water mining
value for society

Deliverable 7.4

Three AR-'enhanced' demo cases

Date: 29 August 2023

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 869474.

Acknowledgements

This report was produced under the co-finance of the European financial instrument H2020 as the fourth Deliverable (D7.4) of Work Package 7 (WP7) of WATER-MINING project (Grant Agreement No 869474) during the implementation of its Task 7.4 entitled "Testing and Customisation of the WATER-MINING AR app to the case studies".

The WATER-MINING team would like to acknowledge the European H2020 financial instrument for the financial support.

Disclaimer

Keywords

▪ Augmented Reality ▪ Application ▪ ICT tool ▪ Engagement ▪ Immersive

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Deliverable information

Deliverable 7.4	Three AR-'enhanced' demo cases
Related Work Package	WP 7 – Development of ICT tools supporting process monitoring, control & optimization (DATA-MINING), immersive stakeholder engagement (AR-applications) & market creation
Deliverable lead	ICCS
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Reviewer	WP7 partners
Grant Agreement Number	869474
Instrument	Horizon 2020 Framework Programme
Start date	1st September 2020
Duration	48 months
Type of Delivery[1]	DEM
Dissemination Level[2]	PU
Date last update	20 January 2022
Website	www.watermining.eu
Name of contributors	Tina Katika (Researcher, AR app); Dimitra Tsiakou (Researcher, AR app)

History of changes

Version	Date	Description	Author(s)
v1	10/06/2023	First draft	Tina Katika
v2	30/06/2023	Second version	Dimitra Tsiakou
v3	30/07/2023	Third version	Dimitra Tsiakou
v4	31/10/2023	Comments from the reviewers	Tina Katika
v5	07/11/2023	Final version	Dimitra Tsiakou
v6	08/1/2024		

[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other; **ETHICS**=Ethics requirement, **ORDP**=Open Research Data Pilot

[2] **PU**=Public; **CO**=Confidential, only for members of the consortium (including the Commission Services); **EU-RES** Classified Information: RESTREINT UE (Commission Decision 2005/444/EC); **EU-CON** Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC); **EU-SEC** Classified Information: SECRET UE (Commission Decision 2005/444/EC)

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Executive Summary

Deliverable 7.4 demonstrates the deployment of the Augmented Reality (AR) application to three Case Studies (CSs) and a preliminary demonstration in Athens Science Festival. In order to achieve the smooth development and customization of AR application, dedicated meetings and online training were implemented. During these workshops, the main goal was to define the content which will be showcased in the Communities of Practice (CoPs) meetings through the AR app. The AR application was deployed for CS2, CS4, and CS5 and this deliverable extensively describes the process of finalizing the content for the AR application for each CS. More specifically, together with the pilot partners, the content was defined to meet the needs of the end-users. Additionally, the user experience in each demonstration was compiled and described in this deliverable. Finally, to achieve the full potential of the AR app and reach the final version of the application, a set of feedback was collected in each demonstration.

In more details, the following deliverable includes the following sections. The first section describes a concrete methodology on the curation of AR campaigns for each CoP, including all steps of the entire process of crafting, prototyping, designing, developing, testing and showcasing the AR demonstrations. The next section highlights the communication activities performed at the Athens Science Festival (ASF) (21,22, and 23 of October 2022), which it is one of the largest science and technology festivals in Greece. The AR application demonstration during the Athens Science Festival aimed to collect valuable feedback on the project's activities and to analyze the impact of WATERMINING project by quickly educating the end-users and familiarizing them with the elements of the water cycle and the proposed solutions from the CSs, aiming to achieve a high acceptance rate. Following, the demonstration activities in CS2, CS4 and CS5, ar Almeria, Cyprus and La Llagosta respectively. A detailed description of the demo case and campaign curation is also provided. Regarding each demonstration activity, feedback was collected to reflect the way the stakeholders -end-users of the application perceived the activities to transform the UI and UX of the application and enable the design and development of additional functionalities. All feedback was collected and translated to user stories and further elaborated by the design team.

List of Revisions

Comment from reviewer	Reply from authors
The report could however add some additional information on what the user's experience was in CS 2 (Almeria), CS4 (Cyprus) and CS5 (La Llagosta) beyond the technical feedback (e.g., how the educational purposes were achieved)	In each chapter reffering to the Case Studies (4,5,6) an additional paragraph has been added focusing on the user engagement.
Front page comes without Deliverable number and project logo.	The front page now has both project logo and Deliverable number.
Dissemination level given as "internal" in contradiction with DoA (AMD 869474-9, p. 49 of 78) where it is given as PU, type is given as "internal" while it is DEM.	Thank you for your comment. This error has been corrected.
Executive summary is missing.	An executive summary has been inserted.
Layout of the report deviates from the standard project template (footer is missing, font type/size of figure and table captions, etc.)	Thank you very much for this indication. The report has been updated based on the projects' template.
The report requires proper language proof-reading.	The Deliverable has been proof-read.
Why does the report come with annexes plus appendix?	The appendix has been converted to ANNEX 4. The ANNEX 4 has been considered important as it provides a visual summary of the development efforts within the watermining.

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Acronyms

AR	Augmented Reality
CMS	Content Management System
APIs	Application Programming Interfaces
CoP	Communities of Practice
VLLs	Virtual Living Labs
PoI	Point of Interest
CE	Circular Economy
UI	User Interface
CS	Case Study

1. Overview of the project

WATER-MINING is a project funded by the European Commission (Horizon 2020 – Grant Agreement No 869474) with a total duration of 48 months (Start date: 01/09/2020 – 31/08/2024) and a total budget of approx € 19 million (EU Contribution: € 16,876,959.59). The project is entitled "Next generation water-smart management systems: large scale demonstrations for a circular economy and society" and it is a project granted under the call topic "CE-SC5-04-2019: Building a water-smart economy and society". Further information about all the sister projects funded under this topic can be found at the CORDIS website here. The WATER-MINING consortium comprises 38 partners from 12 countries, led by the Delft University of Technology (TU Delft). More information about the project can be found at the project website (https://watermining.eu) as well as the dedicated website at CORDIS database (https://cordis.europa.eu/project/id/869474), while an overview is provided below.

The WATER-MINING project aims to provide for real-world implementations of Water Framework Directive (and other water related legislation), as well as the Circular Economy and EU Green Deal packages by showcasing and validating innovative next generation water resource solutions at pre-commercial demonstration scale. These solutions combine WATER management services with the recovery of value-added renewable resources extracted/MINED from alternative water resources ("WATER-MINING").

The project integrates selected innovative technologies that have reached proof of concept levels under previous EU projects. The value-added end-products (water, platform chemicals, energy, nutrients, minerals) are expected to provide regional resource supplies to fuel economic developments within a growing demand for resource security. Different layouts for urban wastewater treatment and seawater desalination are proposed, to demonstrate the wider practical potential to replicate the philosophy of approach in widening circles of water and resource management schemes. Innovative service-based business models (such as chemical leasing) are being introduced to stimulate progressive forms of collaboration between public and private actors and access to private investments, as well as policy measures to make the proposed water solutions relevant and accessible for rolling out commercial projects in the future. The goal is to enable costs for the recovery of the resources to become distributed across the whole value chain in a fair way, promoting business incentives for investments from both suppliers and end-users along the value chain. The demonstration case studies are to be first implemented in five EU countries (NL, ES, CY, PT, IT) where prior successful technical and social steps have already been accomplished. The broader project consortium representation will be an enabler to transferring trans-disciplinary project know-how to the partner countries while motivating and inspiring relevant innovations throughout Europe.

2. Scope of the deliverable

Within WATER-MINING project, Work Package 7 (WP7) is focusing on the "Development of ICT tools supporting process monitoring, control & optimization (DATA-MINING), immersive stakeholder engagement (AR-applications) & market creation". WP7 is structured on the following five (5) Tasks:

- **Task 7.1**: Development of a flexible process monitoring, control and optimisation dashboard for WATER-MINING;
- **Task 7.2**: Customisation of the WATER-MINING Dashboard and deployment in selected cases;
- **Task 7.3**: Development of the Augmented Reality (AR) applications for the WATER-MINING case studies;
- **Task 7.4**: Testing and Customisation of the WATER-MINING AR app to the case studies;
- **Task 7.5**: Development of the WATER MINING Platform.

The results from the implementation of this work package are presented through six (6) deliverables:

- **Deliverable 7.1**: The WATER-MINING Dashboard (associated with Task 7.1);
- **Deliverable 7.2**: WATER-MINING Dashboard deployments in the 3 demo cases (associated with Task 7.2);
- **Deliverable 7.3**: The WATER-MINING AR (authoring tool and mobile application) (associated with Task 7.3);
- **Deliverable 7.4**: Three AR-'enhanced' demo cases (associated with Task 7.4);
- **Deliverable 7.5**: The WATER MINING Platform (associated with Task 7.5);
- **Deliverable 7.6**: D7.6 The WATER-MINING AR (authoring tool and mobile application) – Final Version (M36) (associated with Task 7.3).

The current deliverable comprises the fourth deliverable of WP7. The work was led by ICCS within Task 7.4.

This deliverable is also a "Public" deliverable, thus not containing any confidential information.

3. Introduction

3.1. Purpose of this document

The purpose of this report is to present the demonstration activities of the AR application (CirculAR) at the Case Studies. Overall, 3 demonstration activities were planned, designed and performed during the CoP meetings of the Case Studies between February and May of 2023 in Almeria, Larnaca and Barcelona. In addition, one preliminary demonstration was performed in Athens the 13th of October 2022. Section 2 elaborates on the curation process for the AR demonstrations which can also be used as a guide for similar activities.

The preliminary demonstration is described in section 3. The activity emphasized on the collection of feedback on the alpha version of both the mobile application and content curated. More than 300 participants provided input in semi-structure interviews and demonstrations. The Case Study demonstrations are further elaborated in sections 4 to 6, where workshops, brainstorming activities and content discussions are highlighted. Case study owners, stakeholders and CoP participants had access to the advanced features and functionalities of CirculAR enriched with captivating content, both designed and developed by ICCS. Feedback, collected in a concise manner (using forms, surveys and questionnaires) during the demonstration activities, further improved the AR application.

3.2. Document's structure

The document is structured in a format to present the design and curation process of the mobile AR application demonstration activities for the Case studies. To avoid duplicating information about the design and development of the AR application itself, we will often refer to the D7.3 ''The WATER-MINING AR (authoring tool and mobile application) – First Version''. First, we provide an overview of the preliminary demonstration in Athens to collect feedback on the demonstration itself, the content augmented, the campaigns created and the overall textual information. Then we present the 3 demonstration activities that took place in Almeria, Larnaca and Barcelona for Case studies 2, 4 and 5 respectively. We conclude the deliverable with some remarks and future studies.

4. Campaign curation for the AR app

As AR campaign curation we describe the entire process of crafting, prototyping, designing, developing, testing and showcasing the AR demonstrations and includes the following:

- The brainstorming activities on the content selection to be augmented via CirculAR during the demonstration activities (typically 2-3 workshops between the case study owners and the ICCS design and development team). These workshops are used to "translate" the technical and scientific specifications of the Case Study, to meaningful augmented scenarios to be visualized by the end-users of the AR app;
- Content creation activities include all workshops (typically 2-3 online) and email or other online document communication that start from the generation of crafts and prototypes on the content that best reflects the CS activities to be augmented and finalize with the digital content to be demonstrated. During this step of the process, the ICCS content creator and 3D artist collect requirements from the CS owners. Through an iterative process, they improve the content to meet the high standards of the CS owners while also ensuring an immersive and captivating experience for the end-users of CirculAR;
- Textual information of the AR campaigns includes all the content item descriptions, the quiz questions, their answers and feedback provided, and additional input of the content. This step typically includes the translation of the content to the local language of the demonstration activity to avoid any language barrier;
- Content curation is then finalized after one meeting. The ICCS content curator assesses the exact location of the AR demonstration activity and ensures that all content is in place and has the correct format;
- Upon finalization of the AR campaign curation, then the testing activities include the processes of downloading, installing, using and testing of the AR campaigns. Typically, this step includes dummy testing of the campaign from CS local participants to ensure that there are no localization shortcomings or other authorization issues. Usually, 2-3 hours suffice for this activity and gives the final validation check for the demonstration activity;
- AR campaign demonstration takes place at the premises of the CS and usually lasts 0.5-1 hour. During demonstration, feedback is collected in a semi-structured format by the demonstrators and upon finalization, feedback is collected through forms aiming to assess the AR performance (including the software and content engagement).

5. Preliminary AR demonstration

To demonstrate CirculAR and receive feedback not only on the design features and functionalities, but also on the draft content items prepared for the Case Studies, a treasure hunt game was created for students aged 5 to 15, along with their educators, parents and guardians. End-users were called to enter a map and look for the virtual agent (ARis), who aimed to educate about sustainability processes through virtual content related to the WATERMINING activities. An AR campaign was created and curated using virtual content through the AR CMS prepared to ensure an engaging activity for participants of all ages (Figure 1). The educational and gamification features and the object recognition functionality were also utilized to ensure an even more immersive experience. During the 3-day demonstration, feedback was continuously gathered (more than 2000 students from various schools visited the exhibitions). Interviews and discussions during the event ensured that the feedback was collected in a structured way. The main goal of gathering this feedback is to refine and improve the AR application, leading to the final version of the application that meets the overall objectives of the WATER-MINING project.

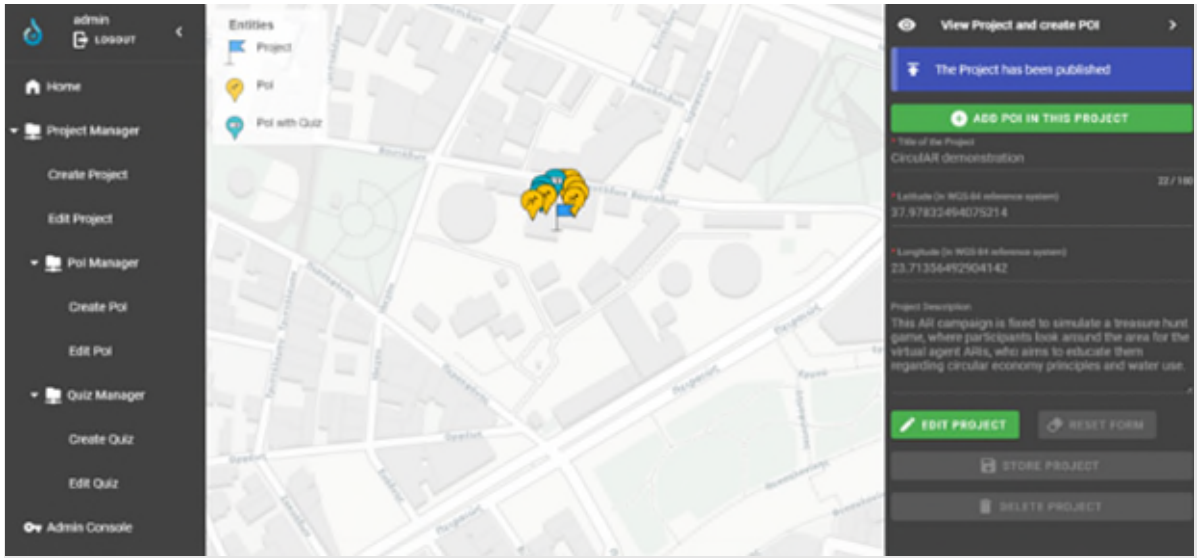


Figure 1- The AR CMS UI where the AR campaigns for the treasure hunt game are curated. each one of the blue and orange bubbles in the middle of the map, contain virtual content (i.e., videos, images, 3d objects, questionnaires).

Five researchers from ICCS during the 3-day activity explained the game to the students, presenting their mission and goal when using CirculAR. The students were told that finding ARis across the room would identify interesting hints about the WATERMINING principles. The act of improving their score through quizzes was also described. The game was finalized when the end-user found ARis in all "hidden" spots and answered all quizzes associated with the virtual content revealed. As demonstrated by the app analytics, more than 250 students finalized the treasure hunt game. Figure 2 shows the app analytics.

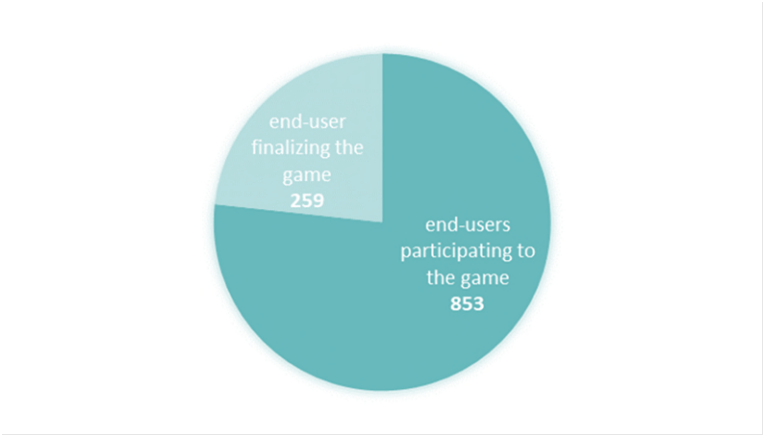


Figure 2- End-users participating and finalizing the treasure hunt game showcased via CirculAR.

5.1. Selection of demo site

The Athens Science Festival (ASF) (21,22, and 23 of October 2022), was primarily selected for this showcasing, since it is one of the largest science and technology festivals in Greece. WATERMINING activities related to sea, industry and urban mining felt relevant to the overall mission of the festival. Finally, the festival attracts a heterogenous audience interested in science and technology interested in such settings and willing to provide feedback. The AR application demonstration during the Athens Science Festival was also chosen in order to collect valuable feedback on the project's activities and to analyze the impact of WATERMINING project by quickly educating the end-users and familiarizing them with the elements of the water cycle and the proposed solutions from the CSs, aiming to achieve a high acceptance rate. Figure 3 shows the team of ICCS researchers demonstrating the main findings of the WATERMINING Case Studies via the AR app.

Figure 3- ICCS researchers that took part in the Athens science festival.

5.2. Content curation for the AR app

Along with other partners of WATERMINING involved in the Task 7.3, (REVOLVE, DECHEMA, EXCITE and SciCo), the demonstration activity was planned and organized as follows:

- Workshops among the partners helped to shape the demonstration activity, including content that was initially prepared by REVOLVE, but additionally curated to be part of the AR demonstration activity. The end-users of the activity were further defined with SciCo, EXCITE, and DECHEMA;
- Additional content was prepared based on information collected from the Case Studies (including their KPIs and metrics) but also from digital 3D material prepared from ICCS to ensure an engaging activity for all participants of all ages;
- ICCS finalized the virtual WATERMINING campaign using the Content Management System, addressed to the audience participating in the ASF. Quiz questions and object recognition features were also utilized to educate further and ensure an even more immersive experience;
- During the 3-day demonstration feedback was continuously gathered from the end-users (more than 2000 students from various schools visited the exhibitions!). Interviews and discussions conducted during the event ensured that the feedback was collected in a structured way. The development and User Experience (UX) team from ICCS participated and drove the discussions to ensure that the feedback gathered will be used for the final fine-tuning of the AR app.

The following Table includes the AR content demonstrated during the 3-day activity at the ASF. The language used was Greek, to ensure that there is no language bias during the demonstration. In addition, the ages varied from very young children to seniors and we aimed to increased participation regardless of their English-understanding abilities. It was a challenge to create content suitable for such a wide range of end-users, which was overcome by including both simplified and more complex content.

Table 1- Content curation activities for ASF.

AR curation activities	
Brainstorming activities	Meeting with REVOLVE and DECHEMA on 29/09/2022 to discuss the concept of the ASF
1st set of content sent by REVOLVE	REVOLVE sent the roll up of WATERMINING project and a video to specify the general material on 30/09/2022
2nd set of content sent by REVOLVE	ICCS asked the images from the website in raw format in order to translate the text in Greek due to the younger audience that will participate in the festival on 3/10/2022
ICCS requested modifications	ICCS sent to REVOLVE the translated material and some minor modifications for the images for a more comprehensive AR visualization on 6/10/2022

3rd set of content sent by REVOLVE	REVOLVE sent the translated images regarding the factsheets of the WATERMINING project on 11/10/2022
Final set of content sent by REVOLVE	After some minor changes requested from ICCS, REVOLVE sent the final images for the ASF on 14/10/2022
1st set of content by ICCS	ICCS drafted images to complete the AR campaign to be visualized through the CirculAR app on 10/10/2022
2nd set of content by ICCS	ICCS team requested from the content curator a video and 3D model regarding the circular economy and the impact of the linear economy respectively on 15/10/2022
Final set of content by ICCS	ICCS finalized the whole campaign on 19/10/2022
Final test of the AR demonstration	ICCS tested the campaign prior to the ASF on 20/10/2022

The Figures 4-13 below show the AR content that has been curated through the CMS for the purposes of the preliminary demonstration.

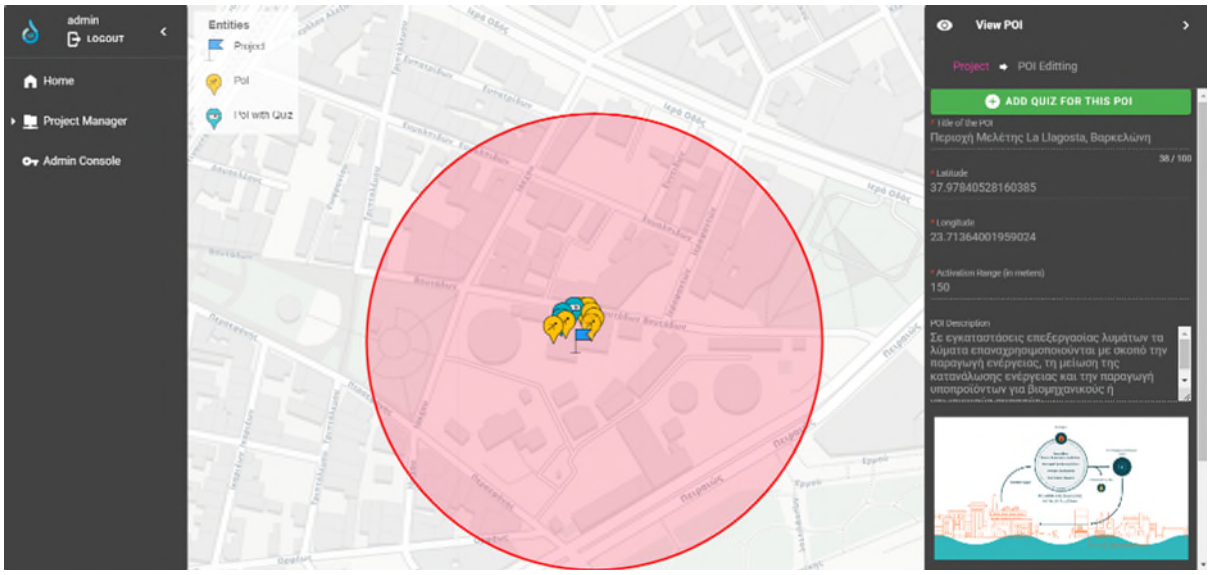


Figure 4- Virtual content describing the innovative technologies of case study in La Llagosta.

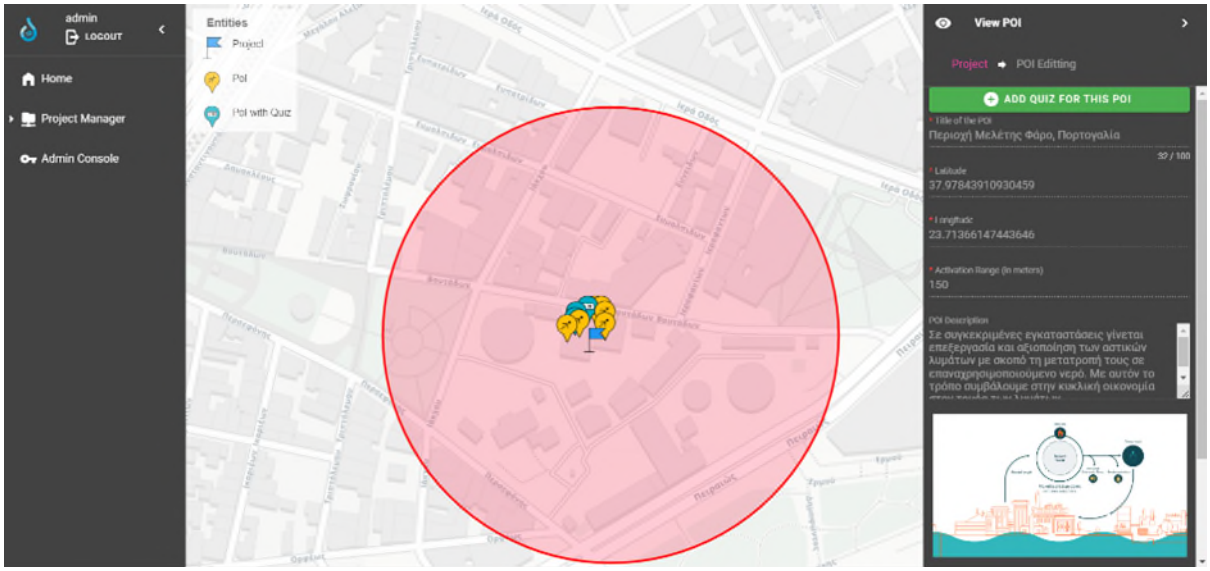


Figure 5- Virtual content describing the innovative technologies of case study in Faro.

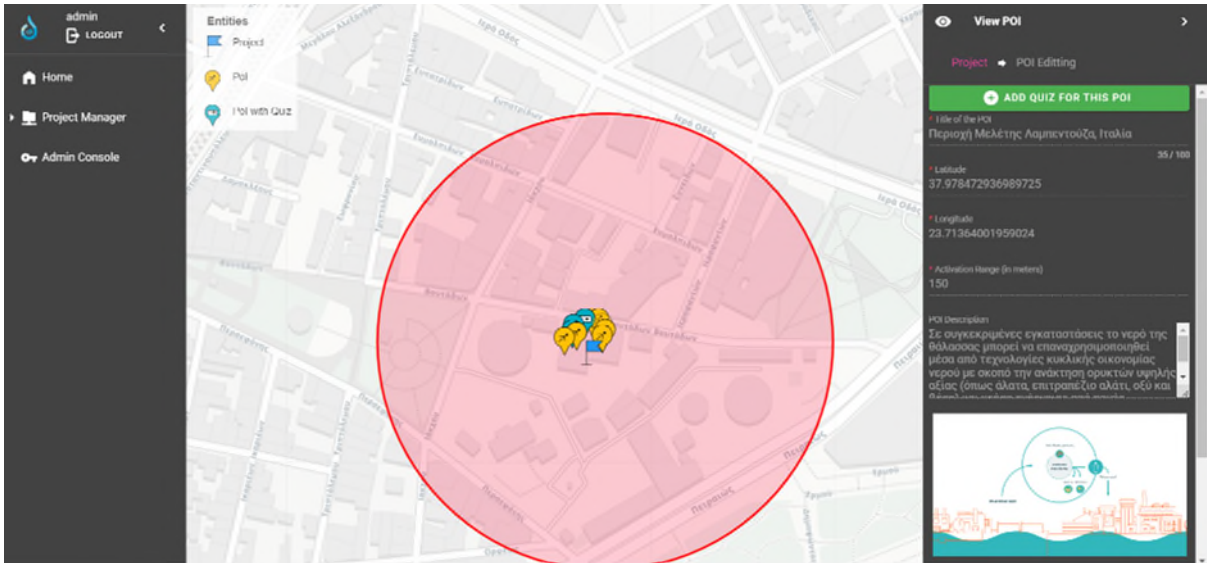


Figure 6- Virtual content describing the innovative technologies of case study in Lampedusa.

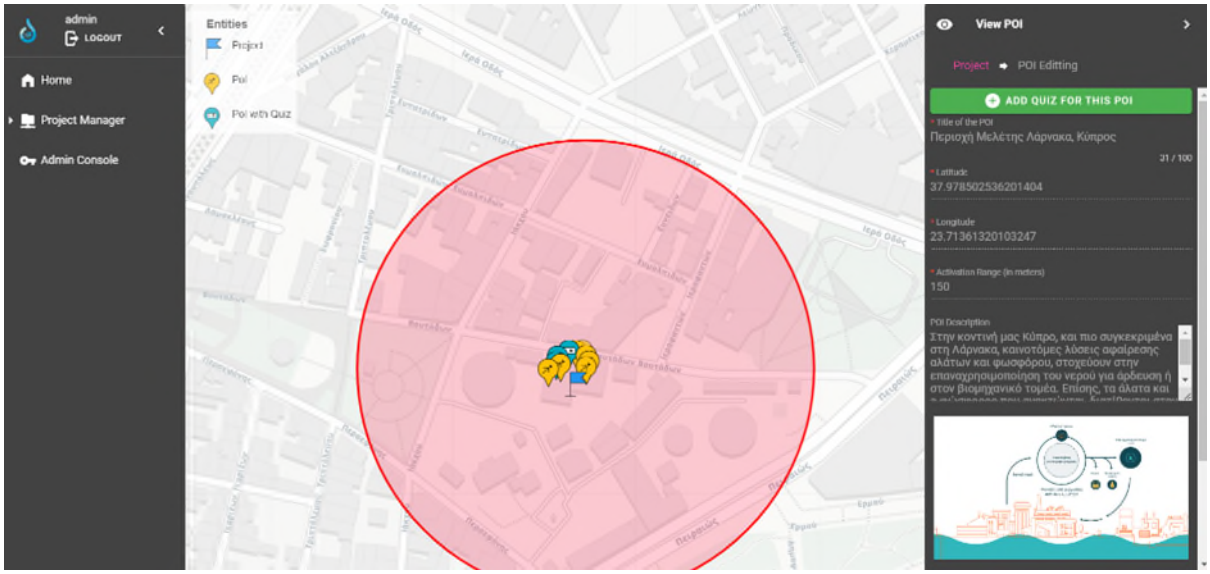


Figure 7- Virtual content describing the innovative technologies of case study in Cyprus.

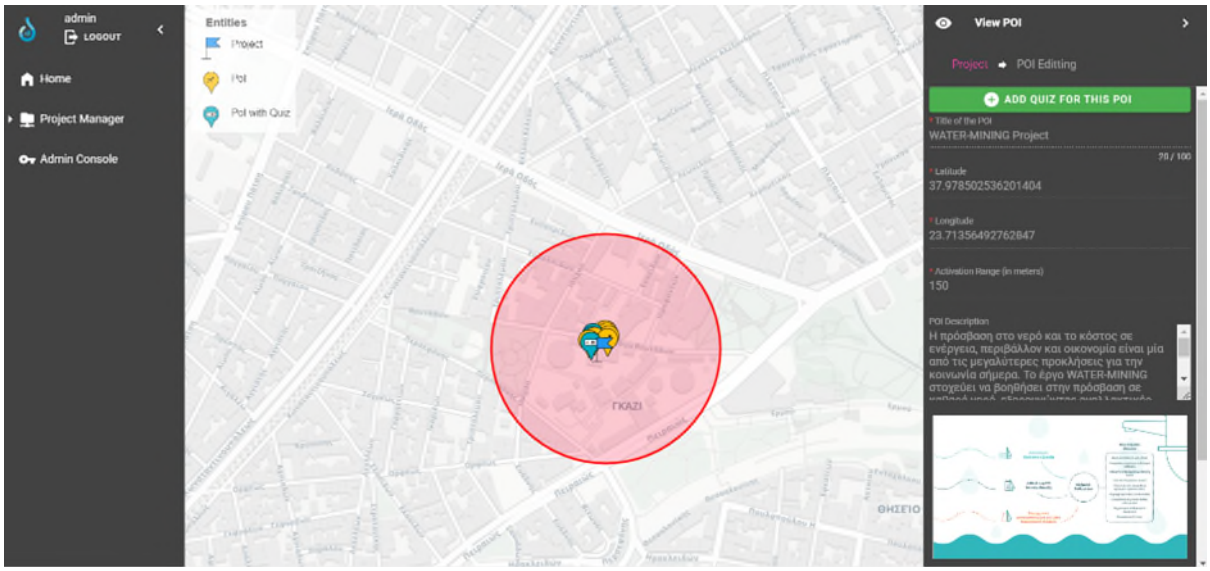


Figure 8- Virtual content describing the key objectives of Water-Mining project.

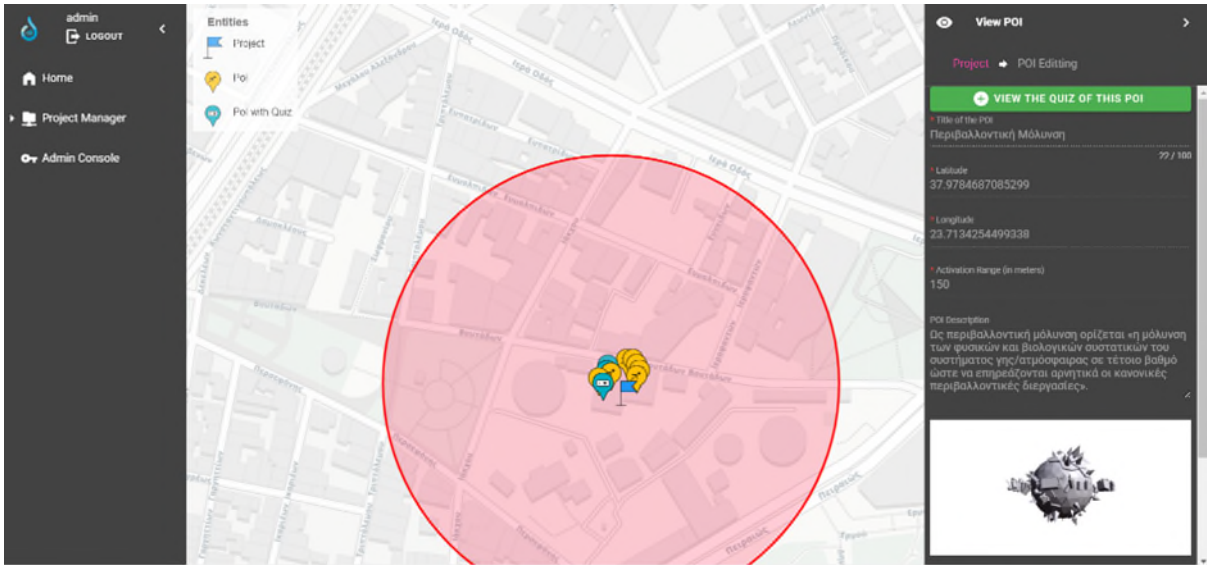


Figure 9- Virtual content describing the environmental pollution.

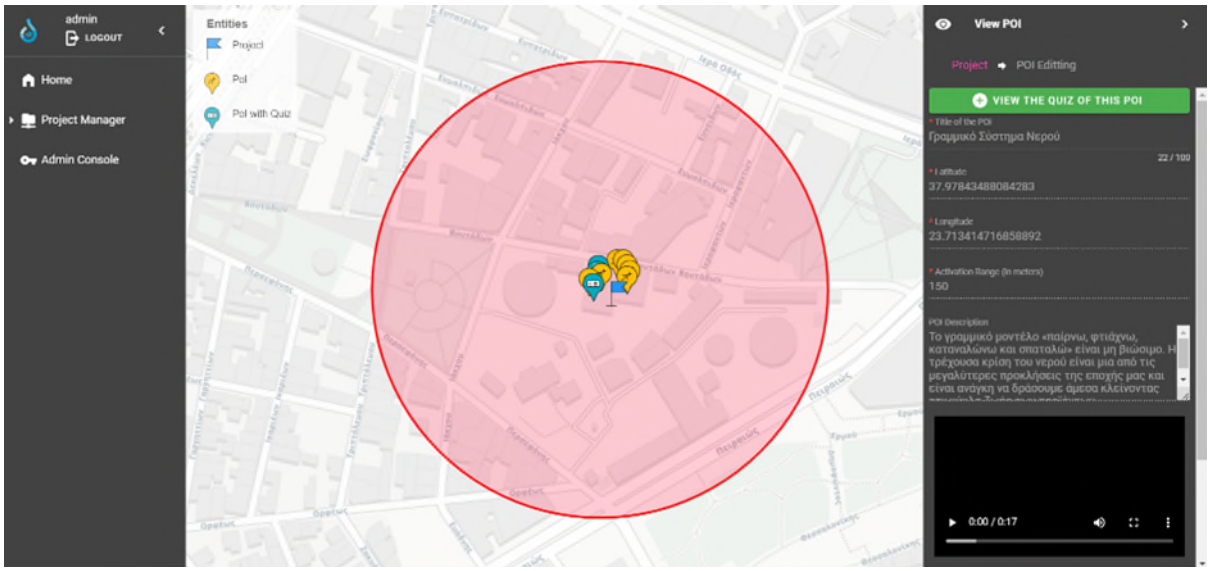


Figure 10- Virtual content describing the linear water system.

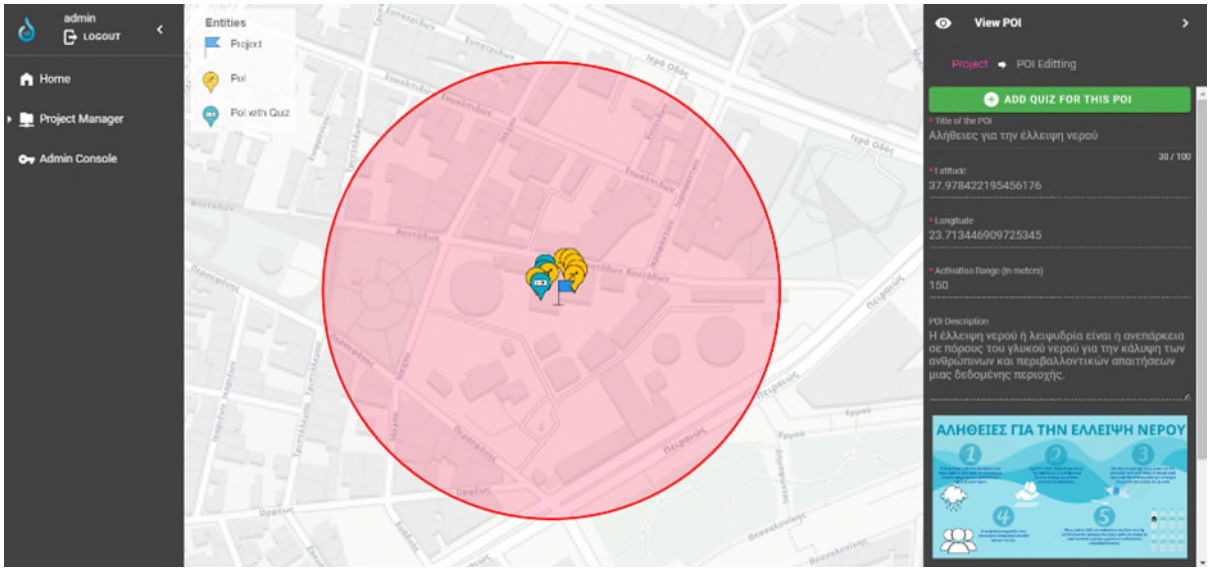


Figure 11- Virtual content describing the water scarcity.

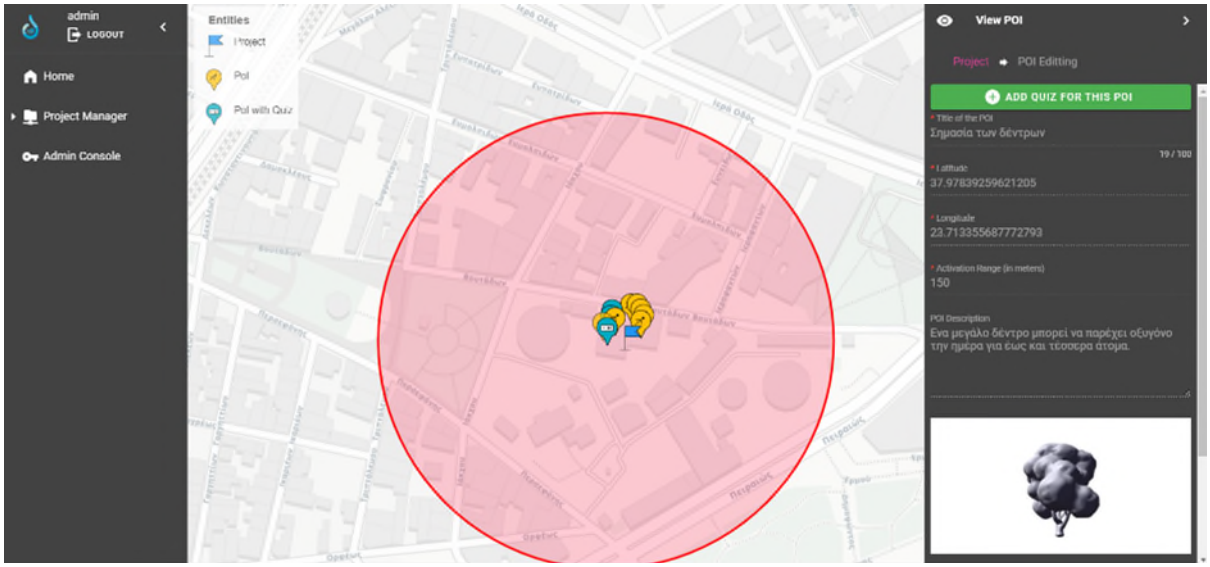


Figure 12- Virtual content describing the importance of trees.

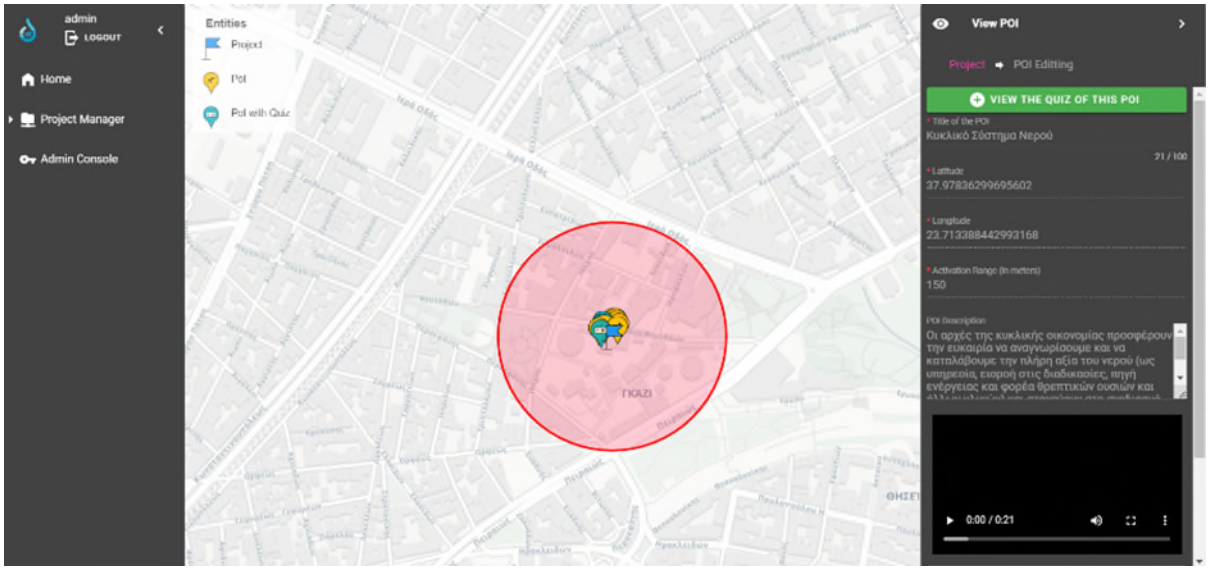


Figure 13- Virtual content describing the circular water system.

5.3. AR demo campaigns for end-user engagement

Upon selection, curation and publishing from the AR CMS platform (see D7.3), the content has reached a format compatible to the mobile AR application, is user-friendly and interactive. We prepared one AR campaign to engage the visitors of the Athens Science Festival. In order for the end-users to better understand the concept of the key circular economy innovations of WATERMINING, the content is related to the activities taking place in the CSs and the project itself. Also, the campaign contains general information regarding the circular economy, water scarcity, and water reuse purposes. Finally, quiz questions and surveys were attached to the content to ensure the educational character of the AR experiences.

The content of the campaign is thoroughly described below:

1. Environmental pollution: Environmental pollution is defined as "the contamination of the physical and biological components of the earth/atmosphere system to such an extent that normal environmental processes are adversely affected.";
2. Linear water system: The linear model of "take, make, consume and waste" is unsustainable. The current water crisis is one of the greatest challenges of our time and there is a need to act immediately by closing the life cycle of products;
3. Circular water system: Circular economy principles offer the opportunity to recognize and understand the full value of water (as a service, input to processes, source of energy and carrier of nutrients and other materials) and aim to design products that reduce pressure on natural resources and waste;
4. Water scarcity: Water scarcity or water shortage is the insufficiency of fresh water resources to meet the human and environmental demands of a given area;
5. The importance of trees: A large tree can provide oxygen per day for up to four people.
6. CASE STUDY 1 – Lampedusa, Italy (Desalination / Sea-Mining): In specific cases seawater can be reused through circular water economy technologies to recover high value minerals (such as salts, table salt, acid and base) and use from waste sources;
7. CASE STUDY 4 – Larnaca, Cyprus (Urban Mining): In Cyprus, and more specifically in Larnaca, innovative solutions for the removal of salts and phosphorus are aimed at the reuse of water

for irrigation or in the industrial sector. Also, the salts and phosphorus that are recovered are available on the market;

8. CASE STUDY 3 – Faro, Portugal (Urban Mining): In specific facilities, municipal wastewater is treated and utilized in order to convert it into reusable water. In this way we contribute to the circular economy in the wastewater sector;
9. CASE STUDY 5 - La Llagosta, Barcelona, Spain (Urban Mining): In wastewater treatment plants, wastewater is reused to generate energy, reduce energy consumption, and produce by-products for industrial or agricultural purposes;
10. General WATERMINING Project: Access to water and the cost in energy, environment and economy is one of the biggest challenges for society today. The WATER-MINING project aims to help access to clean water by exploring alternative water sources and developing innovative solutions for sustainable water management, such as urban and industrial wastewater utilization and seawater desalination.

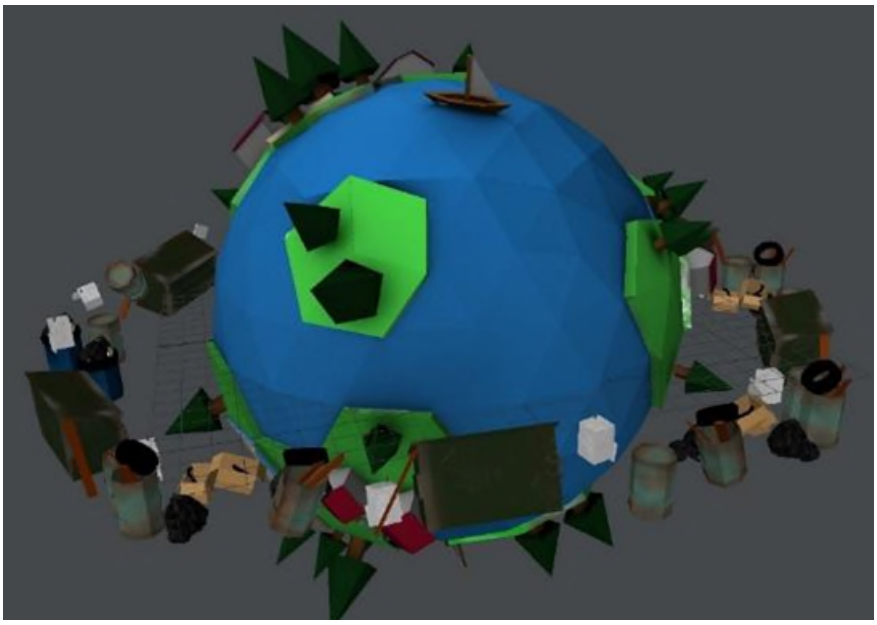


Figure 14- A 3D model of a polluted earth.

Figure 15- A video explaining the linear water system.

Figure 16- A video explaining the circular water system.

Figure 17- An image regarding the water scarcity.

Figure 18- A 3d tree demonstrating the importance of trees.

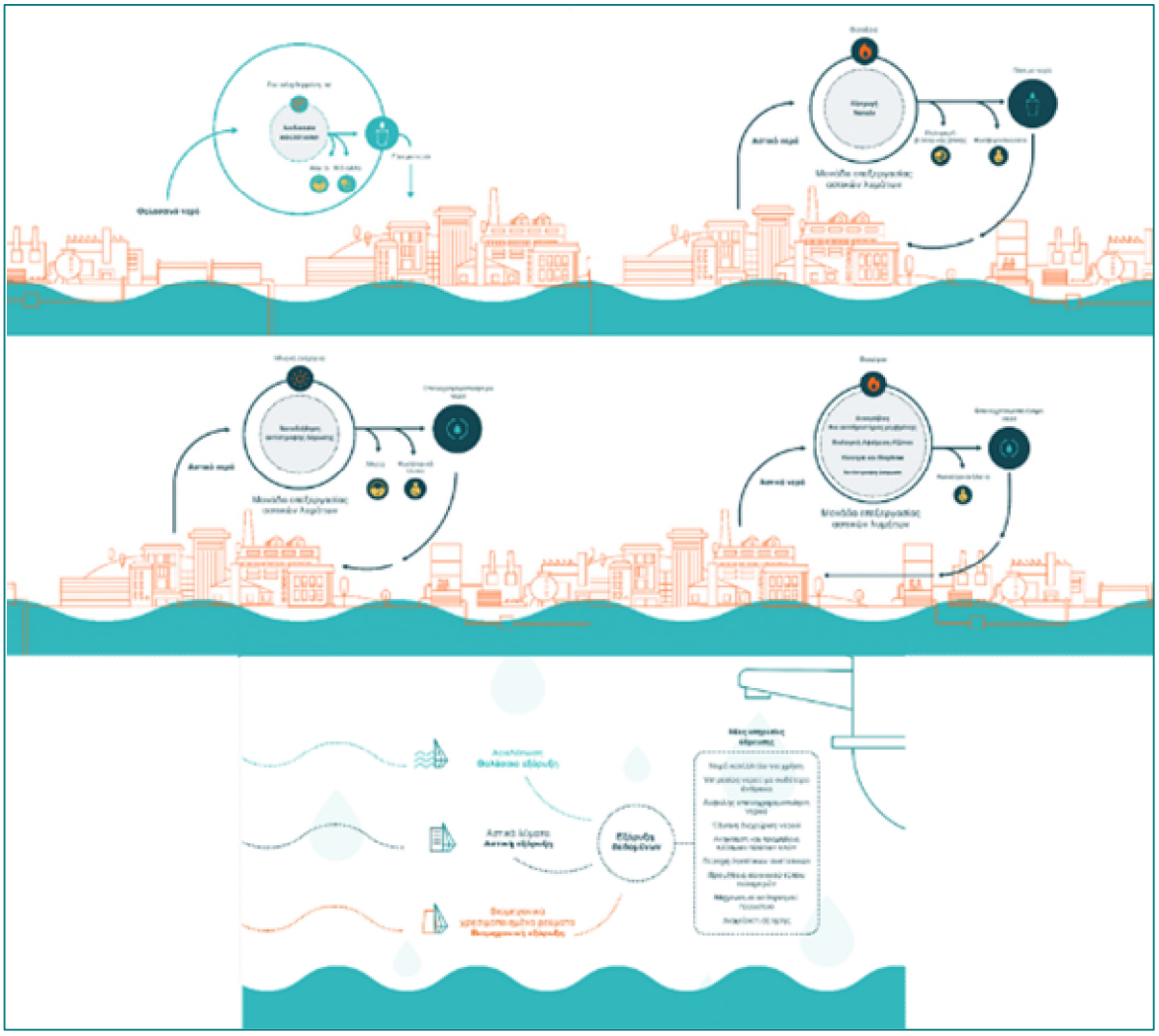


Figure 19- Virtual content for case studies 1, 3, 4, and 5.

During the 3-day course hundreds of students, parents, scientists and academics visited and learnt about the Water-Mining activities through the AR app (CirculAR). Athens Science Festival is righteously considered as one of the largest science and technology festivals in Greece. This year alone, the 21st of October 2022 (the first day of the festival) more than 2000 students from various schools visited the exhibitions. The following images were captured during the event:

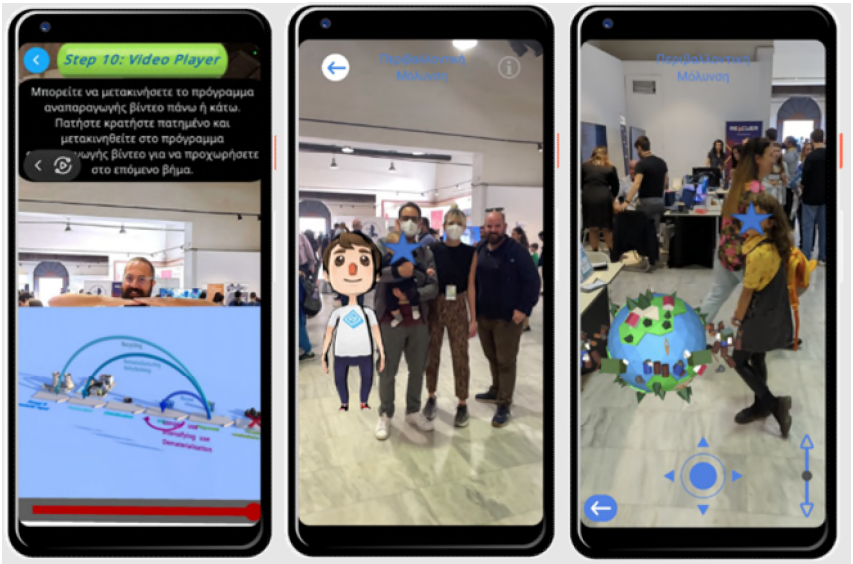


Figure 20- Images captured during the event.

5.4. Feedback from the demonstration activity

During the showcasing, we observed how students (below 18 years of age) approached the treasure hunt game. Unfortunately, the young audience found more interest in finding ARis than revealing the virtual content that the agent meant to disclose. Next, in order of importance, came the quiz answering that led to gaining more points upon correct answering, and contributed in becoming competitive with

each other through the leaderboard. It became apparent that the students shifted the mission of CirculAR, from finding educative content to finding the virtual agent and earning the highest score. Considering how students approached the augmented reality platform developed for environmental simulations by Klopfer and Squier, [5], it became apparent that young audiences tend to be less emotionally engaged in the problem and thereafter, the design principles of an educative tool using AR technology should be further tailored to the end-users needs and capabilities. Possible introductory video or audio material, lectures or working groups, could familiarize the young end-users to the content and topic discussed through the AR app (in our case, sustainability and circular economy). Supporting this argument, Katika et al., [1] demonstrated that participants older than 18 years old participating in other demonstration activities, connected further to their mission and tasks through the app, since the topics augmented where part of their social and environmental agenda. CirculAR may require further tailoring to become an educative tool for end-users younger than 18 years old or be combined with other educational material to support.

As a summary, the following feedback was incorporated to enhance the application:

- The application's content underwent updates to make it more appealing to young audiences, ensuring it captures their attention and interest;
- The ARis model underwent a redefinition process, accompanied by the implementation of new animations. These improvements aim to make the application more interactive for the end-users, providing them with an engaging and immersive experience;
- In addition to the visual enhancements, voice functionality was integrated into the ARis model. This addition enables users to interact with the application using their voices, adding another layer of convenience and accessibility to the overall experience.

By incorporating these improvements, the application now offers enhanced content, increased interactivity, and improved accessibility, catering to the preferences and needs of young audiences.

6. The AR application in CS2-Almeria

Case Study 2 (CS2) was the first structured demonstration activity specifically dedicated to the WATERMINING stakeholders that followed the preliminary investigation at the ASF. Considering the fact that in February we still didn't have a stable version of CirculAR that all collected feedback and changes were implemented, we decided to perform the demonstration activity with the older version of CirculAR to ensure that potential bugs or other game breaking factors that would jeopardize the user experience. As in all demonstration activities, workshops were held to progress on the selection of content to be augmented, the information and other facts to be curated, the installation and use of the AR app, issues related to the performance of the app given the location of the demo, and other shortcomings that can be avoided related to the specifications of the specific location. On top of them, considering that this was the first demonstration to be performed, we performed an additional workshop where a group of people was gathered before the demo to perform a dummy test of the activity and ensure a seamless immersive experience. The exact nature and content of the workshops is described in the sections below.

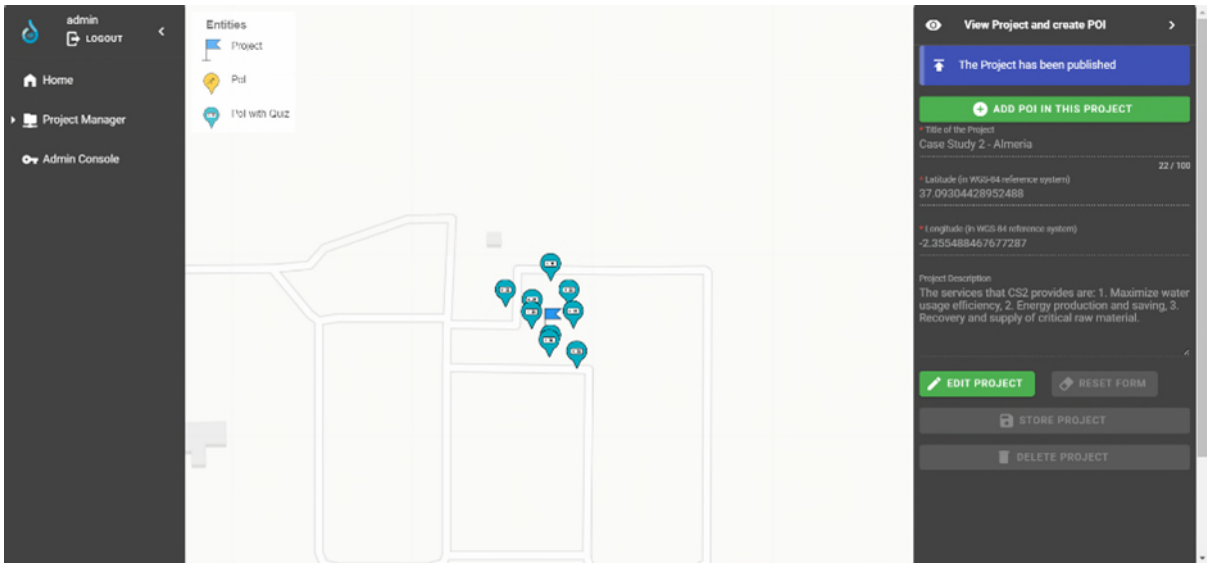


Figure 21- The AR CMS UI where the AR campaign for the CS2 are curated. each one of the blue bubbles in the middle of the map, contain virtual content (i.e., images, 3d objects, questionnaires).

6.1. Demo case description

The Plataforma Solar de Almeria (PSA) is located in southern Spain and has become a point of reference in the use of solar energy for desalination. PSA is recognised for its research infrastructure which is crucial for the development of top-quality and cutting-edge research, as well as the communication, exchange, and preservation of knowledge, the transfer of technology, and promotion of innovation. PSA is devoted to the use of solar thermal energy, both for concentrated solar power production and for desalination and water treatment, and as a Living Lab it will support the engagement of stakeholders involved in the Water-Energy-Food nexus in specific events, and by reaching citizens with their regular programme of visits.

6.2. Campaign curation for CS2

Along with the involved partners of CS2, the demonstration activity was planned and organized as follows:

- Workshops among the partners helped to shape the demonstration activity, including content that was going to be prepared by ICCS. The end-users of the activity were further defined with the pilot partners;
- Additional content was prepared based on information collected from the Case Study (including their KPIs and metrics) but also from digital 3D material prepared from ICCS to ensure an engaging activity for all participants;
- ICCS ensured the smooth demonstration of the AR app by the case study owners through a training module. The training module lasted 4 hours, in which ICCS explained to all participants:
    - How to download and install the AR app;
    - How to register and login;
    - How to select the AR campaign of your choice;
    - How to navigate towards the nearest AR experiences;
    - How to visualize and manipulate the AR content;
    - How to answer quiz questions;
- ICCS finalized the virtual WATERMINING campaign using the Content Management System, addressed to the audience participating in the CoP meeting of CS2. Quiz questions were also utilized to educate further and ensure an even more immersive experience;
- During the demonstration feedback was gathered from the end-users (18 participants). A survey was circulated to the participants which ensured that the feedback was collected in a structured way.

The following Table includes the content curation activities for CS2 in Almeria.

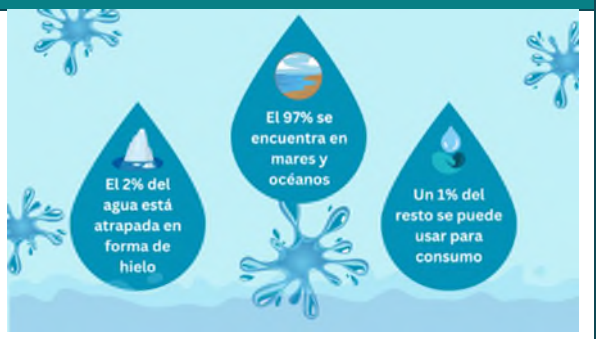
Table 2- Content curation activities for CS2.

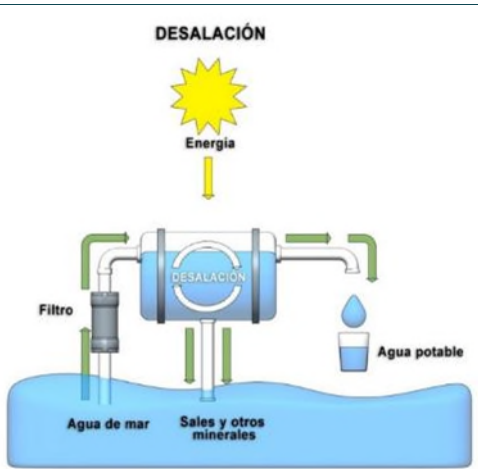
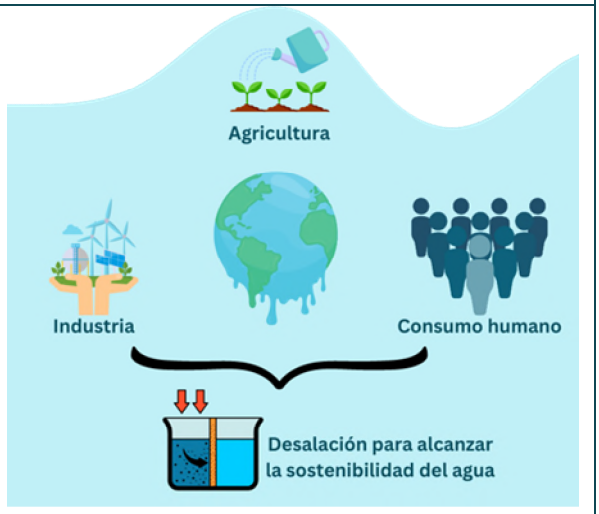
AR curation activities	
Brainstorming activities	Meeting with PSA on 11/09/2022 to discuss the concept of the CS2
Explanation of the AR app	Meeting with PSA on 24/10/2022 to explain in a detailed way the use of AR app
1st set of content sent by ICCS	ICCS sent a draft document with possible content for CS2 on 13/12/2022
2nd set of content sent by PSA	ICCS asked additional information regarding the proposed content and PSA sent them on 21/12/2022
PSA requested modifications	PSA confirmed that the content must be translated in Spanish and ICCS sent the translated material and some minor modifications for the images for a more comprehensive AR visualization on 25/01/2023

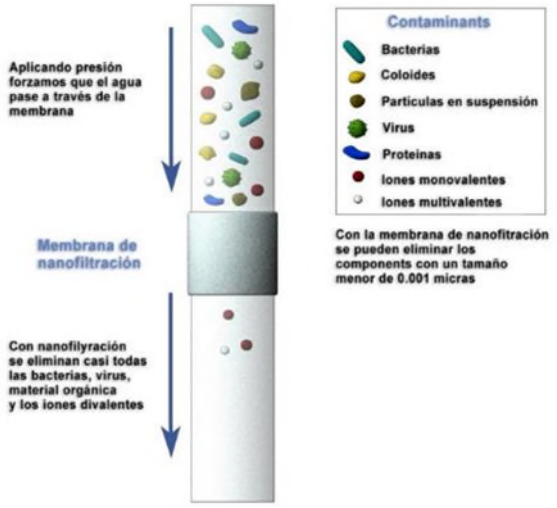
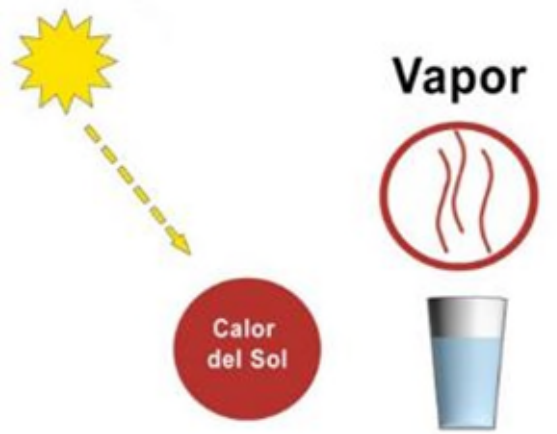
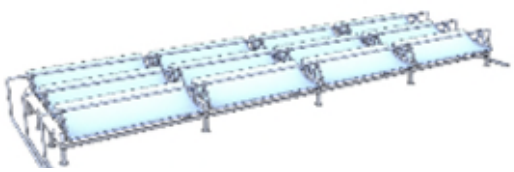
3rd set of content sent by ICCS	ICCS sent the final translated images after some minor corrections and the 3D models on 26/01/2023
Training module	ICCS held a training module on 06/02/2023 in order to train the case study owners for the use of CirculAR app
Final set of content by ICCS	ICCS finalized the whole campaign on 19/02/2023
Final test of the AR demonstration	ICCS tested the campaign prior to the CoP meeting on 20/02/2023

The following Table includes the AR content demonstrated during the CoP meeting demonstration of CS2 in Almeria. The language used was Spanish, to ensure that there is no language bias during the demonstration. We were advised by the organizers that due to the sensitivity and complexity of the displayed information via the AR app, it would be appreciated by the end-users if the material was entirely in Spanish.

Table 3- Content displayed at the AR campaign during the CoP demonstration of CS2 in Almeria.

Description	Content
Content 1 (Image): El agua es un componente fundamental para la vida. El 71% de nuestro planeta está cubierto de agua. Sin embargo, la mayor parte no es aprovechable para el consumo humano. Por este motivo, todos debemos cuidar este importante recurso.	
Content 2 (Image): A medida que aumenta la población, aumentan los retos a los que nos enfrentamos para aprovechar el agua. En 2025 la población mundial en áreas urbanas puede llegar a ser el doble, un aumento que puede tener serias implicaciones en la demanda de agua urbana y en la agricultura.	

Content 3 (Image): Desalación significa eliminar las sales del agua y hacerla útil para el consumo humano. En el interior de este edificio podéis ver una planta de desalación. Con este planta se pueden obtener 3 metros cúbicos de agua a la hora, es decir, tres vasos de agua cada segundo.	
Content 4 (Image): ¿Qué podemos hacer para mejorar la sostenibilidad del agua en el mundo? Usar energías renovables (como energía solar) para desalación Mejorar las técnicas de desalación para aumentar la producción de agua. Aprovechar las salmueras dándole valor a las sales que contienen, por ejemplo como fertilizantes.	
Content 5 (Image): ¿Quieres saber cómo funciona esta planta de desalación? La energía solar se usa para producir vapor o agua caliente y así poder calentar unas tuberías. El agua de mar se vierte de manera muy fina sobre estas tuberías calientes, provocando la evaporación de parte del agua de mar. Este vapor, que ya no tiene sal, se utiliza como energía en el siguiente efecto, donde el vapor condensa y se recoge como agua dulce pura. Esto se hace varias veces para recoger más y más agua.	

Content 6 (Image): La destilación de este tipo tiene algunas limitaciones, como la energía necesaria, el coste y la gestión de los residuos generados. Una forma de mejorar el proceso es aumentando la temperatura, pero algunos componentes del agua de mar a altas temperaturas provocan que las tuberías se ensucien más. ¿Qué podemos hacer para evitar este problema? Eliminar estos componentes que "ensucian" mediante nanofiltración.	
Content 7 (Image): La nanofiltración se compone de varias membranas. Cuando aplicamos presión al agua de mar, solo las moléculas de agua son capaces de atravesar las membranas, mientras que otros compuestos más grandes no pueden pasar. Con esta técnica, podemos obtener agua de mar sin esos componentes que causan las limitaciones en la desalación térmica.	
Content 8 (Image): El sol irradia una cantidad enorme de energía en forma de luz y calor. La energía solar es la fuente de energía más abuntante de nuestro planeta. Una forma de aprovechar la energía solar es utilizando el calor del sol, lo que se denomina energía solar térmica.	
Content 9 (3D model): Hay diferentes tecnologías para aprovechar la energía solar térmica. Una de ellas son los captadores cilindro-parabólicos que utilizan espejos para reflejar los rayos del sol y concentrarlos en una tubería. Por	

dentro de esta tubería pasa aceite térmico que se calienta hasta 300-400 ºC.	

6.3. AR demo campaigns for end-user engagement

More than 18 stakeholders participated in the AR demonstration with the following characteristics:

- Both females and males;
- Age range 21-50;
- Most of the participants were from private sector;
- Also participated in the demonstration researchers and people from public sector;
- Their education level varied from university graduate, master, and PhD.

We prepared one AR campaign to engage the stakeholders of the CS2. In order for the end-users to better understand the concept of the key innovations of CS2 in Almeria, the content is related to the activities taking place in the CS and general information regarding the desalination process. Also, the campaign contains general information regarding the water scarcity, and water reuse purposes. Finally, quiz questions and surveys were attached to the content to ensure the educational character of the AR experiences.

The following images were captured during the event.

Figure 22- The stakeholders of CS2 using the AR app.

Figure 23- The stakeholders of CS2 using the AR app.

Figure 24- Screenshot from the UI of the AR app.

Figure 25- Screenshot from the UI of the AR app.

6.4. User experience during the CoP at CS2

The main priority of both ICCS and the demo/technology owners was the positive user experience during the demonstration of augmented reality visualizations to ensure effective learning. To do so, the main priority was fallen at the generation of meaningful content and to ensure a user-friendly interface, realism, adaptability, reception of feedback, contextual learning, accessibility, and clear objectives.

During the demonstration, feedback was provided to reflect the way the stakeholders -end-users of the application perceived the activity. The following feedback was considered to transform the UI and UX of the application as further mentioned in the deliverable D7.6:

- The AR application can provide context for educational content. In more details, the AR app could help the end-users visualize how the technologies are shaped. This context aided in comprehension and retention of information.
- At the same time, CirculAR was able to provide feedback and track progress. This functionality was considered essential for educational purposes and motivations.
- AR applications should consider features like text-to-speech, voice commands, and adjustable font sizes.
- At the same time, to ensure an engaging AR educational experience, the technology providers aimed at having the visualizations as realistic as possible.

6.5. Feedback collected from the CS2

Throughout the planning, testing and demonstration of the AR app at CS2, feedback was continuously collected from end-users and relevant stakeholders. Feedback was collected from surveys, workshops, emails and semi-structured interviews. Considering that ICCS was involved both in the development of the AR app, the design and curation of the content, as well as the performance of the demonstration, the feedback was divided to three categories:

1. Feedback for the content augmented via the app. This was of particular importance, since the end-user engagement was ICCS top priority, therefore, engagement to the content presented had to be of high quality;

2. Feedback for the AR mobile application. As mentioned above, for the development of the CirculAR application, we followed an iterative approach where feedback was collected and continuously implemented to ensure a fast development process;
3. Feedback for the curation and demonstration activities. To ensure that ICCS fixed any bottlenecks or other shortcomings to the next activity. Also, according to the CS owners the content asserted and demonstrated during the CoP helped the CS to meet their objectives.

All feedback was collected and translated to user stories and further elaborated in D7.6. Also, Annex 1 includes the survey and below is listed the feedback collected during the CoP meeting:

Starting with the feedback for the content augmented via the app, the following items were collected:

- The end-users wanted to have access to more textual information during the 3D content augmentation
    - In response to the feedback received, additional information has been incorporated in the form of accompanying text to provide context of the presented 3D content. This text serves as a guide to help users understand the purpose, features, and usage of the augmented content.

Regarding the feedback for the AR mobile application, the following items were collected:

- The end-users needed audio descriptions because when their device's camera is on it is difficult to read long texts and it is better to hear it.
    - Based on this feedback, audio description on top of each text was implemented;
    - The text fields and the scrolling functionalities received notable improvements, all designed to seamlessly complement the audio description functionalities.
- Based on user feedback, it was observed that some end-users encountered difficulties interacting with the augmented content due to unstable location services in certain areas. This instability caused the augmented content to continuously change its location, resulting in a suboptimal user experience.
    - To address this issue, significant improvements were made to the process of displaying content in real space. The redefined approach ensures stability and precision in presenting the augmented content. The application now incorporates measures to mitigate extreme changes in content location, preventing disruptive shifts and maintaining a more consistent and reliable user experience. Only reasonable adjustments to the content's location are considered, ensuring smoother interaction with the augmented elements;
    - Furthermore, to facilitate the process of locating points of interest, directions to these points have been added to the screen. This addition aims to assist users in easily identifying and navigating towards the desired points of interest, especially when they are not in close proximity to the user's current location. By providing clear directions, the application enhances user convenience and streamlines the overall experience, making it easier for users to find and engage with the points of interest they seek.

Regarding the feedback for the curation and demonstration activities, the following items were collected:

- The end-users had trouble downloading the AR app for iOS
    - Based on this feedback, the documentation on downloading the application, in iOS devices, was updated.

7. The AR application in CS4-Cyprus

Case Study 4 (CS4) was the second structured demonstration activity specifically dedicated to the WATERMINING stakeholders. The CoP meeting was held on 27th of April, and the final version of CirculAR app was used for the demonstration activity. Also, CS4 was the first CS in WATERMINING project in which the object detection feature of the AR app was tested successfully.

As in all demonstration activities, workshops were held to progress on the selection of content to be augmented, the information and other facts to be curated, the installation and use of the AR app, issues related to the performance of the app given the location of the demo, and other shortcomings that can be avoided related to the specifications of the specific location. The exact nature and content of the workshops is described in the sections below.

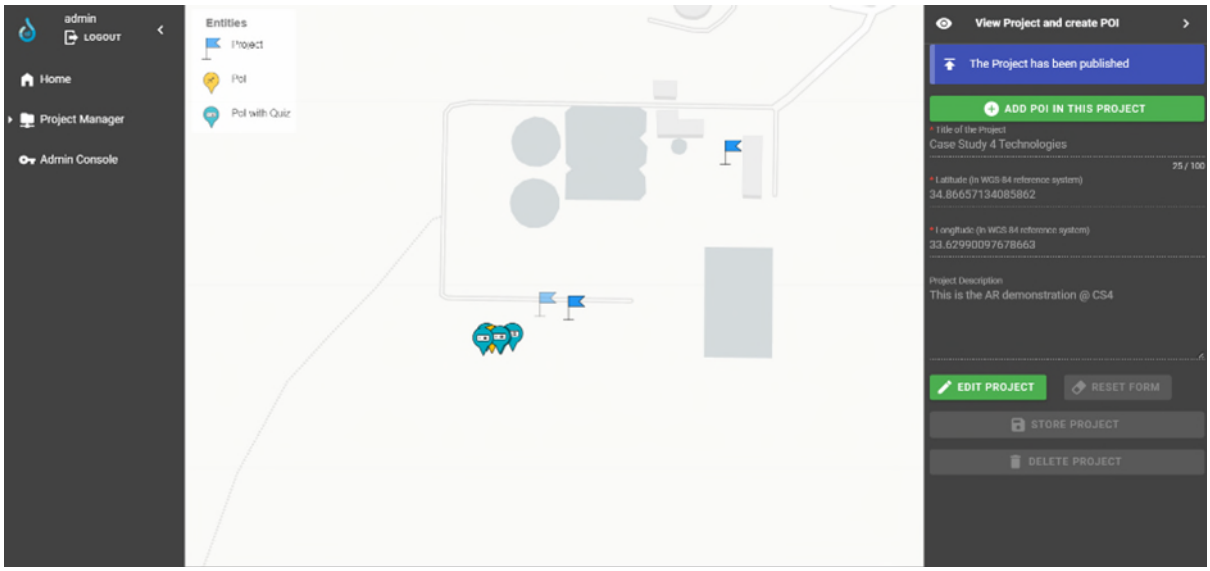


Figure 26- The AR CMS UI where the first AR campaign for the CS4 is curated. each one of the blue and orange bubbles in the middle of the map, contain virtual content (i.e., images, 3d objects, questionnaires).

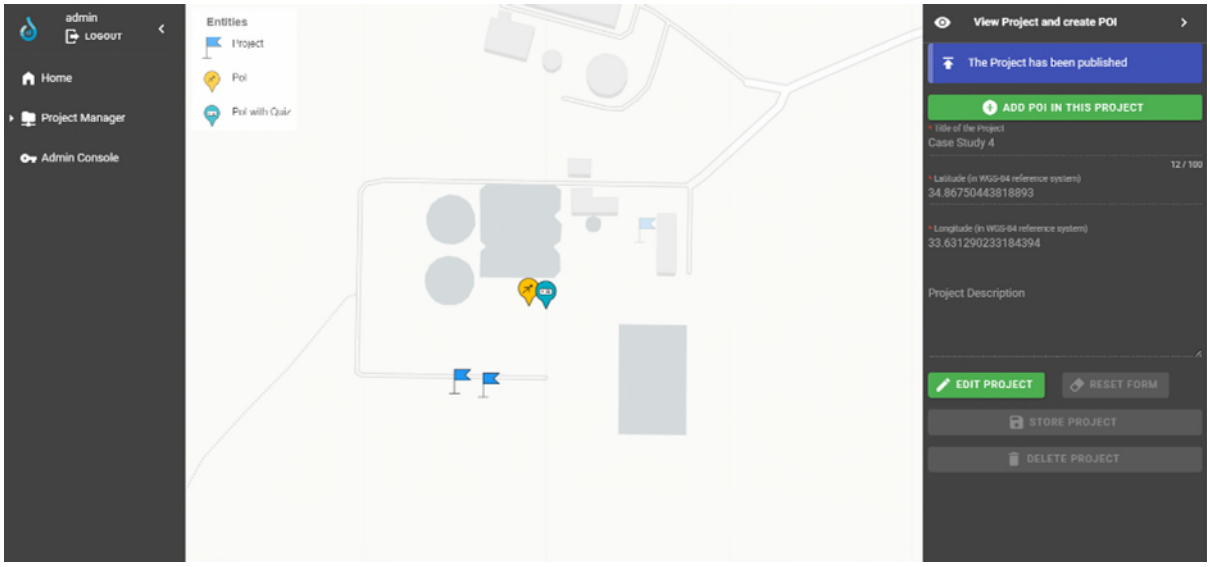


Figure 27- The AR CMS UI where the second AR campaign for the CS4 is curated. each one of the blue and orange bubbles in the middle of the map, contain virtual content (i.e., images, 3d objects, questionnaires).

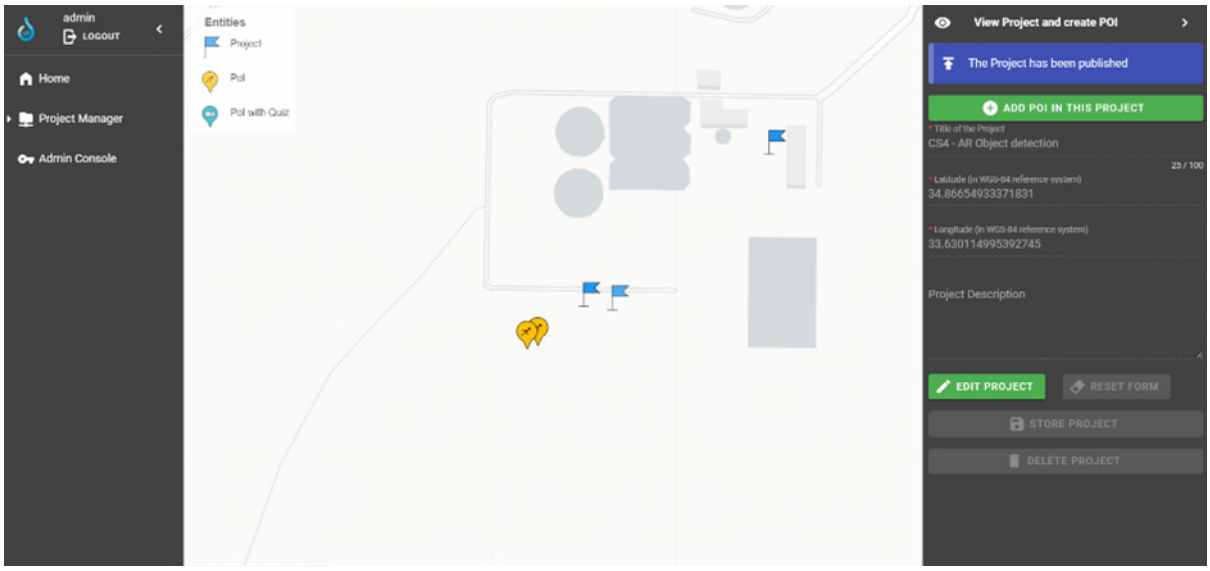


Figure 28- The AR CMS UI where the third AR campaign for the CS4 is curated. each one of the orange bubbles in the middle of the map, contain virtual content (i.e., images, 3d objects, questionnaires).

7.1. Demo case description

CS4 focuses on the desalination of urban wastewater (Urban-Mining). At the Larnaca WWTP different innovative solutions for phosphorus removal to ultra-low levels through adsorption and salts removal using filtration and evaporation technologies (potentially powered by renewable energy) are demonstrated. The treated water can be then used for irrigation or in the industrial sector. Next to water, valuable salts and phosphorus can be recovered and marketed.

The proposed process is demonstrated at pilot scale and was designed to treat an inflow of 24 m^3/day (1m^3/h). The pilot systems installed at the Wastewater Treatment Plant are the following:

- BioPhree: An adsorption process that is capable to remove phosphate to ultra-low concentrations (<10ppb). The recovered phosphorus can be used in fertilizers;
- Nanofiltration: A NF stage follows the phosphorus recovery stage for the removal of divalent ions as Ca and Mg salts;
- Reverse Osmosis: At this stage, the monovalent ions mainly Na and Cl are separated from water resulting in two streams one of high purity water and one containing NaCl;
- Multi-Effect Distillation: Evaporator (MED) and Crystallizer: More high purity water is recovered at these two processes from which is finally produced a saturated solution of NaCl or NaCl crystals.

7.2. Content curation for the AR app

Along with the involved partners of CS4, the demonstration activity was planned and organized as follows:

- Workshops among the partners helped to shape the demonstration activity, including content that was going to be prepared by ICCS. The end-users of the activity were further defined with the pilot partners;
- Additional content was prepared based on information collected from the Case Study (including their KPIs and metrics) from ICCS to ensure an engaging activity for all participants;
- ICCS with UBRUNNEL trained the model for the object detection feature specifically for the CS4's technologies;
- ICCS and LARNACA decided that the best way to inform the stakeholders about the CS4 processes is to create 3 different campaigns:
    - general information;
    - CS4 technologies; and
    - object detection.
- ICCS finalized the 3 virtual WATERMINING campaigns using the Content Management System, addressed to the audience participating in the CoP meeting of CS4. Quiz questions were also utilized to educate further and ensure an even more immersive experience;
- During the demonstration feedback was gathered from the end-users (around 15 participants). A survey was circulated to the participants which ensured that the feedback was collected in a structured way.

The following Table includes the content curation activities for CS4 in Cyprus.

Table 4- Content curation activities for CS4.

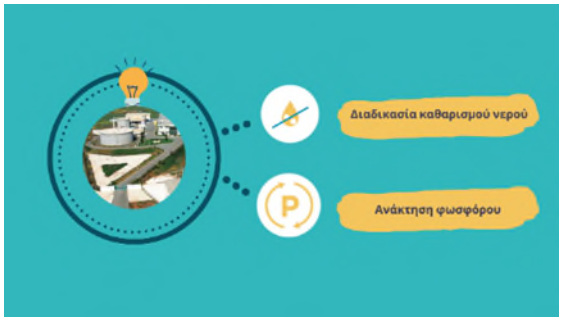
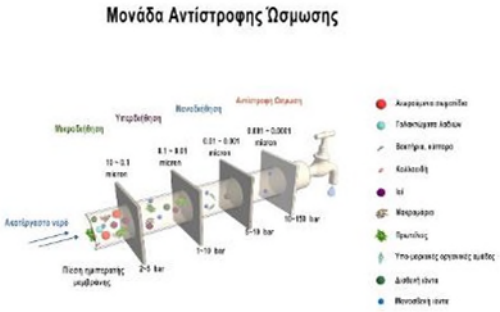
AR curation activities	
Brainstorming activities	Meeting with LARNACA on 10/11/2022 to discuss the concept of the CS4

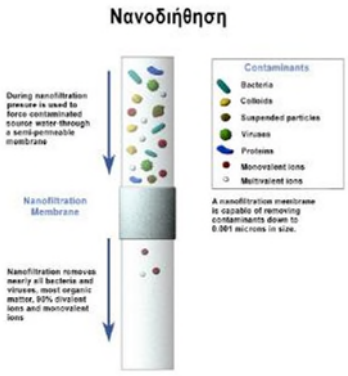
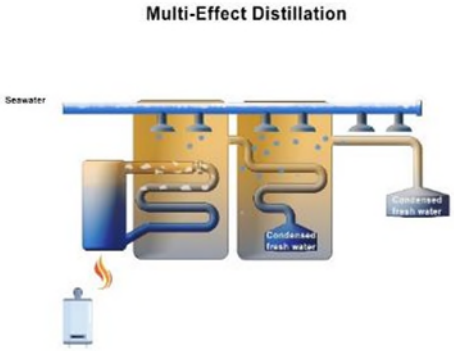
Explanation of the AR app	ICCS sent to LARNACA a detailed document on 11/11/2022 to explain the use of AR app
1st set of content sent by ICCS	ICCS sent a draft document with possible content for CS4 on 13/11/2022
2nd set of content sent by LARNACA	ICCS asked additional information regarding the proposed content and LARNACA sent them on 12/01/2023
LARNACA requested modifications	LARNACA confirmed that the content must be translated in Green and ICCS sent the translated material and some minor modifications for the images for a more comprehensive AR visualization on 16/01/2023
3rd set of content sent by ICCS	ICCS sent the final translated images after some minor corrections on 29/01/2023
Testing of the trained model for object detection	ICCS tested the trained model for object detection on 15/02/2023 in order to finalize it for the use of CirculAR app in the demonstration
Final set of content by ICCS	ICCS finalized the whole campaign on 17/03/2023
Final test of the AR demonstration	ICCS tested the campaign prior to the CoP meeting on 27/04/2023

The following Table includes the AR content demonstrated during the CoP meeting demonstration of CS4 in Cyprus. The language used was Greek, to ensure that there is no language bias during the demonstration. We were advised by the organizers that due to the sensitivity and complexity of the displayed information via the AR app, it would be appreciated by the end-users if the material was entirely in Greek.

Table 5- Content displayed at the AR campaign during the CoP demonstration of CS4 in cyprus.

Description	Content

Content 1 (Image): Η πιλοτική μονάδα η οποία έχει εγκατασταθεί και λειτουργεί στο Σταθμό Επεξεργασίας Λυμάτων της Λάρνακας έχει ως στόχο τη βελτίωση της ποιότητας του νερού, το οποίο παράγεται από το Σταθμό, με την απομάκρυνση χλωριούχου νατρίου και φωσφόρου.	
Content 2 (Image): Οι βασικοί στόχοι του CS4 είναι: 1) Επαναχρησιμοποίηση νερού που ανακτάται από την επεξεργασία νερού του ΣΑΛ (100%), 2) Απομάκρυνση και ανάκτηση φωσφόρου (< 10ppb) και 3) Ανάκτηση κορεσμένου ρεύματος υψηλής καθαρότητας σε NaCl ή ανάκτηση άλατος (καθαρότητα >99%).	
Content 3 (Image): Η αντίστροφη ώσμωση χρησιμοποιεί τη μεμβράνη για να ενεργήσει όπως ένα εξαιρετικά λεπτό φίλτρο για να δημιουργήσει το πόσιμο νερό από το μολυσμένο νερό. Η πίεση εφαρμόζεται στα μόρια νερού καταναγκασμού μολυσμένου νερού μέσω της μεμβράνης. ο διαλύτης κινείται από μια λύση της μεγαλύτερης συγκέντρωσης μέσω μιας μεμβράνης προς μια λύση της μικρότερης συγκέντρωσης.	
Content 4 (Image): Στην μονάδα αντίστροφης ώσμωσης το νερό διέρχεται, μέσω ημιδιαπερατής μεμβράνης, με σκοπό τον διαχωρισμό ιόντων. Ο διαχωρισμός στην επιφάνεια της μεμβράνης στηρίζεται στην άσκηση πίεσης μεγαλύτερης της ωσμωτικής, ώστε τα μόρια του διαλύτη να μεταφερθούν από το διάλυμα προς τον καθαρό διαλύτη, όπως φαίνεται και στο πιο κάτω σχήμα. Η μονάδα έχει ως σκοπό την ανάκτηση καθαρού νερού.	

Content 5 (Image): Η νανοδιήθηση είναι μια διαδικασία φιλτραρίσματος μεμβράνης με εφαρμογή υψηλής πίεσης. Γενικά, η μεμβράνη της νανοδιήθηση έχει ανοικτή δομή επιτρέποντας κυρίως μονοσθενή ιόντα να διέλθουν διαμέσου της, με αποτέλεσμα τα δισθενή ιόντα απορρίπτονται σε μεγάλο βαθμό. Η εγκατεστημένη μονάδα νανοδιήθηση έχει ως σκοπό τον διαχωρισμό των μονοσθενών ιόντων από τα δισθενή για την προστασία των επόμενων συστημάτων και την ανάκτηση καθαρών προϊόντων στο τέλος των διεργασιών.	
Content 6 (Image): Ο Εξατμιστήρας Πολλαπλών Βαθμίδων αποτελείται από συστοιχία δύο βαθμίδων, οι οποίες λειτουργούν σε διαφορετικές θερμοκρασίες και πιέσεις. Σε κάθε βαθμίδα το νερό της τροφοδοσίας θερμαίνεται, υπό κενό, μέσω εναλλάκτη από τον οποίο περνάει το θερμικό μέσο (ζεστό νερό). Ακολούθως, ένα μέρος του νερού εισόδου εξατμίζεται και μεταβαίνει στην επόμενη βαθμίδα σαν θερμικό μέσο και η υπολειπόμενη άλμη ψεκάζεται στην επόμενη βαθμίδα και εξατμίζεται περαιτέρω. Η διαδικασία επαναλαμβάνεται με αντλία ανακυκλοφορίας και ο παραγόμενος ατμός της συμπυκνώνεται στον τελικό συμπυκνωτή του συστήματος.	
Content 7 (Image): Η μονάδα κρυστάλλωσης έχει ως σκοπό την συμπύκνωση της παραγόμενης άλμης από τον εξατμιστήρα και την ανάκτηση κορεσμένης, σε χλωριούχο νάτριο, ροής. Η ανακτώμενη ροή μπορεί να χρησιμοποιηθεί στον Σταθμό Επεξεργασίας Λυμάτων Λάρνακας στο στάδιο χλωρίωσης. Η προαναφερθείσα κορεσμένη ροή, μετά από ηλιακή ξήρανση, οδηγεί στην ανάκτηση αλάτων χλωριούχου νατρίου υψηλής καθαρότητας.	

Content 8 (Image): Το σύστημα BioPhree έχει ως στόχο την αφαίρεση και ανάκτηση του φωσφόρου. Στήλες με προσροφητικά μέσα που έχουν ως βάση το οξείδιο του σιδήρου, απομακρύνουν τον φώσφορο από το νερό της εισόδου σε εξαιρετικά χαμηλά επίπεδα (<10 ppb). Τα προσροφητικά μέσα μπορούν να αναγεννηθούν και να επαναχρησιμοποιηθούν πολλές φορές, καθιστώντας την τεχνολογία οικονομικά αποδοτική.	
Content 9 (Object detection):	
Content 10 (Object detection):	

7.3. AR demo campaigns for end-user engagement

More than 15 stakeholders participated in the AR demonstration with the following characteristics:

- Both females and males;
- Age range 21-50;
- Most of the participants were from private sector;
- Also participated in the demonstration researchers and people from public sector;
- Their education level varied from university graduate, master, and PhD.

We prepared three AR campaigns to engage the stakeholders of the CS4. In order for the end-users to better understand the concept of the key innovations of CS4 in Cyprus, the content is related to the activities taking place in the CS and general information regarding the desalination process. Also, one campaign was dedicated to the object detection feature, in which the end-users detected the multi-effect distillation unit and a vacuum pump. Finally, quiz questions and surveys were attached to the content to ensure the educational character of the AR experiences.

The following images were captured during the event.

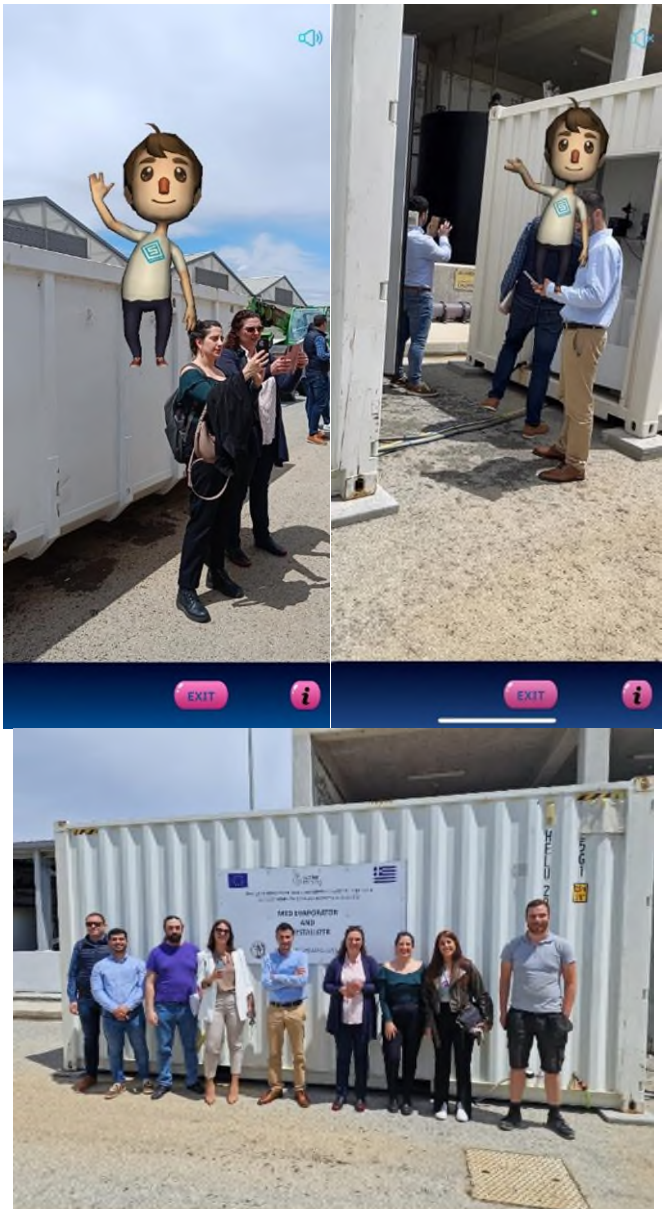


Figure 29- Images captured during the event.

7.4. User experience during the CoP at CS4

Similar to CS2, during the demonstration of CS4, feedback was provided to reflect the way the stakeholders -end-users of the application perceived the activity. The following feedback was considered to transform the UI and UX of the application as further mentioned in the deliverable D7.6:

- The AR application has a user-friendly interface and was considered as one of the most essential features to engage learners effectively.
- At the same time, it allows end-users to virtually interact with media and artifacts, zooming in for a closer look or even virtually handling them to gain a deeper understanding.
- The AR application should consider features that provide clear navigation and intuitive controls to engage learners effectively.
- At the same time, to ensure an engaging AR educational experience, the application should adapt to individual learning styles. Gamification features should reflect the style of the end-users via profile customization and AI functionalities that support intuition.

7.5. Feedback collected from the surveys

In CS4, similar to the CoP demonstration of CS2, comprehensive feedback was consistently gathered from end-users and relevant stakeholders. A variety of methods, including surveys, workshops, emails, and semi-structured interviews, were employed to collect this feedback. Given ICCS's involvement in the development of the AR app, content design, curation, and demonstration, the feedback was categorized into three distinct areas:

1. Feedback for the augmented content via the app: The quality of end-user engagement with the content presented was of utmost importance to ICCS. Therefore, feedback specific to the augmented content played a pivotal role in ensuring high-quality engagement. This feedback helped ICCS understand the effectiveness of the content and make necessary improvements of the AR application to enhance user satisfaction;
2. Feedback for the AR mobile application: As mentioned earlier, a fast development process was achieved by following an iterative approach in the development of the CirculAR application. Feedback received for the AR mobile application was crucial in driving this iterative process. Continuous collection and implementation of feedback ensured that the application evolved rapidly, incorporating user preferences and addressing any issues or concerns that arose during the development phase;
3. Feedback for curation and demonstration activities: To optimize future activities, ICCS actively sought feedback regarding the curation and demonstration processes. This feedback allowed ICCS to identify and address any bottlenecks or shortcomings, ensuring smoother and more effective activities in subsequent iterations. Also, according to the CS owners the content asserted and demonstrated during the CoP helped the CS to meet their objectives.

All feedback was collected and translated to user stories and further elaborated in D7.6. Also, Annex 2 includes the survey and below is listed the feedback collected during the CoP meeting:

Based on the feedback received for the content augmented via the app, we have compiled the following key observations:

- Based on user feedback, it was evident that end-users faced challenges in understanding the usage of certain components when relying solely on text-based manuals and a limited number of images.
    - In response to this feedback, some steps had to be taken to enhance the user experience. Additional content in the form of multimedia files, including pictures, videos, and animated visuals. These media files serve as visual aids, providing a descriptive representation of the 3D content, while complementing the text-based information.

Regarding the feedback received for the AR mobile application, we have collected the following items:

- Some end-users encountered difficulties when using the new image recognition feature.
    - In response to this feedback, improvements were made to the presentation of bounding boxes. These enhancements aim to make the feature more user-friendly and easier to use;
    - The tutorial section of the application has been updated to provide additional information on the image recognition feature, to make it more comprehensible and accessible to end-users.
- Certain users reported issues with running the image recognition feature on their devices.
    - In light of this feedback, we have updated the feature to ensure compatibility with low-end devices, without altering the user experience for the devices that were already compatible.

In relation to the feedback received for the curation and demonstration activities, the process proceeded smoothly without encountering any notable issues in terms of distributing the application to end-users' devices.

8. The AR application in CS5-La Llagosta

Case Study 5 (CS5) was the third structured demonstration activity held in Spain, following the one in Almeria and Cyprus. Some of the CS participants had also attended the CS2 CoP meeting. Thereafter, this case study had very specific requirements in terms of content and emphasized on the generation of creative and gamified content for the participants. Workshops were held to progress on the selection of content to be augmented, the information and other facts to be curated, the installation and use of the AR app, issues related to the performance of the app given the location of the demo, and other shortcomings that can be avoided related to the specifications of the specific location. The exact nature and content of the workshops is described in the sections below.

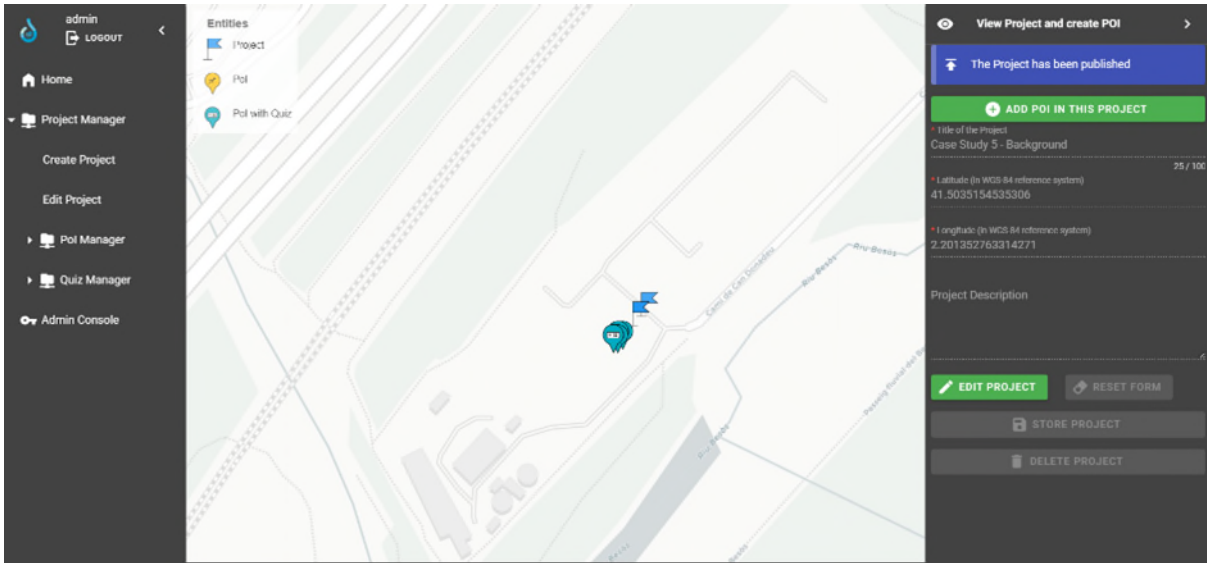


Figure 30- The AR CMS UI where the first AR campaign for the CS5 is curated. each one of the blue bubbles in the middle of the map, contain virtual content (i.e., images, 3d objects, questionnaires).

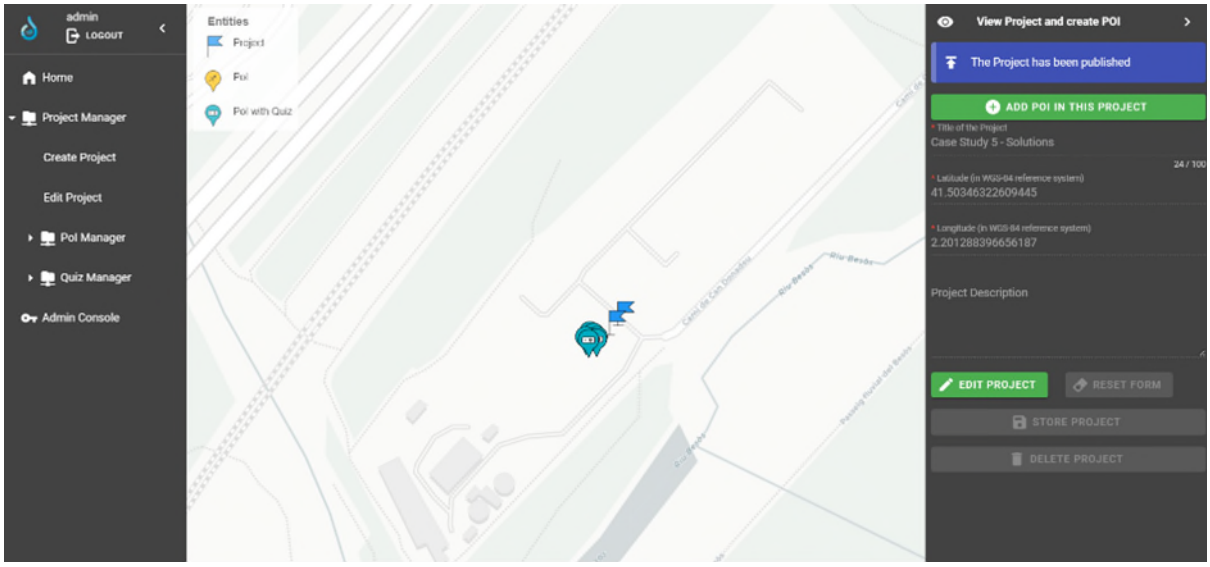


Figure 31- The AR CMS UI where the second AR campaign for the CS5 is curated. each one of the blue bubbles in the middle of the map, contain virtual content (i.e., images, 3d objects, questionnaires).

8.1. Demo case description

The CS5 demonstrates the feasibility of implementing innovative technologies to treat and valorize urban wastewater and transform wastewater treatment plants (WWTP) to resource recovery facilities, contributing this way to circular economy in the wastewater sector. The proposed next generation of urban WWTP includes several innovative technologies aiming to produce energy, reduce energy consumption and generate by-products for industrial or agricultural purposes. The proposed innovative treatment train will be demonstrated at pilot scale in the WWTP La Llagosta (Barcelona) and will be designed to treat an inflow of about 400 L/h (±10m^3/d).

The key innovations of the CS5 are:

- Granular Anaerobic Membrane Bioreactor (AnMBR) to convert the organic matter in urban WW into a biofuel: The granular AnMBR is a suitable way to reduce energy costs by treating organic matter from urban wastewaters, in comparison to conventional aerobic activated sludge. Also, under anaerobic conditions, biogas is produced, which is a mixture of methane and carbon dioxide and can be used as energy source;
- Phosphorous recovery: Removal and recovery of phosphorus with two innovative technologies developed by WETSUS: ViviCryst and BioPhree. The effluent from the anammox reactor will be treated with ViviCryst, a technology based on the chemical precipitation of phosphorus with iron in form of vivianite crystals, which have a potential application as fertilizer. The effluent from ViviCryst will be treated with BioPhree, an adsorption process that is capable to remove phosphate to ultra-low concentrations;
- Partial nitritation coupled to anammox: A suitable way to remove nitrogen from urban wastewaters is via autotrophic Biological Nitrogen Removal (BNR) processes, combining partial nitration and anammox processes. However, conventional nitrogen removal processes (nitrification followed by heterotrophic denitrification) are high energy demanding and technically limited to low loading rates. This CS proposes a two-stage approach to achieve autotrophic BNR, i.e., the removal of ammonium without the need of organic matter.

8.2. Content curation for the AR app

Along with the involved partners of CS5, the demonstration activity was planned and organized as follows:

- Workshops among the partners helped to shape the demonstration activity, including content that was going to be prepared by ICCS. The end-users of the activity were further defined with the pilot partners;
- Additional content was prepared based on information collected from the Case Study (including their KPIs and metrics) from ICCS to ensure an engaging and immersive activity for all participants;
- ICCS and Sorigue decided that the best way to inform the stakeholders about the CS5 processes is to create 2 different campaigns:
    - Background; and
    - solutions
- ICCS finalized the 2 virtual WATERMINING campaigns using the Content Management System, addressed to the audience participating in the CoP meeting of CS5. Quiz questions, related to each content, were also utilized to educate further and ensure an even more immersive experience;
- During the demonstration feedback was gathered from the end-users (around 20 participants). A survey was circulated to the participants which ensured that the feedback was collected in a structured way.

The following Table includes the content curation activities for CS5 in La Llagosta.

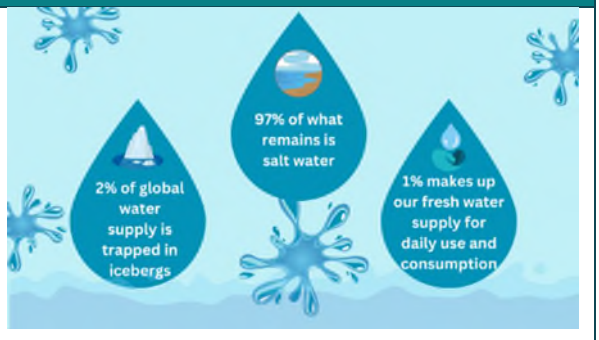
Table 6- Content curation activities for CS5.

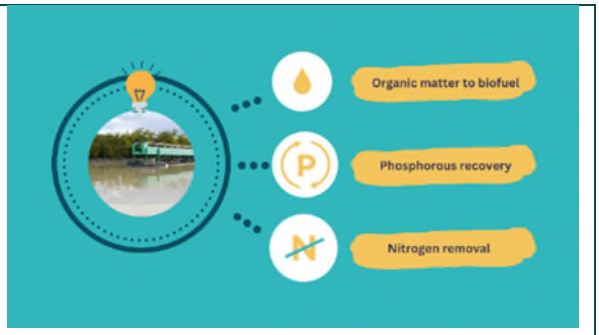
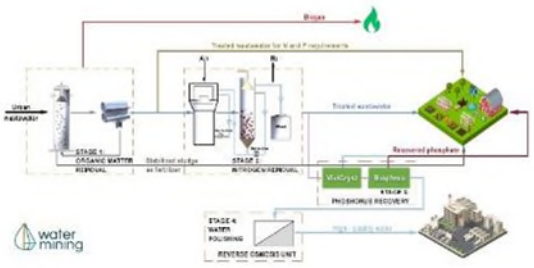
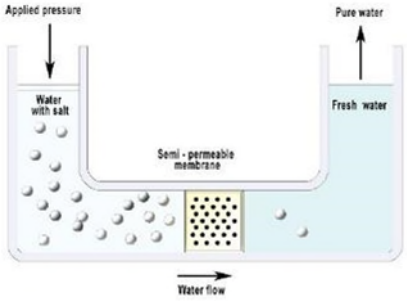
AR curation activities	
Brainstorming activities	Meeting with Sorigue on 09/11/2022 to discuss the concept of the CS5
Explanation of the AR app	ICCS sent to a detailed document on 10/11/2022 to explain the use of AR app
1st set of content sent by ICCS	ICCS sent a draft document with possible content for CS4 Sorigue on 25/11/2022
2nd set of content sent by Sorigue	ICCS asked additional information regarding the proposed content and Sorigue sent them on 05/12/2022

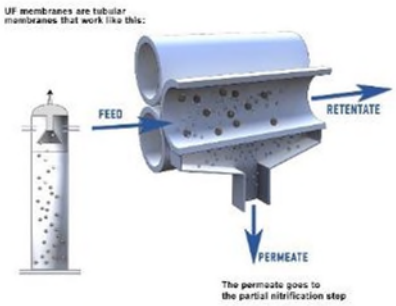
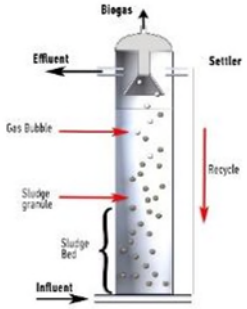
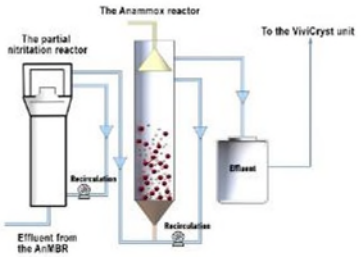
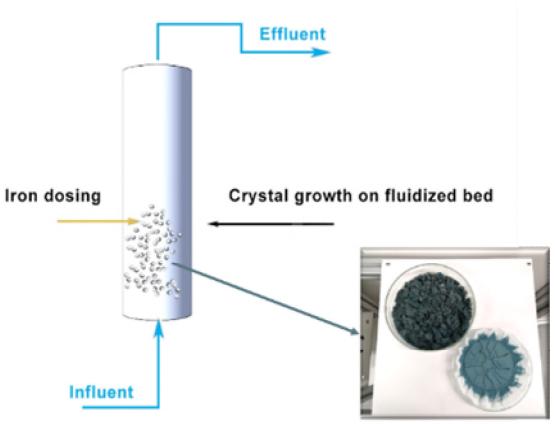
Sorigue requested modifications	Sorigue requested some minor modifications for the images for a more comprehensive AR visualization on 12/12/2022
Sorigue requested more simplified images	Sorigue requested more images based on their previous experience in other CoPs on 23/03/2022
3rd set of content sent by ICCS	ICCS sent the modified images after some minor corrections on 27/04/2023
Final set of content by ICCS	ICCS finalized the whole campaign on 20/05/2023
Final test of the AR demonstration	ICCS tested the campaign prior to the CoP meeting on 30/05/2023

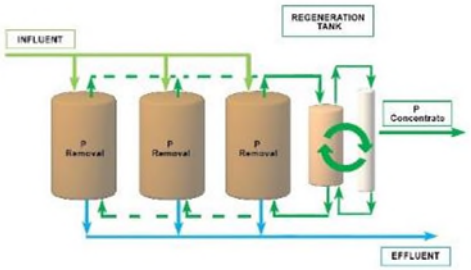
The following Table includes the AR content demonstrated during the CoP meeting demonstration of CS5 in La Llagosta. The language used was English, as the stakeholders were comfortable with this language for the demonstration. We were advised by the organizers that even though the displayed information via the AR app was sensitive and complex, the end-users would not have any problem if the material was entirely in English.

Table 7- Content displayed at the AR campaign during the CoP demonstration of CS5 in La Llagosta.

Description	Content
Content 1 (Image): Water is a fundamental component for the life in the world. 71% of the planet is covered by water. We must take care of the water because most of it is not suitable for human consumption.	

Content 2 (Image): La Llagosta demonstrates the feasibility of implementing innovative technologies to treat and valorize urban wastewater and transform wastewater treatment plants (WWTP) to resource recovery facilities, contributing this way to circular economy in the wastewater sector.	
Content 3 (Image): CS5 demonstrates, at pilot scale, circularity in an urban wastewater treatment plant, and shows to the society the technical, economical, and environmental feasibility of the proposed solution. This CS is also aligned with the SGD 6 (sustainable development goal 6) of the UN, which aims to ensure availability and sustainable management of water and sanitation for all.	
Content 4 (Image): CS5 proposes next generation of urban WWTP that includes several innovative technologies aiming to produce energy, reduce energy consumption and generate by-products for industrial or agricultural purposes. The proposed innovative treatment train will be demonstrated at pilot scale in the WWTP La Llagosta (Barcelona) and will be designed to treat an inflow of about 400 L/h (±10m3/d).	
Content 5 (Image): In the reverse osmosis unit, water passes through a semi-permeable membrane to separate ions. Separation on the surface of the membrane is based on the application of pressure greater than osmotic, so that the solvent molecules are transferred from the solution to the pure solvent, as shown in the figure. The purpose of the unit is to recover clean water.	

Content 6 (Image): Ultra Filtration technology using membranes provides an effective way to purify water by using physical barrier filtration to remove pathogens from water. Ultrafiltration purification requires no chemicals; it is efficient; and does not remove all natural minerals such as calcium and magnesium.	
Content 7 (Image): In this treatment step, the water is treated anaerobically, meaning that no aeration (no energy input) is needed in the reactor. Moreover, biogas is produced by removing the organic matter, that is transformed into CH4.	
Content 8 (Image): Partial nitritation-Anammox, a process of Anaerobic Ammonium Oxidation, is an innovative technological advancement in the removal of ammonia nitrogen in wastewater. This quite new process combines ammonia and nitrite directly into dinitrogen gas instead of passing through a two-stage process of aerobic nitrification and anaerobic denitrification. Anammox eliminates the necessity of an organic carbon source for nitrification, reduces energy demand for aeration and has a smaller production of excess sludge and lower CO2 emissions.	
Content 9 (Image): Phosphate is a scarce nutrient which can cause eutrophication in water bodies. As such, its removal and recovery from urban wastewater is becoming increasingly relevant. By keeping phosphorus in solution during the wastewater treatment process, it can selectively be removed at the end and recovered. This idea is called post-precipitation. ViviCryst is a postprecipitation technology that precipitates the phosphate as vivianite. This is done in a so-called fluidized bed crystallizer.	

Content 10 (Image): BioPhree is a phosphate adsorption technology to remove soluble phosphate from water streams down to ultra-low levels, which can be used to prevent eutrophication in fresh water bodies, for remediation of already eutrophied water bodies or also to prevent biofouling in water treatment systems. Recovered phosphate can be converted and used as fertilizer. Nowadays, one fourth of the imported Phosphate fertilizers is lost by percolation/leaking.	

8.3. AR demo campaigns for end-user engagement

More than 15 stakeholders participated in the AR demonstration with the following characteristics:

- Both females and males;
- Age range 21-50;
- Most of the participants were from private sector;
- Also participated in the demonstration researchers and people from public sector;
- Their education level varied from university graduate, master, and PhD.

We prepared two AR campaigns to engage the stakeholders of the CS5. In order for the end-users to better understand the concept of the key innovations of CS5 in La Llagosta, the content is related to the activities taking place in the CS and general information regarding the water scarcity. Finally, quiz questions and surveys were attached to the content to ensure the educational character of the AR experiences.

The following images were captured during the event.

Figure 32- Images captured during the event.

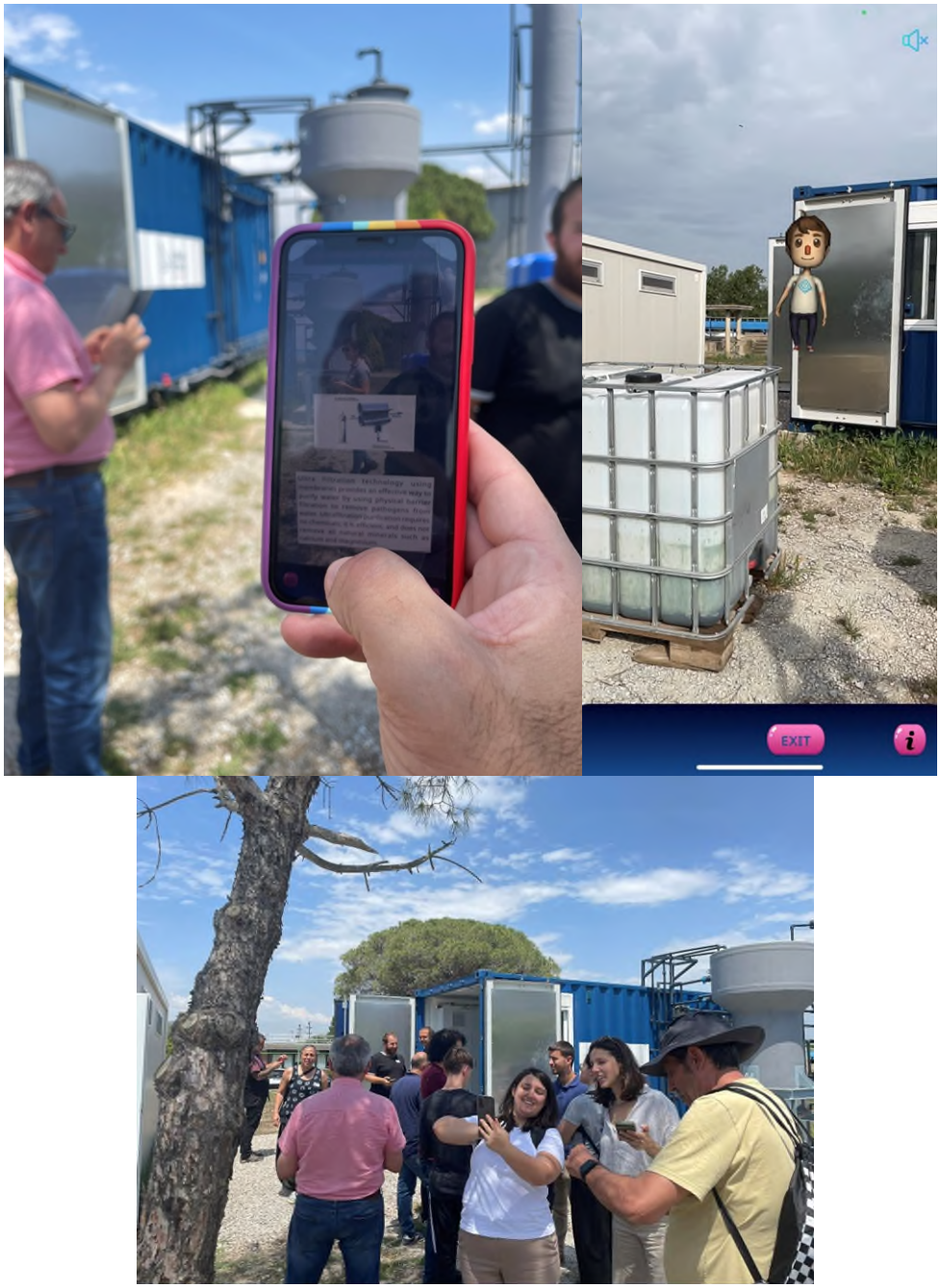


Figure 33- Images captured during the event.

8.4. User experience during the CoP at CS5

Similar to CS2, during the demonstration of CS5, feedback was provided to reflect the way the stakeholders -end-users of the application perceived the activity. The following feedback was considered to transform the UI and UX of the application as further mentioned in the deliverable D7.6:

- The AR application can guide users toward achieving learning objectives through interactive simulations and quizzes. The objectives were set from the CS owners during the demonstration.

- The AR campaigns during the demonstrations should have more intuitive and clear learning objectives to be set by the application itself without the need of further guidance.
- Finally, considering that not all environments have consistent internet access to ensure a smooth engaging experience, the AR app should offer offline functionality, allowing users to access content without an internet connection.

8.5. Feedback from the surveys

Similar to the CoP demonstration of CS2 and CS4, feedback was continuously collected from end-users and relevant stakeholders also in CS5. Feedback was collected from surveys, workshops, emails and semi-structured interviews. Considering that ICCS was involved both in the development of the AR app, the design and curation of the content, as well as the performance of the demonstration, the content was divided to three categories:

1. Feedback for the content augmented via the app. This was of particular importance, since the end-user engagement was ICCS top priority, therefore, engagement to the content presented had to be of high quality;
2. Feedback for the AR mobile application. As mentioned above, for the development of the CirculAR application, we followed an iterative approach where feedback was collected and continuously implemented to ensure a fast development process;
3. Feedback for the curation and demonstration activities. To ensure that ICCS fixed any bottlenecks or other shortcomings to the next activity. Also, according to the CS owners the content asserted and demonstrated during the CoP helped the CS to meet their objectives.

All feedback was collected and translated to user stories and further elaborated in D7.6. Also, Annex 3 includes the survey and below is listed the feedback collected during the CoP meeting:

Starting with the feedback for the content augmented via the app, the following items were collected:

- Based on user feedback, it was evident that end-users comprehend each one of the components of CS5 due to the large number of images and their related simplified text description.
    - In response to this feedback, some steps had to be taken to enhance the user experience. The text fields and the scrolling functionalities received notable improvements, all designed to seamlessly complement the audio description functionalities. The text description function had to contain larger letters because the light reflection made it difficult to read.

Regarding the feedback received for the AR mobile application, we have collected the following items:

- The end-users had trouble downloading the AR app for iOS due to a bad internet connection around the demonstration area.
    - Based on this feedback, the documentation on downloading the application on iOS devices was updated.
- It was observed that some end-users encountered difficulties downloading the campaigns with the augmented content due to unstable internet services in certain areas. This instability caused the augmented content to download at a prolonged rate, resulting in a suboptimal user experience.

- We addressed this issue by downsizing each content, resulting in a faster download process.

In relation to the feedback received for the curation and demonstration activities, the process proceeded smoothly without encountering any notable issues in terms of distributing the application to end-users' devices.

7. Conclusions

The present deliverable showcased the customized AR application in terms of content for each one of the three CSs used for enhancing user engagement produced by T7.4, and one preliminary demonstration activity. In this deliverable, is described the whole process of the content curation from the workshops among the partners that helped to shape the demonstration activity to the final demonstration activity. Furthermore, this deliverable provides proof of the end-user engagement by showcasing photos taken during the demonstration of the AR app. Finally, D7.4 serves as a manual for D7.6, due to the wide collection of feedback from surveys, workshops, emails and semi-structured interviews.

In the Annex section, through a Factsheet, the added value of AR applications, the challenges faced by the Water-mining project, and the next steps for AR application development are made clear.

8. Next steps

THE AR app is continuously improved in terms of functionalities and will be made available to other Case Studies that wish to disseminate their content and results to their respective stakeholders. This initiative will be discussed with the WP2 leaders in the framework of co-creation through social engagement for societal embedding.

The final version of the AR application will be also used if needed during the final events of the project and other communication events like conferences or workshops in the context of WATER-MINING project.

Annex 1

Anonymous survey

Augmented Reality (AR) impact on user's engagement

Invitation to participate

Dear Participant,

If this questionnaire has reached you, this means that you are assisting a Research Team to extract valuable results concerning the use of a novel software to convey a very important message. Our aim is to understand how the WaterMining solutions demonstrated at the CS2 – Almeria site may positively affect our lives and how they could be taught through unconventional means of teaching, such as a smartphone. In order to do so, we invite you to try our mobile application designed for your Android and iOS smartphone and answer a series of questions.

On behalf of the Research team at ICCS,

Dr. Tina Katika

Prerequisites

- A smartphone/tablet operating with Android or iOS software
- Access to data/internet (Wi-Fi, LTE and 4G networks are preferred)
- Give access to the application to use your Location and Camera Settings (when using the app)

Technology and assessment

The mobile application you are called to test with your smartphone is utilizing Augmented Reality (AR) technology. AR will overlay virtual elements in your physical surroundings using the camera of your smartphone.

The survey is designed to assess the acceptance of such technologies[1] as well as the engagement to such topics[2]. The questions asked are carefully selected and formulated to offer valid and reliable data.

Privacy policy

The survey is anonymous. Each participant will be assessed according to their profile and answers to Part 1.

During the download and use of the AR application, **the data you provide is stored in an encrypted form**.

Part 1 (demographics)

Participants info

Age: Choose an item.

Gender: Choose an item.

Education Level: Choose an item.

Occupation: Choose an item.

Technological profile of user and exposure to CS2 demo technologies: Select all that apply

	Never	A few times	Often	Everyday
I play mobile games	☐	☐	☐	☐
I am exposed to AR technology	☐	☐	☐	☐
I use a mobile phone to learn new things (ie. Google or Wikipedia)	☐	☐	☐	☐
I use a phone for regular things (such as, calling and texting)	☐	☐	☐	☐
I use email and perform web-searches	☐	☐	☐	☐
I have visited the demo site of Almeria (CS2)	☐	☐	☐	☐
I have been informed about the activities performed at CS2	☐	☐	☐	☐

After using the AR application

Please indicate how you agree with the following statements:

	completely agree	agree	disagree	completely disagree
I understand the basic concepts taking place in CS2 described through the AR app	☐	☐	☐	☐
I am confident about the basic concepts taking place in CS2 described through the AR app				
The work performed at CS2 is a useful concept	☐	☐	☐	☐
I am confident that I can explain concepts I learnt today to a friend	☐	☐	☐	☐
Learning about the processes in CS2 site through the AR app was worthwhile	☐	☐	☐	☐
The AR application was very complex	☐	☐	☐	☐
My interaction with AR has been clear and understandable	☐	☐	☐	☐
It was easy to learn how to use the AR app	☐	☐	☐	☐
The AR application was easy to navigate	☐	☐	☐	☐
I feel positive when I use the AR app	☐	☐	☐	☐
I was really drawn into finding the AR experiences	☐	☐	☐	☐
The AR experience was fun	☐	☐	☐	☐
When using the AR app I lost track of time	☐	☐	☐	☐
The AR application is attractive	☐	☐	☐	☐
I liked the graphics and images in the AR application	☐	☐	☐	☐
I consider my experience a success	☐	☐	☐	☐
Doing tasks in AR did not work out the way I planned	☐	☐	☐	☐
I would recommend the AR app to my friends and family	☐	☐	☐	☐
The content of the AR app incited my curiosity	☐	☐	☐	☐
I felt annoyed when using the AR app	☐	☐	☐	☐
The AR experience was demanding	☐	☐	☐	☐
I couldn't do some of the things I needed to do in AR	☐	☐	☐	☐

Annex 2

Anonymous survey

Augmented Reality (AR) impact on user's engagement

Invitation to participate

Dear Participant,

If this questionnaire has reached you, this means that you are assisting a Research Team to extract valuable results concerning the use of a novel software to convey a very important message. Our aim is to understand how the WaterMining solutions demonstrated at the CS4 – Cyprus site may positively affect our lives and how they could be taught through unconventional means of teaching, such as a smartphone. In order to do so, we invite you to try our mobile application designed for your Android and iOS smartphone and answer a series of questions.

On behalf of the Research team at ICCS,

Dr. Tina Katika

Prerequisites

- A smartphone/tablet operating with Android or iOS software
- Access to data/internet (Wi-Fi, LTE and 4G networks are preferred)
- Give access to the application to use your Location and Camera Settings (when using the app)

Technology and assessment

The mobile application you are called to test with your smartphone is utilizing Augmented Reality (AR) technology. AR will overlay virtual elements in your physical surroundings using the camera of your smartphone.

The survey is designed to assess the acceptance of such technologies[1] as well as the engagement to such topics[2]. The questions asked are carefully selected and formulated to offer valid and reliable data.

Privacy policy

The survey is anonymous. Each participant will be assessed according to their profile and answers to Part 1.

During the download and use of the AR application, **the data you provide is stored in an encrypted form**.

Part 1 (demographics)

Participants info

Age: Choose an item.

Gender: Choose an item.

Education Level: Choose an item.

Occupation: Choose an item.

Technological profile of user and exposure to CS4 demo technologies: Select all that apply

	Never	A few times	Often	Everyday
I play mobile games	☐	☐	☐	☐
I am exposed to AR technology	☐	☐	☐	☐
I use a mobile phone to learn new things (ie. Google or Wikipedia)	☐	☐	☐	☐
I use a phone for regular things (such as, calling and texting)	☐	☐	☐	☐
I use email and perform web-searches	☐	☐	☐	☐
I have visited the demo site of Cyprus (CS4)	☐	☐	☐	☐
I have been informed about the activities performed at CS4	☐	☐	☐	☐

After using the AR application

Please indicate how you agree with the following statements:

	completely agree	agree	disagree	completely disagree
I understand the basic concepts taking place in CS4 described through the AR app	☐	☐	☐	☐
I am confident about the basic concepts taking place in CS4 described through the AR app				
The work performed at CS4 is a useful concept	☐	☐	☐	☐
I am confident that I can explain concepts I learnt today to a friend	☐	☐	☐	☐
Learning about the processes in CS4 site through the AR app was worthwhile	☐	☐	☐	☐
The AR application was very complex	☐	☐	☐	☐
My interaction with AR has been clear and understandable	☐	☐	☐	☐
It was easy to learn how to use the AR app	☐	☐	☐	☐
The AR application was easy to navigate	☐	☐	☐	☐
I feel positive when I use the AR app	☐	☐	☐	☐
I was really drawn into finding the AR experiences	☐	☐	☐	☐
The AR experience was fun	☐	☐	☐	☐
When using the AR app I lost track of time	☐	☐	☐	☐
The AR application is attractive	☐	☐	☐	☐
I liked the graphics and images in the AR application	☐	☐	☐	☐
I consider my experience a success	☐	☐	☐	☐
Doing tasks in AR did not work out the way I planned	☐	☐	☐	☐
I would recommend the AR app to my friends and family	☐	☐	☐	☐
The content of the AR app incited my curiosity	☐	☐	☐	☐
I felt annoyed when using the AR app	☐	☐	☐	☐
The AR experience was demanding	☐	☐	☐	☐
I couldn't do some of the things I needed to do in AR	☐	☐	☐	☐

Annex 3

Anonymous survey

Augmented Reality (AR) impact on user's engagement

Invitation to participate

Dear Participant,

If this questionnaire has reached you, this means that you are assisting a Research Team to extract valuable results concerning the use of a novel software to convey a very important message. Our aim is to understand how the WaterMining solutions demonstrated at the CS5 – La Llagosta site may positively affect our lives and how they could be taught through unconventional means of teaching, such as a smartphone. In order to do so, we invite you to try our mobile application designed for your Android and iOS smartphone and answer a series of questions.

On behalf of the Research team at ICCS,

Dr. Tina Katika

Prerequisites

- A smartphone/tablet operating with Android or iOS software
- Access to data/internet (Wi-Fi, LTE and 4G networks are preferred)
- Give access to the application to use your Location and Camera Settings (when using the app)

Technology and assessment

The mobile application you are called to test with your smartphone is utilizing Augmented Reality (AR) technology. AR will overlay virtual elements in your physical surroundings using the camera of your smartphone.

The survey is designed to assess the acceptance of such technologies[1] as well as the engagement to such topics[2]. The questions asked are carefully selected and formulated to offer valid and reliable data.

Privacy policy

The survey is anonymous. Each participant will be assessed according to their profile and answers to Part 1.

During the download and use of the AR application, **the data you provide is stored in an encrypted form**.

Part 1 (demographics)

Participants info

Age: Choose an item.

Gender: Choose an item.

Education Level: Choose an item.

Occupation: Choose an item.

Technological profile of user and exposure to CS5 demo technologies: Select all that apply

	Never	A few times	Often	Everyday
I play mobile games	☐	☐	☐	☐
I am exposed to AR technology	☐	☐	☐	☐
I use a mobile phone to learn new things (ie. Google or Wikipedia)	☐	☐	☐	☐
I use a phone for regular things (such as, calling and texting)	☐	☐	☐	☐
I use email and perform web-searches	☐	☐	☐	☐
I have visited the demo site of La Llagosta (CS5)	☐	☐	☐	☐
I have been informed about the activities performed at CS5	☐	☐	☐	☐

After using the AR application

Please indicate how you agree with the following statements:

	completely agree	agree	disagree	completely disagree
I understand the basic concepts taking place in CS5 described through the AR app	☐	☐	☐	☐
I am confident about the basic concepts taking place in CS5 described through the AR app				
The work performed at CS5 is a useful concept	☐	☐	☐	☐
I am confident that I can explain concepts I learnt today to a friend	☐	☐	☐	☐
Learning about the processes in CS5 site through the AR app was worthwhile	☐	☐	☐	☐
The AR application was very complex	☐	☐	☐	☐
My interaction with AR has been clear and understandable	☐	☐	☐	☐
It was easy to learn how to use the AR app	☐	☐	☐	☐
The AR application was easy to navigate	☐	☐	☐	☐
I feel positive when I use the AR app	☐	☐	☐	☐
I was really drawn into finding the AR experiences	☐	☐	☐	☐
The AR experience was fun	☐	☐	☐	☐
When using the AR app I lost track of time	☐	☐	☐	☐
The AR application is attractive	☐	☐	☐	☐
I liked the graphics and images in the AR application	☐	☐	☐	☐
I consider my experience a success	☐	☐	☐	☐
Doing tasks in AR did not work out the way I planned	☐	☐	☐	☐
I would recommend the AR app to my friends and family	☐	☐	☐	☐
The content of the AR app incited my curiosity	☐	☐	☐	☐
I felt annoyed when using the AR app	☐	☐	☐	☐
The AR experience was demanding	☐	☐	☐	☐
I couldn't do some of the things I needed to do in AR	☐	☐	☐	☐

Annex 4

The Augmented Reality Application (@TRL7)

An Augmented Reality application aiming to enhance the real world with the use/infusion of digital elements, like images, videos and 3D objects. Is a user friendly and accessible 2-part solution, the AR mobile app which is designed to provide the generated experiences to end users and the AR Content Management Service (CMS) which is a web-based application that allows the administrators to create campaigns and add content to the platform.

0. Past work it builds on

- *NextGen* (2018 - 2022): An AR application that will be built and demonstrated for selected NextGen demo cases, which will drastically increase the learning value of the showcases by making visible 'hidden' or 'intangible' elements of the cycle and demonstrated solution to visitors. The AR application will deliver the content adjusted to the specific target group of site visitors (from trainees to researchers, from children to adults) and will be accompanied by advanced visualization, data annotations and call for actions.

AR Content Management Service (CMS)

AR mobile app

1. The Water Mining AR app

- The AR app will make 'hidden' or 'intangible' elements of demonstrated solutions visible to visitors enhancing their engagement and learning with the demonstrated innovations through a curated gamified experience.
- The AR app will be used for enhancing users' engagement practices through miniaturized 3D models and will be customized for 3 CS. Also, the AR app will be used for training and capacity building purposes.

2. Challenges in Water Mining project

- Regarding the Demo Cases (CS1, CS4, CS6), the local deployment is not possible due to accessibility issues, and so demonstration activities cannot be performed at the demo sites.
- Key challenge the limited content and the ability not to be used for further end-user engagement given its very technical and segmented context.

3. Developments up to M18

- We developed the system design of the two AR components, the AR Content Management System (AR-CMS), and the mobile AR app (CircuIAR).
- An effort has been made, in relation to the collection and curation of content for the preparation of the proof of concept and the initial demonstration, that was due in M18. The efforts included both back-end and front-end development, while UX/UI research aims at minimizing usability and user adoption bottlenecks.
- To ensure that the AR applications remain relevant for the purposes of the Water Mining project and address the mining techniques developed and applied for the purposes of this project, we held two workshops with Case Studies 1 and 6, to brainstorm and discuss on data (AR media content) to be used for the AR demonstration through a proof-of-concept.
- At the same time, ICCS participated in workshops and other brainstorming activities with NEMO, EXCITE and REVOLVE to discuss the possibility of incorporating the mobile AR application in dissemination and other communication activities reaching end-users (such as, modular exhibitions, website posts, etc).

4. Next steps

- More customization of AR campaigns based on the needs of the CSs. Extended testing of the mobile AR application with end-users given the content collected from the CSs.
- iOS deployment.
- Improve UIs and gamification features.
- The development of an image/object detection feature to enable further integration of the AR with the environment.

5. Added value

- Enhance the engagement and learning of the users, with the demonstrated innovations through a curated gamified experience.
- Open new opportunities to visualise, share and collectively understand opportunities and challenges in dissemination target groups.
- Will help users visualise 'hidden' or 'intangible' parts of the circle and hence help them understand the bigger picture in CE.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 869474.