CHIST-ERA Project Periodic Report

SWAIN
Sustainable Watershed Management Through IoT-Driven Artificial Intelligence

Periodic report n°1
31.03.2022

This document must be filled in by the project coordinator with the help of the project partners and must be uploaded online in the dedicated web portal at the end of each period (typically every year after project start). The Joint Secretariat ensures distribution to the concerned research funding organisations. The project coordinator is responsible for sending a copy of the report to the project partners.

The information provided should cover the whole duration since project start (information from a previous period should be kept in for the next period if still relevant; the report for the final period thus also constitutes the project final report covering the whole project duration).

You are also encouraged to take advantage of this reporting to update your project factsheet on the CHIST-ERA website as well as associate to your project the scientific publication in open access: https://www.chistera.eu/toolbox

1. Progress Report

1.1. Project objectives and activities implemented

(Indicative length: 2 pages per period)

Describe the work performed during each period and assess it with respect to the initial work plan. Clearly indicate who performed each part of the work and which parts are done in cooperation, describing the nature of the cooperation. Mention any difficulty encountered and the solutions implemented.

If applicable, indicate the work planned during the rest of the project, relating it to the initial work plan and the work already performed. Mention any open issue (e.g.: technical deadlock, service provider default, failure to meet deadlines, budget control), the solutions envisaged, and any foreseen need for a contractual project content revision or schedule extension.

In line with the project proposal and the timeline, the SWAIN consortium initially focused on WP2 and WP4 in the project's first year. In summary, WP2 aims to develop a hybrid contaminant transport model for a watershed, which simulates the concentration distribution of source-specific (fingerprint) micropollutants along the river. Whereas WP4 focuses on the design of a fault-tolerant and energy-efficient measurement infrastructure. WP5 is led by partners ITU and BOUN and was estimated to start in the project month 6. However, due to the deep involvement of ITU to WP4 activities and BOUN to WP2 activities, it was not possible to begin WP5 in the first year of the project. This delay does not pose a major risk for the project since neither T5.1 or T5.2 have tasks that strictly depend on them and they both have sufficient slack time.

Partners UNIVIE, TUW, and ITU have finalized T4.1 and T4.2, which constitute more than 50% of the workload required for WP4. T4.1 deals with the geographical placement of water quality sensors, whereas T4.2 addresses the communication aspect of the problem in terms of network gateway placement. To that end, we implemented the GENS Framework, which aims for sustainable deployment of the IoT infrastructure. The four modules that constitute the GENS framework, their order of invocation, and input/output relationships are demonstrated in the data-flow diagram in Fig. 1. The process starts with the gateway placement module, which takes the offline sampling locations (1) as its input and generates a hypothetical gateway deployment (2). In this deployment, it is assumed that each offline sampling location is equipped with a sensor. Although far from optimal, the hypothetical deployment provides the means of estimating the optimal communication quality for a large number of locations covering the target environment. The estimates (3a) are based on the network simulation within the network modeling module.

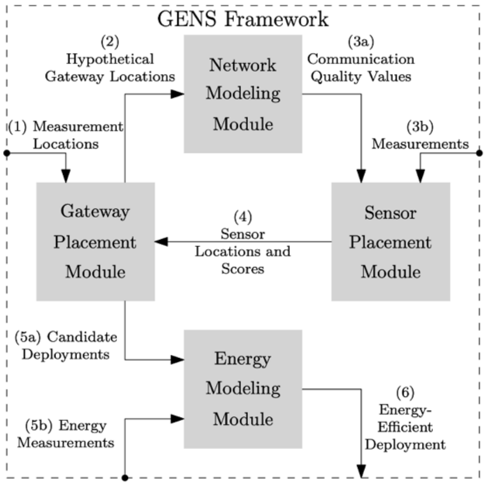


Figure 1: Data Flows among the Four Modules of the GENS Framework. Three sets of external inputs to GENS are highlighted with dots.

In the next step, the sensor placement module identifies the optimal locations for collecting the most representative data based on offline measurements (3b) and for transferring them effectively based on communication quality (3a). The output is the optimal sensor locations ranked by their scores (4), which the gateway placement module utilizes to determine the actual gateway locations. This module ensures that streaming data from these sensor locations can be transmitted to where they are processed; however, the actual impact on the energy consumption is not known. For instance, a higher number of gateways could lower consumption due to the reduced data transmission distance. Therefore, several candidate solutions with a varying number of gateways and sensors or varying coverage areas of gateways are generated. The purpose of the energy modeling module is to evaluate these solutions (5a) using energy consumption models that rely on real measurements (5b) and determine the final deployment (6).

In WP2, SYKE has prepared deliverable D2.1, which includes general information on the micropollutants in the environment, their characteristics, transportation, and transformation mechanisms. Also, hydrological, hydrodynamical, water quality and multimedia modeling are described in general with case study examples from literature. Micropollutants with concentration data at the study areas River Kokemäenjoki (performed by SYKE) and River Ergene (performed by BOUN) have been implemented with water quality characteristics from the same area to assess the possible correlations. Initial estimations about the applicability of machine learning models on estimating metal leachates from catchment areas have been conducted. SYKE is involved in identifying challenges in Task 3.4, "Near real time quality control" scheduled for the 3rd year of the SWAIN project. SYKE has also provided (Task 2.2) consortium partners concentration data of artificial sweeteners, poly- and perfluorinated compounds, and pharmaceuticals measured from the River Kokemäenjoki. This data will be used as input data for machine learning. SYKE has been involved in discussions (Task 2.3) with USI considering hydrology and hydrodynamics to promote the use of micropollutant modeling. SYKE has been supporting machine learning developers in hydrological and hydrodynamical (i.e., chemical transport relating issues) modeling, and this work is still ongoing. SYKE has a search for optimal online measurement devices to be purchased.

BOUN has consolidated the existing meteorological (e.g., precipitation, temperature, etc.), geographical (e.g., elevations, river network, etc.), socioeconomic (e.g., settlements, areal distribution of industries, etc.) data, as well as river bathymetry, flowrate and MP measurements collected for the Ergene watershed. Some of those datasets were updated with the most recent publicly available measurements. Those datasets were processed and transformed to a format compatible database prepared under Task 2.2 by USI. BOUN has also transferred the HEC-RAS model of the Ergene River to SYKE. BOUN also performed descriptive statistical analysis on the existing MP measurements to identify the correlation between MPs and conventional pollution parameters under Task 2.1. For the Ergene River, BOUN identified hexa (methoxymethyl)melamine (HMMM) as a marker pollutant of two industrial zones discharging the highest amount of toxic organic wastewater into the Ergene River with a flow rate between 2.9 - 5.0 m^3/s. Given that HMMM is very slowly degradable and has $LogK_{ow}$ of 3.07 and $LogK_{aw}$ of -9.94, it persists in the river and behaves like a tracer without significant loss during the transport in the river (Fig. 2). In addition, HMMM has an absorption maxima at 217 nm wavelength, which makes it measurable rapidly using a UV-VIS spectrometer. Pearson correlation between HMMM concentration and absorbance at 217 nm in the mainstream of the Ergene River is equal to 0.62, suggesting a reasonable correlation.

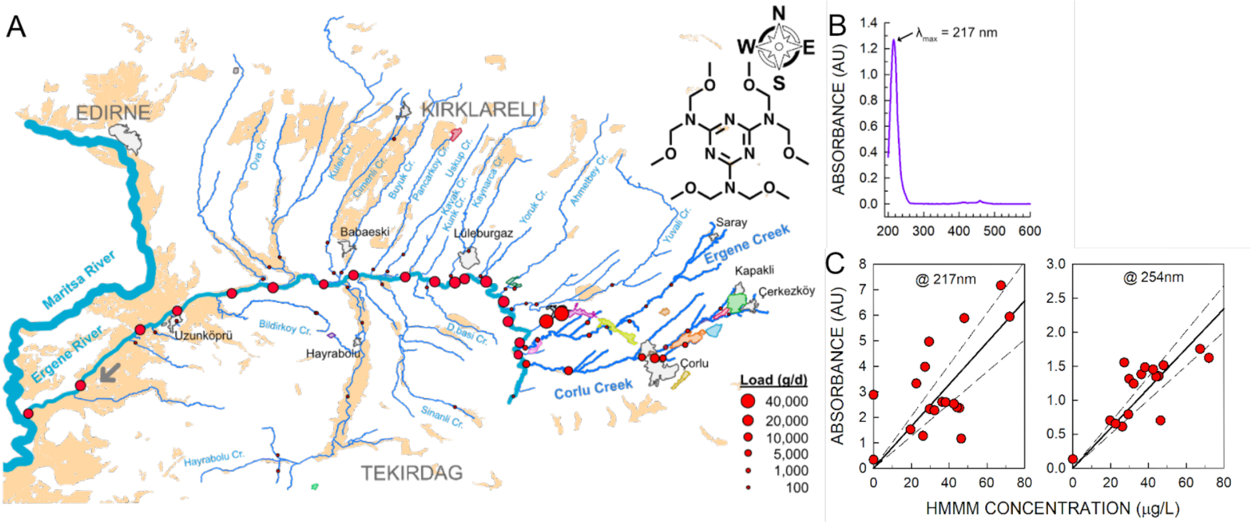


Figure 2: Profile of (A) HMMM load distribution along the Ergene River, (B) HMMMs UV-Vis spectrum, and (C) relationship between HMMM concentration and absorbance at 217 and 254 nm measured in the mainstream samples.

BOUN team developed a mass spectrometry-based analytical method to identify and quantify the metabolites of HMMM in the river water samples using the most-common-fragment ion. The method is based on detecting a common MRM transition of the metabolites $[M_{meabolite}+1] \rightarrow 177.1Da$. BOUN has been developing an LC-MSn method to measure artificial sweeteners (e.g., acesulfame K and sucralose) that SYKE previously measured in the Kokemäenjoki in order to match at least two persistent MPs in two rivers.

USI focused on creating a comprehensive and unified data management setup (Fig. 3) to embrace heterogeneous data provided from various sources. Different data types, formats, sampling rates, and structures have been identified, investigated, and finally standardized. At first, to enable datasets exchange among different parties, the Data Exchange Protocol (DEP) has been designed and agreed upon with the other partners, which ensures data is both human and machine-readable. The river measurements and related historical data have been parsed and moved to a centralized DB. The database itself is designed as modular and flexible so that a wider set of data can be added as the project evolution may require.

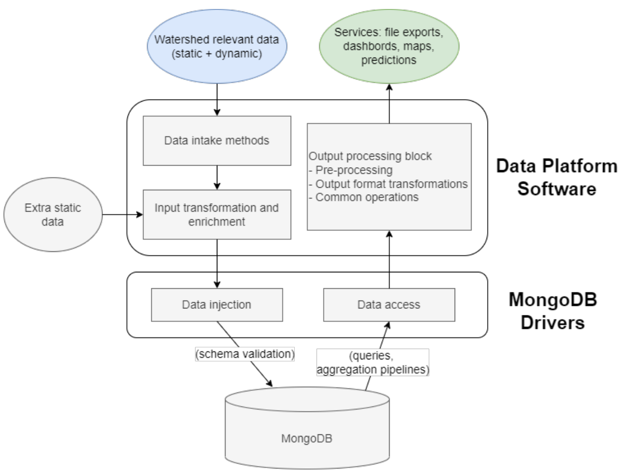


Figure 3: Data Structure and Layers

On top of that, a solution for easy data access is implemented as well as a layer that enables extra services such as data export and visualization. USI has developed the deliverable D2.2, "Data consolidated to a single database". USI is also in charge of task T2.3, "Design and implementation of AI-assisted micro-pollutant transport model". To obtain additional relevant data for more credible scientific experiments, USI also investigates alternative data sources, such as two possible candidates for a supplementary dataset, the CAMELS-US, and the LamaH corpora. A literature review of rainfall-runoff models has been conducted, revealing many interesting architectures, such as MC-LSTM, EA-LSTM, ODE-LSTM. USI has also been studying how to map the river network and the associated meteorological forcings into a heterogeneous graph capable of representing both intermediate hydraulic stations and meteorological ones scattered around the basin(s). It would be the first time such a graph has been built. USI identified a set of architectures that can be implemented for the purpose, such as STGCN, DC-RNN, GraWave, and GARNN. Some of these originate from traffic-optimization problems and might be suitable for T2.3. USI is also studying ways to integrate physical knowledge into the data-driven model in close contact with ITU.

1.2. Transnational collaboration

Describe the added value and synergies in the collaboration, any obstacles to the transnational collaboration, and the proposed solution (if necessary).

Two task forces focusing on WP2 and WP4 have been formed in order to facilitate efficient collaboration. The WP2 task force included USI, BOUN, and SYKE, whereas the WP4 task force included UNIVIE, TUW, and ITU. Both task forces organized their internal meetings and communication channels while they informed the whole consortium at every consortium meeting. Judging by the completion of the interdisciplinary tasks and corresponding deliverables in line with the project timeline, this approach is proven successful. Furthermore, each task force has prepared a strong manuscript to be submitted to leading academic venues for publication.

Collaboration between machine learning experts (USI) and environmental scientists (SYKE) has clarified the possibilities of ML methods in the field of hydrology and hydrodynamics and has clearly demonstrated these methods' limitations. The project has therefore strengthened SYKEs knowledge concerning machine learning. The discussion has led to several research ideas for which funding is applied from several EU funding channels as well as from national funding channels. Intensive discussions with SYKE helped USI clarify the ways physical models for Hydrology work, what they need in terms of input data, and what they can produce. Partnership with BOUN has been critical in understanding how and at what rate micropollutant measurements can be produced. Collaboration with both partners has sparked plenty of research ideas for USI, mainly concerning the definition and planning of the necessary steps in the design and implementation of the transport model (deliverable D2.3).

Collaboration towards WP4 has enabled the convergence of expertise at three institutions, which also formed the three objectives of the GENS framework (see Section 1.1). More specifically, UNIVIE took responsibility for data quality, TUW for energy efficiency, and ITU for communication quality when optimizing sensor and gateway placements. New research directions and further collaboration opportunities have emerged. Further collaboration could be on edge intelligence and energy harvesting as well as the visualization of sensor data. Additionally, two future avenues for collaboration are identified: (i) UNIVIE and TUW are working on the dynamic scheduling of machine learning tasks (D4.5), and (ii) UNIVIE and SYKE have initiated work on quality control of sensor data on edge devices (D4.6).

Nevertheless, collaboration has been hindered by the ongoing COVID-19 situation with recommendations not to travel. In highly diverse research areas such as machine learning, distributed cloud, and environmental sciences, lack of body language and/or other subtle hints make progress less effective than in face-to-face discussions.

1.3. Significant events and results

(Indicative length: 2-4 pages)

Describe the main achievements of the project. For example:

- *New ideas, new knowledge, new interpretative models of complex phenomena;*
- *Realization of new scientific instrumentation and/or advanced devices;*
- *Implementation of new advanced scientific methodologies;*

- *Realization of prototypes;*
- *Proposal of new technologies;*
- *Contribution to innovation in the production of goods and services;*
- *Development of innovative software;*
- *Economic impact and results exploitation.*

For each achievement, provide a description with factual and, if relevant, quantitative information.

For significant results you would like to publicise using the communication channels of CHIST-ERA, please feel free to forward the information to CHIST-ERA Joint Secretariat using the Toolbox dedicated to the funded projects: https://www.chistera.eu/toolbox

The following are the main achievements of the SWAIN project in the first year of its lifetime. The achievements can be categorized into three classes as algorithms and mechanisms, analyses for water quality, or the curation of data repositories. The technical details of each achievement are described in Section 1.1.

Algorithms and Mechanisms

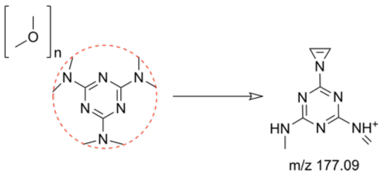
- A novel ML-based algorithm for choosing locations for a given number of water quality sensors that maximizes the information value of the data to be collected and minimizes the cost of transmitting collected data.
  - The algorithm is able to detect almost all micropollutants with 60% fewer sensors (30 instead of 75 locations) than state-of-the-art.
- A novel heuristic algorithm for choosing locations for LoRaWAN gateways that collect data from water quality sensors to minimize packet drop rate and energy consumption.
  - The gateway placement algorithm, combined with sensor placement, can reduce the required number of gateways by at least half with a comparable packet drop rate and energy consumption.
- Network simulation of LoRaWAN-based wireless sensor network to estimate packet drop rate, energy consumption, transmission time, etc., using the ns3 simulator.
  - The deployment with 30 sensors and 1km ranged gateways can achieve the highest network performance and least transmission time. However, the range can be extended to decrease the number of gateways required.
- A genetic algorithm for energy-aware placement optimization, which configures selected gateways to cover corresponding sensors with minimum energy footprint.
  - Energy consumption can be reduced by up to 45% compared to no optimization case, although sensor and gateway placement algorithms are also energy-aware.

Analyses for Water Quality

- A descriptive statistical analysis of the existing micropollutant measurements to identify the correlation between MPs and conventional pollution parameters. [Ergene River]
  - Hexa(methoxymethyl)melamine (HMMM) is identified as a marker pollutant of two industrial zones discharging the highest amount of toxic organic wastewater into the Ergene River with a flow rate between 2.9 - 5.0 m^3/s.
  - Other quantitative information about HMMM is available in Section 1.1.
- An analysis of micropollutants in the environment, their characteristics, transportation, and transformation mechanisms. Also hydrological, hydrodynamical, water quality, and multimedia

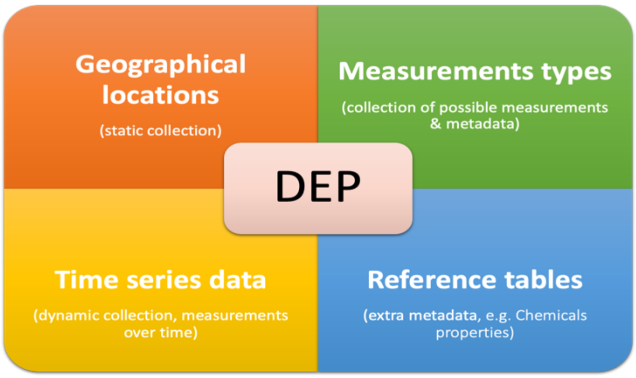
modeling. An assessment of the possible correlations between water quality characteristics and micropollutant concentration. [Kokemäenjoki River]

- A mass spectrometry-based analytical method to identify and quantify the metabolites of HMMM in the river water samples using most-common-fragment ion. The method is based on detecting a common MRM transition of the metabolites [$M_{meabolite}$+1] → 177.1Da based on the following reaction scheme:



Curation of Data Repositories

- Consolidated dataset of existing meteorological (e.g., precipitation, temperature, etc.), geographical (e.g., elevations, river network, etc.), socio-economic (e.g., settlements, areal distribution of industries, etc.) data as well as river bathymetry, flowrate and MP measurements collected from Ergene and Kokemäenjoki watersheds.
- Comprehensive and unified data management setup to embrace heterogeneous data provided from various sources. A centralized database of river measurements and related historical data implemented in MongoDB, including:
    - Static GIS data: mainly composed of geographical features, such as river networks, basins, land use, geographical landmarks, and weather stations. This data is composed of geo-referenced points, lines, and polygons.
    - Dynamic time series data: weather data, river measurements, physical and conventional parameters, chemicals, micropollutants, and other water quality indicators. All these are functions of time and space.
- A data exchange protocol flexible enough to support the exchange of all types of data related to SWAIN.



1.4. Technology readiness level (TRL)

Describe the global positioning of the project (from 'idea to application', or from 'lab to market'). Refer to Technology Readiness Levels (see definition here) at the beginning and at the end of the project.

SWAIN targets a technology readiness level of 5, which results in the validation of the technology in relevant environments, i.e., Ergene and Kokemäenjoki watersheds. Current TRL can be estimated at each work package as follows.

- WP2: TRL 4 – Data set has been created.
- WP3: TRL 1 – WP has not yet started
- WP4: TRL 3 – Algorithms have been developed and validated via simulation
- WP5: TRL 1 – WP has not yet started

1.5. Consortium meetings

Provide the cumulative list of consortium meetings from project start.

Meetings				
N°	**Date**	**Location**	**Attending partners**	**Purpose**
1	01.03.2021, 03.03.2021	Online	All	Kick-off meeting
2	15.04.2021	Online	All	Regular monthly meeting + Workshop
3	07.05.2021	Online	All	Regular monthly meeting
4	10.06.2021	Online	All	Regular monthly meeting
5	15.09.2021	Online	All	Regular monthly meeting
6	18.10.2021, 19.10.2021	Vienna, Austria	All (P5 remotely)	Regular monthly meeting + Workshop
7	02.12.2021	Online	All	Regular monthly meeting
8	13.01.2022	Online	All	Regular monthly meeting
9	28.02.2022	Online	All	Regular monthly meeting
Bilateral and multilateral meetings of the two task forces are omitted for brevity.				

1.6. Deliverables

Provide the cumulative list of deliverables from project start.

Deliverables					
N°	**Title**	**Nature**	**Delivery date (month)**		**Partner in charge**
			Contractual	**Actual**	
D1.1	Project Management Plan	Report	June 2021	May 2021	P1
D1.2	Annual Activity Report 1	Report	April 2022	April 2022	P1
D1.5	Quality Assurance and Risk Assessment Plan	Report	September 2021	May 2021	P1
D1.6	Data Management Plan	Report	September 2021	February 2022	P1
D1.7	Project Website and Promotional Materials	Multimedia	June 2021	June 2021	P1
D1.8	Dissemination and Exploitation Plan	Report	June 2021	June 2021	P1
D2.1	Hydrogeographical and chemical parameters for water quality model (WQM)	Report and Article	November 2021	March 2022	P6
D2.2	Consolidated Geo-Database	Database and Report	December 2021	February 2022	P3&P5
D4.1	Placement model	Report and Article	August 2021	January 2022	P1
D4.2	Offline placement algorithm	Report and Article	December 2021	December 2021	P1
D4.3	Models for communication technologies	Report and Article	January 2022	January 2022	P1
D4.4	Adaptive communication channel selection method	Report and Article	June 2022	January 2022	P1

1.7. Free comments

Compliance with project objectives, interaction between the partners, issues, questions to CHIST-ERA...

To request a project modification, please use the dedicated form on the Toolbox: https://www.chistera.eu/toolbox

N/A

2. Dissemination of results, exploitation, impact

2.1. Scientific publications (conferences/workshops, book chapters, etc.)

Indicate the publications resulting from the project. Mention only those that result directly from the project (after it started, and which mention the support of CHIST-ERA and the project reference). Indicate whether they correspond to single or multi-partner communications (multi-partner means involving several project partners). Indicate if they are available in Open Access and linked to the respective underlying data. Provide the corresponding Digital Object Identifiers (DOI).

Distinguish the different categories of publications (journals/conference proceedings, technical reports, etc.). Use the usual citation standards for the field reference. If the publication is accessible on line, indicate the URL.

Please harmonise the bibliography and use only one font.

Scientific publications						
Reference (list of authors, journal/conference proceedings/other, pages, year of publication, ...)	**Multi-project partners of same country (Yes/No)**	**Multi-project partners of different countries (Yes/No)**	**Open Access (Yes/No)**	**DOI**	**URL**	**DOI(s) of underlying data**
Toczé, K., Schmitt, N., Kargén, U., Aral, A., & Brandić, I. (2022). Edge Workload Trace Gathering and Analysis for Benchmarking. In 6th IEEE International Conference on Fog and Edge Computing (ICFEC 2022).	Yes	No	Yes		https://eprints.cs.univie.ac.at/7299/	
Ding, A. Y., Peltonen, E., Meuser, T., Aral, A., Becker, C., Dustdar, S., ... & Wolf, L. (2022). Roadmap for edge AI: a Dagstuhl perspective. ACM SIGCOMM Computer Communication Review, 52(1), 28-33.	No	No	Yes	10.1145/3523230.3523235	https://doi.org/10.1145/3523230.3523235	
Zhou, H., Aral, A., Brandic, I., & Erol-Kantarci, M. (2021). Multi-agent Bayesian Deep Reinforcement Learning for Microgrid Energy Management under Communication Failures. IEEE Internet of Things Journal.	Yes	No	Yes	JIOT.2021.3131719	https://doi.org/10.1109/JIOT.2021.3131719	
IoT-Enabled Sustainable Environmental Monitoring via LoRaWAN and Signal Reconstruction (under review)	Yes	Yes				
Hydrogeographical and chemical parameters in water quality modelling (WQM) (in preparation)	No	Yes				

URL of Data Management Plan (optional): https://swain-project.eu/pdf/D16.pdf [also available as a live document on the OpenAIRE ARGOS tool]

2.2 Exploitation plan

Outline an exploitation plan of your most significant exploitable results including:

- *Who will exploit the result output (project participant/if someone else then who and how will they be informed);*
- *Use type (commercial/other use);*
- *Intellectual property rights arrangements if relevant;*
- *Target end user;*
- *Roadmap and goals during and after the project's lifetime (plan of actions to be taken to achieve exploitation);*
- *Timeframe.*

The following are the main exploitation goals of the SWAIN project.

<u>*Scientific publications and data sets*</u>

- Outputs: Several deliverables (estimated 11) of the SWAIN project contain scientific breakthroughs that can be disseminated in academic journals/conferences and exploited by fellow scientists also in other areas of environmental monitoring and quality management.
- Use type: Academic
- Target end-user: Data scientists, environmental scientists, hydrologists, information system engineers/ scientists, etc.
- Timeframe: Throughout the three years, in line with the project timeline

<u>*New collaborations and partnerships*</u>

- Outputs: New project proposals that include partners of the SWAIN project, joint publications with the partners of related projects.
- Use type: Academic
- Target end-user: SWAIN partners
- Timeframe: Second and third years of the project

<u>*Micropollutant early-warning system*</u>

- Outputs: An AI-based early warning and prediction system for domestic, industrial, and agricultural pollution in European watersheds
- Use type: Public
- Target end-user: Authorities responsible for water pollution
- Timeframe: The years following the project completion

<u>*Pollutant visualization tool*</u>

- Outputs: A decision support system/pollutant visualization tool that presents the results of the pollution model and adapts to the specific context and needs of the stakeholders, e.g., in visualizing uncertainty
- Use type: Public
- Target end-user: Authorities responsible for water pollution as well as the general public
- Timeframe: The years following the project completion

2.3 Exploitation overview (software, products, spin-offs, etc.)

Use the table below to outline your current progress in the exploitation plan (see previous section): achievements so far and next steps. Fill in the goals foreseen in your plan for every year of your project and 3 subsequent years after the end of your project (column 1) and actual exploited results up to date (column 2).

Period	Planned goals	Actual exploited results
Year 1	• D2.1 published as a scientific article • D4.1, D4.2, and D4.3 published as a scientific article • Consolidated Geo-Database	• The article is being prepared. • The article submitted to the IEEE Internet of Things Journal is under review. • Geo-Database is shared internally
Year 2	• D4.4 and D4.5 published as a scientific article • D5.2 published as a scientific article • Collaboration with WATERLINE and/or ANDROMEDA projects	n/a
Year 3 *(if applicable)*	• D2.3 published as a scientific article • D3.1 and D3.2 published as a scientific article • D4.6 published as a scientific article • Early warning system validated both in Turkey and Finland.	n/a
Project end + 1 year	• Pollutant visualization tool (D5.3) publicly accessible and used by public authorities. • Early warning system integrated with local authorities. • New collaborations between SWAIN partners • Databases are available publicly	n/a
Project end + 2 year	• Pollutant visualization tool (D5.3) actively used. • Early warning system actively used.	n/a
Project end + 3 year	• Pollutant visualization tool (D5.3) actively used. • Early warning system actively used.	n/a

Describe project spin-off effects, for example:

- *Software and any other prototype;*
- *Standardization actions;*
- *National and international patents, licences, and other elements of intellectual property;*
- *Launching of product or service, new project, contract, etc.;*
- *Development of a new partnership;*
- *Creation of a platform available to a community;*
- *Company creation, spin-off companies, fund-raising.*

The following are the spin-off effects from the first year of the SWAIN project.

As a result of WP2, two artifacts have been created but not yet made public.

1. An analysis of hydrogeographical and chemical parameters with their impact on water quality model (to be published as a technical report and a scientific article)
2. A consolidated geo-database of available and envisioned environmental data (to be published as an open database)

As a result of WP4, a software for sensor and gateway placement has been developed. The software will be made public at the end of the project whereas scientific findings are documented as an article that is currently under review of publication.

Additionally, a new collaboration between relevant projects of the CHIST-ERA call is currently being created. To that end, meetings with the participants of the ANDROMEDA and WATERLINE projects have been scheduled in May 2022.

2.4 Other dissemination of results

Mention any communication actions, including the project website creation and management and the target audience.

In the first month of the project, a video interview (https://www.youtube.com/watch?v=cRY3X2FUQrk) with the project coordinator was produced with the help of the Corporate Communications team of the University of Vienna. The interview is aimed at the general public and includes subtitles in multiple languages in order to increase its reach. This video has also won the best video award at the CHIST-ERA project video contest that was held for the first time during the projects seminar 2021, with voting open to all attendees (https://www.chistera.eu/news/and-winners-chist-era-project-video-contest-2021-are).

The project website (https://swain-project.eu/) was created within the first three months of the project and kept updated continuously. The website contains the publishable abstract of the SWAIN project, details about partners and funding, list of scientific publications and project deliverables, project news, and media appearances.

Additionally, a Twitter account (https://twitter.com/SWAIN_Project) was created to disseminate project updates and achievements on social media. In the first year of the project, this account has been visited more than 3,200 times, and its tweets have been seen more than 11,000 times, according to Twitter Analytics.

Finally, the project coordinator has given various talks on the SWAIN project. A list of selected talks is given below.

- **Sustainable Environmental Monitoring**, Austrian Academy of Sciences - Colloquium Digitale: Digitalization, People, and Society, Vienna, Austria (March 2022)
- **A Computational Approach Towards Early Detection of Micropollutants in Rivers**, ERN - Environmental Engagements: talks, Vienna, Austria (October 2021)
- **Identifying Key Enablers in Edge Intelligence**, Dagstuhl Seminar 21342, Wadern, Germany (Hybrid event) (August 2021)

3. Resources and Funding

3.1. Project level (from project start)

Budget used				
N°	**Partner**	**Person.months**	**Total costs**	**Percentage of requested budget**
1	University of Vienna	12.40	EUR 79,153.47	31.7%
2	Vienna University of Technology	9.00	EUR 68,617.15	42.9%
3	Università della Svizzera italiana	6.00	EUR 27,500.00	12%
4	Istanbul Technical University	56.70	TRY 180,658.33 ≈EUR 11,316.44	32.7%
5	Bogazici University			
6	Finnish Environment Institute	11.24	EUR 77,326.380	21.0%

Comments on expenses

General Comments

The percentage of the requested budget spent by each partner is compatible with the project timeline and expected contributions from each partner in the first year of the project. Partner 3 will make significantly more contributions with WP3 in the next two project years (which explains the lower percentage in the first year). In contrast, partner 2’s contributions will decrease in the last project year (which explains the higher percentage in the first year). Therefore, there are no concerns currently regarding the project spending and remaining budget.

Comments per partner

University of Vienna (UNIVIE, partner 1) employs a senior post-doc (since 01.03.2021) and a part-time (%20) master student (since 01.01.2022). Total personal costs were EUR 77937.89. The remaining costs (EUR 1215.58) were allocated to the purchase of small pieces of equipment and to the organization of the partner meeting in Vienna.

Vienna University of Technology (TUW, partner 2) employs a part-time (50%) post-doc (since 01.09.2021) and a Ph.D. student (since 01.07.2021).

Università della Svizzera italiana (USI, partner 3) employs a part-time post-doc as an advisor and a full-time Ph.D. student (since 01.09.2021).

Istanbul Technical University (ITU, partner 4) and Boğaziçi University (BOUN, partner 5) are funded together by the Turkish funding organization. The project employs three researchers and five undergraduate/graduate scholars. Researchers join the project efforts from the beginning, where the scholars are separately joined afterward. The total cost of person.months is 28658TRY. 88120TRY is used for laboratory expenses; 20312.56TRY is used for laboratory equipment; 28567.77TRY is used for maintenance and calibration of existing equipment. The remaining 15000TRY is spent on the travel costs of the partner meeting in Vienna.

Finnish Environment Institute (partner 6) employs 7 part-time researchers. Total personnel costs were EUR 75823.90. The remaining costs (EUR 1502.41) are due to participating in the partner meeting in Vienna.