WaterJPI project

SMARTControl

Smart framework for real-time monitoring and control of subsurface processes in managed aquifer recharge (MAR) applications

Deliverable D6.2

Training courses in the use of the SMART-Control software
Implementation of training courses in Cyprus and Brazil

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Deliverable D6.2

Training course in the use of the SMART-Control software

Implementation of training courses in Cyprus and Brazil

Short summary

This report summarizes the content and main outcomes of the first series of training activities within the SMART-Control project. The events are focused on the introduction of the tools and approaches developed within the project to a designated audience of technical and managerial stakeholders in Cyprus and Brazil. The activities included a preliminary needs assessment to identify and characterize the interest of the participants in the content provided, followed by the implementation of public workshops and specialized training courses in SMART-Control software.

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ABSTRACT

Managed aquifer recharge (MAR) is a nature-based, worldwide successful process for sustainable water resource management and significantly helps increasing the security of water supply. However, the lack of detailed and real-time data continues to hinder reliable monitoring as well as the forecasting and avoidance of risks in aquifer recharge processes. This leads often to a hesitant implementation of MAR despite their far-reaching advantages. To help overcome these challenges, the SMART-Control project consortium (https://smart-control.inowas.com/) trains and engages MAR stakeholders using a three-step approach:

- Firstly, public stakeholder events are held to raise awareness and inform about the benefits of MAR and how to manage associated risks, bringing together a wide range of actor groups from academia, policy and practice,
- Secondly, managers and technical operators of MAR schemes are trained in the use of the SMART-Control innovative web-based real-time monitoring and control system (RMCS) at pilot sites in Cyprus and Brazil; and
- Thirdly, the concept is replicated at new potential MAR sites and discussed with interested stakeholders.

A needs assessment helped to best tailor the SMART-Control technical training to the needs of management and technical operators. A high interest was expressed for (a) real-time monitoring with online sensors including data visualisation and interpretation, (b) groundwater model-based predictions and running different scenarios, (c) microbial risk assessment and (d) cost-benefit analysis for MAR systems. The SMART-Control web-based modelling platform offers a variety of tools, including tools for the first three topics, the use of which was the primary topic of the technical training. Interactive discussion and feedback sessions organised at the end of each training session helped to further improve and adapt the SMART-Control platform to the needs of MAR stakeholders. A list of additional risks related to MAR that are not yet covered by the platform was compiled, as well as relevant future scenarios that are worth considering in MAR planning and monitoring.

The feedback from the training participants revealed a high interest in MAR solutions and improved real-time data management to reduce MAR-associated risks, as well as a need for training and stakeholder engagement in solution development as an important pillar to reduce barriers towards MAR implementation.

This training report covers the first training course implemented at the SMART-Control pilot site in Cyprus and Brazil. This includes preparatory activities (Chapter 2), the detailed training programme (Chapter 3), and a summary of the impressions and results of the interactive sessions (Chapter 4).

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ABBREVIATIONS

APAC	Pernambuco's Water and Climate Agency
CBA	Costs-benefits analysis
ECoE	Eratosthenes Centre of Excellence
GSD	Geological Survey Department
KWB	Kompetenzzentrum Wasser Berlin (engl.: Competence Center Water Berlin)
PI	Performance Indicator
RMCS	real-time monitoring and control system
TUD	Technical University Dresden
UCY	Univeristy of Cyrus
UFPB	Federal University of Paraíba
UFPE	Federal University of Pernambuco
QMRA	Quantitative microbial risk assessment
WDD	Water Development Department

1. INTRODUCTION

1.1 ABOUT THE SMART-CONTROL PROJECT

Managed aquifer recharge is a nature-based, worldwide successful process for sustainable water resource management. By storing temporarily excess water in geologically suitable subsoils, groundwater-dependent ecosystem services can be restored such as the production of fresh water, prevention of saltwater intrusion and improvement of water quality. This contributes significantly to increasing the security of water supply. However, the lack of detailed and real-time data continues to hinder reliable monitoring as well as forecasting and avoidance of risks in aquifer recharge processes.

SMART-Control aims at reducing these risks in the application of sustainable groundwater management techniques, by the development of an innovative web-based, real-time monitoring and control system (RMCS) in combination with risk assessment and management tools. At pilot sites in-situ-real-time monitoring systems consisting of state-of-the-art online sensors were installed and new web-based tools for control, modelling and prediction are developed. The following key risks in water reuse applications were considered against quantifiable performance indicators (PI):

- public health (PI: microbial concentration in water reuse below 1 µDALYs per person per year)
- environmental risks (PI: spatial and temporal extent of infiltration bubble by water quality parameters e.g. nitrogen concentration, salinity)
- clogging management (PI: maintenance intervals)
- recovery efficiency (PI: recovery of water with defined quality in %)
- residence time (PI: subsurface residence time in days from estimation-based approach with unknown uncertainties to real-time assessment with quantifiable uncertainties).

The approach was tested at a total of six pilot sites in Brazil, Cyprus, France and Germany under different environmental and operating conditions to reach a wide range of objectives: increase water availability in urban areas, prevent saltwater intrusion in coastal aquifers and mitigate extreme climatic events. Reducing the risks associated with MAR facilities increases their manageability and controllability. This will lead in a broader sense to the promotion of social acceptance of water reuse technologies and demonstrates the feasibility of MAR as climate change adaptation measures.

1.2 AIM AND NECESSITY OF THE TRAINING COURSE

In order to strengthen the SMART-Control approach and to help stakeholders in its application at the SMART-Control pilot sites, the project team provided the management and technical operators of the pilot sites an introduction to the use of the innovative SMART-Control instruments. In addition, the SMART-Control approach providing a real-time monitoring and controlling solution for MAR sites is directly applied by the participants to concrete use cases formulating technical and operational improvements. Besides that, the project consortium aims to examine the applicability of SMART-Control tools for different needs. This ensures a sustained and large-scale application of the project approach. The training programme is characterized by close cooperation between developers and users and concludes with a series of meetings to initiate replication activities within the project and beyond.
The trainings have been conducteding with the below listed specific objectives:

(1) To **meet prior communicated local needs** for reliable monitoring and control methods for MAR
(2) To **raise awareness** on MAR risks and innovative monitoring and control methods to reduce these risks
(3) To **build capacities** for innovative approaches to reduce the risks associated with MAR through:
    - hands-on training on selected SMART Control tools and
    - demonstration of their application potential and benefits at pilot sites
(4) To **jointly apply and adapt** the SMART-Control solution to selected local sites
(5) To **improve and align** the SMART-Control solution to local needs on monitoring and controlling of MAR

2. TRAINING PREPARATION

2.1 TRAINING NEEDS ASSESSMENT QUESTIONNAIRE

2.1.1 Aim of the Needs Assessment

To best tailor the SMART-Control Training to the needs of the participants, adelphi in cooperation with the tool developers (TUD and KWB) conducted a needs assessment in the form of an online questionnaire. The resulting priorities of the participants in terms of learning objectives and the stated experience levels and existing knowledge of the participants were incorporated into the design of the training modules.

2.1.2 Structure of the Needs Assessment

The needs assessment comprised two main questions that asked about learning priorities and the existing experience and knowledge of the participants regarding SMART-Control topics. Five SMART-Control topics were in the foreground: groundwater modelling, real-time monitoring of MAR systems, groundwater model-based predictions, microbial risk assessment, and cost benefit analysis for MAR systems. All these five topics are addressed by SMART-Control tools, except for the CBA analysis, which, however, is also an important product of the SMART-Control project. The participants could give a score of 0-3.

A: Learning priority: Which of the following topics in the field of improved MAR management do you want to learn more about or are most relevant for your work? **Rating:**		**B: Experience/knowledge: What experiences and knowledge do you already have?** **Rating:**	
0 = No interest, or not applicable for my organisation	2 = Yes, some interest	0 = Have not yet heard of the topic, would need introduction from scratch	2 = Basic experience in dealing with the topics, but not specifically with the mentioned tools
1 = Little interest, not very relevant for my organisation	3 = Yes, very much interested in learning about this topic	1 = I'm familiar with the mentioned terms, but have not yet dealt with them professionally	3 = I'm regularly dealing with these topics in my day to day work and use the mentioned tools

	A: What is your learning priority?				B: What is your existing experience/knowledge?				
	0 - no interest	1	2	3 - very much interested	0 - not yet heard of	1	2	3 - well known	No answer
Development of an groundwater model and application of groundwater softwares (e.g. MODFLOW, FEFLOW, HYDRUS)	○	○	○	○	○	○	○	○	●
Real-time monitoring with online sensors and visualization/interpretation of the results	○	○	○	○	○	○	○	○	●
Groundwater model-based predictions and running of different scenarios	○	○	○	○	○	○	○	○	●
Microbial risk assessment (QMRA) and application of QMRA tools	○	○	○	○	○	○	○	○	●
Cost-Benefit-Analysis for managed aquifer recharge systems	○	○	○	○	○	○	○	○	●

Figure 1. Online questionnaire for assessing the needs of key stakeholders of the pilot site in Cyprus

2.1.3 Results for the project pilot site in Cyprus

In the online questionnaire, 15 participants took part from different institutions, such as Water Development Department of Cyprus (WDD), Cyprus Geological Survey, Water Board of Larnaca, Union of Cypriot Farmers, Cyprus University of Technology and the University of Cyprus (NIREAS International Water Research Center). The

Needs Assessment revealed a generally high level of interest in the SMART-Control Tools with the following ranking shown in Figure 2 ranging between 2 (some interest) and 3 (very much interested in learning about this topic). The experience of the participants varies between 1 (participants are familiar with the terms mentioned but have not yet dealt with them professionally) and 2 (basic experience in dealing with the topics) for all topics.

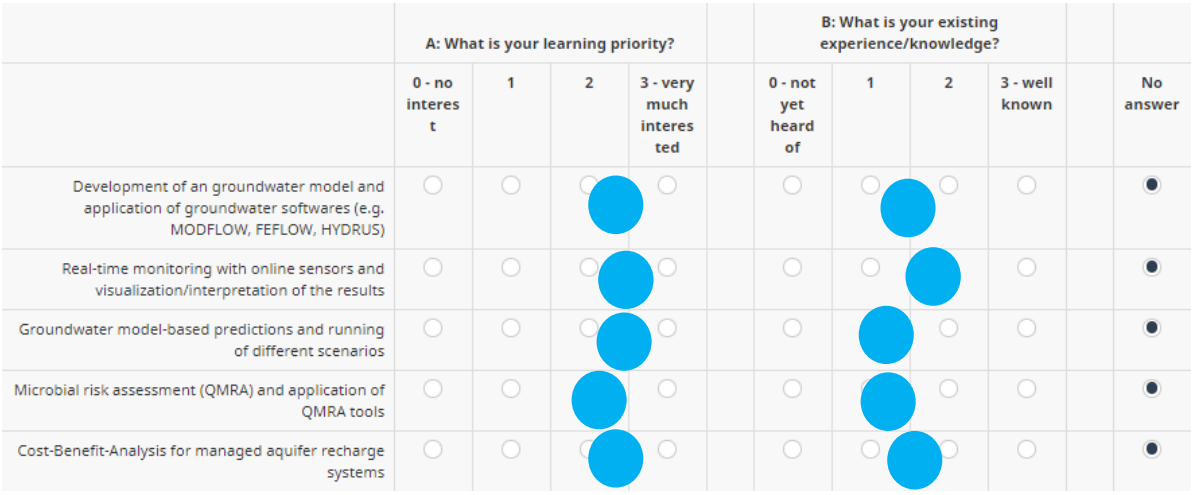


Figure 2. Results of the Needs Assessment Questionnaire

2.1.4 Results for the project pilot site in Brazil

Due to the high number of Corona infections in Brazil at the time of the training preparation, the participation in the needs assessment (which started four weeks before the training) was very low, so that no meaningful results can be presented.

2.1.5 Conclusion

The participants' responses indicate that there is a basic understanding of the SMART-Control tool topics. Thus, the basic terminology can be used without much explanation. On the other hand, there are only a few, who deal with the topics professionally. Most of the interviewees do not deal with the topics on a daily basis. In order to address this, adelphi designed the training course more comprehensive in terms of content in order to cover all needs.

3 TRAINING PROGRAMME

Based on the results of the needs assessment and the time availability of the participants, a training programme was developed. Corona-related restrictions at that time (Cyprus Nov 2020 and Brazil Dec 2021) made it impossible to conduct the training in person, making it necessary to switch to online formats. For a successful delivery of the training with maximum impact, it was important to consider this format change also in the planning of the training structure and concept. Accordingly, to ensure maximum attention span of the training participants, the training course was stretched over one entire week divided into a three step approach (see Figure 3) including six sessions. In addition, care was taken to ensure that at least one representative from the key organisations takes part, so that knowledge can be passed within the organizations.

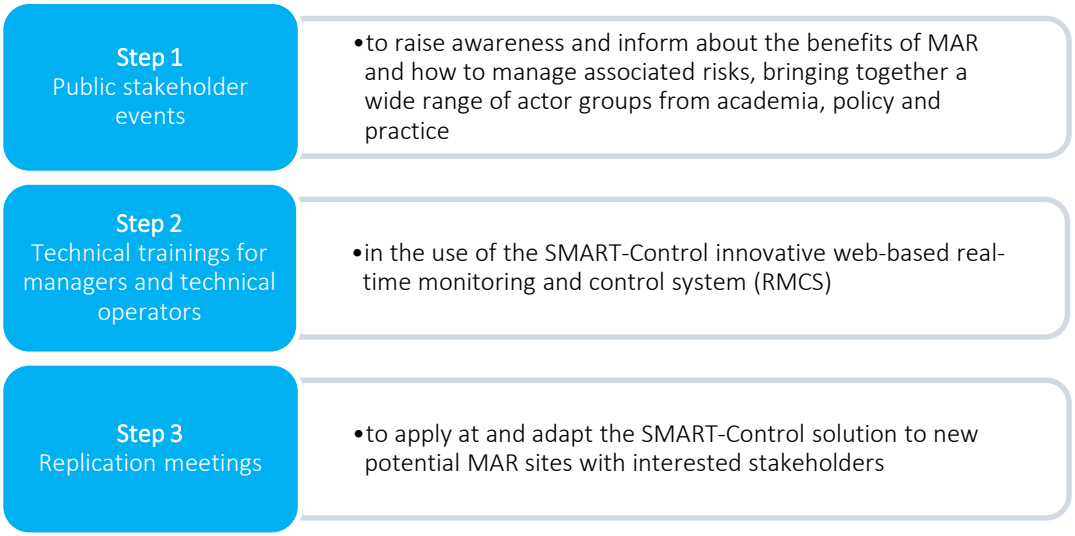


Figure 3. Three step training approach

The training porgramme in Cyprus and Brazil was almost identical, with only a minor change in the order of the technical training sessions. Section 3.1 and 3.2 show the detailed training programme that has been conducted in Cyprus and Brazil, respectively.

3.1 DETAILED TRAINING PROGRAMME CONDUCTED IN CYPRUS (NOV 2020)

3.1.1 Public Event | 23 November, 11:00-13:00

What to expect: Get a general introduction to increasing water security with MAR, associated risks and the benefits of the SMART-Control monitoring and control system
For who: The Public Event is targeted at all interested in, affected by or dealing with increasing water security in Cyprus from management and technical level. At the Cyprus pilot site, the following stakeholders attended the Public Event: NIREAS International Water Research Center, Water Development Department (WDD), Geological Survey Department (GSD), Cyprus Institute (The Energy, Environment and Water Research Center (EEWRC)), Water Boards, ERATOSTHENES Centre of Excellence (ECoE), Agricultural organisations

Detailed agenda:

Table 1. Detailed agenda of the Public Event in Cyprus

Time	Programme	Objectives	Content	Speaker
10:45	Tuning in and introduction	Everyone introduces him/herself by answering a few questions	What is your name and for which organisation are you here? Please answer with: Name, Organisation	adelphi
11:00	Official welcome	Welcome and introduce the speakers of todays session	Welcome and introduction to the programme	UCY
11:10	Introduction to SMART-Control project	Overall objective: present the SMART-Control approach to a wider audience with a practical example from the local case study (Ezousa)	● SMART-Control project ● Web-based platform, its application potential and benefits	TUD
11:20	Introduction to the Ezousa site		General information on the site-specific MAR scheme and its associated risks	WDD
11:30	Introduction to SMART-Control tools	The participants have an overview of the possibilities of the web-based platform, they can better assess whether they are interested in participating in the Technical Workshop (day 3-4)	● Tool 1. Initial risk assessment ● Tool 2. Real-time monitoring ● Tool 3. Real-time model update and simulation ● Tool 4. Model-based predictions	TUD
11:50	Risk assessment	Presenting current results of SMART-Control	Risks assessed for the Cyprus site and other project locations based on D2.1	adelphi
12:00	Groundwater model developed for Ezousas	Focus: presenting current results, only briefly the development	Information Basis, concept and scope of the developed ground water model	UCY
12:15	Upcoming stakeholder interaction in Cyprus	The participants have an overview of the upcoming project activities in which they could be involved	● Needs Assessment ● Training ● Replication identification ● Project development	adelphi
12:35	Q & A	The participants find answers to their questions, but also the SMART-Control project team gets to know potential stakeholders better by asking questions on e.g. ● Experiences with MAR? ● Which risks they find most critical? ● Etc.	Questions, Comments and Suggestions to the presentation and upcoming programme of the next days	Moderated by adelphi

3.1.2 Technical Training Session 1: Developing a Groundwater Model with the INOWAS platform | 24 November 2020, 11:00-13:00

What to expect:

- learn how to upload/create a groundwater model on the SMART-Control platform
- learn how to copy and change a groundwater model on the INOWAS platform and how to run calculations and to read the results

For who: the training sessions are targeted at all involved in the planning, implementation and operation of MAR sites on technical level.
This included at the Cyprus pilot site:

- technical personnel from WDD in charge of the MAR sites in the Ezousa basin and Akrotiri basin as well as for the water resources management in the Germasogeia basin,
- scientific stakeholders from NIREAS, EcoE, and GSD

Detailed agenda:

Table 2. Detailed agenda of training on developing a groundwater model with the INOWAS platform in Cyprus

Time	Programme	Objectives	Content	Speaker
10:45	Tuning in	Setting the scene for the training session: Each of the participants has logged into the Communication Platform and is able to follow the training. New participants are briefly introduced. An open poll session is used to introduce the topic of the session.	Open poll question: What are the risks you see when operating MAR in Cyprus?	adelphi
11:00	Introduction to and overview presentation of the training agenda and its scope	Inform on the overall objectives of the three training days: (for management level)	Introduction to the training contents and the scope of knowledge achieved with the training	adelphi
11:10	Introduction to INOWAS modelling platform	Participants see how to navigate through the platform	• Software architecture • Introduction to the user interface	TUD
11:30	Presentation on setup of the Ezousas groundwater model	Participants know how to upload/create a groundwater model on the SMART-Control platform and how the model can be automatically updated with the extracted sensor data	• Introduction to the setup of the Ezousas Groundwater Model, its functionality directly on the online tool	UCY
12:15	Interactive session on using the platform	Participants will receive access to the INOWAS platform Participants learn how to basically navigate on the platform Participants will actively: 1. login to the platform, 2. copy model into their dashboard, 3. making changes, 4. run the calculation, 5. report on something and 6. read the results	• Registration to the platform (all participants will get a password and user name) • Participants will create a clone of the Cyprus model and get familiar with the platform	TUD
12:45	Discussion and Feedback round	Closure of the day: Participants have the opportunity to ask questions and give their feedback on how to improve the training and SMART-Control approach.	Questions, comments and feedback from the participants	Moderated by adelphi

3.1.3 Technical Training Session 2: Real-time online monitoring of MAR | 25 November 2020, 11:00-13:00

What to expect:

- learn how to prepare data for data monitoring, chemical analysis, modeling
- learn how to upload real-time data to the monitoring tool, to assign data to real sites and how to visualize the results

For who: the training sessions are targeted at all involved in the planning, implementation and operation of MAR sites on technical level

This included at the Cyprus pilot site:

- technical personnel from WDD in charge of the MAR sites in the Ezousa basin and Akrotiri basin as well as for the water resources management in the Germasogeia basin,
- scientific stakeholders from NIREAS, EcoE, and GSD

Detailed agenda:

Table 3. Detailed agenda of the training on real-time online monitoring of MAR in Cyprus

Time	Programme	Objectives	Content	Speaker
10:45	Tuning in	Setting the scene for the training session: Each of the participants has logged into the Communication Platform and is able to follow the training. New participants are briefly introduced. An open poll session is used to introduce the topic of the session.	Open poll question: What parameters should be monitored online when operating a MAR system?	adelphi
11:00	Presentation on real-time monitoring	Objective: Participants know how to prepare data for data monitoring, chemical analysis, modeling	Introduction on connecting data sets and sensors to the platform, sensor data processing and data visualization	TUD, adelphi
11:45	Interactive training on Real-time monitoring	Participants know how to upload real-time data to the monitoring tool, to assign data to real sites and how to visualize the results.	Participants work directly on the Monitoring tool using a real case site for assessing various sources of data including real sensor data	TUD, adelphi
12:45	Discussion and Feedback round	Closure of the day: Participants have the opportunity to ask questions and give their feedback on how to improve the training and SMART-Control approach.	Questions, comments and feedback from the participants	Moderated by adelphi

3.1.4 Technical Training Session 3: Assessing microbial risks of MAR | 25 November 2020, 15:00-17:00

What to expect:

- Learn how to login and navigate on the INOWAS platform
- learn how to assess the microbial risks of a MAR system with the SMART-Control approach,
- get to know the usage of environmental tracer (temperature) for residence time estimation on the INOWAS platform

For who: the training sessions are targeted at all involved in the planning, implementation and operation of MAR sites on technical level

This included at the Cyprus pilot site:

- technical personnel from WDD in charge of the MAR sites in the Ezousa basin and Akrotiri basin as well as for the water resources management in the Germasogeia basin,
- scientific stakeholders from NIREAS, EcoE, and GSD

Detailed agenda:

Table 4. Detailed agenda of the training on assessing microbial risks of MAR in Cyprus

Time	Programme	Objectives	Content	Speaker
14:45	Tuning in	Setting the scene for the training session: Each of the participants has logged into the Communication Platform and is able to follow the training. New participants are briefly introduced. An open poll session is used to introduce the topic of the session.	Open poll question: What kind of water quality related problems do you see for MAR operation in Cyprus?	adelphi
15:00	Qualitative microbial risk assessment tool	Participants see how to assess the microbial risks of a MAR system with the SMART-Control approach	Introduction to QMRA; best practices and studies; live presentation of the QMRA tool on the INOWAS platform	KWB, UCY
15:20	Interactive training on the QMRA tool	Participants use the QMRA tool	Participants apply the tool to a real-life case	UCY
15:30	Groundwater residence time tool	Participants get to know the usage of environmental tracer (temperature) for residence time estimation	How to use heat transport for predicting the groundwater residence time and linkage to microbial risk assessment; application example in Cyprus	KWB
16:10	Interactive training on the Groundwater residence time tool	Participants use the Groundwater residence time tool	Make use of existing data sets, participants will upload the dataset into the platform and perform residence time calculation while adapting the calculation parameters	adelphi
16:40	Discussion and Feedback round	• Do you see application opportunities of the tools: QMRA, HRT Yes/no • Where do you think could you apply the QMRA tool • Where could you apply the HRT tool? • What kind of risks do you see addressed with the tools • A) QMRA • B) HRT How do you rate the user friendliness of the HRT tool? 1-10? Do you have any suggestions for improvements?	Application options and useability of the tools	Moderated by adelphi

3.1.5 Technical Training Session 4: Groundwater model-based predictions and running of different scenarios | 26 November 2020, 11:00-13:00

What to expect: Learn how to run different scenarios on the SMART-Control platform
For who: the training sessions are targeted at all involved in the planning, implementation and operation of MAR sites on technical level
This included at the Cyprus pilot site:

- technical personnel from WDD in charge of the MAR sites in the Ezousa basin and Akrotiri basin as well as for the water resources management in the Germasogeia basin,
- scientific stakeholders from NIREAS, EcoE, and GSD

Detailed agenda:

Table 5. Detailed agenda of the training on groundwater model-based predictions and running of different scenarios in Cyprus

Time	Programme	Objectives	Content	Speaker
10:45	*Tuning in*	Setting the scene for the training session: Each of the participants has logged into the Communication Platform and is able to follow the training. New participants are briefly introduced. An open poll session is used to introduce the topic of the session.	Open poll question: What challenges do you think do MAR systems have to face in future in Cyprus?	adelphi
11:00	**Presentation on Model-based predictions**: ● Short introduction	Participants know how to run different scenarios on the SMART-Control platform.	How to change boundary conditions of the groundwater model, e.g.: ● Societal changes: Infiltration and extraction rate, add new wells ● Climatic changes: rainfall, groundwater level, sea level, Temperature ● Sensitivity analysis of the above parameters	adelphi, TUD, UCY
11:15	**Interactive training on Model-based predictions**:	Elaboration of two different scenarios on the platform	Participants work directly on the uploaded model and make changes to the boundary conditions and other input data Groupwork in two groups: one on climate change (geohydological changes) One on societal changes (urban development)	adelphi, TUD, UCY
12:00	**Other possible scenarios which could be of interest**	Which impacts of societal change do you see as relevant for operating MAR? (e.g. availability of treated wastewater for infiltration,	Assessment of possible future scenarios and their implementation in the tool	Moderated by adelphi

		demand of water quantity and quality for agriculture) Which impacts of climate change do you see as relevant for operating MAR? (e.g. changing rainfall pattern)		
12:30	**Discussion and Feedback round**	Feedback questions: What additional features on the platform do you need? Are there specific parameters not addressed yet by the real time monitoring tool you want to monitor? Further feedback	General feedback on the tools and requirement for further tool development	Moderated by adelphi

3.1.6 Replication meeting | 27 November 2020, 11:00-13:00

What to expect: Discuss with the project team in a replication meeting how the SMART-Control monitoring and control approach can be applied at other sites in Cyprus
For who: the Replication meeting is targeted at all aiming to optimize the planning or performance of a MAR site from management and technical level
This included at the Cyprus pilot site:

- NIREAS
- ECoE
- WDD
- Farmer organisation of Paphos

Detailed agenda:

Table 6. Detailed agenda of the replication meeting in Cyprus

Time	Programme	Objectives	Materials and methods	Speaker
11:00	Main benefits of SMART-Control for MAR sites	Participants know the main characteristics of the SMART Control approach and its benefits.	Free speech	TUD
11:10	Open discussion on the replication potential at Akrotiri region with key stakeholders	• (pre)explore the application potential of SMART-Control concept at other sites (= opportunities for further projects) • Strengthening of network with core stakeholders • Elaboration of replication workshop programme Guiding questions: • What are the risks to be mitigated at the site? • What future scenarios are foreseen? • Which kind of sensors are of interest? • What questions should the modelling answer?	Pre-assessment of potential replication sites Miro Template for fact sheet that will be filled with the key stakeholders to capture all the information for the preparation of the technology transfer concept; accessible to all participants	Moderated by adelphi
12:10	Open discussion on the replication potential at Germosia region with key stakeholders			

Time	Programme	Objectives	Materials and methods	Speaker
12:50	Closing speech	Participants received an overview of the key messages of the past training programme	Free speech	UCY

3.2 DETAILED TRAININGS PROGRAMME CONDUCTED IN BRAZIL (DEC 2021)

3.2.1 Public Event | 13 December, 9:30-12:00

What to expect: Get a general introduction to increasing water security with MAR, associated risks and the benefits of the SMART-Control monitoring and control system
For who: the Public Event is targeted at all interested in, affected by or dealing with increasing water security in Brazil from management and technical level
This included at the Brazilian pilot site: adelphi (organisator, 2), interpretor (1), Pernambuco's Water and Climate Agency (APAC), TUD, Federal University of Pernambuco (UFPE), Federal University of Paraíba (UFPB)

Detailed agenda

Table 7. Detailed agenda of the Public Event in Brazil

Time	Programme	Speaker
9:30-9:45 (15 min)	Tuning in and introduction	adelphi
9:45-9:55 (10 min)	Key note	UFPE
9:55-10:20 (25 min)	Introducing MAR and the SMART-Control project	TUD
10:20-10:30 (10 min)	Introduction to the SMART-Control pilot site in Recife	UFPE
10:30-10:40 (10 min)	Introduction to the SMART-Control pilot site in João Pessoa	UFPB
10:40-11:00 20 min	Introduction to the SMART-Control tools	TUD
11:00-11:10 (10 min)	Recent project results at the pilot site in Recife incl risk assessment and groundwater model	UFPE
11:10- 11:20	Recent project results at the pilot site in João Pessoa incl risk assessment	UFPB
11:20-11:30 (10 min)	Upcoming stakeholder interaction in Brazil	adelphi
11:30-12:00 (30 min)	Q&A and feedback session	Moderated by adelphi

3.2.2 Technical Training Session 1: Assessing microbial risks of MAR | December 14, 9:30-11:00

See section 3.1.4
Participants of the technical training session in Brazil: adelphi (organisator), UCY, UFPE, UPFB, APAC

3.2.3 Technical Training Session 2: Developing a Groundwater Model with the INOWAS platform | December 14, 11:30-13:00

See section 3.1.2
Participants of the technical training session in Brazil: adelphi (organisator), UCY, UFPE, UPFB, APAC

3.2.4 Technical Training Session 3: Real-time online monitoring of MAR | December 15, 9:30-11:00

See section 3.1.3
Participants of the technical training session in Brazil: adelphi (organisator), TUD, UCY, UFPE, UPFB, APAC

3.2.5 Technical Training Session 4: Groundwater model-based predictions and running of different scenarios | December 15, 11:30-13:00

See section 3.1.5
Participants of the technical training session in Brazil: adelphi (organisator), UCY, UFPE, UPFB, APAC

3.2.6 Replication meeting | December 16, 9:30-11:00

What to expect: Discuss with the project team in a replication meeting how the SMART-Control monitoring and control approach can be applied at other sites in Brazil
For who: the Replication meeting is targeted at all aiming to optimize the planning or performance of a MAR site from management and technical level
This included for the replication meeting in Brazil: adelphi (organisator), APAC, UFPE, UPFB

Detailed agenda

Table 8. Detailed agenda of the replication meeting in Brazil

Time	Programme	Objectives	Content	Materials and methods	Speaker
9:30-9:45 (15 min)	Tuning in: objectives of the day and expectation management, selection of potential replication sites	• (pre)explore the application potential of SMART-Control concept at other sites (= opportunities for further projects) • Strengthening of network with core stakeholders • Elaboration of replication workshop programme	Guiding questions: • What are the risks to be mitigated at the site? • What future scenarios are foreseen? • Which kind of sensors are of interest? • What questions should the modelling answer?	Free speech	adelphi
9:45-10:15 (30 min)	Open discussion on the replication potential in Pernambuco			Pre-assessment of potential replication sites Miro Template for fact sheet that will be filled with the key stakeholders to capture all the information for the preparation of the technology transfer concept; accessible to all participants	
10:15-10:45 (30 min)	Open discussion on the replication potential in Paraiba				
10:45-11:00 (15 min)	Final feedback round			Open discussion	

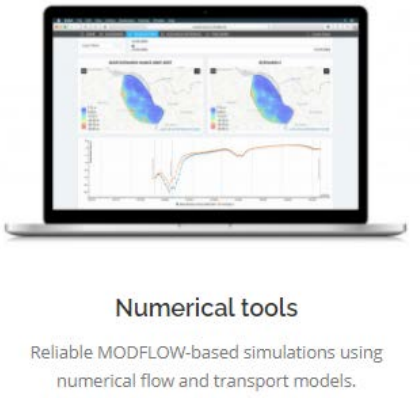
4. SUMMARY OF THE TRAINING IMPRESSIONS AND RESULTS

Figure 4. Online Training Session at the SMART-Control pilot site in Brazil

4.1 OUTCOMES OF TRAINING ACTIVITIES

The pilot training courses with interactive sessions and discussions brought together actors from different Cypriot and Brazilian institutions from science and practice. Among them were in Cyorus the Water Development Department of Cyprus, Cyprus Geological Survey, Water Board of Larnaca, Union of Cypriot Farmers, Cyprus University of Technology and the University of Cyprus (NIREAS International Water Research Center) as well as in Brazil Pernambuco's Water and Climate Agency, the Federal Univeristy of Paraíba and the Federal University of Pernambuco. The training courses provided both management and technical operators with an introduction to real-time data management framed by sessions on the use of selected innovative SMART-Control instruments. The focus laid on the reduction of risks associated with Managed Aquifer Recharge systems (MAR). Among the presented tools were:

- connecting real-time sensors with the INOWAS platform to upload, process and visualize data for real-time monitoring of MAR systems -> Link to Tool 10,
- using temperature measurements to calculate the subsurface travel time as an easy alert system for microbial risk assessment -> Link to Tool 19,
- assessing microbial risks associated with MAR systems -> Link to Tool 15,
- setting up and revising a new numerical groundwater flow model -> Link to Tool 3 and
- analyzing and comparing user-defined model scenarios with each other -> Link to Tool 7.



In discussion rounds, the training participants discussed current water issues such as saltwater intrusion into the groundwater. A possible application of the Groundwater residence time tool in Cyprus was of special interest, which uses temperature measurements to calculate the residence time of the recharged water in the subsurface. In order to make use of this tool, however, an adaptation of the German 50-days rule to the Cypriot conditions would be necessary due to different soil characteristics and climatic conditions. Correctly calibrated, the tool offers a cost-effective and fast method for monitoring microbial risks of MAR systems.

The participation of various institutions from Cyprus and Brazil made it possible to examine the applicability of the SMART-Control tools for different needs. Thanks to various comments and suggestions, the team is able to further improve the online platform in the last remaining year of the SMART-Control project.

The feedback from the training participants revealed a high interest in MAR solutions and improved real-time data management to reduce MAR-associated risks, as well as a need for training and stakeholder engagement in solution development as an important pillar to reduce barriers towards MAR implementation.

4.2 OUTCOMES OF THE REPLICATION MEETING IN CYPRUS AND BRAZIL

Both training courses in Cyprus and Brazil concluded with a replication meeting. Together with key stakeholders two most-promising replication sites in Cyprus and two in Brazil could be identified at which an application of the SMART-Control approach for improved water management seems promising: Akrotiri site and Germasogeia site in Cyprus and the public market of Afogados and Nannai resort in Brazil. With the help of MIRO, a tool to support online collaboration in teams, factsheets were jointly filled for both sides.

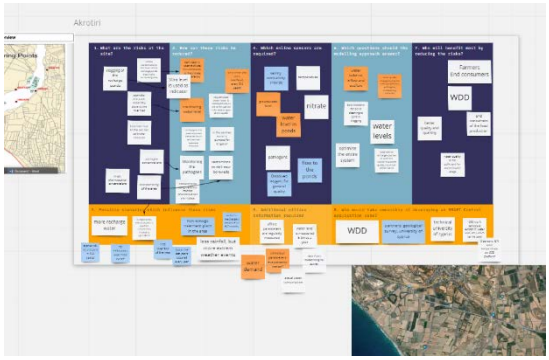


Figure 5. Screenshot of MIRO Board showing collected information during replication meeting

By doing so, the participants focused on the identification of local water-related and MAR-related risks of the current water management systems, risk reduction as well as identification of a suitable set-up and respected beneficiaries of the SMART-Control approach.

The two sites in Cyprus and Brazil, however, differ considerably requiring different transfer approaches: at the Akrotiri region there is already an existing MAR system with an analogue sporadic monitoring system, whereas at the public market of Afogados a MAR system is still in its planning process.

The MIRO Board is still accessible to the public for additions and changes: Link to the factsheets on MIRO for Cyprus and Brazil. Based on the information gathered, the SMART-Control team will develop initial transfer concepts that investigate and identify potential future activities and opportunities at at one selected site each in Cyprus and Brazil. These initial transfer concepts are developed as D7.3 SMART-Control Technology Transfer Concepts, which will be presented and finalised with key stakeholders during replication workshops in the second half of the project (the results of the replication workshops can be found in D7.5 Two replication workshops at transfer sites).

4.3 LESSONS LEARNED

- ✓ Conduct **needs assessment** in advance to specify training content and to understand your audience
- ✓ **Include interactive sessions such as discussion rounds and mentimeter live polls** to visualise the content and help participants to better focus
- ✓ **Regular feedback sessions** helped to further improve and adapt the SMART-Control platform to the needs of MAR stakeholders
- ✓ The best way to learn how to use online tools is to **try them out yourself and apply them to own case studies**; this also helps the developer to discover weaknesses in the platform more quickly
- ✓ **Engaging key stakeholders** through own contributions/presentations increases ownership

5. REFERENCES

Achilleos, M.; Tzoraki, O.; Antunes, M.H.R. (2019). Monitoing of the managed aquifer recharge (MAR) system by treated wastewater reuse in Akrotiri Limassol Cyprus. Conference proceedings: ISMAR 10: International Symposium on Managed Aquifer Recharge. DOI: 10.13140/RG.2.2.26201.16486