Newsletter - Munich

SYnergy of integrated Sensors and Technologies for urban sEcured environMent

N.5 - February 2022

Outline:

Welcome!

We are glad to announce a new newsletter's issue of the European funded project "SYnergy of integrated Sensors and Technologies for urban sEcured environMent" (SYSTEM).

This is the **fifth issue** dedicated to the testing activities carried out in the city of **Munich, Germany.**

You receive this email because your work is strictly related to the output of this project and we have thought you might be interested on our work.

SYSTEM Facts & Figures

Funding programme: Horizon 2020
Call: Fight against crime and Terrorism, SEC-10-FCT-2017
Type of action: Innovation Actions
Project Reference: 787128
Starting date: 1 September 2018
Duration: 42 months
Number of partners: 21
Total cost: € 9.087.796,60
Total EU funding: € 7.926.173,05

SYSTEM is an **Innovation Action** awarded to a consortium led by Fondazione FORMIT addressing the challenge of the topic "Integration of detection capabilities and data fusion with utility providers' network" (SEC-10-FCT-2017) included in the 2016-2017 Work Programme "Secure societies – Protecting freedom and security of Europe and its citizens" of Horizon 2020. SYSTEM started on 1 September 2018 and aims at **developing and testing a customised sensing system** for hazardous substances detection in complementary utility networks and public spaces. The proposed innovative monitoring and observing of fused data sources have been tested across urban areas in six cities (Bratislava, Idstein, Latina, Munich, Rome and Warsaw). Detection results have been gathered in real time and sent and fused in remote mode to a customised monitoring centre that will be helpful to Law Enforcement Agencies to better and faster detect suspicious illegal clandestine laboratories. To achieve these aims, a wide set of skills and capabilities has been considered key to success, determining the large partnership working on the project, made by partners cooperating with more than ten stakeholders supporting the project activities.

Who we are

The SYSTEM Consortium, composed by 21 partner organisations from Belgium, Germany, Greece, Italy, Poland and the Slovak Republic, includes four law enforcement authorities (RaCIS – Arma dei Carabinieri, Bundeskriminalamt Kriminaltechnisches Institut and its associated partner Bayerisches Landeskriminalamt (Kriminaltechnisches Institut), Centralne Laboratorium Kryminalistyczne Policji, Ministry of Interior of the Slovak Republic), three utility network operators (Acea ATO 2 S.p.A., Acqualatina S.p.A., BVS a.s.), five scientific/academic partners (Universität der Bundeswehr München, Hochschule Fresenius GmbH, Warsaw University of Technology, Ustav Hydrologie Slovenskej Akademie Vied, Vrije University Belgium), two industrial partners (Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V., RESI Informatica S.p.A.), three small and medium enterprises (Blue Technologies sp. Z o.o., SENSICHIPS Srl, T4i Engineering), two research foundations/no profit organisations (Fondazione FORMIT, ISEM – Inštitút pre medzinárodnú bezpečnosť a krízover riadenie), one association (Observatory on Security and CBRNe Defence), and one municipality (Roma Capitale). Additional law enforcement agencies, utility network operators and municipalities have already provided their commitment to support the testing and demonstration of innovative technologies.

Discover more about us here!

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SYSTEM testing activities in Munich

Five deployment and demonstration visits were in total performed in Munich during the project lifetime until February 2022. Visits were preceded by extensive preparations and testing of the sensing technologies to ensure the successful application of the sensors in non-controlled environments.

During the first visit held in September 2021 several sensing technologies were successfully deployed in the sewer network. The Micromole rings were able to measure pH and electrical conductivity (EC) and transmit the data to the GENESI Monitoring Centre (MC). The measurements of the Micromole rings were compared to those of the ORI data logger. Additionally, passive sampling was performed using polydimethylsiloxane (PDMS) rods being deployed directly in sewers at three different locations for wastewater monitoring of new psychoactive substances (NPS). The results gained by passive sampling were validated and compared to the analysis of wastewater samples, which were collected as time-resolved 4 h composite samples using the ORI sampling unit.

In October 2021 a second deployment visit took place in two different environments (sewage and air). The Micromole rings allowed a continuous measurement of pH and EC at different locations throughout the catchment area of the sewer system. The monitoring campaign was further supported by sampling of wastewater. PDMS rods were used again for passive sampling of target compounds, and the active sampling was automatically performed using the ORI device. Additionally, wastewater collection for time-delayed analysis by the LC-MS system was conducted at the pumping station downstream the discharge location. In the meantime, the T4i DOVER mounted on a drone was able to detect target substances in the air using its built-in GC-PID.

The collected data were successfully transmitted to the MC. The emphasise of the last demonstration visit in 2021 was the seamless communication of data gathered by different sensor systems, which was successfully met. When the pH and EC measured by the Micromole rings reached a certain threshold, an alarm was raised in the MC. The MC then sent an SMS to the ORI device triggering it to collect a wastewater sample. In parallel, further sensor systems (Smart Cables and T4i DOVER) were included in the experiment from two additional locations (Rome and Lavrio) to demonstrate the real-time data fusion of multiple sensors by the MC.

The last two visits finally focused on wastewater monitoring of NPS in a wastewater treatment plant (WWTP) in Munich. Wastewater sampling was achieved using passive (PDMS rods) and active sampling (ORI sampling unit) of WWTP influent.

A list of deployment and demonstration visits including reference to partners and technologies joining - is shown in the Table below:

Index	Timeframe	Type of Visit	Partners	Technologies
1	20.09.2021–01.01.2021	Deployment	FORMIT, RESI, FhG-IZM, WUT, UNIBWM, BKA	µMole, LC-MS offline, Ori sampler including M-log, passive sampling, MC
2-3	11.10.2021–22.10.2021	Deployment	FORMIT, RESI, FhG-IZM, WUT, UNIBWM, HSF, BKA, T4i	µMole, LC-MS offline, Ori sampler including M-log, passive sampling, T4i Dover, MC
3	13.12.2021–17.12.2021	Demonstration	RESI, FhG-IZM, WUT, UNIBWM, HSF, BKA	µMole, LC-MS offline, Ori sampler including M-log, passive sampling, MC
4	28.01.2022-31.01.2022	Demonstration	UNIBWM, BKA	LC-MS offline, ORI sampling unit, passive sampling
5	04.02.2022-08.02.2022	Demonstration	UNIBWM, BKA	LC-MS offline, ORI sampling unit, passive sampling

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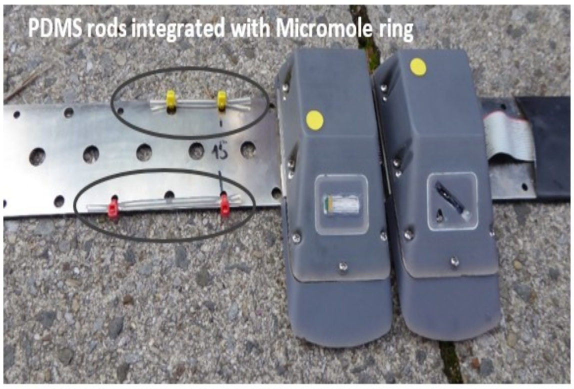
SYSTEM TECH FOCUS
Micromole, Automatised sampling unit, Passive sampling

What is the subsystem made of Micromole, Automatised sampling unit and Passive sampling

Micromole rings are equipped with pH and electrical conductivity (EC) sensors which can autonomously operate in sewage water over longer periods of time (up to two weeks). The collected data can be automatically transmitted to the GENESI Monitoring Centre (MC) and visualised in real-time. Using the pre-defined thresholds for pH and/or EC, an alarm can be generated to trigger the wastewater collection by the automatised sampling unit, which was demonstrated during two visits in Munich. The sampling unit (ORI Basic Ex 1) is a commercial mobile device for automatised wastewater collection with the possibility of a time- or flow-proportional sampling mode. Passive sampling in sewage includes the employment of polydimethylsiloxane (PDMS) rods for enrichment of target chemicals (drugs and explosives) from wastewater. Due to their flexibility and small size, PDMS rods can be mounted on Micromole rings or on the hose of the automatised sampling unit and can thus serve for confirmatory analysis of target chemicals, either on-site by GC-MS or off-site using a laboratory-based GC- or LC-MS system. Additionally, PDMS rods can be employed for long-term monitoring of drugs in wastewater over several days, including the monitoring of NPS, as demonstrated during the demonstration visits in Munich.



The NPS prevalence study in Munich

Wastewater-based monitoring of prevalence of new psychoactive substances (NPS) use with focus on the most prevalent sub-class of NPS, synthetic cannabinoid receptor agonists (SCRA), was performed during the last two demonstration visits in Munich. The approach to assess NPS prevalence included real sewage systems of three different sizes and populations: a Southern German prison population, population of a city district in Munich, and population served by a WWTP in the city. After successful application of active and passive wastewater sampling, several prevalent SCRA were successfully identified in all the investigated sewage systems, thus granting valuable insights into the prevalence of SCRA use during the selected time periods in 2021 and 2022. The comparison of drug use between the corresponding populations, as assessed by wastewater monitoring, was made not only in terms of prevalence of SCRA use but also conventional drugs use. The application of a new wastewater sampling strategy using solid phase extraction with PDMS rods, which was developed and optimised in the course of SYSTEM NPS prevalence studies, demonstrated to be a promising approach for drug prevalence investigations via wastewater analysis, especially for SCRA use assessment.

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SYSTEM outreach events in Munich

During the first deployment visit carried out in Munich in September 2021, two representatives of the Bavarian State Criminal Police (BLKA) drug unit were present on-site and received all information about the assembly and composition of the deployed technologies, as well as about their functionality and limitations. These technologies/sensors included microMole rings (pH and EC sensors), automatised sampling unit for wastewater collection and passive sampling (i.e. PDMS rods). According to the received information in combination with the demonstrated deployment of the technologies in the Munich sewer network, they gave positive feedback and concluded that the installation is not very laborious and time-consuming as it should be feasible in practice. Additionally, during the demonstration visit held in December 2021 in Munich, another outreach event was organised with forensic experts of the Forensic Science Institute of BLKA. The technologies deployed on-site were presented together with the technologies deployed simultaneously in Rome (SCW, SCA) and Lavrio (T4i DOVER) showing the real-time data fusion by the GENESI Monitoring Centre. Possible applications and improvements of the SYSTEM solutions were discussed, and positive feedback with new ideas of application areas in forensics was collected.

SYSTEM suggested readings

Sokáč, M., Velísková, Y. Impact of Sediment Layer on Longitudinal Dispersion in Sewer Systems. Water 2021, 13, 3168. https://doi.org/10.3390/w13223168.

Experiments focused on pollution transport and dispersion phenomena in conditions of low flow in sewers with bed sediment and deposits are presented. Such conditions occur very often in sewer pipes during dry weather flows. Experiments were performed in laboratory conditions. To simulate real hydraulic conditions in sewer pipes, sand of fraction 0.6–1.2 mm was placed on the bottom of the pipe. In total, 23 experiments were performed with 4 different thicknesses of sand sediment layers. For each of them, a set of tracer experiments with different flow rates was performed. The discharge ranges were from $(0.14–2.5)\cdot 10^{-3}$ $m^3\cdot s^{-1}$, corresponding to the range of Reynolds number 500–18,000. Results show that in the hydraulic conditions of a circular sewer pipe with the occurrence of sediment and deposits, the value of the longitudinal dispersion coefficient D_x decreases almost linearly with decrease of the flow rate (also with Reynolds number) to a certain limit (inflexion point), which is individual for each particular sediment thickness. Below this limit the value of the dispersion coefficient starts to rise again, together with increasing asymmetricity of the concentration distribution in time.

Sokac, M., Velísková, Y. & Gualtieri, C. (2019). Application of Asymmetrical Statistical Distributions for 1D Simulation of Solute Transport in Streams. In Water 2019, 11(10), 2145; https://doi.org/10.3390/w11102145.

Analytical solutions of the one-dimensional (1D) advection–dispersion equations are often used to describe the substance transport in streams because of their simplicity and computational speed. Practical computations, however, clearly show the limits and inaccuracies of this approach, that are especially visible when the streams deform concentration distribution of the transported substance due to hydraulic and morphological conditions, e.g., by transient storage zones (dead zones), vegetation, and irregularities in the stream hydromorphology. In this paper, a new approach to the simulation of 1D substance transport is presented, adapted, and tested on tracer experiments available in the published research, and carried out in three Slovak small streams with dead zones. Evaluation of the proposed methods based on different probability distributions confirmed that they significantly approximate the measured concentrations, better than those based upon the Gaussian distribution. Finally, an example of the application of the proposed methods to an iterative (inverse) task is presented.

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