Summary Report - Workshop on using Water Quality Forecasting in Decision Making

Brussels, Belgium – April 19th, 2018

SPACE-O has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 730005.

Disclaimer

The research leading to these results has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 730005 for the research project SPACE-O (Space Assisted Water Quality Forecasting Platform for Optimized Decision Making in Water Supply Services).

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Background

Performance efficiency in water utilities is usually associated with ensuring good water quality and reliability in providing a continuous supply of safe and clear water. Environmental and financial impacts have often been underestimated. More sustainable and efficient use of energy and chemicals in water treatment is an ongoing challenge, together with intensifying water resources protection and management into sectoral policies. Technological innovation is instrumental in addressing our increasingly complex and multidisciplinary water challenges in a way that ensure sustainability while supporting economic growth. Space technology is part of promoting and supporting innovation by providing environmental information which can be used to improve preparedness and planning by water utilities and other end users.

SPACE-O (http://www.space-o.eu/) aims to integrate state of the art satellite technology for water quality monitoring and advanced hydrologic and water quality modelling using ICT tools for generating real time, short to medium term forecasting of water flows and key water quality parameters (e.g. turbidity, algae) in reservoirs, that in turn will be used to support decision making in water supply services.

Workshop overview

The workshop was organized as part of a consultation process within the development of Space-O technology and methods that are targeted to drinking water treatment plants and reservoir managers. The inputs of potential end users have been crucial to ensure the development of functional and user friendly tools. The purpose of this event was to present SPACE-O prototype products to end users in Europe, allowing for outputs to be tested, shaped and customized against real operational conditions.

The event included presentations of key features and components of SPACE-O's risk-based decision support system (DSS) that aims to enable cost-effective and environmental sustainable operation of Water Treatment Plants (WTP). The DSS integrates Earth Observation data to provide information such as water quality forecasting, in-situ monitoring data and data collected through SCADA (Supervisory control and data acquisition) systems in WTP for operation control.

The workshop included opportunities for discussions and interactive exercises aimed at gathering information on the application and economic viability of the decision support system and its potential benefits for water utilities dealing with algal blooms and turbidity in their surface water sources.

Objectives

1. To learn about SPACE-O and how the outputs can be used;
2. To understand how problems like algal blooming and high turbidity affect operations of water treatment plants and reservoir managers in the provision of drinking water;
3. To identify the economic impact of these problems in utility operations, and investments being undertaken to moderate or mitigate these impacts;
4. To compile information on the potential uses of SPACE-O products (e.g. satellite imagery and forecasting).

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Participants:

Participants represented 12 countries with a total of 27 attendees, including high level management and technical staff in utilities and water management organizations. The participants list is included in Annex II.

Workshop outcome

This report summarises the results obtained from the end-user validation workshop, held on April 19th in Brussels, Belgium. For each session during the workshop (see agenda in Annex I), the key results are briefly described. Next to feedback obtained during the workshop, this report further contains the analysis of feedback questionnaires, filled out by all external participants in the workshop.

Session 2 – Priorities and Challenges

The survey

Before the workshop we asked water utilities from different countries across Europe to help us prepare for today's discussions by filling out a short survey on the impacts of turbidity and algal blooms in your organization with the following questions:

- Do high turbidity/algal blooms affect operations?
- What type of economic impact have the algal blooms and turbidity had on operations?
- What type of investments have been undertaken to reduce or deal with the algal blooms and/or turbidity?

Survey results

We received 16 responses from 9 countries (Albania, Belgium, Italy, Iran, Netherlands, Portugal, Serbia, Spain, Turkey)

Do high turbidity/algal blooms affect operations?

- Yes, increased turbidity/algal blooms affect operations (12x)
- No, increased turbidity/algal blooms do not affect operations (4x)

What type of economic impact have the algal blooms and turbidity had on operations?

- Increased operation/treatment costs (5x)
- Additional treatment investments (2x)
- shut down of plants, ban on water source
- increased monitoring costs
- increased maintenance
- reduced recreational value of water bodies
- reduced operational capacity
- Issues with legal compliance
- Bad odors and flavors due to turbidity
- forced to use trucks instead of supply network

What type of investments have been undertaken to reduce or deal with the algal blooms and/or turbidity?

- Additional treatment steps/techniques (6x)
- Increase in monitoring (2x)
- Investments in environmental restoration measures
- More maintenance

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• finding a new water source and WTP

Feedback from group discussions

After presenting the survey results, the same three questions from this questionnaire were discussed in groups of 4-7 people.

1. **Do high turbidity/algal blooms affect operations?**
   High turbidity and algal blooms are significant challenges to utilities operations, for example, algae affects the operation of filters. One of the main causes of algae blooms is considered to be diffuse pollution from agriculture activities and the enrichment of water recipients with nutrients. As diffuse pollution is variable impacts also vary by region and with seasons. In Albania, algae do not represent an important issue but utilities have to deal with high levels of turbidity that regularly clog filters. In Serbia, an algae bloom event in 2017 led to shutting down operations of a drinking water utility and related water reservoir, which even let to legal persecution of the responsible operators due to temporary contaminated drinking water.

   In other European countries like France or Belgium, cyanobacteria are a problem for taste/odour and require additional processing.

2. **What type of economic impact have the algal blooms and turbidity had on operations?**
   Economic impacts show great variability across seasons and local context. In the Netherlands, Belgium and France the main impacts where on procurement, installation and operation of additional treatment process. Across all participating countries, the need for monitoring and therefore costs for monitoring and analysis increase due to algae bloom treats. In one case in Serbia, an algae bloom lead to a complete collapse of the drinking water provision system for an entire city; with severe economic costs due to compensation of water supply with water trucks and the need to construct a new water treatment plant.

3. **What type of investments have been undertaken to reduce or deal with the algal blooms and/or turbidity?**
   Investments in treatment infrastructure were made, namely carbon filters and ultrasound treatment, as well as additional chemicals dosing. Another form of investments made is the development and revision of Water Safety Plans in consideration of algae bloom and high turbidity events. Switching and blending of different water sources are also among the responses to these problems.

Session 3 - DSS Component: Water Information system

After a presentation and live demonstration of this component of the Space-O portal, participants split into groups of 3 to 7 to engage with this component, guided by an exercise.

<u>Feedback from exercise:</u>
During the exercise participants navigated through the portal, guided by instructions. Members of the consortium were present in each group, recording feedback and helping with questions and providing clarifications where necessary. Overall, the feedback was very positive, with most attendees stressing that this tool is very useful and the functionalities relevant for their work and they would be willing to purchase this tool. Points for improvement are the navigation of tasks, and the colour scale for highlighting the threshold for stratification, which need to be more distinctive.

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Session 4 - DSS Component: Early Warning System

After a presentation and live demonstration of this component of the Space-O portal, participants split into groups of 3 to 7 to engage with this component, guided by an exercise.

Feedback from exercise:
Among the feedback received from participants engaging with this component was the suggestion to include a function that automatically sends notifications for required actions by mail or mobile phone to the operators, so they do not rely on checking the system but receive a message if action is required. Smaller, specific points for improvement were:

- Add existing charts to the dashboard, like in WTPO tool
- It should not be necessary to unfold all parameters
- The map is not necessary for this tool
- Another useful parameter that could be calculated and included in the tool would be residence time of the reservoir.

Further general feedback pointed out that this component is useful for planning ahead and especially planning of operational processes. Potential benefits are not limited to drinking water operation, but also for laboratories to save chemicals.

Most interesting feature:

The ability to measure turbidity in layers, as well as monitoring of real time algae, without any chemical analysis was reported as one of the most interesting features.

Crucial information missing? What else information would you like in addition?

One detail that was reported missing is the possibility to see cyanobacteria and chlorophyll separately. This tool should further include what if scenarios; what happens under different management scenarios. (->*This will be customised for users*).

Session 5 - DSS Component: Optimizing WTPO

After a presentation and live demonstration of this component of the Space-O portal, participants split into groups of 3 to 7 to engage with this component, guided by an exercise.

Feedback from exercise:
One of the participants pointed out that what is missing is the optimum of all parameters combined; currently the tool only displays the optimum for each parameter. Participants from BENELUX countries pointed out that forecasts are not needed for most operations, they only need to know the exact parameter values each morning. For these participants, this specific functionality of the tool is therefore mainly interesting to plan stocks of chemicals, not for operation. On the contrary, for participants from west and southern Europe, the tools was regarded as a great added value for weekly operations. Further, in this tool it should be possible to see the costs for each intake point, not only the currently used one, so that operator can make decision by comparing the costs for getting water from each intake.

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Session 6 - DSS component: The potential uses of SPACE-O products in supporting upstream risk management

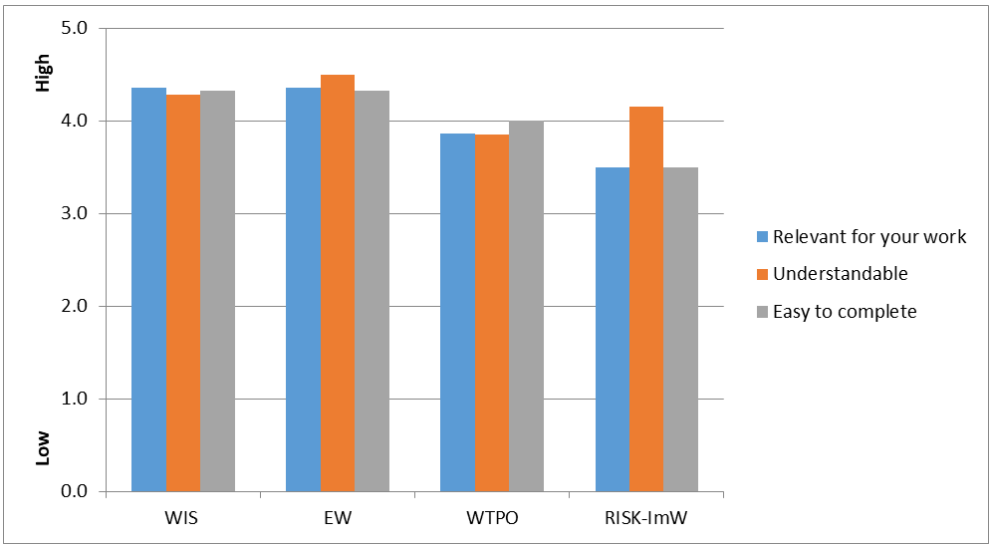
After a presentation and live demonstration of this component of the Space-O portal, participants split into groups of 3 to 7 to engage with this component, guided by an exercise.

Feedback from exercise:
The main feedback received from participants that engaged with this component of the portal was that after arriving at the Risk Matrix, the definition of correct and specific actions is most important and should follow from the hazards risk matrix. The tool was regarded as an added feature to existing risk assessment tools (like WSP) but was not considered as an important component of the DSS system.

Feedback Evaluation Report

After the end of the technical part of the Workshop, an evaluation questionnaire was distributed to the participants who were asked to express their views and add their comments from the demonstration sessions that preceded. The questionnaire was structured in 8 distinct sections with questions for each prototype product of the SPACE-O. Fourteen (14) from the 17 external participants have completed the questionnaire, which were collected and assessed and the main conclusions are presented below.

- In the question on whether the activity given during the testing sessions was relevant to the participants' work, was understandable and easy to complete, all products received very satisfactory average grades above 3.5 in each query. Water Information System and the Early Warning components received the highest score, above 4 in all queries.



Products overall assessment

- In general several suggestions were made to improve the type and level of the information provided, the analysis of results and the way of presenting them. These include:

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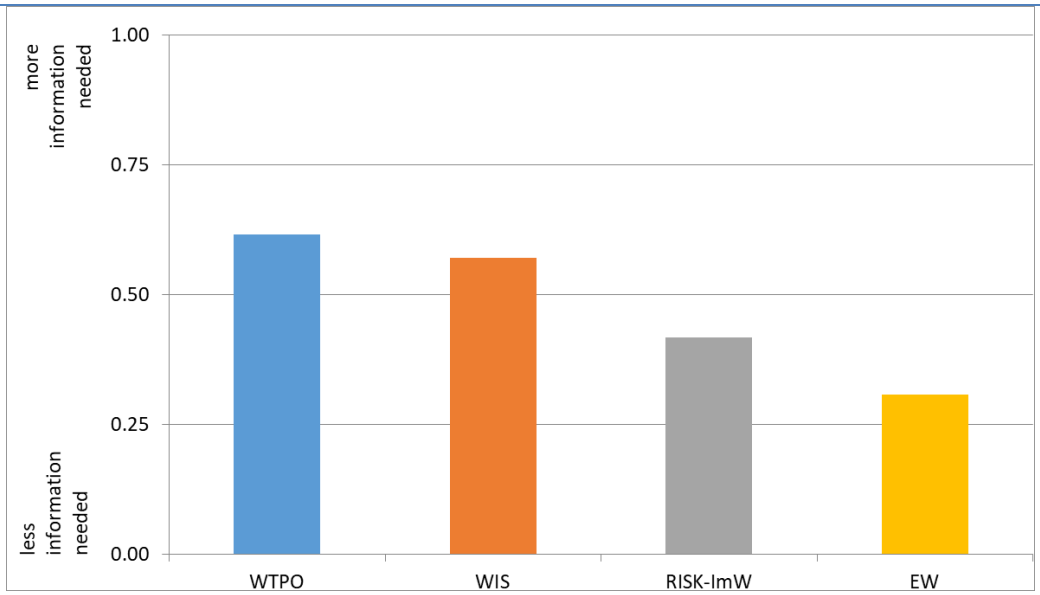

WIS	• Addition of other parameters such as cyanobacteria and correlation of parameters (e.g. organic carbon with turbidity). • Actions needed for customisation of the service to other case studies, and type of open information used. • Presentation of previous forecasts in graphs for comparable purposes. • Inclusion of site images. • Additional hardware information. • How information about operational modes of a small hydro power plant could be taken into account in surface reservoir model.
EW	• Make it more like a dashboard (presentation) with easy to understand "do's" or "don'ts" for the manager operator. • Minimise the need to click to get the information. The useful information should be available at a glance through the colour coding. • Workout the other uses: irrigation, recreation etc.
WTPO	• More customization options and additional information must be added. • The cost should be optimised in relation to other parameters as well, such as TSS and chlorophyll-a. • Should be more clear at which depth the optimum decision is based. • The optimisation does not take into consideration all the parameters that could have an effect in operation.
RISK	• Risk evaluation in the WTP would help overall risk management. • Biological hazards (e.g. invasive species) are not incorporated. • Could be a tool for social control-confidence to the citizen about the water treatment plant.

- The overall assessment of the platform's features received a high score above 4 (on a 1 to 5 scale, 5 - Very easy to use/understand...1 - Not at all easy to use/understand) across different elements in question: a. Display Menu, b. Info boxes, c. Maps, d. Diagrams and e. Overall graphics.

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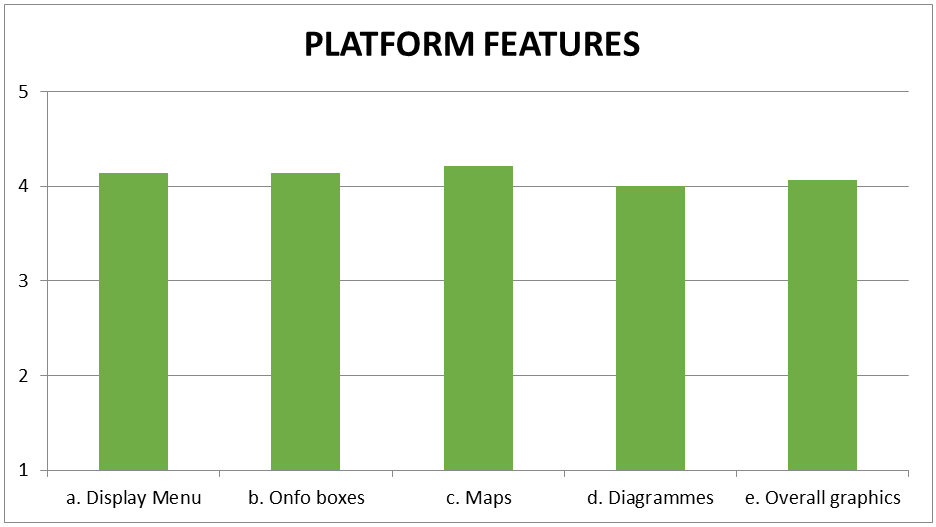

Platform features evaluation

- The different components of SPACE-O were also assessed according to the different functionalities offered and their usefulness based on the participants' views. Group questions were prepared for each component: WIS, EW, WTPO, Risk and ImW (Improve my water) and the usefulness of each functionality was rated at a 5 to 1 scale (5: Very useful…. 1: Not at all useful). The results are presented in the figures below.

  - ✓ All functionalities offered are rated as useful with an average grade over 3.5 and in two cases over 4 (WIS and EW).
  - ✓ WIS was evaluated with the highest score, with forecasting (water quality and hydrological) and EO receiving scores between 4.3 and 4.5 on average.
  - ✓ EW through water quality indicators was also very positively evaluated.
  - ✓ One of the functionalities of WTPO is related to the option of by-pass of the coagulation process and adoption of direct filtration as a treatment process. This option was thoroughly debated during the workshop and revealed the hesitation of some operators to perform this type of process interventions. This justifies the relatively low score received, when compared to other functionalities of the same component.

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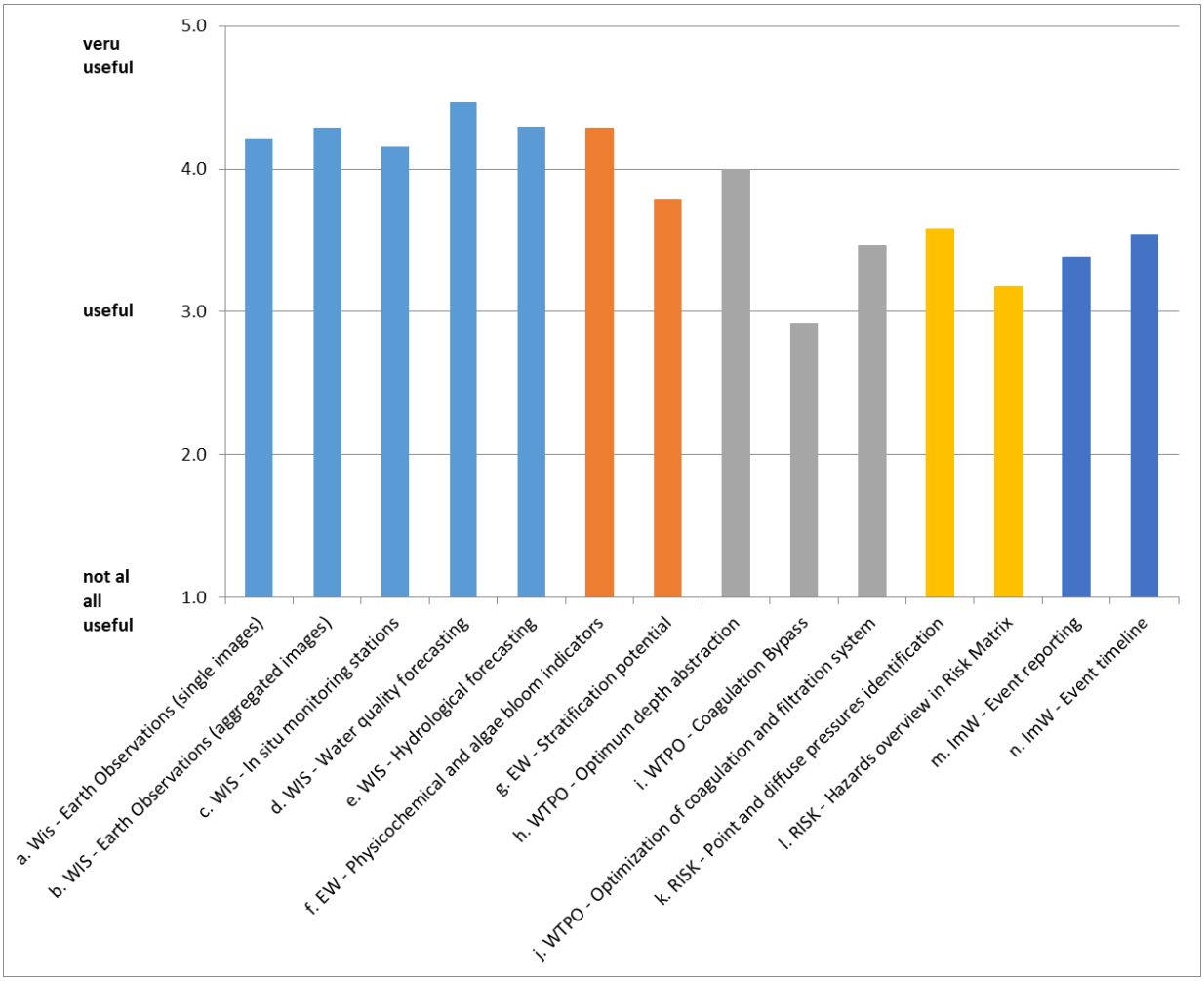

Functionalities' usefulness of SPACE-O components

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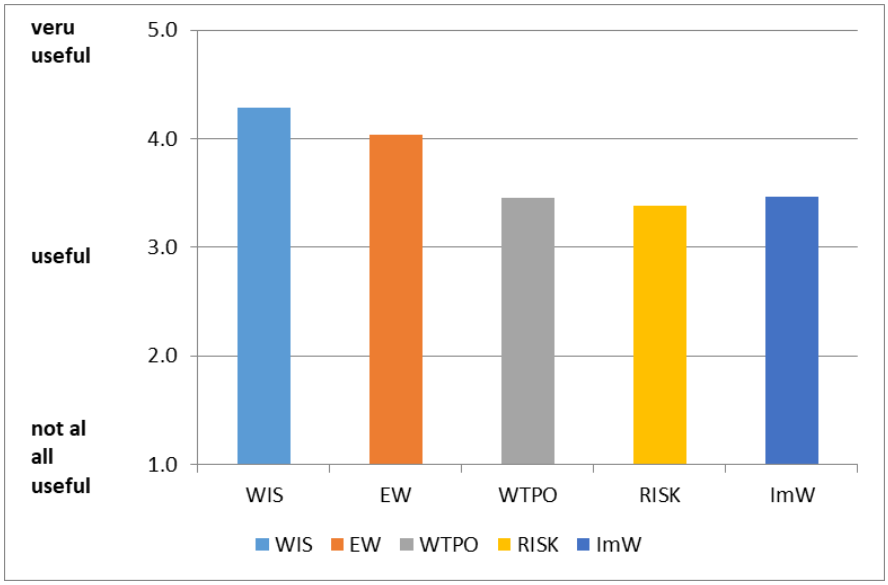
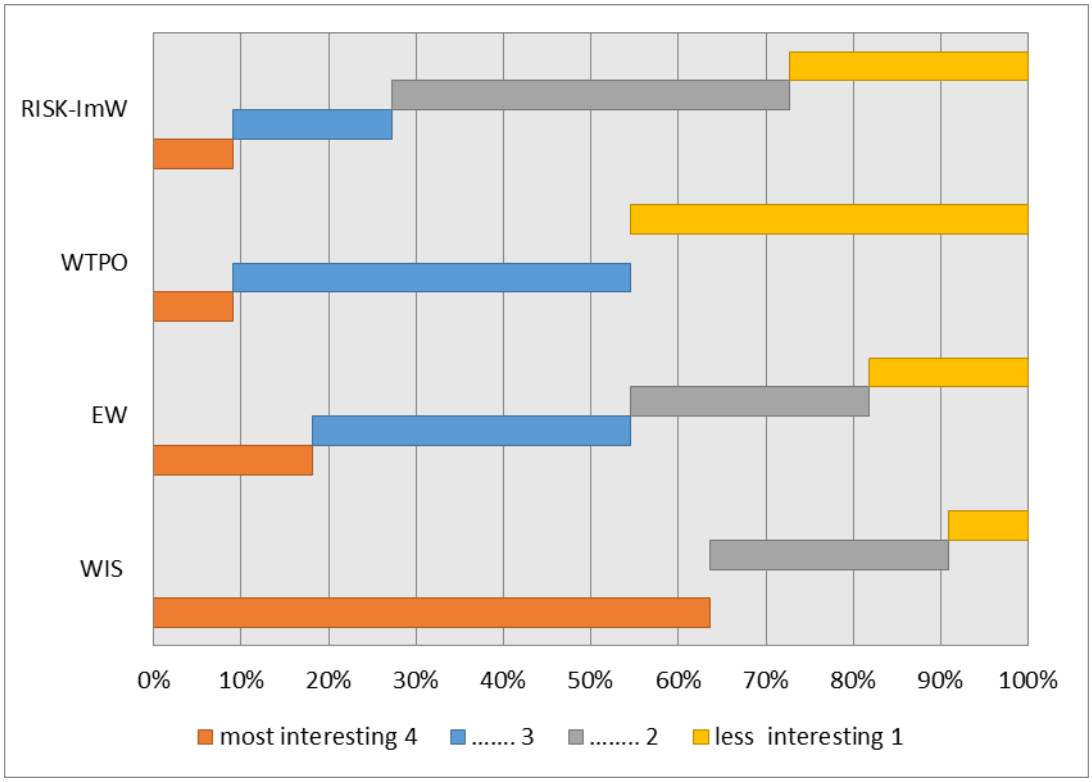


Overall functionalities' usefulness of SPACE-O components

- The comparison of the four SPACE-O platform components revealed the high interest of the participants in all products with the exception of the Risk assessment component that was evaluated as less interesting. This could be attributed to the fact that risk assessments maybe already practiced in many cases with a similar approach. In the evaluation scale of 4 to 1 (4: Most interesting … 1: Less interesting) more than 55% of the participants found the three components very interesting.



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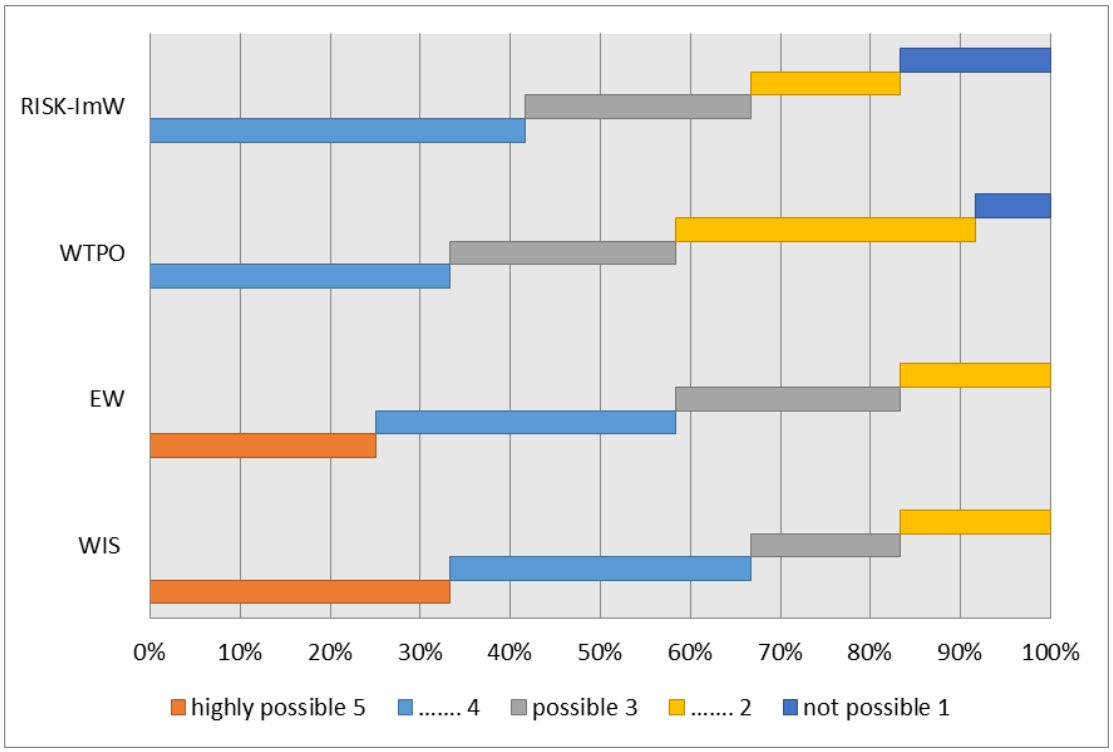
Level of interest of SPACE-O components

- The applicability of the developed tools and willingness of the participants to use them in their everyday workflow was rated at a scale from 5 to 1 (5: Highly possible…. 1: Not possible). Based on the findings of the research almost 60% or more of the participants found it possible to use the tools, while for EW and WIS the possibility to be used exceeded 80%.



Willingness to use the SPACE-O components

- The YES/NO question on willingness to pay was targeting the first reaction of the participants to allocate a portion of their budget to SPACE-O services. The responses were quite satisfactory and indicated that in most cases the participants showed a positive reaction to the products.

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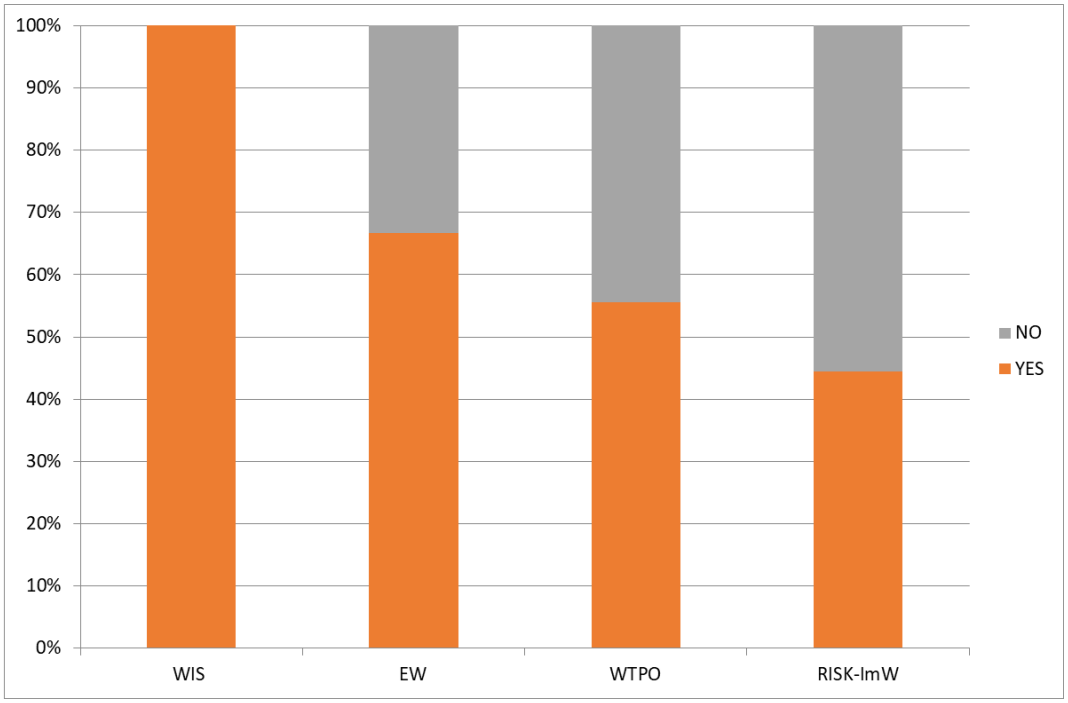

Willingness to pay for SPACE-O services

- Individual comments/suggestions from some of the participants included:
  - ✓ Provide a protocol so that the tools are applied by the consortium.
  - ✓ The software used to forecast water treatment plant performance is very ambitious and interesting, but should be used without any risks from the operator.
  - ✓ Consider to have a test session oriented to different users in order to better address and focus on their needs.
  - ✓ Additional information about modelling was requested, as well as the documentation of the workshop.
  - ✓ Improve interface to become more user friendly.

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ANNEX I Workshop Agenda

Session	Time	Agenda Items
1	09:00-09:30	Welcome and introduction ● Introductions ● Overview of SPACE-O Full operational service line with 10 days forecasts Advanced machine learning techniques ● Workshop objectives ● Structure of workshop
2	**09:30-10:30** 09:30-09:35 09:35-10:15 10:15-10:30	***Priorities and Challenges*** Expected Outputs 1. To understand how problems like algal blooming and high turbidity affect operations of water treatment plants and reservoir managers in the provision of drinking water; 2. To identify the economic impact of these problems in utility operations, and investments being undertaken to moderate or mitigate these impacts *Short presentation of survey results* *Group discussions to share experience guided by the following 3 questions:* 4. Do these "problems" (high turbidity/algal blooms) affect operations? 5. What type of economic impact have the algal blooms and turbidity had on operations? 6. What type of investments have been undertaken to reduce or deal with the algal blooms and/or turbidity? Note – groups will be determined by operation type and will discuss all questions Feedback from each group
	10:30-11:00	Coffee break
3	**11:00-12:00** 11:00-11:20 11:20-12:00	***DSS Component: Environmental Information system*** Expected Outputs: 1. To learn about SPACE-O and how the outputs can be used; 2. Demonstrate functionality of an EIS for utility staff and citizens *Overview of what SPACE-O will provide (how will process EO and model data) - EuroDynamics* 20 mins (5 min overview, 10 min demonstration, 5 min Q&A) *Exercise using environmental information system* - *Follow a set of exercises* - *Discussion questions (e.g. how would you use the information in practice? Who would find it useful and how would they apply it?)* - *Assessment of the Environmental Information System component*

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Session	Time	Agenda Items
4	**12:00-13:00** 12:00-12:20 12:20-13:00	***DSS Component: Early Warning System*** Expected Outputs: 1. To learn about SPACE-O and how the outputs can be used; 2. Demonstrate functionality of an EWS for utility staff and lake managers *Overview of what SPACE-O will provide - EMVIS* 20 mins (5 min overview, 10 min demonstration, 5 min Q&A) *Exercise using early warning system* - *Follow a set by step exercise* *Discussion questions (e.g. what information is useful, what is missing?)* - Assessments of the Early Warning component
	13:00-14:00	LUNCH – Group Picture!
5	**14:00-15:00** 14:00-14:20 14:20 - 15:00	***DSS Component: Optimizing performance in water treatment plants – sharing experiences*** **Expected Outputs:** 1. To learn about SPACE-O and how the outputs can be used 2. Information on how forecasting data can be used to make decision on operations *Overview of what SPACE-O will provide on forecasting and decision support – EMVIS* 20 mins (5 min overview, 10 min demonstration, 5 min Q&A) *Exercise on the use of forecasting in decisions to improve performance* - *Follow a set of exercises* - *Discussion questions (e.g. what forecasting information do you need, how would the information be used to make decisions)* - *Assessment of the Optimizing Performance component*
	15:00-15:30	Coffee break
6	15:30-16:30 15:30-15:50	***DSS component: The potential uses of SPACE-O products in supporting upstream risk management*** Expected Outputs: 1. To learn about SPACE-O and how the outputs can be used 2. Information used and gaps to asses upstream risks 3. Process of responding to risks *Overview of what SPACE-O will provide in supporting upstream risk management – IWA/EMVIS* 20 mins (5 min overview, 10 min demonstration, 5 min Q&A) *Exercise on upstream risk assessment*

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Session	Time	Agenda Items
	15:50-16:30	- *Follow a set of exercises* - *Discussion questions (how do you determine your upstream risks, where do you get information from?)* - *Assessment of the Upstream Risk component*
7	16:30-16:45	Complete survey providing feedback on training
	16:45-17:00	Close and next steps
	17:15-18:15	Networking drinks

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ANNEX II Participants list

Title	First name	Last name	Organization	City	Country
Mr	Suat	Balci	ESKİ Water & Sewerage Administration	Eskisehir	Turkey
Mr	Georgios	Bazdanis	OAK Organisation for the Development of Crete S.A.	Heraklio	Crete
Mr	Mariano	Bresciani	CNR (CONSIGLIO NAZIONALE DELLE RICERCHE)		Italy
Ms.	Loretta	Cabras	ENAS (Ente Acque della Sardegna)	Sardinia	Italy
Ms.	Ana	Camacho	Aguas do Vouga	Albergaria-a-Velha	Portugal
Mr	Ümit	Cantürk	TEKSU Teknolojik Su Kontrol Sistemleri ve Yönetimi A.Ş.	Istanbul	Turkey
Ms.	Maria A.	Dessena	ENAS (Ente Acque della Sardegna)	Sardinia	Italy
Mr	Hanno	Fuhren	IWA	The Hague	The Netherlands
Ms.	Evina	Gavalakis	EMVIS Consultant Engineers S.A.	Athens	Greece
Mr	Alkiviadis	Giannakoulias	EUROPEAN DYNAMICS BELGIUM SA	Brussels	Belgium
Ms.	Arlinda	Gordani	Water Supply and Sewerage Utility of Tirana (UKT sh.a)	Tirana	Albania
Ms.	Claudia	Guerreiro	Aquapor		Portugal
Ms.	Ingrid	Keupers	De Watergroep	Brussel	Belgium
Mr	Lefteris	Kopasis	OAK Organisation for the Development of Crete S.A.	Crete	Greece
Ms.	Carolina	Latorre	IWA	The Hague	The Netherlands
Dr	Gang	Liu	Oasen Drinkwater / TU Delft	Gouda	The Netherlands
Ms.	Patrizia	Ragazzo	VERITAS S.p.a	Venice	Italy
Mr	David	Ribes	Aguas de Alicante		Spain
Mr	Evangelos	Romas	EMVIS Consultant Engineers S.A.	Athens	Greece
Ms.	Karin	Schenk	EOMAP GMBH & CO KG	Munich	Germany
Mr	Aleksandar	Sotic	Belgrade Waterworks and Water Association of Sebia	Belgrade	Serbia
Mr	Emmanuel	Soyeux	Veolia Recherche & Innovation	Chemin de la Digue	France
Mr	Bruno	Tisserand	Veolia Recherche & Innovation	Chemin de la Digue	France
Mr	Apostolis	Tzimas	EMVIS Consultant Engineers S.A.	Athens	Greece
Mr	Andrea	Virdis	ENAS (Ente Acque della Sardegna)	Sardinia	Italy
Mr	Guido	Waajen	Brabantse Delta	Breda	The Netherlands
Ms.	Brunilda	Xhixho	Water Supply and Sewerage Utility of Tirana (UKT sh.a)	Tirana	Albania

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