the pollutant concentrations at various points in the sewer network
- Consider factors as industrial discharges, residential areas, known pollution sources and criticality in terms of environmental risk and public health of the final water bodies

Determine Flow Rates:

- Calculate the flow rates for each edge based on the incoming flow from upstream edges and the available capacity of the pipes
  Consider the variable flow velocities in different pipes

Evaluate Storage and treatment Capacities:

- Assess the storage capacities of each node in the network.
- Asses the treatment capacities of treatment nodes.
- Nodes with higher storage capacities can accumulate more water, while nodes with higher treatment capacities can handle larger flows and treat more polluted water.

Decision-Making:

- Prioritize node based on the pollutant concentration and the capacities of treatment and storage
- Select the nodes with the heist pollutant concentration and ensure its flow rate does not exceed the treatment capacity
- If treatment capacity is not exceeded, direct the flow to the treatment node
- If treatment capacity is exceeded, check the storage capacities of other nodes and redirect the flow to a node with sufficient storage capacity.

Adjust Discharge Levels:

- Determine the discharge levels of valves at the selected node(s) to regulate the flow and ensure it does not exceed the capacities.

Iterate:

- Repeat the process periodically or when a significant changes occur in pollutant concentration or flow rates.

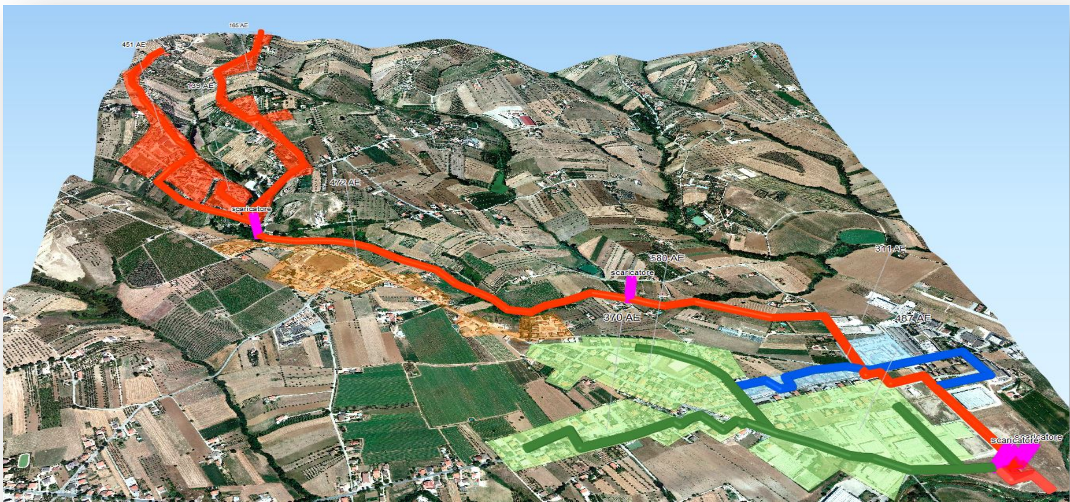
The system utilizes the variables "Storage Capacity" and "Treatment Capacity" to make informed decisions about directing wastewater flow. By considering pollutant concentrations and the capacities of storage and treatment nodes, the algorithm optimizes the routing to maximize treatment efficiency and minimize pollution impact.

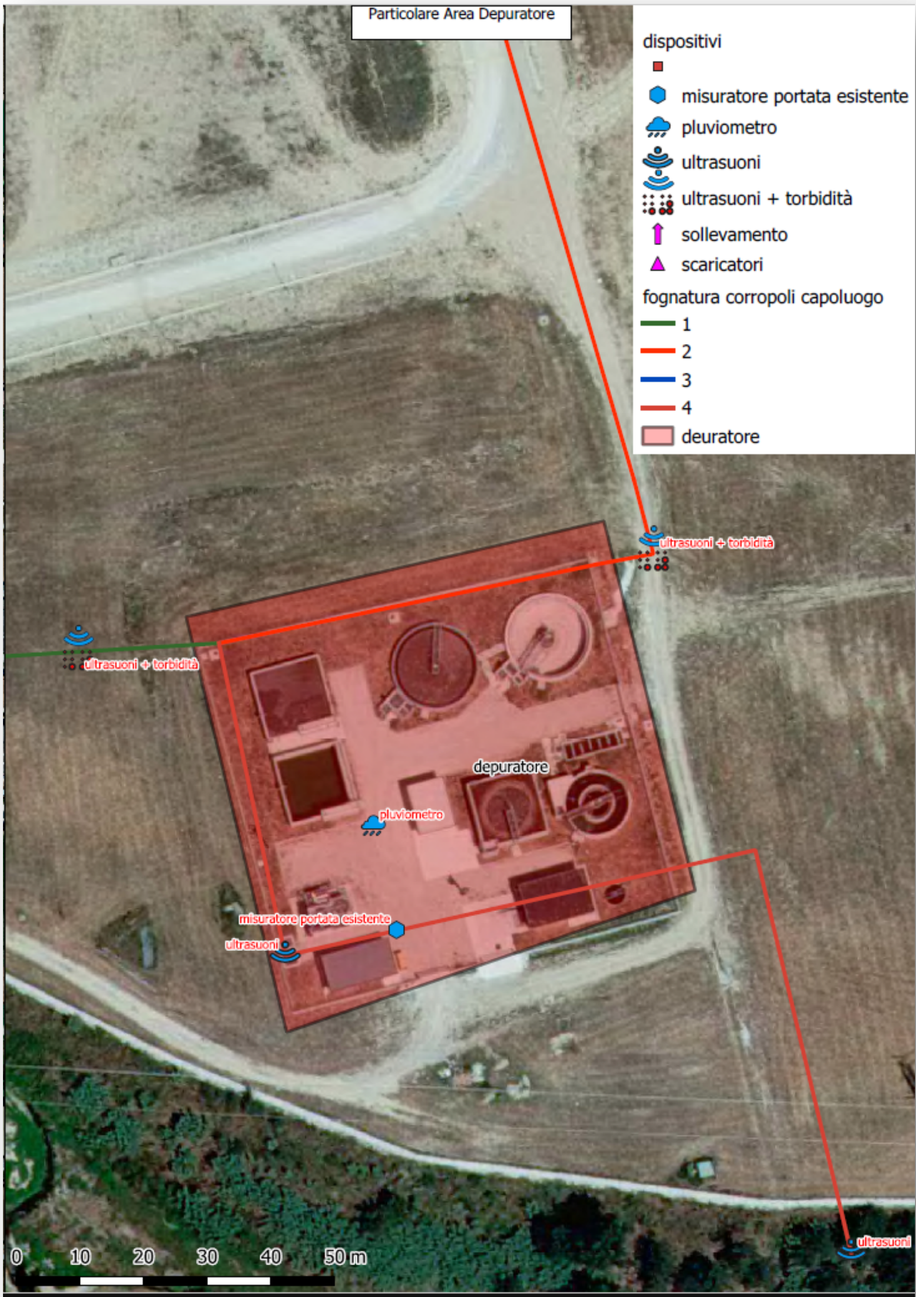
Key Local Variables associated with node 'i' in the decision-making algorithm. Local variables associated with the node 'i' plays a crucial role in the decision-making process and optimizing the management of the sewer systems. It enable the storage and manipulation of data such as flow rates, pollutant concentrations and capabilities, facilitating effective decision-making and optimization of the sewer system management.

- **'av_pollution_i'**: represents the pollution level in the node and is calculated based on a weighted average of multiple pollutants that can be measured or calculated;
- **'max_flow_i'**: maximum flow that the node 'I' can handle considering downstream system capacities;
- **'distance_i'**: the distance from valve 'I' to the final treatment plant;
- **'storage_capacity_i'**: the maximum amount of water that can be stored at the node 'I' before further discharge or treatment is required
- **'treatment_capacity_i'**: the maximum capacity of node 'I' to treat wastewater.

2.6 Location

The site chosen is a small agglomeration near the Adriatic coast. Served by a wastewater treatment plant in Corropoli, Teramo province.
The development of the platform primarily focused on the management of the pumping station and the integration of qualitative and quantitative data derived from the network. The platform enables efficient control and monitoring of the lift station's operations while incorporating and analyzing the data obtained from the network.
The decision to prioritize the lift station stems from its pivotal role as fundamental infrastructure component of the costal sewer system. By focusing on the management of the pumping stations, the platform ensures effective operation and integration of data for optimal performance of the coastal sewer system.





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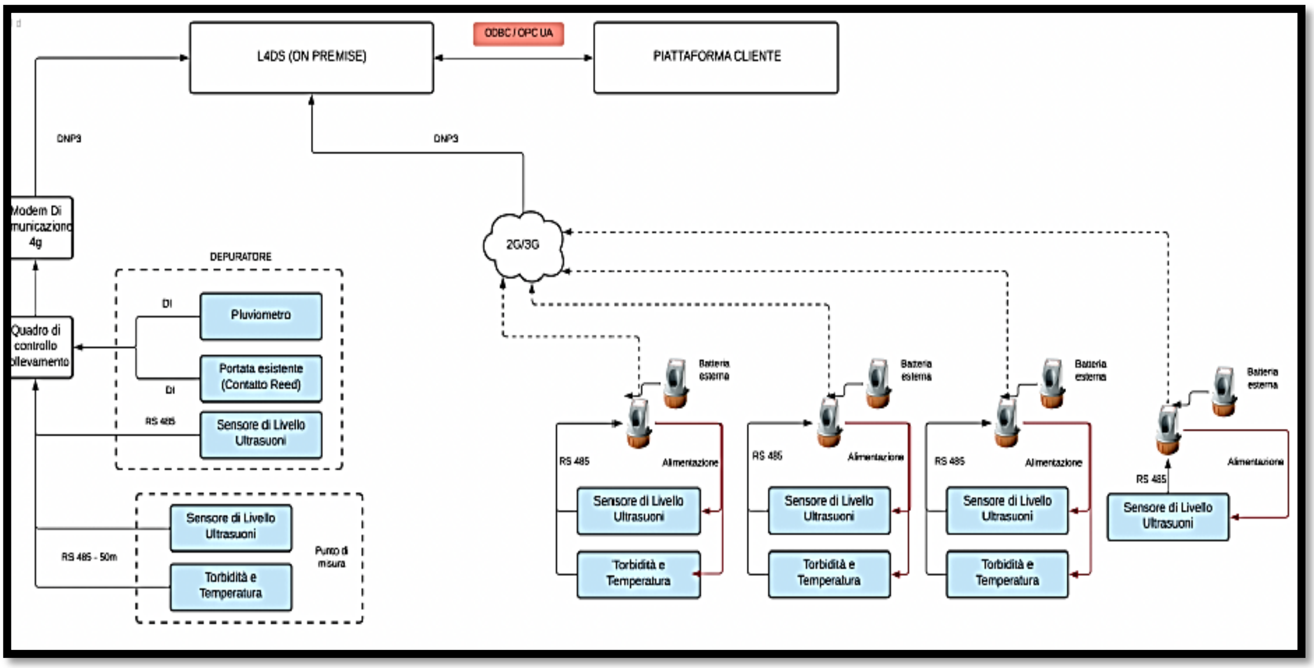
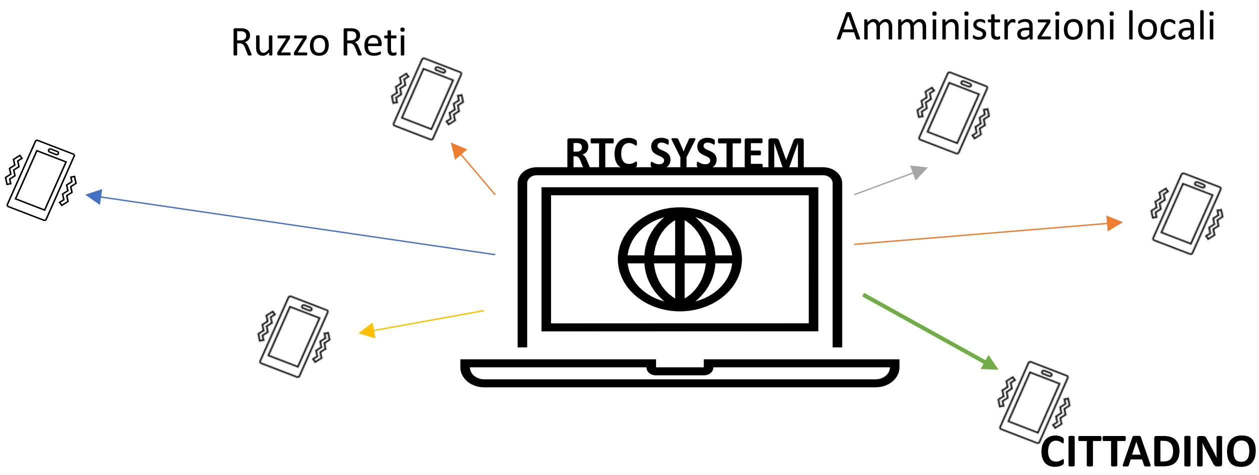
2.7 IOT Platform



3. Conclusion

For the purposes of the project, it is essential that information regarding emergency situations, primarily related to water quality for bathing, can be promptly communicated not only to Company technicians but also to all local stakeholders.

The system will be able to report real-time risk situations or network malfunctions to technicians, company officials, as well as regulatory bodies, and most importantly, to the citizens.



4. ANNEXES

- Power point presentation
- Photos
- Platform screenshots