WaterJPI project

SMARTControl

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

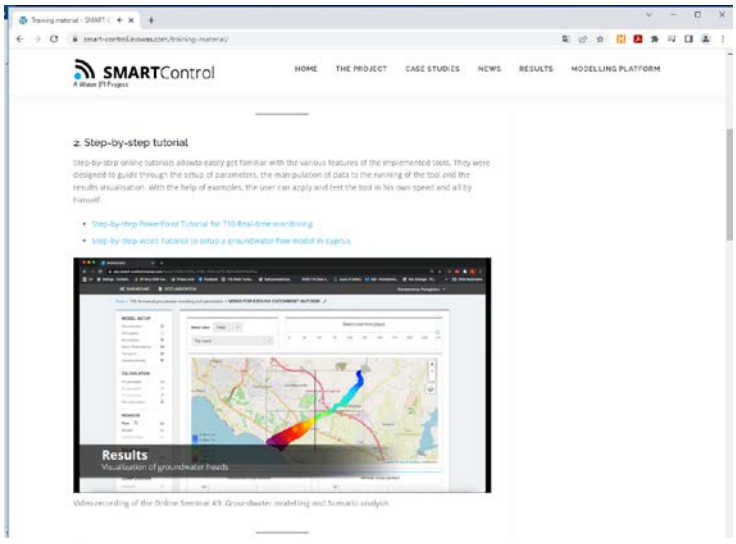
Deliverable 6.1

Online training materials

Overview of developed training approaches to strengthen the dissemination and application of the INOWAS platform

Author

Jana Glass, Technische Universität Dresden



https://www.smart-control.inowas.com

July 2022

Project funded by:

Deliverable 6.1

Online training materials

Overview of developed online training approaches to strengthen the dissemination and application of the INOWAS platform

Short summary

This report summarizes the developed online training material in the frame of the SMART-Control project for the newly developed or improved web-based tools to estimate groundwater residence time, assess the microbial risk as well as groundwater monitoring and modelling of MAR systems in real-time. The online training material comprises online documentations, tutorials and a series of online seminars. This fosters the dissemination and application of the newly developed tools on the web-based INOWAS platform.

Work package	WP6: Training in the use of SMART-Control software
Deliverable number	D6.1
Partner responsible	Technische Universität Dresden, Germany
Deliverable author(s)	Jana Glass (Technische Universität Dresden)
Quality assurance	Catalin Stefan (Technische Universität Dresden)
Planned delivery date	June 2022
Actual delivery date	July 2022
Dissemination level	PU (Public)
Citation	Glass, J. 2022. Online training materials: Overview of developed online training approaches to strengthen the dissemination and application of the INOWAS platform. Deliverable D6.1 of the SMART-Control project.

ABSTRACT

Managed aquifer recharge (MAR) is recognized as a vital solution for sustainable groundwater management. Nevertheless, the lack of detailed real-time data and tools hinders reliable management of MAR systems as risks associated with the recharge processes cannot be managed properly. This often leads to a rather hesitant implementation of MAR despite its far-reaching advantages. Thus, the main objective of the SMART-Control project is to reduce the risks associated to MAR by the development of an innovative web-based real-time monitoring and control system (RCMS) in combination with risk assessment and management tools.

The initial risk assessment tools cover the groundwater residence time tool and the quantitative microbial risk assessment (QMRA) tool. In the groundwater residence time tool the subsurface travel time from the area of recharge to the abstraction point during MAR can be determined using seasonal temperature fluctuations observed in the recharged water and the MAR recovery wells. This parameter is critical in terms of sufficient attenuation of hygienic parameters and other undesired substances. The second tool comprises QMRA, which is recognized as an evidence-based approach to minimize water-related diseases. The tool is based on a probabilistic risk assessment and allows the quantification of pathogen occurrence in source water and their removal by various treatment steps which helps in the risk assessment caused by pathogenic microorganisms.

Real-time monitoring data is essential to assess the in-situ processes and risks occurring during MAR. The web-based real-time monitoring and control tool (T10) collects in-situ site-specific monitoring data and facilitates the operational management of MAR sites. Besides data collection, pre-processing and visualization of time-series data is possible with the developed tool.

To assess the sustainable management of groundwater resources, numerical groundwater flow models are suitable tools. The INOWAS platform was further improved to not only allow the setup and calculation of groundwater models but also the automatic integration of real-time sensors data into the numerical groundwater flow model. This facilitates the update of numerical groundwater flow models with up-to-date data for advanced-scientifically-based decision making.

Besides up-to-date groundwater modelling, scenario analysis serves to evaluate various management options as well as to integrate land use, urban or climate change into the numerical model. The MODFLOW model scenario manager (T07) offers the unique possibility to compare various model runs with each other using distinct results visualization options.

To allow the wide-spread dissemination and application of the aforementioned developed web-based tools, training material has been developed within SMART-Control. The main objective of the training material is to build capacity on the associated risks relevant for MAR facilities as well as the use of the web-based monitoring and modelling platform. The training material demonstrates the new capabilities of the web-based platform. As all training material is available online free of charge, application barriers are reduced and internet learning is facilitated.

CONTENT

Abstract 2
Content 3
Figures 3
Tables 3
1. Introduction 4
1.1 About the SMART-Control project 4
1.2 Aim of the Report 5
2. Online User Guide 6
3. Online Tutorials 8
3.1 Step-by-step Power Point Tutorial 8
3.2 Step-by-step Video Tutorial 9
4. Online Seminars 10
5. Conclusions 12

FIGURES

Figure 1. Example screenshot of the online user guide for tool T10 Real-time monitoring 6
Figure 2. Step-by-step tutorial for the tool T10 Real-time monitoring 8
Figure 3. Screenshot of the step-by-step tutorial on how to setup a groundwater flow model in Cyprus using the INOWAS platform 9
Figure 4. Flyer for the SMART-Control online webinar series 10
Figure 5. Screenshot of the online seminar on initial risk assessment using the INOWAS platform 11

TABLES

Table 1. Short description of simulation tools developed in the SMART-Control project 4
Table 2. Overview of online user guides developed within SMART-Control. 6
Table 3. Summary of the SMART-Control online webinar series. 11
Table 4. Overview of tools and links of the developed and improved training material 12

1. INTRODUCTION

1.1 ABOUT THE SMART-CONTROL PROJECT

"SMART-Control" is an international research project funded through the Water Joint Programming Initiative (WaterJPI) and implemented by nine institutions from Germany, France, Cyprus and Brazil. The main objective of the project is to reduce the risks associated to MAR by the development of an innovative web-based real-time monitoring and control system (RCMS) in combination with risk assessment and management tools. The SMART-Control approach relies on coupling a real-time in-situ observation system consisting of state-of-the-art online sensors and a web-based groundwater monitoring and modelling platform. The resulting system provides operators and managers of MAR schemes with automatic decision support tools for monitoring, controlling and prediction of processes occurring during MAR. The approach was tested and validated at six MAR sites under different environmental and operating conditions. More information about SMART-Control is available on the project website: https://www.smart-control.inowas.com.

The SMART-Control software infrastructure is based on the free groundwater modelling platform developed by the Research Group INOWAS at Technische Universität Dresden, Germany. The platform contains a collection of empirical, analytical and numerical tools for assessing groundwater flow processes with focus on managed aquifer recharge applications (https://www.inowas.com). The INOWAS platform was amended in the SMART-Control project by four additional simulation tools (more info and the complete documentation of the tools is available at: https://www.smart-control.inowas.com/tools).

Table 1. Short description of simulation tools developed in the SMART-Control project

No.	Tool name	Tool description
T1	Initial risk assessment	The tool represents an easy-to-use instrument to evaluate the viability of a MAR project and the preliminary assessment of human health and environmental risks. The tool has two parts: A) a component for the estimation of groundwater hydraulic residence times during subsurface passage (see Deliverable D4.1, http://smart-control.inowas.com/wp-content/uploads/SMART_Control_D4_1.pdf); and b) a component for quantitative microbial risk assessment (QMRA) of MAR schemes, including hazard identification, exposure assessment, dose analysis and risks characterization (see Deliverable D4.3, http://smart-control.inowas.com/wp-content/uploads/SMART_Control_D4_3.pdf). The risk is assessed for selected reference pathogens such as bacterial, protozoan and viral pathogens for different hydraulic residence times during MAR.
T2	Real-time monitoring and control	This tool aims to facilitate the operational management of MAR sites. The tool includes a web-based monitoring system developed for real-time integration of time series data into the INOWAS modelling platform. Sensors installed at MAR facilities worldwide can be connected to the INOWAS platform to transfer collected data in real time. The data can be visualized, processed, downloaded and prepared for further usage (see Deliverable D4.2, http://smart-control.inowas.com/wp-content/uploads/2020/06/SMART_Control_D4_2.pdf).
T3	Automatic groundwater simulations	Real-time observations collected from MAR sites can be integrated into a web-based modelling workflow. The system relies on the existing groundwater modelling capabilities of the INOWAS platform, which were expanded by additional features. The integration of real-time monitoring data into the simulation workflow enables fast response time and optimized management, which helps to minimize and control the associated risks (see Deliverable D4.4, http://smart-control.inowas.com/wp-content/uploads/SMART_Control_D4_4_Real-time-modelling_tool.pdf)

No.	Tool name	Tool description
T4	Predictions for advanced system management	The tool allows building climate change and development scenarios for groundwater flow models to predict future boundary conditions and compare them to the present situation using the INOWAS Scenario Analyser. The tool provides a novel way of using real-time, web-based groundwater models to assess the effects of climate change, urbanisation, land use change (irrigation demand) and population growth on spatial and temporal water availability (see Deliverable 4.5, http://smart-control.inowas.com/wp-content/uploads/SMART_Control_D4_5.pdf).

1.2 AIM OF THE REPORT

This report summarizes the developed online training material within SMART-Control which can be divided into:

- online user guide
- step-by-step tutorials
- online seminars

In combining those three formats, it is guaranteed that interested users can get to know the INOWAS platform including the developed web-based tools and learn how to apply the tools for their own needs. For this, an extra section on the SMART-Control website has been created to allow an overview of all available training material (https://smart-control.inowas.com/training-material/).

In addition to the online training material, training courses at selected demonstration sites have been conducted to wider the user circle of the SMART-Control tools. These are described in the Deliverable D6.2a (http://smart-control.inowas.com/wp-content/uploads/SMART_Control_D6_2a.pdf) and D6.2 (http://smart-control.inowas.com/wp-content/uploads/D6_2_Training_course_CyprusBrazil.pdf).

2. ONLINE USER GUIDE

For the developed tools within the SMART-Control project, online user guides were written to provide background knowledge and an easily accessible full documentation of all tool features (Table 2).

Table 2. Overview of online user guides developed within SMART-Control.

Tool	Tool name	Link to documentation
T10	Real-time monitoring	https://inowas.com/tools/t10-real-time-monitoring/
T15	Quantitative microbial risk assessment	https://inowas.com/tools/t15-quantitative-microbial-risk-assessment/
T19	Groundwater residence time	https://inowas.com/tools/t19-groundwater-residence-time/
T20	Real-time modelling	https://inowas.com/tools/t20-real-time-modelling/

The newly written documentations utilize the existing WordPress installation of the main INOWAS website and were incorporated in the already existing online user guide (Figure 1).

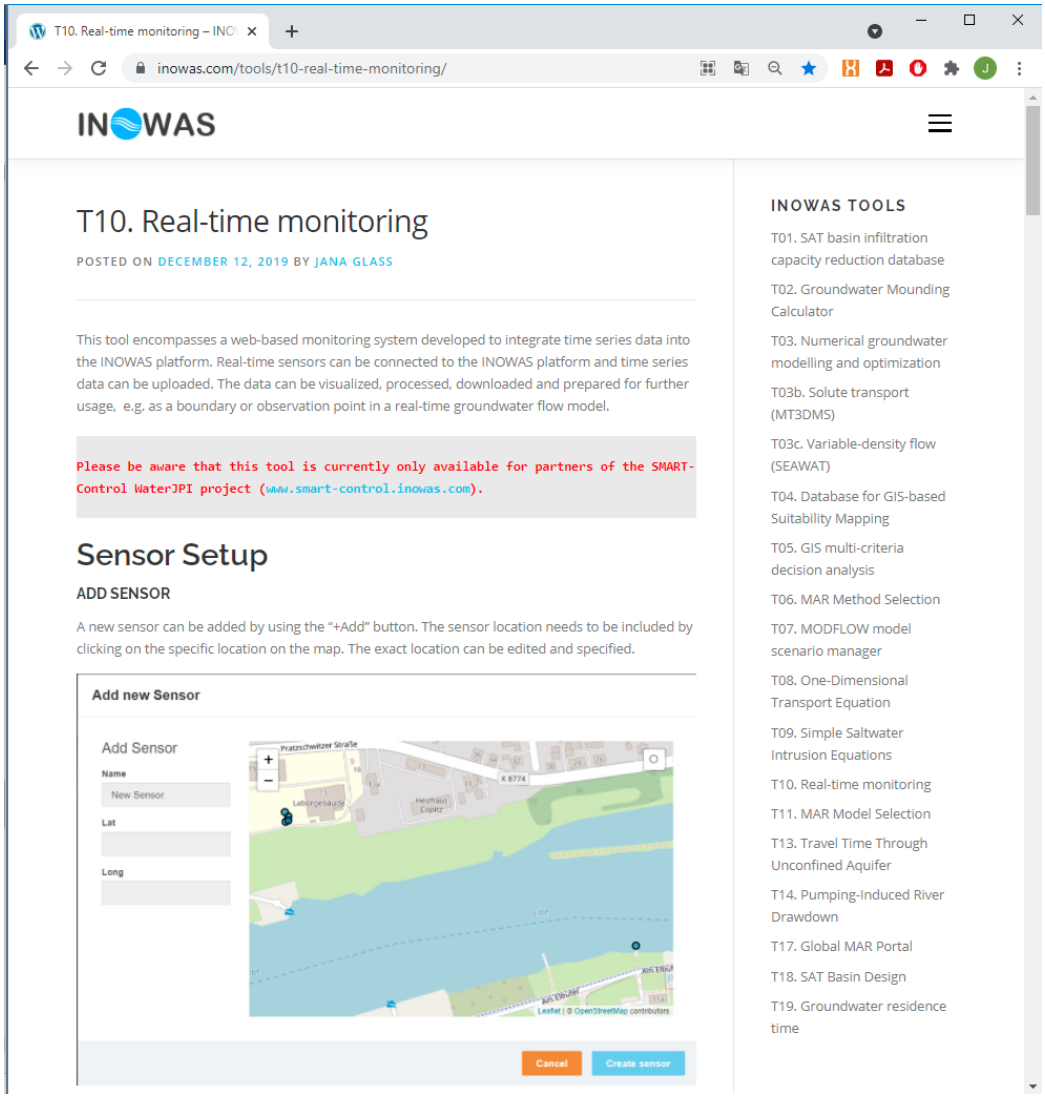


Figure 1. Example screenshot of the online user guide for tool T10 Real-time monitoring

The documentations explain the various features of the tool, show the user how to setup parameters and upload data and explain the theoretical background, if applicable. Screenshots of the INOWAS platform are integrated for an easier understanding.

An online user guide has the advantage that changes in the tool or the addition of new features can be immediately integrated in the documentation and in that way the documentation can be easily kept up-to-date. This is especially relevant for the INOWAS platform, as new features and tools are consistently added to the platform.

3. ONLINE TUTORIALS

Step-by-step online tutorials allow a new user to easily get familiar with the various features of the implemented tools. They were designed to guide a new user through the setup of parameters, the manipulation of data to the running of the tool and the results visualisation. With the help of examples, the users can apply and test the tool in their own speed and all by themselves.

3.1 STEP-BY-STEP POWER POINT TUTORIAL

The first released online tutorial covers the tool T10 Real-time monitoring. The tutorial can be accessed under the following link: https://inowas.com/tutorials/tutorial-5-real-time-monitoring/.

The tutorial guides users to add, manipulate and visualize time series data using tool T10 (Figure 2). For each step, a new PowerPoint slide shows the necessary steps to follow as well as the features of the tool. The user is guided how to setup a new project, add sensors and connect time series data using various data sources. In addition, a csv file is provided to upload temperature time series data into T10.

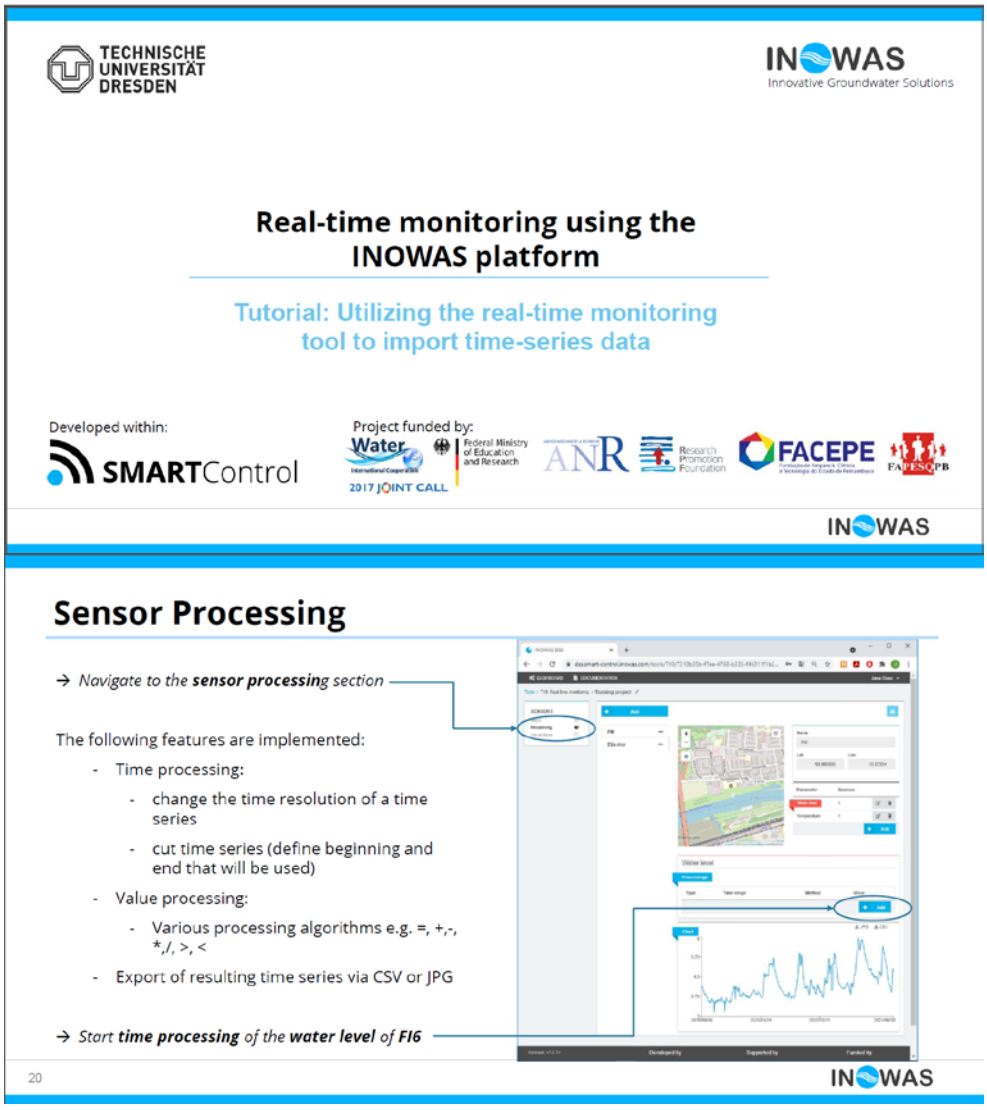


Figure 2. Step-by-step tutorial for the tool T10 Real-time monitoring

3.2 STEP-BY-STEP VIDEO TUTORIAL

A video tutorial has been created by Dr. Konstantinos Panagiotou (University of Cyprus) to guide users through the web-based INOWAS tool "T03 Numerical groundwater modelling and optimization" (Figure 3). The tutorial shows in about an hour how to setup and run a groundwater flow model on the INOWAS platform for the SMART-Control demonstration MAR site in the Ezousa catchment, Cyprus. The video tutorial can be accessed under https://smart-control.inowas.com/training-material/.

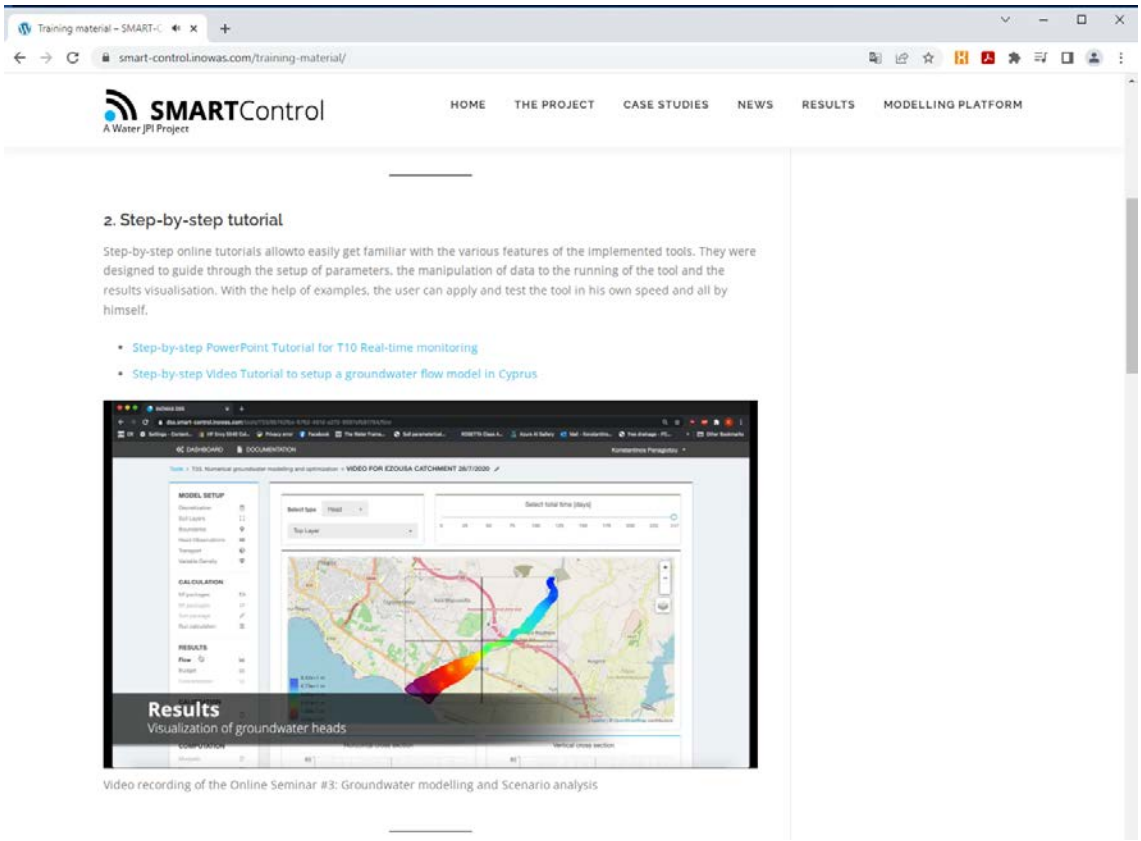


Figure 3. Screenshot of the step-by-step tutorial on how to setup a groundwater flow model in Cyprus using the INOWAS platform

4. ONLINE SEMINARS

In the frame of SMART-Control project, an online seminar series representing the developed web-based tools has been organised. A flyer was created to advertise the seminars (Figure 4). Advertisement was done via the following channels:

- project partners
- project website (SMART-Control, TU Dresden, INOWAS)
- newsletter of IAH-MAR Commission and WaterJPI
- announcement during presentations on conferences previous to the online seminars

Figure 4. Flyer for the SMART-Control online webinar series.

The first online seminar dealt with initial risk assessment at managed aquifer recharge (MAR) facilities. The participants learned how to assess the microbial risk at the MAR facilities using the web-based quantitative microbial risk assessment as well as how to quantify the underground residence time between an infiltration basin and an extraction well based on temperature time series data using the web-based INOWAS platform.

The second seminar was dedicated to real-time monitoring. The participants learned how to connect existing real-time monitoring sensors to the web-based INOWAS platform, how to upload time series data and how to process monitoring data on the INOWAS platform.

The third seminar dealt with groundwater modelling and scenario analysis of MAR schemes using the web-based INOWAS platform. The participants learned how to setup and run a numerical groundwater flow model based on MODFLOW on the web-based INOWAS platform including results evaluation and scenarios analysis.

The video conference platform Zoom Meetings (https://explore.zoom.us/de/products/meetings/) was used for the online seminars. A registration link was created for participants to register which was used to keep track of registrations (Table 3). The most popular online seminar was the third one dealing with groundwater modelling and scenario analysis.

Table 3. Summary of the SMART-Control online webinar series.

No	Title	Covered INOWAS tools	Number of registered participants
1	Initial risk assessment of MAR systems	T15, T19	36
2	Real-time monitoring of MAR systems	T10	29
3	Groundwater modelling and scenario analysis	T03, T07, T20	84

The online seminars took place live and were recorded to make them available later on. The online seminars were uploaded on YouTube and linked on the SMART-Control and INOWAS website for future access for interested users (Figure 5, see https://smart-control.inowas.com/training-material/).

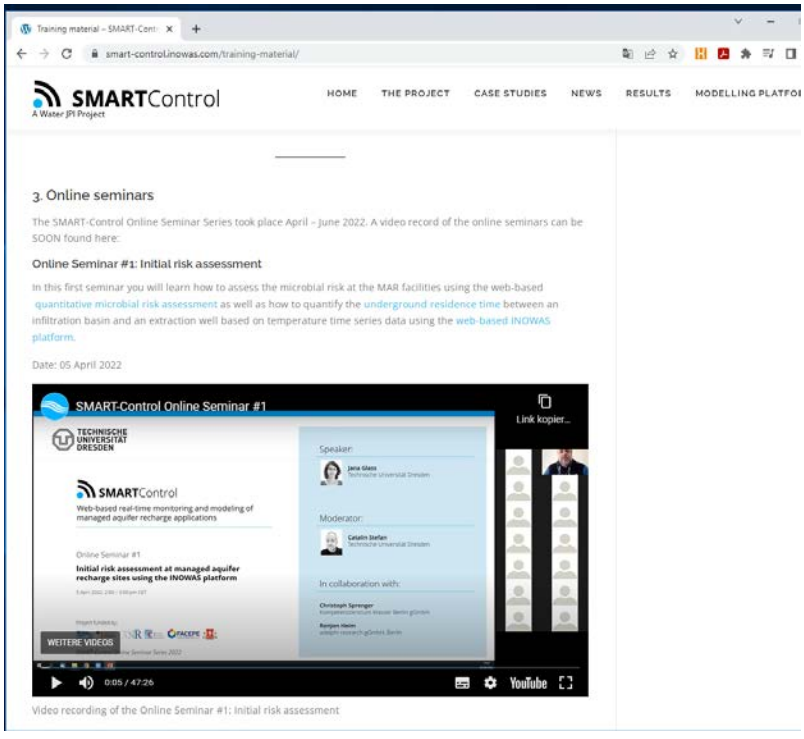


Figure 5. Screenshot of the online seminar on initial risk assessment using the INOWAS platform

5. CONCLUSIONS

A suite of training material was developed within the frame of SMART-Control to allow the widespread use of the improved capabilities of the web-based INOWAS platform. Table 4 gives an overview and provides links for the developed or improved tool.

Table 4. Overview of tools and links of the developed and improved training material

Tool name	Documentation	Online Seminar	Step-by-Step Tutorial
T03. Numerical groundwater modelling and optimization	https://inowas.com/tools/t03-modflow-model-setup-and-editor/	https://youtu.be/9TgP5CCFMzk	https://youtu.be/oTXOzhhrcU8
T07. MODFLOW model scenario manager	https://inowas.com/tools/t07-application-specific-scenarios-analyzer/		
T10 Real-time monitoring	https://inowas.com/tools/t10-real-time-monitoring/	https://youtu.be/lQSKYJmugeg	https://inowas.com/tutorials/tutorial-5-real-time-monitoring/
T15: Quantitative microbial risk assessment	https://inowas.com/tools/t15-quantitative-microbial-risk-assessment/	https://youtu.be/2EviEk5Q2pA	
T19. Groundwater residence time	https://inowas.com/tools/t19-groundwater-residence-time/		
T20: Real-time modelling	https://inowas.com/tools/t20-real-time-modelling/	https://youtu.be/9TgP5CCFMzk	

Some of the training material focuses on self-learning, other training material can also be used in training courses and workshops.

The diverse training materials foster the widespread dissemination and use of the SMART-Control approach. The training material helps to build capacity on the associated risks relevant for MAR facilities as well as the use of the web-based monitoring and modelling platform. As all training material is available online free of charge, application barriers are reduced and internet learning is facilitated.