D4.2 Policy Briefs and Solution Packages for SWS Stakeholders

Participatory Technology Assessment of Subsurface Water Solutions – A Step-by-Step Guide to Stakeholder Involvement

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The SUBSOL project

SUBSOL targets a market breakthrough of Subsurface Water Solutions as robust answers to freshwater resources challenges in coastal areas, by demonstration, market replication, standardization and commercialisation. The route to market includes business cases, market scans and capacity building in selected regions in Europe (Mediterranean, Northwestern Europe) and worldwide (USA, Brazil, China, Vietnam). SUBSOL shares experiences and outcomes with stakeholder groups through an online platform which will be linked to existing networks, including EIP on Water.

The SUBSOL consortium combines knowledge providers, technology SMEs, consultants, and end-users from across Europe. Our ambition is to introduce a new way of thinking in terms of water resources management, promoting the sustainable development of coastal areas worldwide. This will stimulate economic growth and will create market opportunities and jobs for the European industry and SMEs.

Credits and disclaimer

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1. Introduction

Subsurface Water Solutions (SWS) offer a series of solutions to freshwater resources problems in coastal areas by means of advanced groundwater management (pumping, infiltrating, controlling). This enables protection, enlargement and sustainable utilization of fresh water resources. As part of the EU H2020 SUBSOL project the technology was tested in pilot studies in Denmark, The Netherlands, Greece and Mexico.

The pilot studies involved two elements: 1) Practical testing and adjustment of the technology and 2) development of a methodology for stakeholder involvement in a political and societal assessment of the technology to inform decision making and implementation. This document sums up the lessons learnt from the latter in a condensed guide for participatory Technology Assessment (pTA) of Subsurface Water Solutions.

Besides from drawing on the lessons learnt from the SUBSOL project the guide is also based on the extensive experience of the Danish Board of Technology Foundation with participatory Technology Assessment, citizen and stakeholder involvement and political process facilitation.

A pTA is an extremely helpful tool to:

- Inform decisions about which water management solutions to use,
- adjust them to local needs and conditions,
- ensure stakeholder buy-in and cooperation,
- identify and tackle potential conflicts on beforehand and
- ensure that the resulting water management provides efficient and long-term solutions for all users.

This guide introduces the concept of pTA and provides an easy to use step-by-step guide for how to carry it out. It is directed to decision makers, managers, consultants, researchers, private water supply enterprises and anyone else interested in taking the first steps to identify and implement solutions for water management.

As the pilot studies showed, no such tool can be transferred directly from one context to another. Therefore, the model presented in this guide may require adjustments to fit the particular setting, and in some sections we present different variations to choose between. We do, however, strongly recommend that the main idea of substantial stakeholder involvement remains the overarching aim and is reflected in the practical organization of the process. There are multiple reasons to do so, which we will get back to in the following.

Seven steps in pTA

The guide is organized in seven sections, each describing in chronological order the recommended steps to follow:

Identifying the challenge and stakeholders

A. Overview of the challenge
B. Identification of stakeholders
C. Interviews to identify key issues, stakes and responsibilities

The stakeholder workshop

D. The workshop programme
E. Workshop preparation

Analysis and next steps

F. Report and communication
G. Strategy for the further process

In a set of appendixes in the back you will find examples of and suggestions for checklists, interview guides and information material. Appendixes 7-10 are reports from the four pTA processes in Denmark, The Netherlands, Greece and Mexico which are referred to throughout the guide.

Policy briefs

Parallel to the pilot studies, a SUBSOL team analysed a series of potential markets for SWS technologies through desk studies and meetings with authorities, water companies and research units. Policy briefs were made for the sites where SWS technologies were considered particularly suitable: Laizhou Bay in China, Pernambuco in Brazil, Cyprus, Baja California in Mexico and Ho Chi Minh City in Vietnam. These policy briefs are included in Appendix 11.

2. Participatory Technology Assessment – what is it and why do it?

Technologies change our societies and environment – in intended and unintended ways. Technologies designed to solve water issues, for example, can also affect institutional structures, economic activities, social and cultural issues and the surrounding environment. This has at least two important implications: 1) Choosing between technological solutions is an act of politics, and 2) it can be difficult to foresee the full scope of effects from implementing a particular technology.

The concept of *participatory Technology Assessment (pTA)* is a kind of cost-benefit analysis to foresee and assess the positive and negative potential impacts of a given technology. A pTA is not merely an assessment of the technology as a stand-alone object. It is an assessment of the way a particular technology works and has effect in a particular societal and environmental context. A pTA can be used to inform policies, further develop the technologies or be taken into account in their implementation and use.

In its early history, technology assessment tended to be performed by experts. However, as technologies affect our society, everyday lives and environment, and as they often give rise to public debate and conflict, it is increasingly acknowledged that such assessments are not merely a matter of technical expertise. It is also a matter of politics, values and stakes.

In the case of water supply, for example, solutions such as reverse osmosis – a process which transforms salt water to fresh water – is very costly and can, if it is paid by the users, make it very difficult for small-scale farmers to survive. This could potentially change the landscape of farming enterprises and social inequality. Technical experts may be able to assess whether the solution works, but they will not be able to foresee the full effect on local societies.

Taking this into account, a pTA is not performed by experts alone, but also by stakeholders and decision makers. It is based on the notion that those whose lives, activities and values are at stake:

- ought, from a democratic perspective, to have a say in decisions about technology,
- are highly knowledgeable when it comes to foreseeing the potential impacts of the technology in their particular setting,
- can provide valuable input about how to improve, enhance and manage the effect of the technology in a given setting, and
- will, if they are involved in the assessment and their concerns are taken into account, show greater support for the technology, which in turn will enhance its efficiency and positive effect.

pTA in context

A pTA needs to be repeated in every new setting in which Subsurface Water Solutions is considered. The idea of assessing a technology once and for all is appealing. However, the effects are not simply embedded in the technologies, so that a given technology comes with a given set of consequences. The effects are co-produced by technology and the social context in which they are embedded[1]: The same technology can have one set of effects in one context and another if it is implemented elsewhere.

[1] Guston, D.H. and D. Sarewitz. Real-time Technology assessment. In Technology in Society (2002), pp. 93-109.

For example, a pTA in Maneadero in Mexico showed that water is used for irrigation of crops which are exported, mostly to the U.S. A major concern among farmers and officials was that injecting reclaimed water would raise concerns among their main foreign customers for buying their products. Hence, the implementation of subsurface water technologies would require extensive continuous control of the quality of reclaimed water being injected and with the irrigation water in order to ensure that the use of reclaimed water does not affect the export of crops.

In Schinias in Greece, on the other hand, a pTA showed that one of the main issues were about the area being an important archaeological site. A main concern was whether changes of the salinity of the groundwater would affect the archaeological artefacts in the ground, and whether the drilling would make any damage. An eventual implementation of subsurface water technologies in Schinias would require careful cooperation with archaeologists to control the potential effects of the technology on archaeological artifacts.

In this way, the effects of technologies do not depend on the technologies alone, but on the interplay between technologies and context. Accordingly, the technology assessment needs to be contextualised – that is, the implementation of subsurface water technologies requires a new pTA in each new setting where it is considered.

Benefits from pTAs

A pTA can contribute in several ways to a process of handling water management issues. It can:

- Provide information about the current and future water needs of different stakeholders.
- Provide information about the main concerns and possibilities which different stakeholders see in particular solutions to water management issues.
- Provide information about which criteria (for example price, water quality or the effect on the surrounding environment) stakeholders find important when choosing between water management solutions.
- Help identify potential conflicts of interest and open up possibilities to handle them in due time, before they grow to become unmanageable.
- Be used as an informational basis for decision making and increase chances that the final decisions receive broad support.
- Inform the details of the implementation of Subsurface Water Technologies (for example regarding the distribution of costs, the choice of particular sites and the continuous monitoring of water quality).
- Engage different stakeholders (e.g. the water company, different water management authorities, farmers etc.) in the further process of finding and implementing a solution.

3. Step-by-step guide to pTA

Identifying the challenge and stakeholders

In order to perform a proper pTA it is important to put an effort into the initial research. This serves to get a proper idea of the water management issues, engage and account for all stakeholders and make sure that the workshop addresses all issues of concern and importance for stakeholders. This involves developing an overview of the challenge, identifying all stakeholders and performing a series of interviews with key stakeholders.

A. Overview of the challenge

The first task is to develop an overview of the water management issues, the challenges involved in solving them, and the potential role of Subsurface Water Solutions. This is needed when identifying stakeholders, when introducing them to the issue and when planning which information needs to be communicated at the pTA workshop.

Maybe you are already acquainted with the case and can address these questions as a simple desk exercise. If not, a water management technician or the local water management authority or water company may be helpful. Central questions to address could be:

- What are the local water issues?
- What is the current status and what is planned for in the future?
- Which Subsurface Water Solutions would be relevant for the site?
- How would they solve the issues?
- What is the technical basis of recommending Subsurface Water Solutions? (Scoping study, geological assessment etc.)
- Which solutions other than Subsurface Water Solutions have been considered or suggested, and by whom?
- Which other solutions could be considered?
- From a first glance, which technical and non-technical problems/challenges exist? Include political, economic, environmental and societal issues.

Once this initial analysis has been made, next step will be easier to make:

B. Identification of stakeholders

The stakeholders are those who have stakes, directly or indirectly, in the current and future water management solutions. Stakeholders hold important information about which problems the current water management situation creates in households, enterprises and the local environment, how various solutions would address such problems and which new problems might arise from such solutions (for example from the price or water quality), future needs for water supply etc.

Also, bringing stakeholders together to debate will help identifying eventual conflicting interests regarding water management solutions – information which will open up possibilities to tackle such potential conflicts on beforehand rather than once they have grown to be hard to manage. The same counts for those who might be particularly critical about potential solutions: Leaving them out might just intensify the conflict and prevent decision makers from identifying and tackling the problems in due time.

When the broad spectrum of stakeholders is covered and no groups have been overlooked or left out, the resulting pTA will be nuanced and useful and enable decision makers to make decisions which are efficient and receive broad public support.

Identifying and grouping stakeholders

In order to identify the main stakeholders, consider these questions:

- Who are affected by the current water management status?
- Who are potential funders of a solution?
- Who are the primary beneficiaries from implementing Subsurface Water Solutions?
- Who might have contradicting interests?
- Who might be concerned about the effects of Subsurface Water Solutions – on the surrounding environment, on the price or quality of water etc.?

The stakeholder groups can be quite broad – hence it is an advantage to categorize the stakeholders into a general framework of categories. The stakeholders could for example be categorized as listed below, each stakeholder category representing a particular set of stakes:

- Homeowners/local residents
- Farmers
- Local businesses
- Environmental organizations
- Local authorities

The framework will vary from setting to setting. For example, as Marathon in Greece is an important archaeological site, archaeologists are an important group with particular concerns about making subsurface interventions. And as the island Falster in Denmark is an important tourist site, the tourist industry is a distinct stakeholder group with particular interests in the water supply during the high season.

Be aware that a particular category of stakeholders is not necessarily homogeneous in their interests and perspectives. One group might have sub-groups with different interests, each of which need to be represented. For example, the farmers on the Mexican site had different interests depending on whether they were producing edible crops or flowers. Those producing edible crops were particularly concerned about the quality of the irrigation water because of their reputation on the international market while those producing flowers were less concerned. Hence, it would have been problematic to let the flower-producing farmers represent them all.

Also, if a stakeholder group is represented by an association, consider whether the association covers them all or just one part of the group or whether there are internally conflicting interests which a particular representative will not capture. It is generally recommended to include more than one member from the different stakeholder groups.

Not all stakeholder groups are organized. If residents, farmers or local businesses are not organized, make sure to get in touch with those close to the potential location of the Subsurface Water Solutions and those potentially affected by changes in the water table. Be especially aware if some farmers or local business which are not benefitting from the project could be affected negatively.

Interest organizations representing non-monetary interests or values, for example nature, birds and archaeological findings which cannot speak up themselves, are important to include.

Authorities (local, regional, national) are often easier to identify than the other stakeholder groups. The group consists of all authorities in some way involved in fresh water management and in granting permission for a Subsurface Water Solutions project. It is important to figure out how they interact with other authorities and who has the responsibility and resources in relation to which areas. It is also particularly interesting to find out how the other stakeholder groups are usually involved by authorities.

Identifying stakeholders is an ongoing process. Once the first identification exercise has been done it is time to interview the main stakeholders. Make sure to include a question in the interviews about which other stakeholders they find important. This will most likely add new groups to the list.

C. Interviews to identify key issues, stakes and responsibilities

The final step involved in mapping the issues and stakeholders is to interview representatives from all main stakeholder groups. The purpose of the stakeholder interviews is to identify site specific challenges regarding water resources, to understand the history of relationships and conflicts regarding use and management of water seen from the perspective of the different stakeholder groups and to identify the main issues of concern which need to be discussed at the pTA workshop.

Interviews with each group of stakeholders individually are preferred. Experience from all sites show that potential conflicts, administrative hierarchy or informal power structures might provide barriers for good and open discussions if particular groups are interviewed together.

The interviews should be performed in a semi-structured way enabling the interviewer to pursue eventual new relevant issues detected during the interviews (see Appendix 1 for an example).

Main points to identify are:

- Their previous and future use and need of water.
- Challenges regarding present and future water issues.
- Their role in relation to water management.
- Collaboration with other stakeholder groups.
- Previous initiatives or (formal or informal) debate about water management.
- Conflicting interests among different stakeholders.

It is important to see the identified challenge with salt water intrusion and water scarcity as multifaceted including technical, social, environmental as well as political perspectives. Remember to address all these areas. Open questions like ‘are there any other issues which you find important to raise?’ will allow the interviewees to bring in issues which were not foreseen when making the interview guide.

Besides broadening the knowledge base on what the challenge entails, the stakeholders’ impressions can be used to map where awareness raising is crucial and which topics and barriers are most fruitful to focus on when planning the further dialogue process. For example, at Falster stakeholders focused on whether the existing problem of flooding could be solved simultaneously

with Subsurface Water Solutions, and in Schinias several stakeholder groups focused on the authoritative and administrative level which they considered to be the main barrier.

Send out informational material on beforehand

At all sites it has been a challenge to be able to convey the complex issues and Subsurface Water Solutions in a non-technical and non-academic way to the stakeholders with no previous knowledge of the issues. Therefore brief and easily accessible information material provided to stakeholders prior to interviews is very crucial, eventually combined with visualizing material such as a short introductory video. See Appendix 2 for an example of information material.

The four pilot projects demonstrated that it is essential to be very clear about the scope of the project in order to make sure that stakeholders do not get false expectations, for example about how close the final decision is. It is also important to stress that the local society needs to take their share of the initiative and responsibility in introducing such a technology.

Outcomes

The data from the initial overview and interviews should feed into four outcomes:

a. List of potential participants to invite to the pTA workshop:

It should now be possible to develop a list of representatives from all stakeholder groups to invite to the pTA workshop. As mentioned, it is important not to leave anyone out and to consider whether a particular organization or spokesperson represents all perspectives and interests in the stakeholder group or should be supplemented by another representative. Also, make sure to invite enough to allow for a number of cancellations. People who are not stakeholders, but just know much about the subject, can be invited as presenters, and they can also join an eventual panel of experts which people can consult during the event. They should, however, not take directly part in the discussions at the table. The purpose of the workshop is to get stakeholders to engage in dialogue and to get to know their values, needs and concerns. Experts, however, tend to dominate the discussion, because they have a lot to say about the issue, and hence take time from the others. Moreover, they will seldom just provide neutral information – they will also engage actively in the debate with their opinions. Finally, while they are there as experts, people will tend to listen to and consult them rather than form their own opinions. It is an impossible task for table facilitators to manage such discussion properly.

b. Second round of interviews

Mostly the interviewees will mention other organizations or actors or even entire new stakeholder groups which they find important to include, hereunder important people to interview. Hence, once the initial list of stakeholder representatives have been interviewed, a new round of interviews might follow.

b. Stakeholder analysis:

The interviews provide valuable data about the particular perspectives of each stakeholder group. This will feed into the final report which includes an analysis of each stakeholder group: Their interests, current and future water management needs, perspectives and concerns.

c. Identification of issues to be debated at the pTA workshop:

The interviews will help to identify the main issues of concern for stakeholders which should be debated at the workshop. For example, clean groundwater is an important value in Denmark – hence, an important issue on the Falster site showed to be the quality of the water being injected into the ground. This was given particular focus in the interview guide for the discussion rounds. At other sites the distribution of costs between different actors and the way it will affect the price of water is a major concern. The list of issues identified from the interviews should form the basis for a guide for the discussion rounds at the workshop (see 'Guide for table facilitators' under 'E. Workshop preparation').

d. Identification of criteria:

The workshop will involve a voting session where all participants are asked to vote individually about which criteria they find most important when choosing between water management solutions. This could for example be the water quality of the water before it is injected into the ground or the water quality when it is later extracted from the ground. It could be about the effect of the system on the local flora and fauna, the price of the technology or the price of water for individual households and businesses. It is important to include all criteria which showed to be of importance to someone, also if there was no agreement about it.

The stakeholder workshop

The pTA workshop brings representatives from all stakeholder groups together to debate potential solutions to the water supply issues. The workshop serves to:

- Identify and debate the main stakes, values and roles and eventual conflicts of interest
- Assess Subsurface Water Solutions and alternative solutions from different stakeholder perspectives
- Facilitate dialogue between different kinds of stakeholders
- Inform the further political and technical process, for example in order to:
    - Adapt the technology and implementation to the local context
    - Enhance the quality of and general support for the final decisions
    - Tackle conflicts on beforehand
- Engage stakeholders in the further process

As water management can be very technical and difficult to understand by laymen, the first part of the workshop – which should be held in brief – is aimed at equipping the participants with the information they need in order to debate and form an opinion about Subsurface Water Solutions technologies and eventual alternative solutions at hand. The rest of the workshop is then organized as sessions of debate.

The difference between a pTA workshop and a traditional public consultation meeting is that where the latter tends to invite people to debate in plenum, often with no or little structured steering of the discussion, the debates at a pTA workshop are organized in smaller groups with a facilitator at each group and with an agenda for the discussion. This form:

- Gives more time to each participant.
- Ensures that the entire debate is not dominated by a few participants or perspectives.
- Ensures that participants feel safer and are more prone to share their views.
- Results in a more dialogue-based debate, brings out the nuances and makes it more likely that stakeholders with initially conflicting views find some common ground or mutual understanding.
- Gives a more structured discussion and makes sure that all themes of importance are covered.

D. The workshop programme

A workshop will typically take 4-5 hours. In order to make sure that most important perspectives are reflected and debated, it should optimally involve between 20 to 30 participants. Also, each stakeholder group should favourably be represented by two or more representatives.

Note that the programme needs to be adjusted to the particular site, particularly regarding the content: Which particular challenges and issues should be introduced to the participants, who should be invited to present that information, which main issues were identified as important for stakeholders during the interview round etc. For an example of a workshop programme see Appendix 3.

The programme involves an introductory part and a series of discussion rounds:

Introduction

- The main moderator welcomes the participants and introduces them to:
    - The concept of the workshop and why their opinions are important. In Mexico and Greece people were generally unacquainted with the concept of inviting ordinary lay people to debate with experts and authorities on such issues.
    - The role which the outcome of the workshop will play in the further process. Make sure to clear on beforehand with decision makers and technicians whether and in which ways they will take the inputs into account. Participants invest a full day and would appreciate to know whether their opinions make a difference. On the other hand, don't promise too much.
- A local authority presents:
    - The current water management situation: The problems, challenges, initiatives till now and future plans.
- Water management experts (one or more) presents:
    - Potential solutions to the problem – including alternatives to Subsurface Water Solutions.
    - More about Subsurface Water Solutions.
    - Pros and cons for choosing the different solutions.

NOTE: It is important that the crowd is not invited to comment during this introduction. People can have questions for clarification, but it requires a very tight moderator to ensure that they stick to this and don't drift into commenting and debating. In Mexico people were invited to comment which led to a long and engaged discussion which unfortunately was not documented by the facilitators at the tables.

Discussions

Now follows three or four discussion rounds at the tables. Each round focuses on a particular issue which showed during the interview round to be of concern or interest for the stakeholders.

Depending on the issue and the tasks which the groups are given during the discussion (writing recommendations, voting etc.) a discussion can take 20-40 minutes. Remember that there should be time enough for each participant at the table to share their perspectives and debate. A round involves a short introduction to the issue in plenum. Then follow discussions at the tables moderated by the table facilitators which are distributed at the tables. The facilitators follow a guide (see 'Guide for table facilitators' under section E) and make sure that all questions are debated.

Voting about the criteria for a solution: The second or third round ends with a voting about which criteria the participants find most important in considering which solution to choose (e.g. costs, the effect on the environment etc.). See Appendix 10 for an example of such voting. As there might be very different perspectives at the table and the aim is not about reaching consensus, it is important that the votes are individual.

Dedication to roles in the further process: A pTA is normally performed at an early stage in the process where no or few decisions have been made and there are many open ends. Hence, it is important to encourage the different actors to dedicate themselves to the process. In the last round

participants are sitting together with the other members of their own stakeholder group (see 'Organizing the tables' under section E). Each group is asked to debate which role they would be willing to take on in order to support the further progress of deciding on and implementing solutions for the water management. The round ends in plenum where a person from each table introduces their discussions and plans to the rest.

E. Workshop preparation

It is important to have the practical preparation ready a good time in advance. The first step is to find a date and a venue for the workshop and send out invitations with the necessarily information material to the participants. When the participants have registered for the workshop it is possible to book catering, organizing the tables and select and instruct the table facilitators.

Choosing a date

Setting up an ideal time for a workshop is difficult because some stakeholders will attend as part of their job (e.g. authorities, local businesses, interest organizations) while others (e.g. residents, NGOs etc.) attend to represent their private interests or as volunteers for organizations – and while some have odd-schedule jobs (e.g. farmers). Including a question about the timing of the workshop in the initial interviews will ease the task. The event will typically be a weekend day. As it lasts 4-5 hours, it is seldom realistic to expect that people participating as private persons will join after a full day's work.

Venue and catering

The workshop venue should be booked a good time in advance. It should be easily accessible for all participants.

The workshop last 4-5 hours and requires active participants throughout the event – hence, refreshments and lunch is important. See Appendix 4 for a checklist for venue and catering.

Invitations

Speakers should be invited in due time – they have a packed calendar.

Participants should receive invitations 6 weeks before the workshop and again 3 weeks before as a reminder. Deadline for registration should be in due time for the organizers to be able to follow up if particular stakeholder groups are not represented properly – 2 weeks before the workshop for example. Make sure that all stakeholder groups are represented on the final participation list.

The invitation should introduce the water management challenge and, based on the information from the interviews, describe central issues which showed to be of concern for the stakeholders. The invitation should demonstrate the relevance of the issue to all stakeholder perspectives. Also, it is important to clarify how the contributions of the participants will influence the further process.

Some stakeholders have difficulties in seeing their role in such a workshop, often because they don't know anything about the issue. Therefore it is important to explain that their opinions are important because:

- They are knowledgeable about their own current and future water needs and concerns.
- Their interests should be heard in a decision which will affect them.

Finally, the invitation should introduce the participants to the main format of the workshop. That they will be given the information they need in order to discuss things, that they will be discussing in smaller groups with a facilitator to steer the discussion, and that the event includes a free lunch.

Informational material for preparation

Approximately 10 days before the workshop the participants should receive preparation materials and a programme. Close enough for people to have the information fresh in mind, soon enough for people to have time to prepare. The material should be in the local language and targeted at laymen. The preparation material contains:

- Introduction to the main water management problems
- Introduction to the measures currently taken to address the problems
- Introduction to the Subsurface Water Solutions technology
- Introduction to potential implications – environmental, economic, social etc. – of implementing the technology (above-ground constructions, effects on local environment, changes in water prices etc.)
- If available, a map of the potential sites for pilots or implementation

See Appendix 2 for an example of information material.

The information material could include a link to an informational video about what the workshop entails. See for example the video used for the pilot workshops: https://vimeo.com/186188458. The video can be downloaded and is free to use.

Main moderator

The main moderator opens and ends the workshop, is responsible for the ongoing programme and controls the time schedule. Moreover, as mentioned above in the section about the progamme, the moderator must ensure that people do not drift into commenting and debating in plenum. They will have plenty of opportunities to share their perspectives, but it should be done during the discussions at the tables.

The main moderator should be free of interests and political and regulative influence in relation to the particular technology and decision. As a pTA workshop is often a bit difficult to manage because participants can have big stakes and conflicting interests in the issue, the moderator needs to be able to steer the events in a strict and authoritative fashion and optimally have experience in steering such events. Finally, s/he should speak the local language.

Organizing the tables

The groups at each table should involve 5-8 participants. This ensures that different perspectives are present and stimulates debate, but still allows each participant time to talk and ensures that the crowd is small enough for a relaxed and informal discussion.

The mix of participants at the tables is important and should be organized before the workshop. Make two table arrangements:

- During the first two rounds the stakeholders are mixed at the tables in order to ensure that they get to discuss across stakeholder groups.

- The last two rounds they are reorganized to sit together with members of their own stakeholder groups – and, if there are not enough representatives present to fill a table, another stakeholder group, preferably a bit related (e.g. commercial stakeholders like business and farmers together). In this round don't combine groups which have very different interests or groups with very unequal distributions of power, for example residents and authorities, as this will tend to affect the discussion – for example by making residents reluctant to speak.

It is a good idea to place the more experienced table facilitators at tables where there some of the participants are expected to dominate the discussions. It requires a tight and authoritative moderator to create space for more quiet participants at tables with dominant discussants.

Selection of table facilitators

During the dialogue sessions each group will have a facilitator to steer the discussion and take notes. It may sound simple, but it isn't. The role of the facilitator is extremely important, and it is essential for the success of the workshop that the facilitators are properly instructed on beforehand.

As rules of thumb choose facilitators who:

- Do not have strong stakes in the issue themselves, and they should not be authorities or decision makers. It is important that they are able to keep out of the discussion, and that the participants don't feel uncomfortable about sharing views which might not be welcomed by the facilitator.
- Optimally have some social skills, skills in making interviews or skills in steering meetings. This is, however less important, as long as they are properly instructed.
- Speak the local language. Having to debate in a foreign language will be a barrier to many participants.
- Are able to take extensive notes while steering the discussion.
- Are available for instruction on beforehand – on the same day or days before – and for a debriefing just after the event.

The choice of table facilitators also depends on the cultural setting. In Denmark, for example, students can be perfectly able to steer the discussions, while in some countries they might not enjoy the needed authority and respect among all participants.

In the SUBSOL pilot projects the local partners organized the table facilitators. In Falster, Denmark it was employees from DBT, and in Maneadero, Mexico it was scientists from the university.

It is important that each table has a facilitator - hence make sure to get hold of enough facilitators and remember to take account of possible illness or other excuses from facilitators.

Instruction of table facilitators

The facilitation at the tables is core to the success of the workshop. It is the facilitators who should make sure that all perspectives are presented, that all participants get to talk, that all the planned issues are addressed, that the discussions at the tables are constructive and that the discussions are recorded (in writing). It can be challenging task and should not be underestimated – hence, it is important that the facilitators are well instructed on beforehand.

Experience has showed that if the instruction is planned to take place just before the workshop, it tends to either fall out or be heavily reduced because of other practical, often unforeseen issues. Hence, if at all possible, make sure that the instruction takes place on another day. This will also leave time for the facilitators to prepare themselves.

The facilitator has two main tasks: To steer the discussion and to take notes. The facilitator should:

1. **List the rules for dialogue** (see below) in the beginning of the first session. Eventually repeat if needed at some point.
2. Stress that the aim for the participants is to listen to each other's' perspectives and share their own. It is **not an aim to reach agreement** on the subject.
3. **Keep neutral**. The facilitator should not take part in the discussion or share his/her opinion at any point, but stick to the role as facilitator. The aim is not to inform or convince people, but to get to know their perspectives.
4. Ask participants to **debate with each other**, not with the facilitator.
5. **Avoid long talks to share their eventual expertise** in the field. The participants are contributing with their lay knowledge and personal stakes – the facilitator should not take valuable time to 'correct' them with lengthy expert judgments.
6. Keep the group **focused on the task** and make sure that they comply with the time table.
7. Ensure that the participants **treat each other with respect**.
8. Ask people to raise their fingers and **keep track of the order of speakers**.
9. Ensure that **all participants get to talk**. Some participants tend to dominate the discussion, others tend to keep in the background and be reluctant to speak. This can be done by:
    a. **Making rounds**: At the beginning of each new session and new question, and whenever one or few participants dominate the discussion, the facilitator can make a round, inviting each participant in turn around the table to take maximum one minute to share their main points without being interrupted.
    b. **Interrupt** participants who dominate the discussion.
    c. **Invite quiet participants** to talk by addressing particular questions to them.
10. **Be in charge** and not be afraid to stress their authority to steer the discussion.
11. **Take extensive notes**. And as the purpose of the workshop is to identify the perspectives of different stakeholders, it is important that the facilitator remembers to **note down which kind of stakeholder said what**. For example "farmer: needs water for irrigation", "water company: wants state to pay for pipelines" or "local resident: wants investigations regarding eventual consequences for the stability of the dyke". See Appendix 5 for a framework for taking minutes.

The rules of dialogue should be printed on cards which are placed on the tables. For an example of a set of rules for dialogue, see Appendix 6.

Guide for table facilitators

In order to help the facilitators to keep track of all their tasks they can be given a combined programme, interview guide and note sheet so they always know where they are in the programme, which questions they need to ask and can keep track of their notes. See Appendix 5 for an example of such an interview guide. If the facilitators take notes in hand writing, allow plenty

of space under each question for extensive notes. Otherwise let the facilitators take notes on a computer directly in the table.

Opening the workshop

An engagement workshop can be difficult to manage. At some sites some people will have important stakes and eventually be upset, there can be tensions between different stakeholder groups, and it is generally a challenge to get people with very different power distributions, expertise and stakes to engage in a constructive dialogue with each other. Hence, it is important to put a great effort into the details – this will make people safe and trust the table facilitators and will create surplus to manage all the unknowns and dynamics. For example:

- Organize the tables in the required amount of groups. If you have any apologies, make the required changes and remove eventual empty tables before people arrive. Place a number on each table so you can guide people to sit at the right table.
- Arrange a welcome-table at the entrance when people arrive. Make sure the people standing here are not responsible for anything else until everyone has arrived, so they don't have to leave.
- Give all participants a name tag indicating their name and which stakeholder they represent at the event. Also, equip them with information about which table to sit at in the first and last rounds. This could for example be on their name tag.
- Make sure that the table facilitators are placed at each their table and welcome people as they arrive. Get people to sit at the right tables before the workshop starts.

Analysis and next steps

The last steps in the pTA is to make sure that the results are analysed and documented, that they are distributed to the right people, and that they are fed into the further process of decision making and implementation.

F. Report and communication

The report should give decision makers and stakeholders an overview of the needs, concerns, perceived benefits and ideas for solutions represented among the different stakeholders in the community regarding water management and Subsurface Water Solutions technologies. It should enable stakeholders to develop a nuanced view on the issue and feel that their view is represented in the background material for the further process, and it should help decision makers to find the best solution.

The report should draw both on the initial interviews and on the workshop. It should give an overview of the perspectives of different stakeholder groups and list the main needs, concerns and benefits presented during the discussions. Also, it should present the results from the individual votes on which criteria people found most important for the further process. Remember here that some groups may be well represented while other groups may be represented by one or two people. Hence, make visible which stakeholder groups voted what. Finally, the report should account for eventual suggestions for process, solutions and compromises presented during the meeting.

The results from the meeting should be communicated broadly to decision makers, stakeholder groups, technicians in charge of implementing the technology, other experts or researchers etc. The workshop participants should be informed directly. A broader audience can be contacted through the media.

G. Strategy for the further process

The purpose of the pTA is to inform the further process. It can inform decision making, the process, the details in how the project is implemented (e.g. choice of sites, distribution of costs, quality control of water etc.) and provide the basis for handling potential conflicts of interest. Finally, the pTA can help identifying which stakeholders are interested in taking on which roles and responsibilities in the further process to decide on and implement solution for water issues.

4. Want to know more about pTA?

One important lesson learnt from the four pilot studies is that each country has its own history, traditions and values when it comes to democratic practices. For example, Denmark has a long tradition for bringing authorities and ordinary citizens to debate together while the form is rather new in a Greek setting. Hence, it is important to stress that this guide lists some recommendations and presents a model, but that each setting will require its own adjustments.

This guide is tailored to the process of finding solutions for water management issues – with a particular focus on Subsurface Water Solutions. It is based on four pilot projects in Denmark, The Netherlands, Greece and Mexico. However, participatory Technology Assessment is a useful tool anywhere where particular technologies are in some way considered in decision making, no matter whether the decision is about choosing between technologies, regulating existing technology, developing policies for technology development etc. Depending on the particular issue and level of decision making participatory Technology Assessment can be organized as intimate local processes as in this guide, as national processes, as part of a parliamentary process or on an international scale, either over the internet or as parallel and coordinated workshops in different countries.

Participatory Technology Assessment is a broad field, and there are multiple sources of inspiration. To learn more about the more theoretical approaches and debates and methodological differences of Technology Assessment in Europe, broad overviews are given in the anthologies *Policy-Oriented Technology Assessment Across Europe: Expanding Capacities* edited by Klüver, Nielsen and Jørgensen and *Participatory Technology Assessment: European Perspectives* edited by Joss and Bellucci.

As the issues treated in participatory Technology Assessment will often be controversial, it can be a good idea to get an independent actor to facilitate an event. This adds legitimacy to the process and helps create a neutral room for dialogue to ensure that all stakeholders feel that they can talk freely. Furthermore, a professional facilitator will be experienced in handling eventual heated conflicts and make sure that the process contributes to solving the issues of conflict.

5. Appendixes

The following Appendixes are examples of process documents from the four pilot studies in Denmark, The Netherlands, Greece and Mexico. They are adjusted to particular sites and merely serves as examples for inspiration.

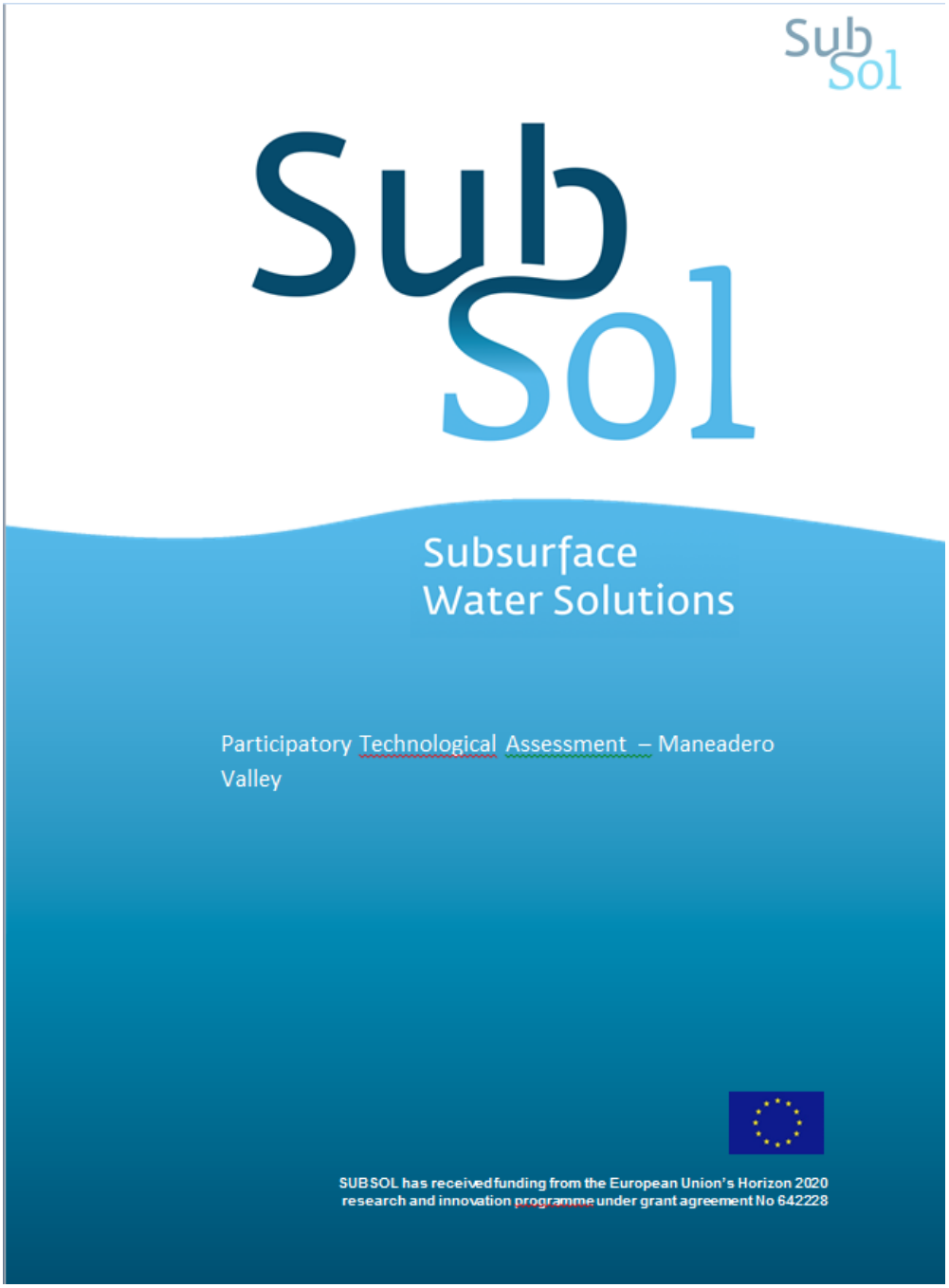
Appendix 1 Interviewguide

Interviewguide used in Maneadero, Mexico. Interview group: Authorities

Subjects to be uncovered in interviews	**Interviewguide used in Maneadero, Mexico. Interview group: Authorities**
Stakeholder role	• What is your area of responsibility in relation to water related issues? • Who do you work/collaborate with in your work? (stakeholders)
Water resources (Supply, standards and responsibility)	• How is the water quality and quality of supply/ier? • Is there a history of issues with water supply or quality? • Has there been any other water related issues? • Have you been engaged in conversations surrounding these subjects? (Formal – hearings etc. or informal - meetings, discussion?) • Have there been any controversies or disagreements about water related issues? • Is there local interest for water related issues (Do local people or organisations discuss or show interest in these issues?) • Which future water issues or challenges do you anticipate? (Which issues do you expect to intensify/become a problem in the future? – Climate change? Socio-economic development?)
The institutional setting	• Can you give us an overview of the regulatory environment in terms of providing permits for projects regarding surface and groundwater? • Who are responsible for regulating which areas? • Which factors play a role in assessment of and approving the project as a whole and the Subsurface Water Solutions technology specifically? (Security of water supply, Water quality, Environmental considerations, Economy (price of water), Increased groundwater levels) • Which business models/economic analyses have been presented to you?
Actors of importance - perceived (Input for stakeholder mapping exercise)	• Who are the main actors of importance in your opinion?

Appendix 2 Information material to interviewees and workshop participants

This information material was sent to the interviewees in Maneadero in Mexico before the interviews in order to allow them to prepare. Similar material should be sent to the participants prior to the workshop – however, make sure here to focus on the specific issues which will be discussed at the workshop.



WATER SCARCITY

According to the World Economic Forum's Global Risk Report 2015, water crises are among the largest global risks with regard to both their likelihood and impact. Already now, four billion people live under severe water scarcity for at least one month per year. Since the world's coastal regions accommodate more than half of the planet's human population, they function as hotspots for economic and productive activities. Their high demand for freshwater exerts enormous pressures on coastal ecosystems. Frequently, this leads to overexploitation of groundwater resources, land subsidence or degradation of wetlands. Predictably, these freshwater management issues will intensify with rising populations, ongoing economic growth and climate change. Solving them is one of the big future challenges.

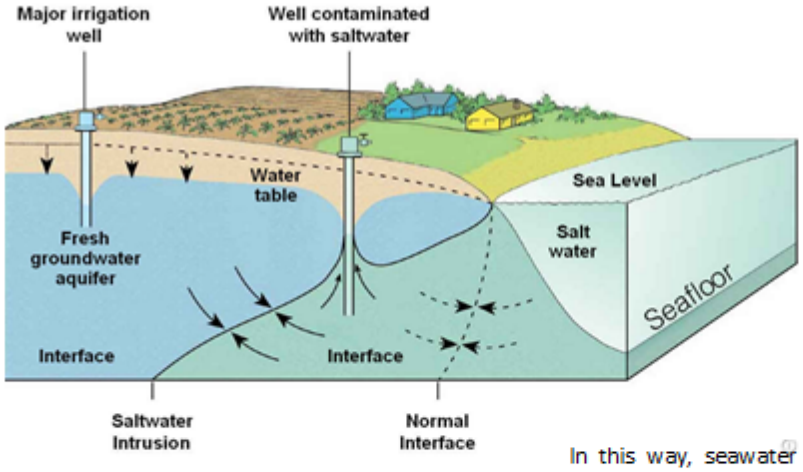


Figure 1: Saltwater intrusion (Studylibe 2015)

Coastal areas are home to a natural transition between freshwater and saltwater. This transition extents underground into a brackish zone where the freshwater and saltwater mix (as shown on Figure 1). The difference in density between the seawater and freshwater prevents that complete mixing occurs. The position of the transition zone is dynamic and is mainly determined by the volume of freshwater in the groundwater layer (often called aquifer).

Human interventions can disrupt this mechanism: an increasing disparity between groundwater withdrawal and recharge, by overexploitation of freshwater, will shrink the freshwater body and facilitates an inland movement of saltwater. This has consequences for the local water supply: wells that were abstracting freshwater at predictable rates until now start tapping into aquifers increasingly intruded by saltwater.

In this way, seawater is pushed away from the fresh groundwater. This flow is however absent in the upper aquifer so that seawater flows inland and mixes with the freshwater resources more easily. High rates of withdrawals, mainly for irrigation in Maneaderos agricultural sector, further facilitate saltwater to enter the upper groundwater layer. As a consequence, freshwater resources are reduced, which puts agricultural production, aquatic ecosystems and tourism at risk.

SUBSURFACE WATER SOLUTIONS AND ALTERNATIVES

Often, responses to water scarcity in coastal areas such as tapping of new well fields further inland only offer short-term relief; they do not address the root cause, namely that too much freshwater is abstracted from the subsurface. Partially, this is because the perception of groundwater as a limited and highly vulnerable resource only slowly gains ground among decision makers and industries. Besides low awareness, poor groundwater management in coastal areas is also a result of absent economic incentives and environmental regulations or a lack of financial means and technological capacities. Additionally, solutions as for instance policies to reduce groundwater withdrawals are seldom promoted. This is because reducing water availability is viewed to have a negative impact on both social and economic activities.

Unsustainable water management often goes hand in hand with the application of technologies that further overstrain ecosystem services (e.g. provision of freshwater) instead of preserving and enhancing them. This may particularly concern large-scale interventions such as water transfers, dam projects or desalination plants.

The lack of adequate solutions to deal with saltwater intrusion has prompted the EU to initiate SUBSOL, a project aimed at further developing, testing and spreading Subsurface Water Solutions (SWS).

SWS are a novel approach combining management and technology to protect, enlarge and utilize fresh groundwater resources (see Figure 2). It is distinguished by new well designs and configurations as well as new management features to precisely control the fresh groundwater resources. SWS are adaptable to changing environmental and socio-economic conditions.

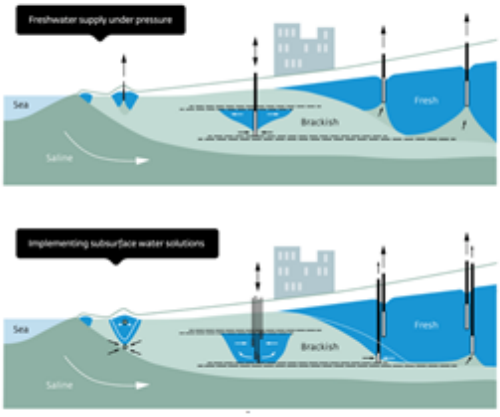


Figure 2: Subsurface Water Solutions

Within SUBSOL, new field testing sites are established to test and demonstrate the benefits of SWS. Maneadero, as one of these locations, will show how freshwater from the lower groundwater layer can be used to prevent saltwater intrusion. In this way, the SWS will help to protect and enhance the local ecosystem while improved access to water supply will enable users, e.g. farmers, to increase their income.

The SWS system tested in Maneodero is called Managed Aquifer Recharge (MAR), which withdraws brackish groundwater from the lower aquifer (see Figure 3).

Subsequently, the abstracted water is treated as well as desalinated in on-site facilities by means of membrane filtration (Reverse Osmosis) and chemical treatment (Advanced Oxidation Processes) before being introduced both to the upper aquifer and the wetland. Thus, the upper aquifer is better protected from saltwater intrusion while the wetland's ecological capacity is restored. The entire system, including the water quality and groundwater level and the performance of the treatment processes, is operated and monitored remotely through novel information and communication technology (ICT).

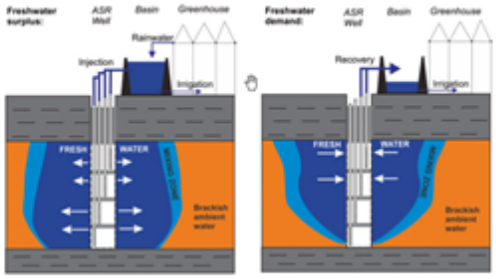


Figure 3: Subsurface Water Solutions

SUBSOL AS A PROJECT

As part of the European Union's Horizon 2020 program for research and innovation, the project SUBSOL seeks to catalyse the market breakthrough of SWS. This will be achieved through a variety of measures, from creation of new pilot sites to testing possibilities and consequences of implementing SWS over knowledge services to market research and promotional activities. The project consortium consists of research institutes, technology providers, consultancies, as well as end-users.

The field testing sites such as Maneadero are set up to assess in which way SWS could function under different hydrogeological and socio-economic framework conditions compared to the existing Dutch reference sites. Project outcomes, decision-making tools and business cases will be used to approach selected target markets, among others in the Mediterranean region, Western Europe, Baja California, as well as overseas markets in the US, Brazil, China and Vietnam.

Here, SUBSOL partners will carry out capacity building and awareness raising interventions to sensitize local stakeholders about water challenges in coastal areas – and discuss the potential of SWS in managing coastal groundwater more sustainably in their region.

STAKEHOLDER DIALOGUE

The best way to solve the challenge of ensuring sufficient freshwater differs from site to site. In the different local settings, distinct opinions prevail about the most important issues and the best solutions to tackle them. For this reason, it is important that the solutions are adjusted to the local setting through dialogue with those who know, live and work in the area. The Danish Board of Technology (DBT), as one partner in the project, aims at ensuring that the solutions support the local wishes regarding the future development of the area.

We will invite the local stakeholders to take an active role in the exploration of the possibilities and consequences potential solutions have, as well as voice their concerns and put forward criteria, which the solution ought to live up to. This will be done through encouraging good and constructive dialogue between stakeholders with different opinions. We will strive for dialogue as open and inclusive as possible, in which everyone with an interest or local knowledge is heard. In practice, this means that we will be in contact with representatives from the different interest groups including residents, local interest organizations, businesses and authorities, both in separate meetings and a joint workshop.

The Danish Board of Technology Foundation is a non-profit organization, which encourages inclusive decision-making through debates about the relation between technology, society and environment. More information at www.tekno.dk

Appendix 3 Workshop programme

This programme was used on the replication site Schinias, Greece. At the time of the workshop, a SUBSOL pilot project was running to test the technology.

9:30-10:00 Short welcome */Aggelos Lenas – President of the Municipal Community of Marathonas.*

Welcome and short presentations of the stakeholder participation agenda and activities of the day */Christos Makropoulos – scientific responsible of NTUA for SUBSOL*

10:00-10:10 Short presentation of the SUBSOL as a project */Christos Makropoulos*

10:10-10:30 Introduction to the challenges of water resources management in Maneadero:

- The underground water resources in Schinias */Theodora Kokla – Director of Water Resources Dept., Decentralised Regional Authority of Attica*
- The mapping of current state of licensed boreholes
- Current management measures /*Nikolaos Chilas – Administrative support Director, Water Resources Dept., Decentralised Regional Authority of Attica*

10.30- 11.15 1st round table discussion (mixed groups): Presentation of participants/stakeholder groups and future water needs:

- Considering the interests you represent as a citizen, business, farmer, NGO or authority, which importance/role does water have?
- What are the current challenges regarding water?
- What do you expect to be the future needs?

11.15-11.30 Presentation of technological solutions for water resources management – Subsurface Water Solutions with Shinias as case.

- Conventional methods – Other solutions available to counter draught and saline intrusion
- The consequence of not doing anything ('business as usual' scenario) (Must be coordinated with the presentation by Mrs. Kokla)
- Subsurface Water Solutions implementation in Schinias
- Project limits- up scaling conditions/ *Andreas Kallioras – Ass. Professor NTUA*

11.30-11.40 Presentation of stakeholder involvement in SUSOL project

- Participation of local stakeholders in SUBSOL so far (catch up from previous meetings during summer)
- Procedure of licensing for the pilot establishment in Schinias
- Benefits derived from the participation procedure/*Andreas Kallioras – Ass. Professor NTUA*

11.40-12.40 2nd round table discussion (mixed groups continued): Solutions

- What do you think about the different potential solutions presented? (Pros and cons.)
- What do you think about the implementation of Subsurface Water Solutions in Schinias?

12.40-13.00 Coffee break

13.00-14.00 3rd round table discussion (unmixed groups): Upscaling and future stakeholder involvement

- The potential of up scaling implementation of Subsurface Water Solution
- What criteria should a Subsurface Water Solutions [upscaling] solution live up to?
- What could be your role in realising a water solution for Schinias and how could you contribute?
- How can your organization contribute towards a realisation of an upscaling/a project that covers local needs
- How can your organization contribute towards a realisation of an upscaling/a project that covers local needs

14.00-14.20 Closing the discussion: Questions /*Christos Makropoulos*

*1*4.20-15.20 Lunch

Appendix 4 Venue and catering

This is a checklist used to prepare venue and catering at the workshop.

- Make sure it is not too far to travel for the participants – this might keep some from showing up.
- The venue should not be too biased by any of the stakeholders – for example the buildings of one of the interested parties. A neutral place to hold a workshop could for example be at a university.
- Consider the options arriving on bike, car and public transportation.
- Make sure that it is possible to arrange the tables and chairs in the required number of groupings.
- Make sure that a projector is available.
- Often the date will be in a weekend. This adds the challenge that often there will be no technician or other people around to help out with problems with internet connection, projector, heating etc. Make sure that there is a person available, either on the site or via a hotline, to help out. Such issues are unexpected, but quite common.
- Consider if you want a venue which offers catering or whether you want to order it from outside.

Checklist for catering:

- The event is intensive, and the participants are required to be active most of the time. They should have access to water, coffee and snacks (e.g. fruit, sweets or bread) the whole day.
- The event takes 4-5 hours – hence, it is important that the participants are offered lunch, either as a break or at the end. Lunch also serves to demonstrate appreciation of the participants' time and efforts and makes people more prone to join if it is included in the programme sent out on beforehand. Remember to ask the participants for allergies in advance.

Appendix 5 Framework for capturing workshop results

This framework was used for capturing workshop results in Schinias, Greece. To ensure that there is space enough for notes, either enlarge each box or let the table facilitators write their notes on a computer.

Table:_____

Please note down as much as possible of the discussions, views, interests and concerns. Indicate which stakeholder said what.
Any of your own reflections and observations on the dialogue could be important.

9.30 - 10.00 Coffee and registration	People arrive and receive nametags
10.00 - 10.10 Introduction of today, programme, background	***People sit in mixed groups***
10.10 – 10.30 The water challenge in Schinias. Presentation: Mrs. Kokla, Director Water directive	
10.30 – 11.15 **First discussion round:** Introduction round and future water needs *Three rounds - one question at a time. The participants answer the question one by one. Thereafter discussion/comments.*	*(Remember in your notes to indicate which stakeholder says what:)* **a) Introduction: who are you and who do you represent? [*Around the table max 2 min. per participant]*** **b) What importance/role does water have in your (the people you "represent") everyday life/business? What are the current challenges regarding water?**

	c) What do you expect to be your future water needs
11.15 – 11.35 Second presentation: Solutions to secure water resources and Subsurface Water Solutions upscaling	Main moderator introduces the presenters and topics, and explains that the next discussion is going to be about pros and cons for different solutions presented, which means that taking notes during the presentations might be useful. a) Water techniques/technology [Andreas] b) What have we done in SUBSOL so far? [Klio]
11.35 – 12.35 Second discussion round: feedback on water solutions and Subsurface Water Solutions upscaling *First they get a couple of minutes to look at their notes on the different solutions, next a general discussion at the table on pros and cons for the different solutions presented. Write pros/cons for each solution on the flip chart.*	*(Remember in your notes to indicate which stakeholder says what:)* **a) What do you think about the different solutions presented? (pros/cons)**
12.35 – 13.00 BREAK	Coffee and fruit The rest of the day, they are seated in the non-mixed groups

13.00 – 14.00 **Third discussion round:** Responsibility, authorities *2 min reflect reflections, select 1-3 criteria.* *They present them to the rest of the table (also note down explanations and reflections).* *The table discusses the choices of criteria, and votes on which criteria are the most important (from the ones selected) – everyone have two votes*	*(Remember in your notes to indicate which stakeholder says what:)* **a) What criteria should an Subsurface Water Solutions [upscaling] solution live up to?** **b) What is your role in realising a water solution for Schinias and how can you contribute?** - What is our own role in an eventual upscaling of Subsurface Water Solutions? - How can you contribute towards a realisation of an upscaling/a project that covers local needs - Who do you think should take lead in starting this process?

	c) Future involvement – How would you like to be a part of the decision-making process in the future? How would you like to contribute to the process?
14.15 – 14.20 Wrap-up and thank you	Head facilitator sums up the day's work.
14.20 – 15.00 Lunch outside	
15.00 – 16.30 **Debriefing**	Go through the programme and evaluate what went well and what didn't. Important observations that needs to be highlighted for the reporting?

Appendix 6 Rules of good dialogue

The table facilitator makes sure the discussions are based on the following rules of good dialogue. The rules is as well printed and placed on the tables.

- Speak out your opinion openly
- Listen to the others
- Don't talk all the time
  Show respect for everyone and don't interrupt
- Keep your comments brief and precise
- Focus on the subject
- Follow the instructions of the facilitator
- Talk to each other, not to the table facilitator- the table facilitator is not a part of the discussion.

Appendix 7 Workshop report from Falster, Denmark

Prior to the workshop, interviews were conducted with the main stakeholders. The interview focused on five main points. “Connection to site”, “Current/historical issues regarding water”, History of controversies/mapping of informal power-structure”,” Concerns regarding the project” and “prioritization”.

Landindviningslauget Bøtø Nor/land Reclamation society Bøtø Nor: are in charge of draining the area through the drainage canal “Nordcanalen”. In the current situation, some wells have been closed due to saltwater intrusion, but this was at the opposite coast. The municipality focus on environmental protection, this means, that water cannot reach pumps due to overgrown canals. The landindviningslauget had some concerns regarding the project, the concerns were mostly focused on the quality of the water, both the ground water and the water pumped down to the ground water. Many concerns regarding the water pumped down, was centered around the question of, why the farmers need to be careful not to pollute, when the suggestion is to let drainage water down? The representative from Landinvingslauget was the chairman of the organization, he said he would vote “not” to the project as a matter of caution.

Farmer

The local farmer has provided land for excess water in case of flooding. The farmer thinks, that there is a lack of respect for the water resource, primarily from the summerhouse area. The water in the Sydkanal is now clean enough for irrigation, but not clean enough to be injected in the groundwater. Previously the used to be more polluted and removing vegetation was not an issue, as it was unable to grow in the polluted water. Today the water quality is higher and the vegetation can grow. Another issue raised by the farmer is, when flooding there is overflow of sewage water at the treatment plant, this can pollute the water. The farmer had only one concern regarding the project. Will it be possible to inject all the excessive water, when there is flood?

Gedser bird watching station:

Falster is an important breeding place for birds. Good quality surface water is important for birds. When water levels drop in wetlands, geese and cranes gets vulnerable to fox attacks. The concerns regarding the project centers around the salt concentration in the area (especially wetlands), and the whether the activities will harm the birds.

Dike Guild of Falster

The high ground water levels cause flood. The dikes play a central role to protect against flooding, but they are not strong enough as they are “cut through” at Marielyst. There are some controversies between the residents, (farmers and homeowners) and the tourists and business organizations. The tourists and business organizations can move in case of flooding, where the residents are bound. Not everyone is happy with the dikes, they take away the view. There have been some critiques of the land reclamation society, who have been accused of not draining the area probably, however, the Dike Guild explains, that many factors affect flooding, and there for the accusations are not fair. The Dike Guild is primarily concerned with the effect on ground water, risk of flooding if the project raise the groundwater levels and whether the dikes will become unstable if water levels increase.

Tourist- and business association

Currently there are two issues:

1) Summerhouse owners have problems with flooding,
2) Drinking water is taken for granted.

There are a few controversies, the tourists would like to be able to bike on the dike, but this is not allowed as the only dike in Europe. The tourist- and business association does not have any concerns regarding the project, but thinks it will be a good idea to use surface water for injections, however water prices and quality are important for tourists.

Utility company of Guldborgsund

The utility company are responsible for water supply, waste water and district heating. Rainwater can in times of flooding be lead into the sewers, this can potentially make vacuum toilets stop. In case of overflow the treatment, plant leads the contaminated water in to the canal. One of the problems is a lack of draining pipes at homeowners, it is the homeowner's association who is responsible for these pipes. Many homeowners are not aware of whether there are drainage pipes from their home. The utility company thinks the water from the treatment plant should be cleaned further, before injecting it to the groundwater. Saltwater intrusion has been a problem, but so far other wells have been available.

Homeowners association

Homeowners experiences large problems with floods, especially in 2007-2011 the floods destroyed houses. Floods causes the vacuum toilets to stop working, and the initiative to dry wells, does not help when the water levels reach a certain level. A storm in 1872 is still a subject for discussion, the storm caused many lives and is part of the reason, why there is a great focus on maintaining the dikes. Generally, there is a good dialogue between the stakeholders, but who should pay to solve the surface water issue? Another issue is in the Bøtø Nor land reclamation society, which are in charge of all draining. their voting system is old and, based on the amount of owned land. In praxis, this means that the board have the same number of votes as the 6500 summerhouses, and the summerhouses may not be able to do anything to change this issue. There is also a conflict with the Digelaug, which holds great economic interest, but it is difficult to get in to the board, and chairman position have been held by the same family for three generations. The tourists and homeowners would like to use the dikes for biking, but this is currently not legal. The homeowner's association focus mainly on the quality of the water and the risk of flooding, but are also concerned that as some houses are not connected to sewer system, waste water could end up in the Nord canal.

What did we learn from the Interview?

- Good water quality is the most important criteria
- Economy is the least important factor
- Flooding is a major problem/threat
- Summerhouse area are accused of taken drinking water for granted

- There are a few controversies
- Old or unfair voting system in Bøtø Nor land reclamation society and the Dike guild

Prioritizing

At the end of each interview, the workshop participants, was asked to rank the following five subject, after what was most important regarding the project.

- Environmental consideration
- Water quality
- Security against flooding
- Security of supply
- Economy

TABLE 1: SHOWS THE PRIORITIZATION IN THE RANKED ORDER, AND THE NUMBER OF VOTES ON EACH NUMBER.

Ranked	Subject	First	Second	Third	Fourth	Fifth
1	Water quality	3	2	0	1	0
2	Environmental consideration	1	4	0	0	1
3	Security against flooding	1	0	3	2	0
3	Security of supply	1	0	3	2	0
5	Economy	0	0	0	1	5

Water quality was a clear winner in the votes, with three stakeholders setting it as the best. Environmental consideration was a clear second with one vote as most important and four votes as the second most important. Security against flooding and security of supply shared the third place with the same distribution of votes. Economy was a clear fifth place, and the only criteria that did not score any first, second or third places. At the workshop the participants voted for prioritization again.

The workshop

Thursday the 12th May 2016 from 12.30-16:00 at the town hall in Guldborgsund municipality, Nykoebing Falster. Invited the Danish board of Technology the local stakeholders on Falster to a workshop, to discuss the current and future water supply on Falster.

The Workshop is part of the EU project SUBSOL. The project aims at investigating and testing new technologies for protection of saltwater intrusion from the ocean. In that context, several test sites have been select, with different subsurface – Dinterloord in Netherland, Schinias in Greece, Maneadero in Mexico and Falster in Denmark. In Falster, the subsurface have a large concentration of calcium carbonate, also known as chalk.

The SUBSOL technologies are different, from the common technologies used in Denmark. Therefore, it is essential to articulate and evaluate the pros, cons, opportunities and risks in the

local area, where there is a desire to test the technologies – not just among the technicians but also the local actors that knows the area.

GEUS (GEOLOGICAL SURVEY OF DENMARK AND GREENLAND) are currently preparing for tests at and around the Marielyst waterworks drillings. As part of the project, water will be pumped down in the subsurface, investigating the impact on water levels and draining and area affected is part of the project. The goal of the workshop was together with the local stakeholders, to set demands and wishes for the results of the project, as well as discuss how to secure the water supply on Falster in the future.

At the workshop the participants was placed at three different tables. The goal of this arrangement was to get as many different views as possible.

Programme

12.30 – 13.00	Welcome and lunch
13.00 – 13.40	Introduction of the day, program and background (Søren Gram, DBT) - The water supply challenge on Falster Insight in the current water situation (Claus Clausen, water supply Falster) The possible consequences of saltwater intrusion now and in the future (Klaus Hinsby, GEUS)
13.40 – 14.00	Table discussion Presentation round - Name, who do you represent? Why are you here today? - What precaution do you find most important relative to saltwater intrusion and securing the water resource? - Why is it important for you and those you represent? Common discussion of the points from the tables. -
14.00 – 14.10	Presentation of current solution on saltwater intrusion.
14.10 – 14.30	Table discussion - Pros and cons with the current solutions and what solutions are relevant on Falster, now and in the future? - Each table presents their results to the other tables, tell one important point from your discussion.
14:30 – 14.45	Cake break
14.45 – 15.00	Presentation of SUBSOL solutions, that can be used on Falster, (Klaus Hinsby GEUS)
15.00 – 15.40	Table discussion, what criteria should the SUBSOL solution meet, to be a good alternative to the current solutions? - Individual: write criteria on a post-it note (one criteria on each) and present them afterwards for the table Common discussion

- Agree on the five most important criteria
- Present the five criteria for the other tables

15.40 – 15.55 Future involvement, discussion in new groups
- How would you like to be informed in the future?
- What information would you like?
- How, how much and how often would you like to be involved?
- .

15.55 – 16.00 Groups present their results
- One from each group briefly sums up the discussion.

16.00 Thanks for today

Resume

The workshop was a combination of presentations and round table discussions. In total four discussion was arranged:

1) What are the main concerns regarding the future evolution of protection against saltwater intrusion and securing the water resources?
2) Pros and cons on different SUBSOL solutions?
3) What are the most important criterions for the SUBSOL solutions?
4) Future involvement

What are the main concerns regarding the future evolution regarding protection against saltwater intrusion and securing the water resources?

Prior to the discussion Søren Gram from DBT gave a short introduction to the day, and the SUBSOL project. Søren talked about the goal of the day, was to make a list of demands for the tests GEUS, are about to make at the Marielyst waterworks. What solutions is the best on saltwater intrusion in this area, this decision is not solely based on technical recommendations, but also on political prioritizations – that is also the reason the local stakeholders should be involved.

Claus Clausen from Marielyst waterwork then gave a overview of the current situation. In the the past 10 years, the waterwork, have had to close or move three of 12 drillings.

Klaus Hinsby from GEUS explained in detail, what saltwater intrusion is, and what thread it poses for the water supply in the future.

After the presentations, it was time for the round table discussion.

All three tables focused on protection of the groundwater, securing good water quality and water quantity (water supply) to secure the residents and tourists in the area. The good water quality was described as a Danish brand, and therefore very important to protect for the residents as well as the tourists. Falster should remain a tourist attraction.
Furthermore, the three tables emphasized the currently high water levels in the area, and the

necessity of draining. The technology should focus on the increase in water level or influence the draining to secure the residents, golf court and fields from flooding. The economical aspect, was either not addressed or only a small part in the discussion.

Other discussions

- How will an increase in the water levels, in specific times a year, in the draining canal influence the problem?
- Whether up pumping groundwater at Bøtø Nor Reservatet is a good idea?
- To what extent the canal should be viewed as a technical facility or should be seen as part of the nature. Some thought, there should be a balance between the two: That the canals main function should be draining, but the water quality should be good enough to secure the animals and nature. Other did not think that nature and draining could be combined in the design of the canal.
- Whether water from Nordkanal is clean enough to use in the project

Pros and cons on different SUBSOL solutions?

Klaus Hinsby from GEUS, went through the different current solutions against saltwater intrusion, that exists around the world. Among the solution was for instance moving drills and cut the water consumption. Here after the tables discussed what solutions are relevant and what are the cons and pros on these solutions.

Discussion current solutions:

1) Moving the drilling for a safer location for extraction: Some agreed, that this solution works on short term, others thought the solution was to expensive. There was a wide agreement, that on the long run, other solutions should be considered.
2) Consume less water: the tourist areas and summer cottage uses a lot of water, some have a swimming pool and the Bøtø Nor sanctuary uses groundwater as well. It was suggested to use price regulation in order to cut the water consumption, establish rain water basins, pump water in winter and store in basins to summer use and last to use a two-string bathroom system, so that the toilets do not use clean water.
3) Cooperation/merge: There should be a coordinated extraction/intelligent control between the water works. There should be a more holistic approach regarding the water on Falster – so the regulation of draining of natural resorts and wetlands are not regulated different places.
4) Increase in water levels in draining canal/include surface water: Can the problem be solved by increasing the water levels in the north and south canal – What will be the consequences?
5) Move: Suggestion to buy the vulnerable areas from the farmers.

What are <u>NOT</u> solutions for Falster

- Continue to move drillings.
- To pump wastewater/polluted water down to the groundwater
- To compromise the dikes foundation or function

SUBSOL solutions

Klaus Hinsby the gave a short technical overview of the technologies offered by SUBSOL, and what solution could be relevant for Falster. Afterwards these solutions were discussed, what conditions should the SUBSOL solutions meet, for them to be a relevant alternative to the current solutions from the earlier discussion. The criteria show, what GEUS, should analyses around Marielyst waterworks.

Discussion of criteria:

The participants had the opportunity to arrange what, cirteria they though was most important.

1) Water quality – It should be ensured:
    - Drinking water quality should not be altered (smell, taste, chemical clean)
    - Groundwater quality/purity should not be risked
    - Only clean water should be pumped down – No use of surface water/polluted partly cleaned water
    - Water type shouldn't be mixed (polluted, industrial/drinking water)
2) Security of supply /quantity of water – it should be ensured
    - The sufficient quantity of water should be ensured on the long run
3) Environment – It should be ensured:
    - The solutions should not create environmental challenges elsewhere
    - Existing environmental/natural values, should be kept, to the extent it is possible.
4) Water levels – It should be ensured
    - Needs clarification for the consequences of the groundwater levels – regarding dikes, floods etc.
    - Robustness of the area in regard to climate change (can the solutions for climate adaptions solutions and solutions for water levels combines? Can collection of rainwater be a solution?
    - There should not be a decline in the draining of buildings and fields
    - The solution should be holistic
    - The dikes subsurface/fundament should not be destabilized

In addition - It should be ensured

- Cooperation between the neighbors and waterworks
- Economy must be reasonable
- Better control of water levels in canal
- Regulating of the north and south canal should be included in the solution
- All stakeholders should ongoing be informed of the progress in the project

Other suggestions to solutions

- Let others test the technologies before implementing it on Falster
- Maintain already existing drillings with saltwater, it is cheaper to clean the water from salt

Discussion 4: Future involvement

The participants were now split in new groups, and discussed the future involvement in the process

There was a wish for a written collection on the day.

Generally, all participants, and the stakeholders they represent, was very interested in the project and wished for a written collection of the day and continuous information (some thought every quarter) on mail about the SUBSOL project, where new steps are reflected and whether they correlated with the output from the workshop.

Some wished for a follow-up meeting when-if there is given permission.

Prior to the drilling and down pump of water, there should be a wider orientation. This could happen through the local newspaper “Folketidende” or through the municipality. The material should not be to technical and detailed.

To get as many people to a workshop, a personal invitation is required.

Evaluation and lessons learnt

- The priority of criteria is almost the same as in the interviews. The Stakeholder still belives water quality to be the most important and the economy to be the least important. The only real change was water supply and environmental consideration change place, so water supply now is the second most important.
- The participants want to be involved/informed in the process
- Moving wells is not an option on the long run
- It is necessary to use drain
- There should be better coordination between actors
- It is not an option to pump polluted water down to the ground water
- The dikes foundation must not be compromised

Experience from the workshop

The stakeholder workshop resulted in very fruitful discussions and stakeholders created a list of criteria to live up to in the test studies. To get all stakeholder-groups represented at the workshop required persistent and personal contact with all of them. However, some still did not show up. Setting date and time for the workshop should be carefully thought through as preferences and practical restrictions such as busy tourist season or harvest season could prevent some stakeholders from showing up. It turned out to be very useful having asked the stakeholders at Falster about their preferences at the interviews.

The same issues as noted in the section above were present at the workshop – focus on flooding rather than salt water intrusion and scepticism about injection. However, setting up a list of criteria to be considered showed stakeholders’ considerations were taken serious.

Relevant and easy to understand information material handed out before and at workshop was very crucial. However, the issues and Subsurface Water Solutions are complex to explain, and again visualisation through e.g. a video would have been highly valuable. The material should explain pros and cons without too academic, detailed or technical language. Ideally the stakeholders need to receive the material before the weekend prior to the execution of the workshop.

Appendix 8 Workshop report from Dinterloord, The Netherlands

Prior to the workshop several interviews were conducted. The interviews focused on three main points, “connection to site”, “current/historical issues regarding water”, “Concerns regarding the project”.

Four interviews were held, with the following participants; “ZLTO Farmers organization”, “Greenhouse owners”, “Water association” and “Department of environment, nature and water management”.

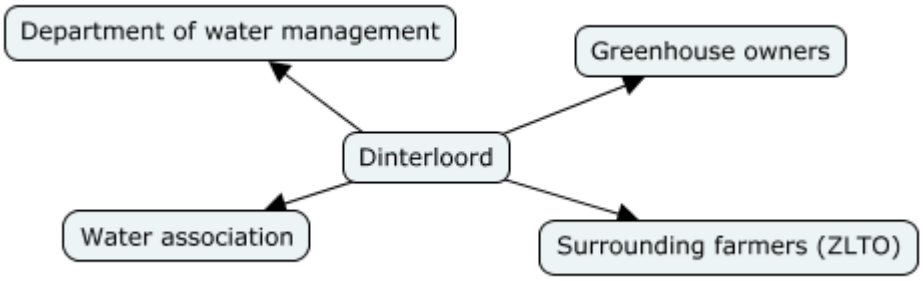


FIGURE 1: SHOWS THE STAKEHOLDERS WHO WERE INTERVIEWED.

ZLTO: Is the farmer’s organization, this includes booth regular farmers and greenhouse owners. ZLTO was represented by three persons, a fourth should have participated, but got sick. The farmers need water for irrigation, they prefer surface water, as it has the right temperature and contains less iron, however, the surface water have algae problems, which are solved by opening dikes and flooding the canals with saltwater. The farmers are concerned there won’t be enough freshwater left. Another concern is a lack of regulation and legislation on the area. The farmer’s concerns regarding the project, the farmers will probably be most concerned effect on water level, subsistence of soil and if conditions worsen, will the farmers be compensated? The main goal of the farmers, are to secure water for irrigation.

Department of environment, nature and water management: oversee setting the frame for water management, but it is the water association that execute the plans. Dinterloord have several problems with groundwater and surface water. Water scarcity and water quality (Nitrate pollution) are the two main issues with the groundwater, however, due to global warming there is a risk of the ground water levels rise, because of heavy rainfalls. The surface water suffers from algae bloom, but it has been decided to open the dikes and lead saltwater into the canals to solve this issue. An institutional problem lies in the lack of a regulative system, which can deal with Subsurface Water Solutions technologies, the main factor in gaining permits for injection is the effect on the surroundings. The goal of the province is to: Find a way to regulate these new technologies, save drinking water, find a method for storing water for energy purpose.

Water associations: are the local regulative body for water management. Earlier groundwater was only used for drinking water, now the higher layers of groundwater can be used for irrigation. The local farmers are concerned regarding the freshwater supply, especially the decision to open

the dikes and making the rivers salt creates uncertainty, and the farmers will need new source of fresh water for irrigation. Saltwater intrusion may be an increasing problem due to global warming. Regarding the regulatory issues, biodiversity play an important role and must be taken into consideration. Un places where there is a conflict between agriculture and biodiversity, it is the water association, that makes the decision, but this is not a big problem in Dinterloord. When it comes to concerns to the problem, the water association focus on the importance of the dike is not compromised.

Greenhouse owners and project developer TOM: Owns an area, and is developing a business park. Wants to sell plots for greenhouse farming including a guaranteed supply of irrigation water. They are using recirculated water from a sugar factory in times of water scarcity. Their main problem is, that the water is not available at the right time and they need storage capacity. The current storage capacity system suffers from algae problems. The farmers wish to be as water efficient as possible and are there for expecting a rise in water efficient crops. The greenhouse owners and TOM's main concerns are, that since it is new, the regulation is not ready for the Subsurface Water Solutions technology and it may take long to get permits. Other concerns are, what happens if the sugar factory closes, only three factories remaining in Holland. What happens to the water quality? Will the water in the underground stay one place or move? will algae be a problem with this technology? What will the water temperature be? Finally, the egg-plant farmer notes that they knew about the Subsurface Water solutions technology and it was part of the reason they brought land.

What did we learn from the interviews?

- Everyone agrees that there is a problem with the water quality
- Algae are a problem which will be solved by opening dikes. Farmers fear that there will not be enough fresh water left for irrigation
- Subsurface Water Solutions can be part of the solution
- As the technology is new, the regulation is not up to date, and it may take time to get a permit.
- Farmers are the biggest consumer of freshwater in the area

The workshop

Tuesday the 12 January 2017, the Danish Board of Technology (DBT) and KWR hosted a workshop in Dinterloord, Netherland. The Workshop is part of the EU-project, SUBSOL, which aims to investigate and test new technologies for protection of groundwater against saltwater intrusion from the ocean. In that context, several test sites have been selected, with different backgrounds – Dinterloord (Netherlands), Schinias (Greece), Falster (Denmark) and Maneadero (Mexico).

The technologies offer different methods to solve the saltwater intrusion in Dinterloord. However, as the method is new it is important to discuss pros, cons, risk and barriers for implementation of the different technologies, in the specific context, not only between technicians, but also between locale stakeholders that know the area.

At the workshop the participants were split into two tables, with a mix of groups to get as many different opinions as possible. The works shop was a combination of presentations and round table discussions.

Programme

08.30 – 09.00	Registration Coffee/tea and croissants.
09.00 – 09.15	Introduction of the day (Klaasjan or Gerard, otherwise Koen, KWR), - SUBSOL as a project and what is going on in Dinteloord.
09.15 – 09.30	Presentation: *The water challenge in Dinteloord*, (Patrick de Rooij, Brabantse Delta) - The extent of the saltwater intrusion, and how severe the issue is expected to be in the future.
09.30 – 10.15	<u>1. discussion round</u> Introduction of the participants and current and future water needs - Who are you and who do you represent? (2 min per participant) - What importance/role does water have in your (the people you "represent") everyday life/business, and what are the current challenges regarding water according to you? - What do you expect to be your future water needs/concerns working with water challenges?
10.15 – 10.35	Presentation: *Upscaling Subsurface Water Solutions*, (Koen Zuurbier, KWR) - Introduction to the Subsurface Water Solutions technique, possibilities/challenges when implementing a large scale solution, and the cost of the water if the Subsurface Water solution is upscaled.
10.35 – 11.00	Break
11.00 – 11.45	<u>2. discussion round</u> Prioritizing of which criteria an upscaled Subsurface Water solution should live up to - All participants select three criteria at which they think are the most important, and explain their choice for the rest of the table. Following this the table votes on which criteria are the most important (from the ones selected) – everyone have two votes.
11.45 – 12.30	<u>3. discussion round</u> Involvement of the stakeholders prospectively - What is our own role in the process, if the Subsurface Water solution should be upscaled in Dinteloord? - How can you contribute towards a realisation of an upscaling/a project that covers local needs? Main barrier/obstacles for initiating the process of upscaling - What do you think is the main barrier/obstacles for initiating the process of upscaling?

12.30 – 12.35	Wrap up
12.35 – 13.00	Lunch

Resume

The workshop was divided into three sessions.

- Introduction and future water needs
- Criteria regarding the upscaling
- Contribution to upscaling

Introduction and future water needs

As part of the introduction, the participants discussed the current and future water challenges/needs. The main points from these discussions are:

- Current situation
  - There is a demand for freshwater, especially farmers need fresh water
  - There is a demand for high quality water
- The future?
  - Limit water needs
  - High water quality and costs
  - Cooperation between different users are important

Criteria regarding upscaling

The workshop participants had the opportunity to vote on six criteria's. Each participant could vote on more than one, the distribution of votes can be seen in figure 1. Impact on above ground function was the most popular with 6 votes. Above ground functions refer to infrastructure, agriculture etc. The second most voted criteria went to "Water quality" and "Impact on environment" each reach a total of 5 votes. "Cost" was the fourth most voted criteria with 4 votes.

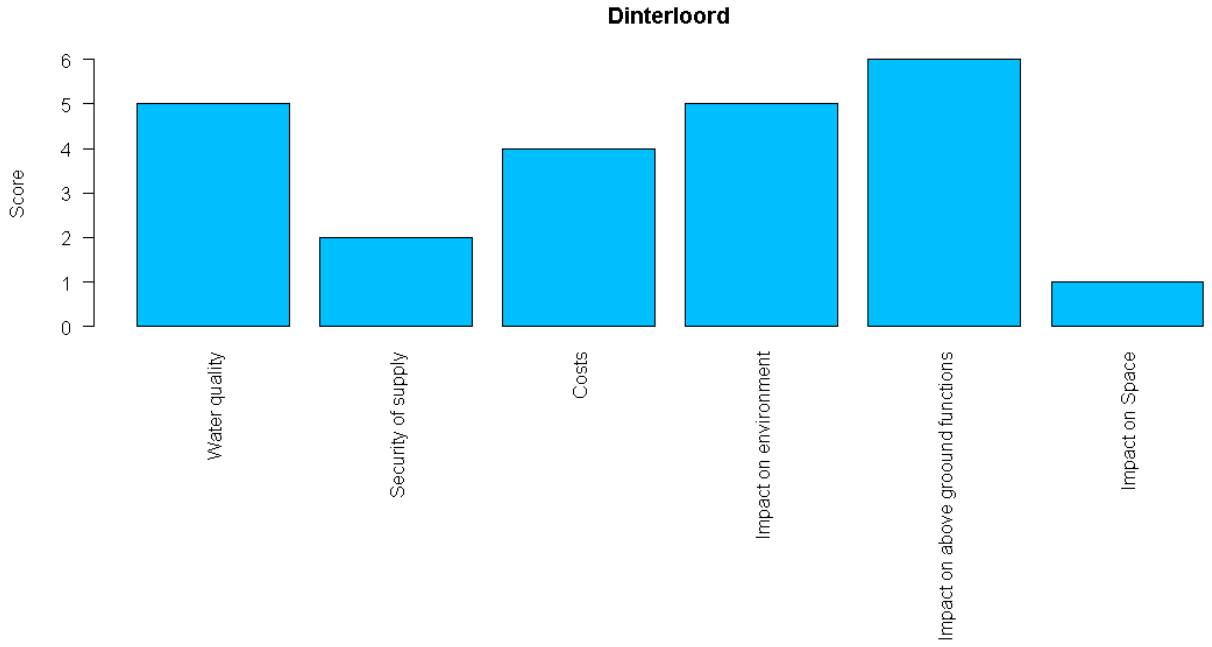


FIGURE 2: SHOWS THE CRITERIA THE PARTICIPANTS VOTED FOR

In the discussion prior to the vote, one table talked about what should be taken in to account, before trying to solve the water issue. The table talked about the number of customers necessary for the project to be relevant as well as monitoring, what should areas can be damaged of a project what kind of permits system is required and who will exploit such systems.

After the votes, the two tables each discussed what three items was most important. Both tables got to the same conclusion listing the following:

1) Impact on environment
2) Impact on above ground functions
3) Costs

Interestingly water quality has not made the list, despite being a shared second in the vote. Another small change is that impact on environment and impact on above ground functions, have changed place.

What is your role in the process?

The participants seemed positive towards the project, and most of the participant was interested in helping one way or the other. For instance, offered a greenhouse owner to share some of the excessive water that falls on his green house. Others were interested in helping with legislation, monitoring or sharing knowledge and user experience.

Observations at the workshop

Two observers were present at the workshop. One from KWR and one from DBT. It was necessary to have an observer from KWR, as the observer from DBT did not speak Dutch.

KWR observer:
All participants are positive for the workshop, and the Subsurface Water Solutios.
The workshop has already improved the cooperation, as there is now communication between the groups, which in most cases did not know one another. An example of this is seen by the sugar factory, that realized, that they could use the water themselves or create extra ASR for themselves.

One issue noticed by the KWR observer, was the lack women at the workshop. No women were among the participants.

Evaluation and lessons learnt

Fewer participants in Dinterloord than in the other replication sites resulting in only two groups. The two non-mixed groups were local and external respectively resulting in one group consisting of both officials and external farmers (from the surroundings). But this was manageable.

The group facilitators did not take notes directly in the summary form which imply that they had to do this afterwards which was good for the group discussion but a challenge regarding documentation.

The group discussion works very fine resulting in delay.

The workshop model and process worked except for the final presentation of results in plenary.

The methodology was new I Holland and preparatory communication is a very important issue. The workshop generated new contacts, new information, new concrete ideas.

Appendix 9 Workshop report from Schinias, Greece

The local partner in Schinias is the National Technical University of Athens (NTUA) who in cooperation with DBT organized the interviews and workshop.

The workshop was organized in connection to a pilot project where a few small-scale Subsurface Water Solutions installations were being tested.

Prior to the workshop a number of interviews were conducted with main stakeholders. The interviews focused on four main points: Connection to site, current/historical issues regarding water, the history of controversies and the landscape of informal power-structures and concerns regarding the project. In the following we list the main findings from the interviews.

The main stakeholders can roughly be split into four categories: Citizens, farmers, environmental NGOs and public administrators and decision makers. The groups are made on the background of the interests and roles of the individual stakeholders. There was a shared understanding across stakeholder groups of saltwater intrusion being a problem. All stakeholders furthermore agreed that Subsurface Water Solutions could be the solution or at least part of the solution. The different groups can be seen in figure 1.

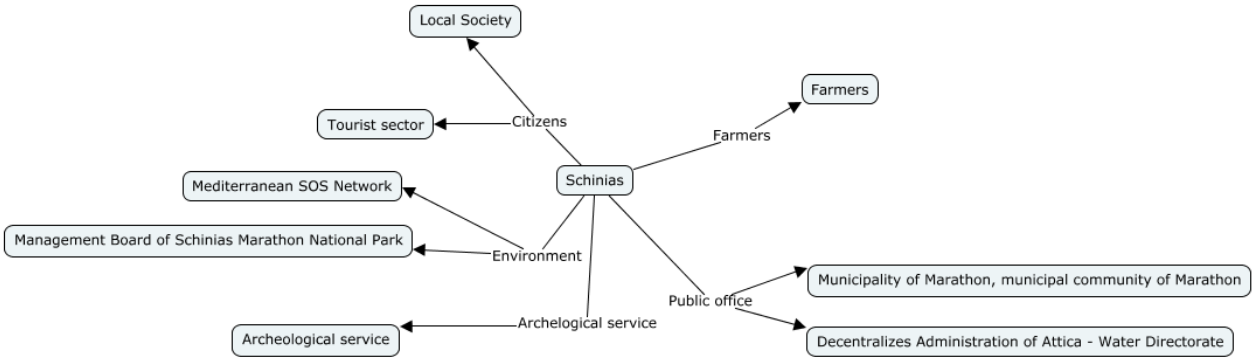


FIGURE 1 THE PARTICIPANTS SPLIT INTO FOUR MAIN GROUPS

Main points from the stakeholder groups

Environmental managers and NGOs: For the environmental NGO representatives the main concern was saltwater intrusion and over pumping, which in time may threaten the national park. Schinias National Park is also threatened by locals clogging canals to wet land and ensure water supply to illegal taverns, hotels and restaurants in the forest and on the beach. The national park is currently in good condition, and the environmental NGO representatives want it to stay that way. As the rest of the stakeholders they see Subsurface Water Solutions as a possible solution, but think that it is important to settle who will pay. Also, they want to see results from the pilot project before an eventual upscaling of the project.

Archaeologists: The area of Schinias is very interesting and important in terms of archaeology. A lot of archaeological remains are preserved – the area is very rich on data, and only a small part

has been discovered/assessed. It is a concern that a change in salinity in the underground – no matter whether it is an increase or decrease in salinity – may affect the archaeological sites underground. Hence archaeologists want to preserve the current salinity levels. Furthermore, it is important that the drillings are done in a safe place where no archaeological sites are endangered. The archaeological service will keep in close contact with NTUA (who is in charge of the pilots) on this matter. Hence, the archaeological service has two main interests: That the drilling is not done in places of archaeological interest, and that the Subsurface Water Solutions technologies help preserve rather than change levels of salinity. The geophysical data found in SUBSOL has been very valuable to the archaeological service.

Public Office: The public office oversees distribution of permits for water-use as well as monitoring the water levels. One major issue is the illegal wells. The illegal wells are a symptom of an uneven system, which does not necessarily give the permits to those needing it most. One major issue is the lack of cooperation between the different levels of authorities. The water directorate is at the level between the state and the local level and tries to mediate between these two. Until now the municipalities have not been involved in projects like this one either because of lack of will or experience or other things. Mostly regional authorities have been involved. The directorate tries to start collaboration with the municipality, but it is difficult to find time.

Public office sees Subsurface Water Solutions technology as a possible solution. They noted, however, that the SUBSOL pilot project will have to be supplemented with more and other measures. They would like to know who will fund an upscaling of the project. The directorate only has resources to give permits. Furthermore, they would like to see the results from the pilot project and weigh them against other solutions: How efficient is it, what are the costs, what about administration and maintenance etc. They would also like to know whether the Subsurface Water Solutions technology will impact the surroundings – for example, will it push nutrients towards the sea? The public office notes that although farmers are partly responsible for the issue, agriculture is an important part of the economy in the area and is an important part of the community.

Citizens: The main goal of the locals and tourist sector is to have enough clean water. The local society explains that there has not been a formal discussion about water supply, although informally this is a topic of great interest and debate within the local community. It is possible that many of the locals have not noticed the saltwater intrusion problems. The main issue of concern mentioned by the citizen participants is the quality of the water. The citizens are concerned about pollution from old pipes (possibly containing asbestos) and pesticides in the water. The citizens have not been provided with data regarding the water quality and are not sure they can trust the water. Despite the issues with the water quality there are no conflicts between the locals, the tourist sector and the farmers. Subsurface Water Solutions could be a solution, but for the locals it is more important to provide data on water quality.

Farmers: The farmers are represented by greenhouse owners and the Agricultural Association of Marathon. The flower farmers were not represented as they were not organized – they are, however, an important stakeholder and an important part of the community. Salt water and quantity are the main issues for the farmers. The farmers have not experienced decreasing efficiency of growing crops yet, but it could be a problem in the future. One of the major reasons for the problems is the number of illegal wells used by farmers. There is no conflict between farmers

and the locals, and the Agricultural Association of Marathon has arranged for the farmers to sign a regulatory to decrease pesticide use. They were enthusiastic about Subsurface Water Solutions as a potential solution and had high expectations to the pilot project. For the farmers, an issue with implementation is the question of who will pay.

What did we learn from the interviews?

- Everyone agrees that to some extent there is a problem with the water quality.
- Subsurface Water Solutions technology was widely accepted as a potential solution. All groups would, however, like to see results of the pilot project before proceeding to an upscaling of the project. The question of who will pay was also an issue with all stakeholders.
- Farmers' use of private, possibly illegal, wells is a major problem.
- Farmers are an important part of the local community and economy – hence, water supply to farming is a main issue for the community.
- There are no internal conflicts between farmers and citizens.
- Environmental organizations are concerned about the potential environmental effect of over-use and increased salinity of the groundwater.
- Citizens are concerned about the water quality in current and future solutions.
- Archaeologists are interested in stabilizing the current level of salinity and in ensuring that drillings and installations do not harm archaeological sites.
- One main issue in relation to water management is lack of cooperation between the different levels of authorities.
- There might be a problem with communication between citizens/farmers and the municipality regarding the quality of water.

Results from the workshop

Tuesday the 24 January 2017, the Danish Board of Technology (DBT) and NTUA hosted a workshop in Marathon, Greece. At the workshop the participants were split into 4 tables, with a mix of groups to get as many different opinions as possible. However due to a small attendance at one table, the workshop was held with three tables.

Programme

9:30-10:00 Short welcome */Aggelos Lenas – President of the Municipal Community of Marathonas.*

Welcome and short presentations of the stakeholder participation agenda and activities of the day */Christos Makropoulos – scientific responsible of NTUA for SUBSOL*

10:00-10:10 Short presentation of the SUBSOL as a project */Christos Makropoulos*

10:10-10:30 Introduction to the challenges of water resources management in Maneadero:

- The underground water resources in Schinias */Theodora Kokla – Director of Water Resources Dept., Decentralised Regional Authority of Attica*
- The mapping of current state of licensed boreholes

- Current management measures /*Nikolaos Chilas – Administrative support Director, Water Resources Dept., Decentralised Regional Authority of Attica*

10.30- 11.15 1st round table discussion (mixed groups): Presentation of participants/stakeholder groups and future water needs:

- Considering the interests you represent as a citizen, business, farmer, NGO or authority, which importance/role does water have?
- What are the current challenges regarding water?
- What do you expect to be the future needs?

11.15-11.30 Presentation of technological solutions for water resources management – Subsurface Water Solutions with Shinias as case.

- Conventional methods – Other solutions available to counter draught and saline intrusion
- The consequence of not doing anything ('business as usual' scenario) (Must be coordinated with the presentation by Mrs. Kokla)
- Subsurface Water Solutions implementation in Schinias
- Project limits- up scaling conditions/ *Andreas Kallioras – Ass. Professor NTUA*

11.30-11.40 Presentation of stakeholder involvement in SUSOL project

- Participation of local stakeholders in SUBSOL so far (catch up from previous meetings during summer)
- Procedure of licensing for the pilot establishment in Schinias
- Benefits derived from the participation procedure/*Andreas Kallioras – Ass. Professor NTUA*

11.40-12.40 2nd round table discussion (mixed groups continued): Solutions

- What do you think about the different potential solutions presented? (Pros and cons.)
- What do you think about the implementation of Subsurface Water Solutions in Schinias?

12.40-13.00 Coffee break

13.00-14.00 3rd round table discussion (unmixed groups): Upscaling and future stakeholder involvement

- The potential of up scaling implementation of Subsurface Water Solution
- What criteria should a Subsurface Water Solutions [upscaling] solution live up to?
- What could be your role in realising a water solution for Schinias and how could you contribute?
- How can your organization contribute towards a realisation of an upscaling/a project that covers local needs

- How can your organization contribute towards a realisation of an upscaling/a project that covers local needs

14.00-14.20 Closing the discussion: Questions /Christos Makropoulos

14.20-15.20 Lunch

Table discussions

The table discussion was split into three sessions as follows:

- A) Introduction round and future water needs
- B) Feedback on water solutions and Subsurface Water Solutions upscaling
- C) Distribution of responsibilities and criteria for upscaling the pilot project

Presentations

Before the discussion of the different Subsurface Water Solutions technologies, the participants were given the opportunity to present themselves. During these presentations, some used the opportunity to explain what they thought was important. Some of the major points were:

- EYDAP is a key player
- Illegal boreholes are a problem
- Farming is the main industry
- Need to find funds

1st discussion: Current challenges with water management

A major focus which was raised at all the tables was the current practice in which farmers use the water. A main concern was that the farmers do not exploit the water efficiently. Furthermore, there was some discussion about illegal wells some mentioned an issue with illegal wells was mentioned. All groups agreed on the need for awareness raising among farmers and lack of access to the responsible official central body as major problems.

All tables also discussed the problem of managing the water. Tables discussed the risk of flooding and one table focused on the problems to impose measures and manage it.

2nd discussion: Water solutions, hereunder Subsurface Water Solutions

Five different solutions were discussed, finding pros and cons on each solution. The pros and cons for the specific method can be viewed in table 1.

Looking at the feedback on the method it is clear that “creation of a hydraulic barrier”, “construction of impermeable wall” and “creation of pumping-through configuration” all received more negative feedback than positive. Particularly the complexity and the cost received criticism from the tables. The two options “application of surface artificial recharge” and “reducing the quantities pumped received” almost equal positive and negative feedback.

Not all tables discussed the same cons and pros, but a few themes came up at all tables:

Positive

- Efficiency
- Impact on nature
- Water quality

Negative

- Cost
- Needs awareness raising
- Lack of central responsible authority
- Complexity

3rd discussion: Responsibility of authorities and stakeholders

In Schinias the stakeholders had the opportunity to vote on which of seven criteria they found important to evaluate Subsurface Water solutions against (figure 2). Each participant could vote on more than one criteria. The “Environmental impacts” was the greatest concern with 15 votes of 23 possible. The second most important was “cost and funding” with 12 votes, with “Quality of water” and “Time of availability” sharing the third place with eight votes each.

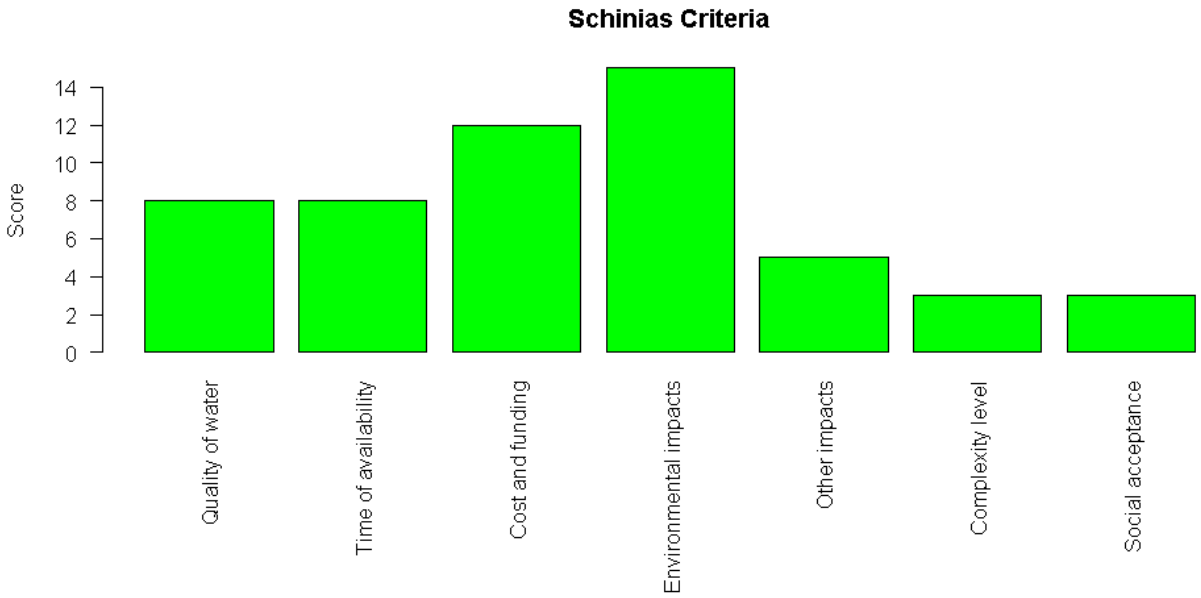


FIGURE 2: SHOWS THE DISTRIBUTION OF VOTES ON THE MOST IMPORTANT CRITERIA AGAINST WHICH SUBSURFACE WATER SOLUTIONS SHOULD BE ASSESSED.

The participants were willing to help with the implementation of the Subsurface Water Solutions in various ways. EYDAP for instance were willing to implement Subsurface Water Solutions technology if there was a funding scheme through the region or if there were pricing schemes that would depreciate investments. Most of the participants, however, are willing to help communicating the idea to potential customers and other stakeholders.

Evaluation and lessons learnt

The discussions at the tables were generally lively and engaged. Many participants found the process very innovative. They've seldom or never had the chance to state their opinion in a forum like this, in front of a group of relevant stakeholders. This could be a gain in terms of engaging them in the next step. They might have a more positive attitude towards this kind of processes in the future.

One archaeology representative thought that stakeholder involvement was a good idea, but found that the issue was much more complicated than what could be displayed in a process like this.

Whereas the same kinds of stakeholders were placed at the same tables in Denmark and the Netherlands, they were mixed at the tables in Greece. This was due to the high number of different stakeholders groups represented (12 different groups/services) and a low number of representatives from each group. Hence, decision makers, farmers, archaeologists and utility companies were put together in mixed groups. This approach had positive and negative effects.

As for the positive effects, many of the participants were not used to talk to each other in this manner and found that it was a good experience. Also, it meant that they had a chance to listen to each other's perspectives and to debate issues where they were not aligned.

As for the negative effects, it meant that at some tables a few people from stakeholder groups with particular authority dominated the discussion while others were silent. At one table representatives from two particular stakeholder groups had an intense debate which dominated the discussion and to a wide degree silenced the other participants. The chairmen at each table tried to give space for all participants, for example by making rounds where each participant in turn should respond to a question. The danger of such a dynamic may be greater in settings where the distance between authorities and ordinary citizens is more outspoken.

It was useful that quite a few of the stakeholder groups were represented by more than one participant. This brought more viewpoints to the table, also internally in the stakeholder groups.

The initial tables' set up was for 35 participants from 12 different groups/services, according to the responses on the invitations, and the available facilitators were 5. Those limits led to the setting of 4 tables with larger and mixed groups. The final number of participants was 28 as not all came for several reasons (personal, professional obligations, etc.). However, the facilitators reported that the group sizes were small enough to enable all participants to speak up.

The questions

The questions leading the discussions in the different sessions were sometimes a bit overlapping, causing the discussions to be repetitive. As one of the facilitators said: "Sometimes I couldn't figure out what the difference was between the different questions we were discussing. For example, what is the difference between discussing their general role and their role in upscaling? It was like asking the same question twice." The general message from facilitators was that they would have preferred less, but more distinct questions with less overlap.

Some of this could perhaps be prevented by giving the participants different kinds of tasks. For example to discuss in the first session and draw in the second. NTUA has been drawing on this approach in other workshops, and their experience is that it extracts more information.

Practical organisation

In general the practical organization of the workshop worked well. A few notes:

- Many participants arrived very late, which caused the workshop to be 50 minutes delayed. Most of the delays had to do with the heavy rain that day, which caused many problems in transportation and traffic. Moreover, the event took place in Marathon (case study area) which is 40km far from Athens city, consequently most of the people who were not locals arrived late.
- Despite being an important stakeholder, the farmers ended up being represented rather weakly on the workshop. They were represented by the Agricultural Cooperation, and the initial response was that 4-5 representatives would come – however, only two participated in the end. Farmers are a productive group of professionals, and during the period in which the workshop was held they had a heavy working routine. Bad weather during January and natural disaster effects on agriculture combined with farmers' demonstrations against the new tax laws resulted in low participation of farmers in the event.

Mobilizing effect

The impression from NTUA facilitators was that the dialogue had a mobilizing effect on the participants. A number of key stakeholders spoke very positively about their potential role in an eventual upscaling process and seemed ready to commit themselves. Key stakeholders who had been less engaged in the project before the workshop seemed to become more positive as a result of their participation.

Appendix 10 Workshop report from Maneadero, Mexico

Prior to the workshop there were conducted interviews in January 2017 with the main stakeholders. The interviews contributed with information of perspective, concerns and expectations off the stakeholders, as in the other replication studies.

The interviews were followed by a workshop with the stakeholders. The workshop started with an introduction to the SUBSOL- project and afterwards group discussions with the stakeholders.

The main stakeholders can be seen in figure X.

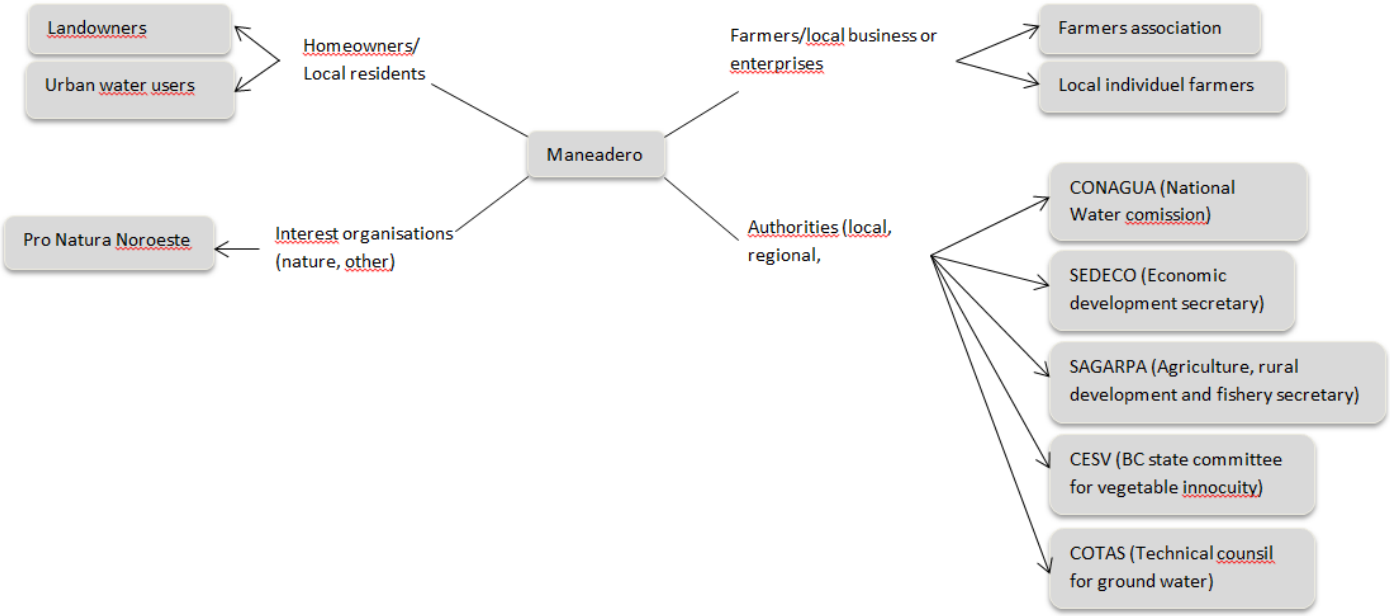


Figure X: INTERVIEWS OF STAKEHOLDERS DIVIDED INTO FOUR MAIN GROUPS

Tuesday the 12 September 2017, the Danish Board of Technology (DBT) and ARCADIS hosted a workshop in Maneadero, Mexico. At the workshop the participants were divided into X tables. In the first two discussions the participants were mixed and in the last discussion the tables were unmixed. However due to a small attendance from NGO's there were not an unmixed table separate for them.

Main points from the stakeholders:

Interest organizations

The most important thing for an implementation/application of this kind of technology (Subsurface Water Solutions) is to demonstrate that the technique is not harming or damaging the environment. How will different spices in the surroundings be affected? There needs to be assured that the water quality is not being diminished.

Homeowners/local residents

Water is needed in the cities. The project could create employments. A big concern is that the SUBSOL project won't be implemented due to lack of support from the government or money issues. Response time form CONAGUA tend to be very slow and can take more than 6 months to give a permit.

Farmers/local business or enterprise

The farmers have seen big changes in rain patters since approximately 2000, and rain is now much more erratic than previously, which challenges the farmers and their management of water and crops. The project is considered as a unique benefit for agriculture and industry. Productive lands have diminished due to the lack of water. Vegetables are the agriculture strength in BC coast for exportation because it has a short shelf life. Much of the agriculture crops are being exported to the US because it is close and cheaper than in the US. As an impact of fresh water shortage in the BC coast, wastewater is being used to irrigation. This causes the US won't by the vegetables and the farmers have to reorganize their livelihood on flowers which has a detrimentally income for the farmers.

Authorities

It is important to clarify what is 'quality water' exactly is in this project. The Technical Consul for Groundwater (COTAS) says in reality no one knows how many wells there are in the Maneadero Valley.

The programme

9:30-10:00 Short welcome */Aggelos Lenas – President of the Municipal Community of Marathonas.*

Welcome and short presentations of the stakeholder participation agenda and activities of the day */Christos Makropoulos – scientific responsible of NTUA for SUBSOL*

10:00-10:10 Short presentation of the SUBSOL as a project */Christos Makropoulos*

10:10-10:30 Introduction to the challenges of water resources management in Maneadero:

- The underground water resources in Schinias /*Theodora Kokla – Director of Water Resources Dept., Decentralised Regional Authority of Attica*
- The mapping of current state of licensed boreholes
- Current management measures /*Nikolaos Chilas – Administrative support Director, Water Resources Dept., Decentralised Regional Authority of Attica*

10.30- 11.15 1st round table discussion (mixed groups): Presentation of participants/stakeholder groups and future water needs:

- Considering the interests you represent as a citizen, business, farmer, NGO or authority, which importance/role does water have?
- What are the current challenges regarding water?
- What do you expect to be the future needs?

11.15-11.30 Presentation of technological solutions for water resources management – Subsurface Water Solutions with Shinias as case.

- Conventional methods – Other solutions available to counter draught and saline intrusion
- The consequence of not doing anything ('business as usual' scenario) (Must be coordinated with the presentation by Mrs. Kokla)
- Subsurface Water Solutions implementation in Schinias
- Project limits- up scaling conditions/ *Andreas Kallioras – Ass. Professor NTUA*

11.30-11.40 Presentation of stakeholder involvement in SUSOL project

- Participation of local stakeholders in SUBSOL so far (catch up from previous meetings during summer)
- Procedure of licensing for the pilot establishment in Schinias
- Benefits derived from the participation procedure/*Andreas Kallioras – Ass. Professor NTUA*

11.40-12.40 2nd round table discussion (mixed groups continued): Solutions

- What do you think about the different potential solutions presented? (Pros and cons.)
- What do you think about the implementation of Subsurface Water Solutions in Schinias?

12.40-13.00 Coffee break

13.00-14.00 3rd round table discussion (unmixed groups): Upscaling and future stakeholder involvement

- The potential of up scaling implementation of Subsurface Water Solution
- What criteria should a Subsurface Water Solutions [upscaling] solution live up to?

- What could be your role in realising a water solution for Schinias and how could you contribute?
- How can your organization contribute towards a realisation of an upscaling/a project that covers local needs
- How can your organization contribute towards a realisation of an upscaling/a project that covers local needs

14.00-14.20 Closing the discussion: Questions /*Christos Makropoulos*

*1*4.20-15.20 Lunch

Resume

The table discussion was divided into three sessions as follows:

a) Introduction round and future water needs
b) Perspectives, observed benefits, challenges and requirements for a successful project
c) Stakeholder involvement and action plan

Criteria regarding upscaling

The participants of the workshop voted on six different criteria regarding upscaling of the Subsurface Water solutions. Four of the criteria has received equal of most votes which is ‘acceptation of products irrigated with this water’, ‘security of supply’, ‘cost’, ‘impact on aboveground function’. The criteria which have received fewest votes are ‘water quality’. The criteria with the second fewest votes are ‘impact on surrounding nature and environmental considerations’.

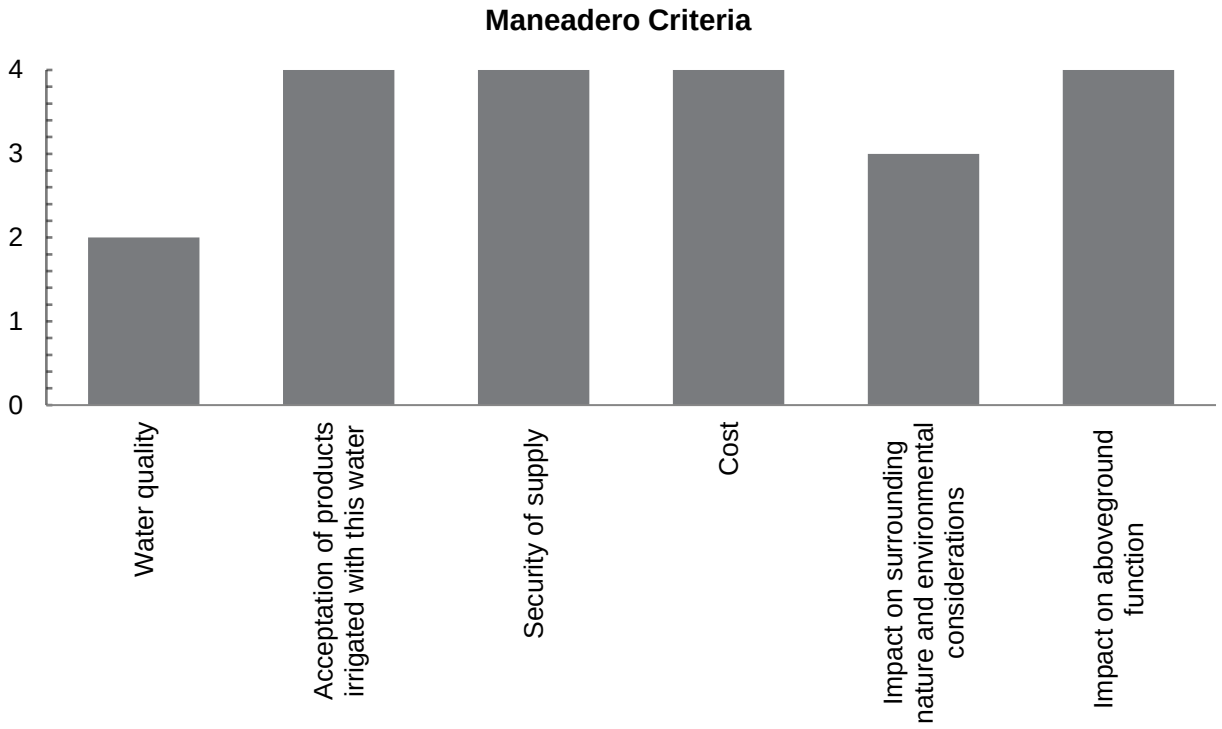


Figure X: SHOWS THE CRITERIA THE PARTICIPANTS VOTED FOR

Technically information

The participants had a general opinion about more need for technical information about the project. The presented technical model doesn't seem technically founded in the existing aquifer and reclaimed water knowledge (no numbers were presented). There is an uncertainty regarding the water quality and the retention capacity of the Subsol. There need to be a clear comparison of cost, quality, environmental impacts and advantages of SUBSOL implementation against other technologies as RO, UV disinfection and Oxone.

What is your role in the process?

The participants agree on the water challenges and that action needs to be done. The participants were general positive regarding the project though more technical information is needed. Most of the participants were interested in helping on way or another. For instance, Pronatura can contribute with environmental advice. COTAS can contribute with advice regarding vegetable innocuity and recharge site and vegetable quality studies. Citizens can contribute with support to the project and pushing the government towards the acceptance of the project.

Observations at the workshop

Three representatives from the SUBSOL-project were present at the workshop. There were one representative from DTB and two from ACADIS.

Evaluation and lessons learnt in Maneadero

Introduction and the facilitators

The day before the workshop ARCADIS and four of the table facilitators from two Universities were briefed by DBT. In the meantime there had been a sign up to the workshop corresponding to 7 tables. One of the scientists from the University ensured to bring students to the purpose. The students were never briefed about the workshop. The briefing of the four Universities facilitators was quite unstructured and got mixed with the briefing of the Subsurface Water Solutions- project itself, caused by their limited foreknowledge about both the project and the process of the workshop. This was even though the DTB had provided with information to the local partners months ago about the project.

Even though the workshop programme had been discussed in details several times between DBT and ARCADIS, who is the main facilitator on the workshop, there is suddenly an opening for questions from the plenum.

The facilitators didn't have the tools to limit dominating persons in the groups and engage the more retaining persons. The role of DTB at the workshop itself was to observe, but the representative had to involve himself several times to among others get the group dynamics to flow. The local partner contributed as well to solving the sudden problems that appeared during the workshop.

One facilitator leaves the workshop before time. At the shift of the round table discussion there is a mix-up in the group structure.

The practical

The local partners were apparently taken by surprise by the practical preparation with both the technique and conference facilities and experience to get the logistic to proceed smoothly with the registration etc.

The minutes taken on the workshop were very unsystematic which resulted in it was impossible to identify which stakeholders expressed which opinions.

Organization

In Maneadero there is an uncertainty of who's in charge of the federal and local government. In the interviews of the stakeholders it is said that CONAGUA have the authority to regulate the water concessions, but are not doing it because of political, social and economic reasons. At the workshop it is said that CONAGUA are still operating as in the past and not in the future which causes current challenge with water management. Today nobody is paying for water so there has to be a change in the organization to make e.g. the farmers pay. Ejidos, CESPE and possibly others could be the owners as a form of consortium. However, some farmers within the Ejidos are not interested in changing the current situation and paying more for water usage, while others are more open to change. The Ejidos situation is not completely clear and they are not speaking with one voice necessarily.

Lesson learnt so far

The workshop in Maneadero, Mexico gathered a lot of participants and the output is comparable with the preliminary results from the other workshops in “Lessons learnt so far” in the Minutes from the pTA. In Maneadero there was a great consensus about the water problems and great interest in a project that can solve the challenges. The stakeholders are of course skeptical first time they are being introduced for a project like this, but they are positive interested and ask for more concrete information about the future project. A communications- and action plan is essential for the work of the SUBSOL- project.

Organizing a workshop is a greater challenge than what one could perhaps think at first. The debates may be heated, and it can show difficult to make sure that the dialogues at the table are constructive, and that all participants get to take part. Also, it takes some effort to build up the legitimacy of the workshop in a way that makes participants feel content about giving their input here and to give the results the needed legitimacy in the further decision making and implementation process.

APPENDIX 11 Policy briefs

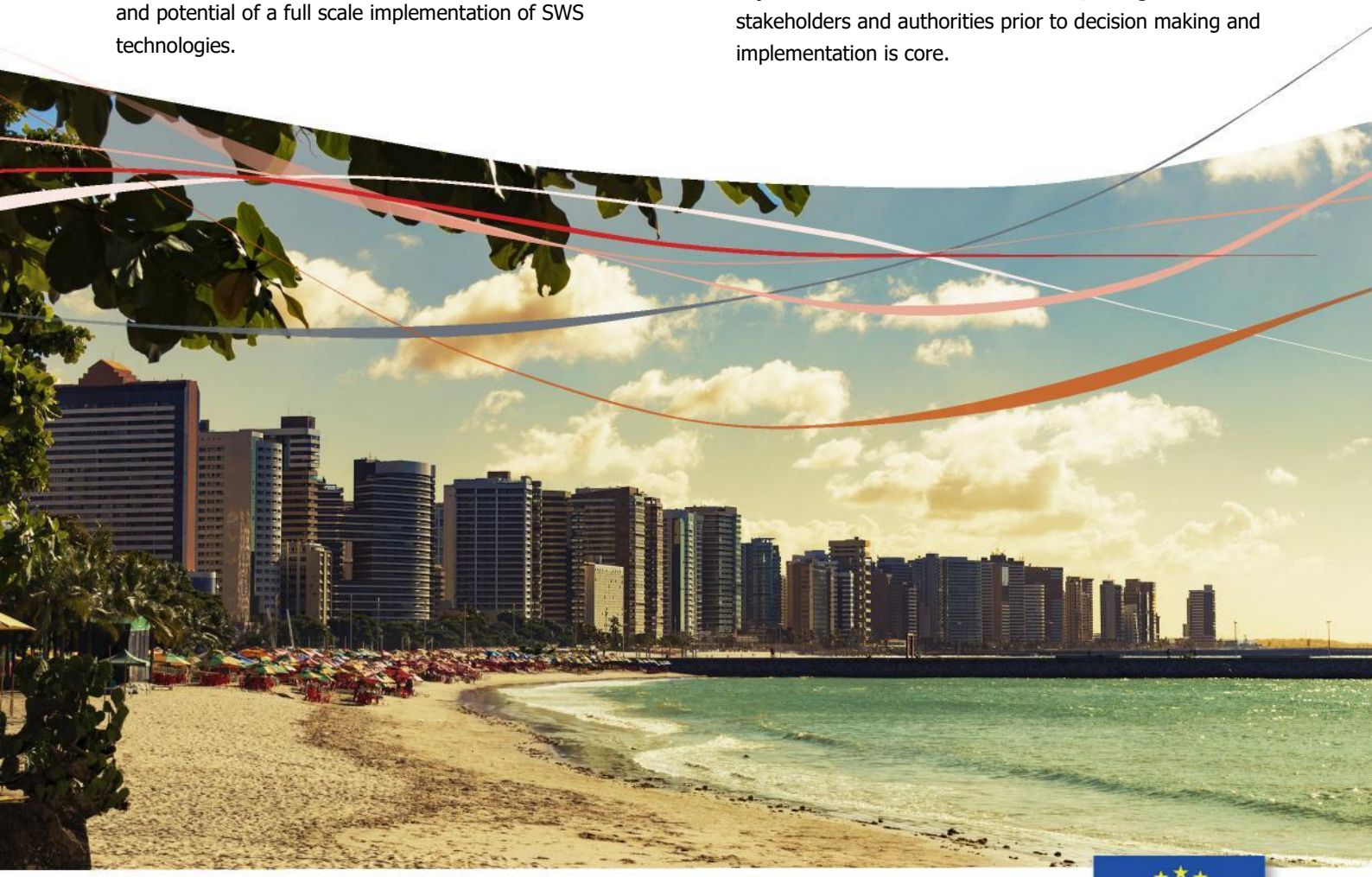
In order to facilitate further advocacy of Subsurface Water Solutions in other areas assessed as suitable for the technology by the SUBSOL team, six policy briefs were produced. The briefs addressed decision makers, researchers and other stakeholders in Laizhou Bay in China, Pernambuco in Brazil, Cyprus, Baja California in Mexico, Ho Chi Minh City in Vietnam, and in the European Union as a whole. Briefs for Brazil, Mexico and Vietnam were produced in English and the national languages. See all briefs on the coming pages:

Safeguarding the water reserves of Pernambuco

Water management is a growing issue in Pernambuco in Brazil. On the background of an analysis of the water supply issues and the legal and policy framework in Pernambuco, drawing particularly on the Recife Metropolitan Region as a pilot case, partners in the EU H2020 project **'SUBSOL – bringing coastal SUB-surface water SOLutions to the market'** have developed a set of recommendations to safeguard the future supply of freshwater.

RECOMMENDATIONS

- Subsurface Water Solutions (SWS) are capable of addressing the water management issues of Pernambuco. Moreover, they are low-cost, low-tech and fit the local institutional capacity.
- The local authorities in Pernambuco are aware of the urgency of the issue and positive towards SWS schemes. A pilot project is however needed to demonstrate the benefits and potential of a full scale implementation of SWS technologies.
- As regulation for aquifer recharge with reclaimed water is very strict, implementation of SWS systems requires careful filtering of reclaimed water, continuous documentation and monitoring of the water quality and eventually close dialogue with authorities about the room of maneuver within existing regulation.
- In order to ensure an efficient and legitimate process with local support and cooperation and a solution that is adjusted to local needs and resources, dialogue with all stakeholders and authorities prior to decision making and implementation is core.



SUBSOL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642228

WATER SUPPLY CHALLENGES IN PERNAMBUCO

A combination of pressures on the groundwater makes water resources management a major challenge in the Recife Metropolitan Region (RMR) and the wider area of Pernambuco. Steady growth of the population and economic activities in the region is increasing the pressure on freshwater resources in the region. Also, periodic shortages of freshwater due to seasonal variations in rainfalls have worsened over the last years due to climate change. The resulting lowered groundwater level has further caused salt water to seep into the groundwater along the coast. The pressure on and lack of control with groundwater resources is further increased by lack of implementation and enforcement of groundwater regulations, leading to widespread unauthorised drilling to establish private water wells. As groundwater is the main source of freshwater in the region, the decreasing level and quality of groundwater is an urgent problem.

Authorities in the RMR region are aware of these challenges and improved water management is high on the agenda. A number of measures have already been taken to mitigate the existing water shortage conditions and regain control with drilling. A number of private wells along the coast have been closed down, and in other areas authorities have given licenses to still pumping wells. Rainwater is collected in cisterns and infiltrated in upper catchment areas to be recharged into the aquifer. However, the measures do not match the scope of the problem – the water supply remains unstable and insufficient, and groundwater levels are decreasing[1].

SUBSURFACE WATER SOLUTIONS

Subsurface Water Solutions (SWS) offer a series of solutions to freshwater resources problems in coastal areas by means of advanced groundwater management (pumping, infiltrating, controlling) which enables protection, enlargement and sustainable utilization of fresh water resources. Combinations of wells extracting brackish water and infiltration (ponds) or injection (wells) of fresh water are used to control the position of the interface between fresh and brackish water, thereby creating a barrier against further saltwater intrusion and securing the freshwater wells inwards. Moreover, it enables storage of large volumes of run-off or recycled water in the underground in order to ensure a stable water supply year-round, irrespective of seasons and shifting levels of exploitation, e.g. from agriculture and tourism.

SWS systems address all of the main water issues of Pernambuco and the wider region. Moreover, while SWS systems work by stimulating natural infiltration to secure the availability of clean water during the dry season, and as they require little energy to run compared to for example desalination technologies, they provide environmentally sustainable and low-cost alternatives for water management. Finally, as SWS systems require little operation and maintenance, and they can be easily implemented with the existing institutional and economic capacities of authorities in Pernambuco.

PERSPECTIVES FOR THE UPTAKE OF SWS SYSTEMS

The federative unit of Pernambuco has resources politics in place, with defined objectives and legal instruments for the establishment of Integrated Water Resources Management. The RMR region is relatively politically stable and an area of government interest as it is one of the most important ports for tourism and trade.

On artificial recharge, the law specifically mentions that the government should provide incentives to private entities for artificial recharge by reducing public fees. This law also checks on well drilling and pumping flow rate. However, there is need for improved implementation and enforcement of groundwater regulations to control extensive over-exploitation. In the municipality of Recife, a law from 2015 obliges new enterprises with more than 500 m^2 to install green roofs and reservoirs for water storage. This is a step towards the implementation of aquifer recharge with seasonal rainfall.

Therefore, even if the legal framework currently in place is still quite prohibitive as it sets strict conditions to implement SWS schemes, the assessment shows that the authorities seem to be aware of the challenges and open to think about potential benefits of SWS schemes to address these.

[1, 3] adelphi: Lessons learned from trust building activities. Report from the EU H2020 SUBSOL project. December 2017.

[2] Pernambuco Decree n20.423, Art. 72.

There are, however, some obstacles that require attention:

- The current legislation regarding the natural resources allows recharging of aquifers only under certain strict conditions. The water which is injected should be of very high quality in order not to threaten the ecological state to the water reserves and aquifers. Further, in order to obtain authorisation from the Pernambuco State Water and Climate Agency (APAC) and the Pernambuco State Environmental Agency (CPRH), it is compulsory to demonstrate the technical, economic and sanitary feasibility of artificial recharge of aquifers to guarantee groundwater quality preservation[2]. This requires complex approval procedures and continuous monitoring and documentation of water quality.

- In order to manage the groundwater barrier between fresh and saline water, proper implementation and enforcement of groundwater regulation to avoid unauthorised wells and control water extraction is important. Also, enforcing the obligation of enterprises to install green roofs and reservoirs for water storage would support the supply of seasonal rainfall water for recharge. Finally, fees for groundwater extraction might be necessary in order to support the implementation and continuous monitoring of any water management solution. Such steps might lead to conflicts with private water users and enterprises as this will have some immediate costs for them, while the benefits of such enforcement will only be visible in the longer run.

On this background, the recommendations for exploring and implementing SWS solutions in Pernambuco involve four main issues:

Adaptation to legislation on infiltration of water

The strict regulation on water quality before recharging it and on permission procedures necessitates a close dialogue with local authorities about the possibilities for SWS projects within the existing regulative framework. For example, the strict demands on water quality before recharging it does not take into account the efficient filtration process which the water undergoes when passing through the aquifer. About 60 to 90 days of aquifer passage is sufficient to remove the most resilient pathogens and other substances. Institutions consulted within SUBSOL seem generally open to review the relevant legislation if SWS pilot projects would deliver promising results to address problems with water supply in the region of Pernambuco.

More specifically, this includes adapting legal frameworks and permission procedures to facilitate implementation of innovative pilot projects and develop practical guidance for the implementation of SWS projects (including technology selection, tendering, operation and maintenance and licensing).

A pilot SWS project

In order to provide the needed documentation for the technical, economic and sanitary feasibility of artificial recharge with SWS schemes, and to test the ability of the aquifer to clean recharged water, an important first step would be to allow for a pilot study. This requires an exception from the current legal framework. The agencies APAC and CPRH have expressed openness towards such a pilot project to explore the potentials of a full scale implementation of SWS technologies.

The positive attitude shown by potential stakeholders towards the SWS technologies in the RMR creates a favourable framework for the realization of necessary pilot studies.

Elaborating an overview of available solutionss

In order to find solutions which fit the water issues, economy and institutional setup of Pernambuco, it is important to achieve an overview of available alternatives and their pros and cons.

Proper process

As water supply is a major issue for households as well as for industry and environment, there are many stakes involved. For example, any attempt to ensure a more stable supply of clean water will require investments, better enforcement of regulation and eventually fees. In order to ensure an efficient and legitimate process with local support and cooperation, and in order to ensure that the solution and particular details of implementation address the actual local needs, resources and institutional framework, it is vital to have a proper, inclusive process prior to decision making and implementation. That is, that all stakeholders and decision makers are properly informed about the alternatives and their pros and cons, that their concerns are addressed with proper information, and that they are involved in a debate about solutions. This may also prevent or reduce potential conflicts, for example about charging additional fees on users for irrigation water. Participatory Technology Assessment (pTA) is an efficient methodology to align water solutions with local needs and capacities and obtain the required dialogue.

The SUBSOL project

SUBSOL targets a market breakthrough of SWS as robust answers to freshwater resources challenges in coastal areas, by demonstration, market replication, standardization and commercialization. The route to market includes business cases, market scans and capacity building in selected regions in Europe [Mediterranean, Northwestern Europe) and worldwide [USA, Brazil, China, Vietnam). SUBSOL will share experiences and outcomes with stakeholder groups through an online platform which will be linked to existing networks, including EIP on Water.

The SUBSOL consortium combines knowledge providers, technology SMEs, consultants, and end-users from across Europe. Our ambition is to introduce a new way of thinking in terms of water resources management, promoting the sustainable development of coastal areas worldwide. This will stimulate economic growth and will create market opportunities and jobs for the European industry and SMEs.

Credits and disclaimer

This policy brief was produced by the Danish Board of Technology [DK) on the basis of the research and analysis by adelphi [GE) and ARCADIS [NL). The work involves meetings and interviews with key informants and a desk study.

The SUBSOL project is funded by the European Union's Horizon 2020 research and innovation programme. The views expressed in this brief do in no way reflect official opinion of the European Union.

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ARCADIS Design & Consultancy for natural and built assets

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Proteção das reservas hídricas de Pernambuco

Existe um assunto em crescimento sobre a gestão hídrica no Brasil. Conforme o contexto da análise dos problemas de fornecimento hídrica no marco legal e do informe em Pernambuco, desenhando particularmente na Região Metropolitana de Recife como caso piloto, os asociados do EU H2020 do projeto **'SUBSOL – bringing coastal SUBsurface water SOLutions to the market'** dsesenvolvendo um conjunto de recomendações para a proteção do futuro fornecimento de água doce.

RECOMENDAÇÕES

- Soluções Hídricas sub superficiais (SWS) capazes de abordar os problemas de gestão hídrica em Pernambuco. Além disso, são de baixo custo, baixa tecnologia e podem ser instalados em qualquer capacidade institucional local.
- As autoridades locais em Pernambuco estão cientes da urgência deste assunto e positivas em relação aos esquemas da SWS. Porém, um projeto piloto é necessário de qualquer forma para demostrar os benefícios e potencial em grande escala da implementação das tecnologias SWS.
- Como regulação de recarga do aquífero com água recuperada é muito estrito, implementação de sistemas SWS que precisa de filtragem cuidadosa da água recuperada, documentação continua e monitoramento da qualidade hídrica e eventualmente diálogo com as autoridades em relação ao espaço de manobra com a regulação existente.
- Com o objetivo de garantir um processo eficiente e legíti-mo contando com o suporte e a cooperação local e uma solução que se ajuste às necessidades e recursos locais, diálogo com todos os investidores e autoridades antes de tomar a decisão e implementar o projeto.

SUBSOL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642228

DESAFIOS DE FORNECIMENTO DE ÁGUA EM PERNAMBUCO

Uma combinação de pressões na água subterrânea faz com que a gestão de recursos hídricos tenha mais desa-fios na Região Metropolitana de Recife (RMR) e uma área maior de Pernambuco.

Crescimento contínuo populacional e atividades econômicas na região aumentam a pressão de recursos de água doce. Assim como, a escassez periódica de água doce devido às variações estacionais nas cachoeiras que tem piorado durante os últimos anos devido às alterações climáticas. Resultando na diminuição do nível de água subterrânea causando que a água do mar penetre na água subterrânea ao longo da costa. A pressão e a falta de controle com os recursos subterrâneos são incremen-tadas posteriormente devido à falta de implementação e aplicação de regulações de água subterrânea, liderando a extensão sem autorização das perfurações as quais estabelecem os poços hídricos privados. Devido a que a água subterrânea é a fonte principal de água doce na região, o baixo nível e qualidade da água subterrânea são problemas que precisam de soluções urgentes.

As autoridades na região de RMR estão cientes destes desafios e a gestão hídrica melhorada é uma das prioridades na agenda. Um número de medidas já foi tomado para mitigar a escassez das condições hídricas existen-tes e retomar o controle com a perfuração. Um número de poços privados na costa foi fechado, e em outras áre-as as autoridades providenciaram licenças para poços de bombeamento. A água de chuva é coletada em cisternas e infiltrada nas áreas de recolecção superiores para serem recarregadas no aquífero. Porém, a medida não coincide com o escopo do problema — o fornecimento hídrico permanece instável e insuficiente, os níveis de água subterrânea estão diminuindo[1].

SOLUÇÕES HÍDRICAS DE SUB SUPERFÍCIES

Soluções Hídricas de Sub Superfícies (SWS) oferecem uma série de soluções para problemas relacionados com recursos de água doce em áreas costeiras através da ges-tão avançada de água subterrânea (bombeamento, infil-tração, controle) o qual permite a proteção, alargamento e utilização sustentável de recursos de água doce. Com-binação de poços de extração e água salobra e infiltração (lagos) ou injeção (poços) de água doce que estejam sendo usados para o controle da posição da interface entre água doce e água salobra, desta forma são capazes de criar uma barreira contra a intrusão de água salgada e segurando os poços interiores de água doce. Além disso, permite o armazenamento de grandes volumes de escorrimento ou de água reciclada no subterrâneo para permitir um fornecimento estável de água durante o ano inteiro, independentemente das temporadas o alterações nos níveis de exploração, como por exemplo a agricultura e o turismo.

Os sistemas SWS abordam todos os principais problemas hídricos de Pernambuco e suas regiões conturbadas. Além disso, enquanto os sistemas de SWS trabalham através do estímulo natural da infiltração que protejam a disponibilidade de água limpa durante a temporada seca, já que requerem pouca energia em comparação a, por exemplo, a dessalinização das tecnologias, proporcionando um meio ambiente sustentável e alternativas de baixo custo para a gestão hídrica. Finalmente, os sistemas SWS precisam de pouca operação e manutenção, e podem ser facilmente implementados com a instituição existente e capacidades econômicas das autoridades de Pernambuco.

PERSPECTIVAS DE CAPTAÇÃO PARA OS SISTEMAS SWS

A unidade federativa de Pernambuco conta com a política em conformidade, com objetivos definidos e instrumentos legais para o estabelecimento de Gestão de Recursos Hídri-cos Integrados. A região RMR é relativamente politicamente estável e é uma área de interesse governamental, já que é um dos portos de turismo e comércio mais importantes.

A recarga artificial, a qual menciona especificamente a lei onde o governo deverá providenciar incentivos a entidades privadas devido à recarga artificial ao reduzir tarifas públicas. Esta lei também verifica a perfuração e fluxo de bombeamento. Porém, existe a necessidade da implementação melhorada e de regulações de água subterrânea para controlar a sobre exploração. A municipalidade de Recife, conforme a lei de 2015 obriga as novas companhias com mais de 500 m^2 para instalar telhados verdes e reservas para armazenamento hídrico. Este é um passo em rela-ção à implementação da recarga aquífera com a chuva de temporada.

Desta forma, mesmo com um marco legal que está cor-rendo atualmente é muito proibitiva pois coloca condições estritas para implementar os esquemas SWS, a avaliação mostra que as autoridades parecem estar cientes dos desa-fios e estão dispostas ao dialogo que possa criar benefícios potenciais aos esquemas de SWS para abordar os mesmos.

[1] adelphi: Lessons learned from trust building activities. (Lições aprendidas de atividades de reforço de confiança) Relatório do projeto EU H2020 SUBSOL. Dezembro 2017.

[2] Pernambuco Decreto n20.423, Art. 72.

Assim, porém, alguns obstáculos requerem atenção:

- A legislação atual em relação aos recursos naturais permitem a recarga de aquíferos apenas sob certas condições estritas. Água que será injetada deverá ter alta qualidade para não ameaçar o estado ecológico da água nas reservas e nos aquíferos. Além disso, com o objetivo de obter a autorização da Agência Pernambucana de Águas e Clima [APAC] e a Agência Estadual de Meio Ambiente [CPRH], e mostra compulsoriamente a viabilidade técnica, econômica e sanitária da recarga artificial de aquíferos para garantir a preservação da qualidade da água subterrânea continua[2]. Isso requer um procedimento de aprovação complexo e continuo monitoramento e documentação da qualidade hídrica.

- Com o objetivo de gerir a barreira de água subterrâ-nea fresca e salina, a implementação apropriada e o reforço da regulação de água subterrânea para evitar poços sem autorização e extração de controle hídrico que é importante. Além disso, forçar a obrigação das companhias a instalar os telhados verdes e reservas de armazenamento hídrico que irá fornecer suporte durante a recarga de água de chuva de temporada. Finalmente, as tarifas de extração de água subterrânea podem ser necessárias para apoiar a implementação e o monitoramento contínuo de qualquer solução de ges-tão hídrica. Ditos passos devem liderar conflitos com usuários de água privada e companhias que tenham custos imediatos, enquanto os benefícios de dito refor-ço será visível apenas a longo prazo.

Neste contexto, as recomendações para a exploração e implementação de soluções de SWS em Pernambuco envolvem quatro assuntos principais:

Adaptação à legislação de água de infiltração

A estrita regulação sobre qualidade hídrica antes de recarrega-lo e os procedimentos de permissão permitem um diálogo próximo com as autoridades locais sobre as possibilidades para os projetos da SWS dentro do marco de regulação existente. Por exemplo, as demandas estri-tas de qualidade hídrica antes da recarga não levam em consideração o processo de filtração eficiente onde a água passa através do aquífero. Entre 60 a 90 dias de passa-gem de aquífero são suficientes para remover os mais resistentes patógenos e outras substâncias. As institui-ções consultadas dentro do SUBSOL parecem geralmente abertas a revisar a legislação relevante se os projetos pilotos de SWS entregam resultados promissores para abordar os problemas de fornecimento hídrico na região de Pernambuco. Especificamente, isso inclui adaptar mar-cos legais e procedimentos de permissão para facilitar a implementação de projetos inovadores pilotos e desenvol-vimento de liderança pratica para a implementação dos projetos SWS [incluindo a seleção tecnológica, licitações, operações e manutenção, assim como licenciamento].

Um piloto do projeto SWS

Com o objetivo de providenciar a documentação neces-sária para a viabilidade técnica, econômica e sanitária da recarga artificial com os esquemas SWS, e para testar a habilidade do aquífero de limpar a agua recarregada, um passo importante é necessário para permitir o estudo de piloto. Este requer uma exceção de dito marco legal. As agências APAC e CPRH expressaram abertura em relação ao projeto piloto para explorar potencialmente uma imple-mentação a escala total das tecnologias SWS.

A atitude positiva mostrada pelos investidores potenciais sobre as tecnologias SWS no RMR cria um marco favorável para a realização de estudos pilotos necessários.

Elaboração de uma visão geral das soluções disponíveis

Com o objetivo de encontrar soluções adequadas para os problemas hídricos, econômicos e institucionais ajustados em Pernambuco, é importante conseguir uma visão geral das alternativas disponíveis com seus pros e cons.

Processos Adequados

Como o fornecimento hídrico é um problema maior nas residências assim como na indústria e no meio ambien-te, existem muitos detalhes envolvidos. Por exemplo, qualquer tentativa de garantir uma forma mais estável de fornecer água limpa que irão requerer investimentos, melhor seguimento da regulação e eventualmente tarifas. Com o objetivo de garantir um processo eficiente e legitimo com apoio local e cooperação, para garantir a solução e detalhes particulares da implementação que aborda as necessidades locais, marco institucional e de recur-sos, que é vital para obter, inclusivamente um processo antes da toma de decisões e implementação. Desta forma, todos os investidores e tomadores de decisão se encon-tram devidamente informados sobre as alternativas e seus pros e contras, suas preocupações foram abordadas com a devida informação, e eles estão envolvidos no debate de soluções. Isso pode prever ou reduzir conflitos potenciais, por exemplo a carga adicional de tarifas em usuários para irrigação de água. Avaliação Tecnológica de Participação [pTA] é uma metodologia eficiente para alinhar as soluções hídricas com as necessidades e capacidades locais para obter o diálogo necessário.

O Projeto SUBSOL

O SUBSOL tem como alvo a entrada no mercado de SWS como resposta para os desafios de água doce nas áreas costeiras ao demostrar, replicar o mercado, padronizar e comercializar. A rota do mercado inclui casos de negócios, escâneres de mercado, capacidade de construção e solução adaptada, desenvolvimen-to nas regiões selecionadas na Europa [Mediterrâneo, Nordeste Europeu) e globalmente [USA, Brasil, China, Vietnam). SUBSOL irá dividir experiências e resultados com grupos de investidores através de uma plataforma online que estará vinculada com as redes existentes, incluindo EIP na ÁGUA.

O consórcio SUBSOL combina conhecimento dos for-necedores, tecnologia das SMEs, consultores e utiliza-dores finais através de Europa. Nossa ambição é introdu-zir uma nova forma de pensamento em termos de gestão de recursos hídricos, promovendo o desenvolvimento sustentável das áreas costeiras mundialmente. Isso irá estimular um crescimento econômico ao garantir o for-necimento hídrico seguro e eficiente em nível de custo.

Créditos e Isenção de Responsabilidade

Este informe sobre políticas foi produzido pela Junta de Tecnologia Dinamarquesa [DK) com base na pesquisa e na análise de adelphi [GE) e ARCADIS [NL). O trabalho inclui reuniões e entrevistas com os informantes chave no estudo de escritório.

O projeto SUBSOL está fundado no Horizonte da União Europeia 2020 do programa de inovação e pesquisa. Os pontos de vista expressados neste informe de forma que reflitam a opinião oficial da União Europeia.

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FONDEN TEKNOLOGI RÅDET
DANISH BOARD OF TECHNOLOGY FOUNDATION

Safeguarding the water reserves of Laizhou Bay

Water management is a growing issue in Laizhou Bay in China. Based on an analysis of the water supply issues and the legal and policy framework in Laizhou Bay, partners in the EU H2020 project **'SUBSOL – bringing coastal SUBsurface water SOLutions to the market'** have developed a set of recommendations to safeguard the future supply of freshwater.

RECOMMENDATIONS

- Subsurface Water Solutions (SWS) are capable of addressing the water management issues of Laizhou Bay. Moreover, they are low-cost, low-tech and can be adapted to the local institutional capacity.
- The local authorities in Laizhou Bay are aware of the urgency of the issue and positive towards SWS schemes. A pilot project is however needed to demonstrate the benefits and potential of a full scale implementation of SWS technologies.
- To ensure implementation of SWS technology, further clarification is needed on the legal framework regarding groundwater management. Additionally, the institutional organization of groundwater management needs to be clearer.
- In order to ensure an efficient and legitimate process with local support and cooperation and a solution that is adjusted to local needs and resources, dialogue with all stakeholders and authorities prior to decision making and implementation is core

SUBSOL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642228

WATER SUPPLY CHALLENGES IN LAIZHOU BAY

The Laizhou Bay area suffers from the most severe saltwater intrusion in China. Salinity is caused by both saltwater intrusion, as well as upwelling of ancient brine deposits. Saltwater intrusion has worsened over the last decades mainly as a result of population growth and steady economic development. This puts available water resources even more under pressure because of higher water demand and over-abstraction of groundwater.

In the North and East of China, salinization of groundwater affects around 38 million people. Additionally, climate change is beginning to show an impact. In the upper reaches of the Yellow River Basin, rainfall is predicted to fall by up to 15%, and more intense local rainfall alternating with longer dry spells is expected. Climate change will also increase the occurrence of extreme weather events, e.g. storm surges which increases saltwater intrusion, and increase temperature and precipitation uncertainties.

The issue of saltwater intrusion in the Laizhou Bay area has been recognized by authorities for about forty years. Local economies are considerably constrained by sali-nized groundwater and a lot of effort has been devoted to mitigate this issue (e.g. several subsurface barriers and enhancement of riverbed infiltration).

The water resources management strategy established by the Chinese government in 2009 recognised "the importance of water for China's future sustainable development as well as prosperity" . The Chinese government seems keen to try and implement innovative technologies if they are perceived as having a high potential. Concerns about over-abstraction mean that new wells and boreholes for agriculture and industry will not be permitted in aquifers that are deemed to be fully exploited. Deep groundwater aquifers will be held as strategic reserves as well as for emergencies."[2]

SUBSURFACE WATER SOLUTIONS

Subsurface Water Solutions (SWS) offer a series of solutions to freshwater resources problems in coastal areas by means of advanced groundwater management (pumping, infiltrating, controlling) which enables protection, enlargement and sustainable utilization of fresh water resources.

Combinations of wells extracting brackish water and infiltration (ponds) or injection (wells) of fresh water are used to control the position of the interface between fresh and brackish water, thereby creating a barrier against further saltwater intrusion and securing the freshwater wells inwards. Moreover, it enables storage of large volumes of run-off or recycled water in the underground in order to ensure a stable water supply year-round, irrespective of seasons and shifting levels of exploitation, e.g. from agriculture and tourism.

SWS systems address all of the main water issues of Laizhou Bay and the wider region. Moreover, while SWS systems work by stimulating natural infiltration to secure the availability of clean water during the dry season, and as they require little energy to run compared to e.g. desalination technologies, they provide environmentally sustainable and low-cost alternatives for water management. Finally, as SWS systems require little operation and maintenance, they can be easily implemented with the existing institutional and economic capacities of authorities in Laizhou Bay.

1 GWP (2015).

2 GWP (2015).

3 Wang et al. (2007).

4 Water Law of the People's Republic of China: http://www.npc.gov.cn/englishnpc/Law/2007-12/12/content_1383920.htm

5 Wang et al. (2007).

6 Bin and Speed (2009).

PERSPECTIVES FOR THE UPTAKE OF SWS SYSTEMS

All contacted stakeholders unanimously confirm that salt-water intrusion is a huge issue in the Laizhou Bay area and agree that additional remediation measures must be initiated. Many resources have been devoted to alternative measures to deal with saltwater intrusion in the area. In contrast to large centralised measures to counter saltwater intrusion, SWSs hold potential to empower specific end-users, e.g. in agriculture and horticulture to participate in the groundwater resources management and exercise more control and ownership, in order to promote more sustainable agribusinesses along the Chinese coast. SWSs offer a decentralised and environmentally-friendly solution for the end-users in coastal regions that are affected by salinization.

Water resources are owned by the state. Hence, all property rights to groundwater resources belong to the state, meaning that "the right to use, sell and/or charge for water ultimately rests with the government"[3]. Water abstractors must pay a water resource fee, which varies between regions depending on local water resources and economic conditions. The 2002 Water Law is China's key water legislation and includes provisions on water abstraction rights (Article 7], stating that: "the law does not allow groundwater extraction if pumping is harmful to the long run sustainability of groundwater use"[5].

The Ministry of Water Resources has the main responsibility for water resources management, and more specifically for the management of abstraction permits[6]. Other ministries involved to manage water-related issues include the Ministry of Land and Resources, the Ministry of Environmental Protection and the Ministry of Housing, Urban and Rural Development:

The recommendations for exploring and implementing SWS solutions in the Laizhou Bay area involve three main issues:

Clarification of legal framework for SWS implementation

There is a lack of official laws and policy measures specific to groundwater management, and the legal framework for implementation of SWSs remains unclear. At the national level, there is not one water regulation that is specifically focused on groundwater management. This results in laws not always being enforced, which also highlights the need for including local authorities in the decision-making process to strengthen their abilities to enforce existing legislation.

A pilot SWS project

In order to provide the needed documentation for the technical, economic and sanitary feasibility of artificial re-charge with SWS schemes, and to test the ability of the aquifer to clean recharged water, an important first step would be to allow for a pilot study. A SUBSOL pilot project could possibly be developed in the Laizhou Bay area under the auspices of the Water Resources Research Institute of Shandong Province (WRISD]. Private companies may be prospective end-users if the financial viability of SWS technologies, ideally in conjunction with rainwater harvesting, can be demonstrated.

Local stakeholders proposed the following cities as potential sites for SWS technology implementation: Longk-ou, Laizhou, Changyi, Shouguang, Binhai as well as near-coast areas in the south of Laizhou Bay. Furthermore, the entire Yantai peninsula may hold favourable conditions for the implementation of SWSs, with the project possibly being developed under the auspices of the Yantai Institute of Coastal Zone Research.

Proper process

As water supply is a major issue for households as well as for industry and environment, there are many stakes involved. For example, any attempt to ensure a more stable supply of clean water will require investments, better enforcement of regulation and eventually fees. In order to ensure an efficient and legitimate process with local support and cooperation, and in order to ensure that the solution and particular details of implementation address the actual local needs, resources and institutional framework, it is vital to have a proper, inclusive process prior to decision making and implementation.

The SUBSOL project

SUBSOL targets a market breakthrough of SWS as robust answers to freshwater resources challenges in coastal areas, by demonstration, market replication, standardization and commercialization. The route to market includes business cases, market scans, capacity building and adaptive solution development in selected regions in Europe (Mediterranean, Northwestern Europe) and worldwide (USA, Brazil, China, Vietnam). SUBSOL will share experiences and outcomes with stakeholder groups through an online platform which will be linked to existing networks, including EIP on Water.

The SUBSOL consortium combines knowledge providers, technology SMEs, consultants, and end-users from across Europe. Our ambition is to introduce a new way of thinking in terms of water resources management, promoting the sustainable development of coastal areas worldwide. This will stimulate economic growth by ensuring a safe and cost efficient water supply.

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FONDEN TEKNOLOGI RÅDET

DANISH BOARD OF TECHNOLOGY FOUNDATION

Safeguarding the water reserves of Cyprus

Water management is a growing issue in Cyprus. On the background of an analysis of the water supply issues and the legal and policy framework in Cyprus, partners in the EU H2020 project **'SUBSOL – bringing coastal SUBsurface water SOLutions to the market'** have developed a set of recommendations to safeguard the future supply of freshwater.

RECOMMENDATIONS

- The water policy in Cyprus needs to focus on secure and sustainable measures for additional sources of supply. Subsurface Water Solutions (SWS) are capable of addressing the water management issues of Cyprus, and they are low-cost and low-tech and fit the local institutional capacity.
- The implementation of SWS schemes requires an efficient strategy for collecting sufficient amounts of reclaimed water for recharge. Further, as SWS schemes work by controlling groundwater, implementation requires more data on hydrology and enforcement of more stringent rules about illegal groundwater extraction.
- Documentation of water quality is important for stakeholders when making decisions about groundwater recharge – and even more when using reclaimed water.
  Also, a large-scale implementation of SWS schemes should be accompanied with continuous monitoring of the water quality.
- In order to provide documentation of the efficiency of SWS schemes and of the resulting water quality – and in order to adjust a potential implementation of SWS schemes to the geology, water use, needs and legal framework of Cyprus – it is recommended to develop a pilot project.
- As several aquifers are shared between the areas of the Republic of Cyprus in which the government of the Republic of Cyprus exercises effective control and the areas in which it does not exercise effective control, implementation of SWS schemes – whether on a pilot- or large scale – will benefit from partnerships encouraging some level ofcooperation between the two areas.

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WATER SUPPLY CHALLENGES IN CYPRUS

Rising demands for water has caused water scarcity in Cyprus for decades and water stress is currently the highest of any country in Europe. Often, the Cypriot government imposes emergency measures including the reduction of domestic water supply. The climate in Cyprus is semi-arid and the island has no perennial streams. Thus, the main water source is groundwater bodies and dams, but overexploitation of groundwater, among other things from irrigation, causes salinization from seawater intrusion. Consequently, many wells in Cyprus' western aquifers have been abandoned due to saline contamination. In addition, urbanization and agricultural activities have led to excessive nitrate concentration. As a consequence, approximately one quarter of the groundwater bodies is at risk. Basically all sectors are affected by water scarcity with agriculture suffering the most.

In Cyprus' larger urban areas, most water is supplied by desalinisation, and the sewerage board of Nicosia utilises treated wastewater for irrigation which is economically competitive. Water for agricultural purposes is mostly retained in private small-scale reservoirs. In 2016, a freshwater pipeline from Turkey has been delivering freshwater to the areas of the Republic of Cyprus in which the government of the Republic of Cyprus does not exercise effective control. In the long run, the pipeline may also affect water supply in the rest of the Republic of Cyprus.

Subsurface storage pilot projects have been performed on the island, e.g. in South-Eastern Mesaoria (Kokkinochoria) aquifer. It was not successful, though, due to lack of sources for recharge. The planned source for recharge – reclaimed wastewater produced at Agia Nappa-Paralimni treatment plant – was all used for irrigation.

SUBSURFACE WATER SOLUTIONS

Subsurface Water Solutions (SWS) offer a series of solutions to freshwater resources problems in coastal areas by means of advanced groundwater management (pumping, infiltrating, controlling) which enables protection, enlargement and sustainable utilization of fresh water resources. Combinations of wells extracting brackish water and infiltration (ponds) or injection (wells) of fresh water are used to control the position of the interface between fresh and brackish water, thereby creating a barrier against further saltwater intrusion and securing the freshwater wells inwards. Moreover, it enables storage of large volumes of run-off or recycled water in the underground in order to ensure a stable water supply year-round, irrespective of seasons and shifting levels of exploitation, e.g. from agriculture and tourism.

SWS systems address all of the main water issues of Cyprus. Moreover, while SWS systems work by stimulating natural infiltration to secure the availability of clean water during the dry season, and as they require little energy to run compared to for example desalination technologies, they provide environmentally sustainable and low-cost alternatives for water management. Finally, as SWS systems require little operation and maintenance, and they can be easily implemented with the existing institutional and economic capacities of authorities in Cyprus.

PERSPECTIVES FOR THE UPTAKE OF SWS SYSTEMS

Finding solutions to groundwater scarcity and saline water intrusion is high on the agenda of local authorities. With the 2010 Law for Water Management, the legal framework for various activities of the Water Development Department (WDD) was established. The WDD is present in the whole life-cycle of water management as authority and as the consultant to local and regional authorities. The main objective of water policy implemented by the WDD is to enhance the national development and sustainable management of water resources in Cyprus. The law harmonised the Cyprus legislation with the European Water Framework Directive which aims to protect all reserves of freshwater by certifying reduction and control of pollution. Consequently, the legal and policy context seems conducive to implementation of SWS schemes in Cyprus.

There are, however, some obstacles that require attention:

- Due to the current tension between the areas of the Republic of Cyprus in which the government of the Republic of Cyprus exercises effective control and the areas in which it does not exercise effective control, there is a lack of cooperation to share data between both sides. This might be a challenge regarding implementation of a pilot project as some of the relevant areas are joint aquifers.
- One main barrier for the implementation of SWS schemes is the lack of sources for recharge. Since rainwater is already used very efficiently, the only available sources of water for aquifer recharge in Cyprus would be treated wastewater or desalinated water from temporary overproduction in certain operation periods of the desalination plants.
- There is a persistent stakeholder opposition to groundwater recharge due to concerns about water quality and pollution. In addition, farmers (who possess the majority if the SWS relevant areas) mistrust the official water quality guarantees, and they have refused to inject treated wastewater into their aquifer. Because of the opposition, reclaimed water not used for irrigation in the winter period is currently being discharged to the sea. SWS could help in this regard with soil passage treatment.
- No particular conflicts between water users and authorities have been identified. However, issues of economic feasibility in the long-term planning might potentially give rise to conflict.

On this background, the recommendations for exploring and implementing SWS solutions in Cyprus involve four main issues:

Strategy for collection of reclaimed water, more data and legal enforcement

An implementation of SWS schemes will require an efficient strategy to collect sufficient amounts of reclaimed water for recharge. Specific areas with availability are to be identified and feasibility studies elaborated laying a focus on water quality criteria. Moreover, controlling the groundwater levels will require more in depth monitoring studies and enforcement of stringent rules to make use of the resources more efficiently.

Documentation and monitoring of water quality

In order to take stakeholder concerns about water quality into account, and in order to provide the required information in order to get access to the SWS relevant areas mostly owned by farmers, it is important to document the water quality of reclaimed water, both before and after infiltration. A pilot project would prove useful for this. Also, a large-scale implementation of SWS schemes should be accompanied with continuous monitoring of the water quality.

Encourage cooperation

As several aquifers are shared between the areas in the Republic of Cyprus in which the government of the Republic of Cyprus exercises effective control and the areas in which it does not exercise effective control, implementation of SWS schemes – whether on a pilot- or large scale – will benefit from partnerships encouraging some level of cooperation between the areas.

A pilot SWS project

In order to provide documentation of the efficiency of SWS schemes and of the resulting water quality – and in order to adjust a potential implementation of SWS schemes to the geology, water use, needs and legal framework of Cyprus – it is recommended to develop a pilot project based on an extensive feasibility study. The project should be formulated by site partners, local authorities and stakeholders. The pilot project should involve a participatory stakeholder involvement approach including a stakeholder workshop in order to ensure that the project addresses the issues of importance and concern for local authorities, users and other stakeholders, and to identify potential issues of importance to the implementation of a large-scale project.

The SUBSOL project

SUBSOL targets a market breakthrough of SWS as robust answers to freshwater resources challenges in coastal areas, by demonstration, market replication, standardization and commercialization. The route to market includes business cases, market scans, capacity building and adaptive solution development in selected regionsin Europe (Mediterranean, Northwestern Europe) and worldwide (USA, Brazil, China, Vietnam). SUBSOL will share experiences and outcomes with stakeholder groups through an online platform which will be linked to existing networks, including EIP on Water.

The SUBSOL consortium combines knowledge providers, technology SMEs, consultants, and end-users from across Europe. Our ambition is to introduce a new way of thinking in terms of water resources management, promoting the sustainable development of coastal areas worldwide. This will stimulate economic growth by ensuring a safe and cost efficient water supply.

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Safeguarding the water reserves of Baja California

Water management is a growing issue in Baja California in Mexico. On the background of an analysis of the water supply issues and the legal and policy framework in Mexico and Baja California, drawing particularly on Maneadero as a pilot case, partners in the EU H2020 project SUBSOL **– bringing coastal SUBsurface water SOLutions to the market have developed a set of recommendations to safeguard the future supply of freshwater.**

RECOMMENDATIONS

- The local authorities in Baja California are aware of the urgency of the issue, but not of all the alternatives available to address them. They will benefit from being presented to available solutions and their pros and cons.
- Subsurface Water Solutions are capable of addressing all water management issues of Baja California, they are low-cost and low-tech and they fit the local institutional capacity.
- As regulation for aquifer recharge with reclaimed water is very strict, implementation of SWS systems requires careful treatment of reclaimed water, continuous documentation and monitoring of the water quality and eventually close dialogue with authorities about the room of maneuver within existing regulation.
- In order to ensure an efficient and legitimate process with local support and cooperation, and a solution that is adjusted to local needs and resources, dialogue with all stakeholders and authorities prior to decision making and implementation is core.

SUBSOL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642228

BACKGROUND

Water resources management is a major challenge in Baja California. Improved water supply has become an important priority on the national as well as on the regional agenda. Due to excessive groundwater extraction and drought, the water table has dropped 1.6 metres in the past 10 years. Further, salinization of groundwater along the coast has caused wells to close. As a result, many areas of Baja California do not have sufficient water supply to support economic development. In Maneadero the primary water source is groundwater, 75% of which is used for agriculture. 1000 ha of agricultural land has till now been taken out of production. Saliniza-tion of the groundwater is also a concern for environmental NGOs who fear the effect on the rich coastal wildlife in Baja California.

Regional authorities are aware of the problem, and a number of initial steps have been taken to address it. A few reservoirs have been constructed to store reclaimed water from a wastewater treatment plant in Ensenada, and some of the treated wastewater is reused for irrigation of non-edible crops (flowers, animal feed crops etc.). But as water reservoirs take up valuable space, which is preferably used for production purposes, this solution has only brought 100 ha back into production. Furthermore, a desalination plant using Reverse Osmosis to serve domestic purposes will open in Ensenada by 2017, and more plants are in the pipeline. However, Reverse Osmosis is very costly and hence not affordable by smaller farmers, and it tends to provoke further intrusion of seawater in the groundwater.

SUBSURFACE WATER SOLUTIONS

Subsurface Water Solutions (SWS) offer a series of solutions to freshwater resources problems in coastal areas by means of advanced groundwater management (pumping, infiltrating, controlling) which enables protection, enlarge-ment and sustainable utilization of fresh water resources. Combinations of wells extracting brackish water and infiltration (ponds) or injection (wells) of fresh water are used to control the position of the interface between fresh and brackish water, thereby creating a barrier against fur-ther saltwater intrusion and securing the freshwater wells inwards. Moreover, it enables storage of large volumes of run-off or recycled water in the underground in order to ensure a stable water supply year-round, irrespective of seasons and shifting levels of exploitation, e.g. from agri-culture and tourism.

SWS systems address all of the main water issues of Baja California. Moreover, while SWS systems work by stimu-lating natural infiltration to secure clean irrigation water, and as they require little energy to run compared to for example desalination technologies, they provide environ-mentally sustainable and low-cost alternatives for water management. Furthermore, as SWS systems are low-tech, they can be adapted to shifting economic frameworks and environmental requirements. Taken together, SWS systems are highly compatible with the institutional and economic capacity in Baja California.

[1] See for example the National Development Plan 2013-2018 (Gobierno Federal (2013) Plan nacional de desarrollo 2013-2018. Gobierno Federal) and the Water Agenda 2030 (CONAGUA. (National Water Comission) (2011) Agenda del Agua 2030. CONAGUA).

[2] Requisitos para la recarga artificial de acuíferos con agua residual tratada Norma Oficial Mexicana NOM-014-CONAGUA-2003. Diario Oficial de la Federa-ción. 3 Junio 2008. [Mexican Official Norm – Requirements for aquifer artificial recharge with reclaimed water]

[3] Gobierno del Estado Baja California (2014) Plan Estatal de Desarrollo. Gobierno del Estado Baja California

[4] NOM-014-CONAGUA-2003 (see above).

[5] NOM-014-CONAGUA-2003 (see above). Diario Oficial de la Federación. 3 Junio 2008. [Mexican Official Norm – Requirements for aquifer artificial recharge with reclaimed water.

PERSPECTIVES FOR THE UPTAKE OF SWS SYSTEMS

Water issues have gained increasing priority in the Mexican national plans over the last decade[1], and wastewater reuse is promoted in a set of official guidelines[2]. On the regional level, water sustainability and aquifier recharge is given high priority in diverse sections of the Baja California State Development Plan 2014-2019[3].

There are, however, some obstacles that require attention:

- The legal frameworks[4] allowing use of treated wastewater for irrigation and aquifer recharge are very strict. Recharge is only allowed for treated water fulfilling the physico-chemical characteristics of drinking water quality[5].
- Farmers who produce high value crops for exportation, mainly to the USA, are reluctant to use treated wastewater for irrigation as they are concerned about the possible presence of pathogens in reclaimed water and about the acceptance of crops which have been irrigated with treated wastewater.
- The desalination technique reverse osmosis is currently given strategic focus in the water resource plans in Baja California. Institutions interviewed by the SUBSOL team were open for presentations about SWS systems, yet not fully aware of the potential of such technologies in terms of lower costs and better sustainability in comparison to desalination techniques.
- There may be a potential conflict between authorities and users about the distribution of costs of improved water supply. Conflicts have already arisen in the past regarding fees and investment costs required for the connection of farmland to the pipe system from Ensenada for reuse of treated wastewater.

On this background, the recommendations for exploring and implementing SWS solutions in Baja California involve four main issues:

Adaptation to legislation on reclaimed water

The strict regulation on water quality before recharging it in the underground does not take into account of the efficient natural treatment process which the water undergoes when passing through the aquifer. A close dialogue with local authorities is needed about the possibility of SWS projects within the regulative framework. A pilot project would be helpful to demonstrate that (1) ambient water quality of the aquifer does not deteriorate when infiltrating treated wastewater, and (2) the aquifer provides sufficient natural treatment capacity to comply with the required standards for irrigation water use.

Communication, documentation and monitoring

An aquifier recharge pilot will have to go hand in hand with careful communication and monitoring. Potential users (and also important food safety regulation institutions, such as SENASICA in the case of Mexico and the FDA in the case of USA) need to be well informed on the actual process and potential of SWS. This includes the water quality obtained, the suitability of the water for irrigation, the potential of SWS systems to reduce the current pressure on groundwater, and the tangible economic benefits, such as cost savings compared to other solutions like Reverse Osmosis.

Continuous monitoring, documentation and communication of the water quality may be important in order to build trust among users, key customers of agricultural products and authorities. This will require some level of capacity building of the research and scientific monitoring resources in Maneadero.

Informing decision makers on available solutions

While regional and local decision makers alike are aware of the urgent need to find solutions for future water supply in Baja California, it is important to make sure that they are aware of the available alternatives and their pros and cons in order to make choices that fit the local needs and economic and institutional framework.

Proper process

In order to ensure an efficient and legitimate process with local support and cooperation, and in order to ensure that the solution and particular details of implementation address the actual local needs, resources and institutional framework, it is core to have a proper process prior to decision making and implementation. That is, ensure that all stakeholders and decision makers are properly informed about the alternatives and their pros and cons, that their concerns are addressed with proper information, and that they are involved in a debate about solutions. Participatory Technology Assessment (pTA) is an efficient methodology to align water solutions with local needs and capacities and obtain the required dialogue.

The SUBSOL project

SUBSOL targets a market breakthrough of SWS as robust answers to freshwater resources challenges in coastal areas, by demonstration, market replication, standardization and commercialization. SUBSOL will share experiences and outcomes with stakeholder groups through an online platform which will be linked to existing networks.

The SUBSOL consortium combines knowledge providers, technology SMEs, consultants, and end-users from across Europe. Our ambition is to introduce a new way of thinking in terms of water resources management, promoting the sustainable development of coastal areas worldwide.

Credits and disclaimer

This policy brief was produced by the Danish Board of Technology [DK] on the basis of the research and analysis by adelphi [GE] and ARCADIS [NL]. The work involves meetings and interviews with key informants, a desk study and a stakeholder workshop in Maneadero.

The SUBSOL project is funded by the European Union's Horizon 2020 research and innovation programme. The views expressed in this brief do in no way reflect official opinion of the European Union.

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Preservación de las reservas de agua de Baja California

La gestión del agua supone un problema cada vez mayor en Baja California (México). Trasfondo sobre un análisis de los problemas de suministro de agua y el marco legal y político de México y Baja California, incidiendo en Maneadero como caso piloto, los socios de Horizon 2020 de la Unión Europea en el proyecto **SUBSOL (SUBsurface Water SOLutions en inglés, «Soluciones de Agua bajo la Superficie»)** han elaborado unas recomendaciones para la preservación de futuros suministros de agua dulce.

RECOMENDACIONES

- Las autoridades locales de Baja California son consci-entes de la importancia del problema, pero no de todas las alternativas disponibles para abordarlo. La present-ación servirá para mostrar las soluciones disponibles y sus ventajas e inconvenientes.
- Subsurface Water Solutions es capaz de abordar todos estos problemas de gestión en Baja California, los costes no son elevados ni sofisticados y se ajustan a la capacidad institucional local.
- Puesto que la recarga de acuíferos con agua reutilizada es muy estricta, la implementación de los sistemas de SWS requiere de un tratamiento cuidadoso de dicha agua, una documentación de forma continua y una monitorización de la calidad del agua. También habrá que dialogar con las autoridades en relación al margen de maniobra dentro de la regulación existente.
- Será fundamental conversar con las autoridades e inversores antes de tomar una decisión y asegurar un proceso legítimo y eficiente con el respaldo y cooperación locales para encontrar así una solución que se ajuste a los recursos y necesidades locales.

SUBSOL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642228

TRASFONDO

La gestión de los recursos de agua supone un reto muy im-portante en Baja California. Mejorar el suministro de agua se ha convertido en una prioridad tanto a nivel nacional como regional. Las sequías y constantes extracciones de agua subterránea han provocado que el nivel freático haya descendido 1,6 metros en los últimos 10 años. Además, la salinización del agua subterránea por la costa ha provo-cado el cierre de varios pozos. Así pues, muchas zonas de Baja California no disponen de suministro de agua para ayudar al desarrollo económico. En Maneadero, la principal fuente de agua proviene del agua subterránea y un 75 % de esta se emplea para la agricultura. A día de hoy, ya son 1000 hectáreas de tierras agrícolas las que se han vis-to obligadas a detener su producción. La salinización del agua subterránea también preocupa a las ONG medioam-bientales, que temen los efectos que podría ocasionar en la rica fauna costera de Baja California.

Las autoridades regionales están al tanto del problema y ya se han tomado una serie de medidas iniciales para abordarlo. Se han construido varios depósitos para acumu-lar agua reutilizada proveniente de la planta de tratamien-to de agua residual de la ciudad de Ensenada. Además, parte de esta agua tratada se está empleando para el riego de cultivos no comestibles (flores, cultivos para animales, etc.). No obstante, pese a que los depósitos de agua ocu-pan un valioso espacio (que se emplea, preferiblemente, para la producción), esta solución solo ha vuelto a poner en marcha 100 hectáreas de producción. Por otro lado, una planta desalinizadora por medio de ósmosis inversa abrirá sus puertas en Ensenada en 2017 a nivel doméstico y hay más plantas en desarrollo. Sin embargo, la ósmosis inversa es una práctica de purificación del agua muy cos-tosa que no está al alcance de los pequeños agricultores y, además, esta tiende a provocar la introducción del agua marina en el agua subterránea.

SUBSURFACE WATER SOLUTIONS

Subsurface Water Solutions (SWS) ofrece una serie de soluciones _____ para los problemas de suministro de agua dulce en zonas costeras a través de una gestión avanzada del agua subterránea (bombeo, infiltración y control) que permite la preservación, el aumento y el empleo sostenible de los recursos de agua dulce. Las combinaciones de los pozos de extracción de agua salobre con la infiltración (es-tanques) o la inyección (pozos) de agua dulce se emplea para controlar la posición de un punto de conexión entre el agua dulce y la salobre, creando, de este modo, una barre-ra contra la intrusión del agua salada en los pozos de agua dulce. Además, permite el almacenamiento de grandes volúmenes de agua de escorrentía o reutilizada bajo tier-ra para asegurar un suministro anual estable de agua, sin tener en cuenta las estaciones y modificando los niveles de explotación, como para la agricultura y el turismo.

Los sistemas SWS se encargan de tratar todos los prob-lemas principales relacionados con el agua en Baj California. Por si fuera poco, además de que los siste-mas SWS estimulan la infiltración natural para asegurar la irrigación de agua limpia y requieren poca energía en comparación a la tecnología de desalinización, ofrecen alternativas respetuosas con el medio ambiente y poco costosas para la gestión del agua. Los sistemas SWS no son demasiado sofisticados, por lo que pueden adaptarse a diferentes marcos económicos y requisitos medioambien-tales. En definitiva, los sistemas SWS son muy compatibles con las capacidades económicas e institucionales de Baja California.

[1] Veamos, por ejemplo, el Plan Nacional de Desarrollo 2013-2018, del Gobierno Federal (2013), y la Agenda del Agua 2030 (CONAGUA, Comisión Nacional del Agua 2011).

[2] Requisitos para la recarga artificial de acuíferos con agua residual tratada Norma Oficial Mexicana NOM-014-CONAGUA-2003. Diario Oficial de la Federación. 3 de junio de 2008.

[3] Gobierno del estado de Baja California (2014). Plan Estatal de Desarrollo. Gobierno del estado de Baja California.

[4] NOM-014-CONAGUA-2003 (ver a continuación).

[5] NOM-014-CONAGUA-2003 (ver a continuación). Diario Oficial de la Federación. 3 de junio de 2008. Norma Oficial Mexicana: requisitos para la recarga artificial de acuíferos con agua residual tratada.

PERSPECTIVAS DE USO DE LOS SISTEMAS SWS

Solucionar los problemas de agua se ha convertido en una prioridad en la agenda nacional mexicana a lo largo de la última década[1], de modo que se promueve la reutilización de agua residual mediante una serie de pautas oficiales[2]. A nivel regional, la sostenibilidad del agua y la recarga de los acuíferos se ha vuelto primordial en muchas secciones del Plan Estatal de Desarrollo 2014-2019 de Baja California[3].

No obstante, hay algunos obstáculos a tener en cuenta:

- Los marcos legales[4] que permiten el uso del agua residual tratada para el riego y la recarga de acuíferos son muy estrictos. La recarga solo se permite con agua tratada que cumpla las características fisico-químicas de calidad de agua para su consumo[5].

- Los agricultores que producen cultivos de alta calidad para su exportación, sobre todo a Estados Unidos, son reacios al uso de agua residual tratada para el riego, puesto que les preocupa que el agua reutilizada presente patógenos y dudan de la aceptación del cultivo regado con dicha agua.

- La técnica de desalinización por ósmosis inversa es la estrategia actual en los planes de recursos de agua de Baja California. Las instituciones que ha entrevistado el equipo de SUBSOL se han mostrado dispuestas a conocer los sistemas SWS, aunque no estaban al corriente de dichas tecnologías a nivel de reducción de costes y mejor sostenibilidad en comparación con las técnicas de desalinización.

- Existe un riesgo potencial de conflicto entre autoridades y usuarios sobre la distribución de costes en cuanto a suministros de agua mejorados. En el pasado ya surgieron conflictos en relación a las tarifas y costes de inversión requeridos para la conexión de las tierras de cultivo con los sistemas de tuberías de Ensenada para la reutilización de agua residual tratada.

Bajo esta tesitura, las recomendaciones para estudiar e implementar las soluciones SWS en Baja California se enfrentan a cuatro problemas principales:

Adaptación a la legislación del agua reutilizada

La estricta regulación sobre la calidad del agua antes de inyectarla bajo tierra no tiene en consideración el eficiente proceso de tratamiento natural por el que pasa el agua cuando atraviesa el acuífero. Se requiere dialogar para acercar posturas con las autoridades sobre la viabilid-ad de los proyectos de SWS dentro del marco regulador. La elaboración de un proyecto piloto sería muy útil para demostrar que (1] la calidad del agua natural de los acuíferos no se ve deteriorada tras la infiltración de agua residual tratada y que (2] los acuíferos ofrecen una capacidad de tratamiento natural suficiente para cumplir los estándares requeridos para el uso de dicha agua como regadío.

Comunicación, documentación y monitorización

Es necesario incluir un proyecto piloto en la recarga de acuíferos con comunicación y monitorización minuciosas. Los usuarios potenciales (además de instituciones de regulación de seguridad para alimentos importantes, como SENASICA en el caso de México y FDA en el de Estados Unidos] tienen que recibir información sobre el procedimiento actual y futuro de SWS. En este se incluye la calidad del agua obtenida, la idoneidad para el riego, el potenci-al de los sistemas SWS para reducir la presión actual del agua subterránea y los beneficios económicos reales que se pueden alcanzar, como el ahorro de costes comparado con otras soluciones como la ósmosis inversa.

La monitorización, documentación y comunicación ininterrumpida de la calidad del agua puede resultar esencial para generar confianza entre los usuarios, los principales clientes de productos agrícolas y las autoridades. Esto requerirá de cierto aumento de capacidad de investigación y monitorización científica de los recursos de Maneadero.

Informar a los dirigentes de las posibles soluciones

Aunque los dirigentes locales y regionales ya están al tanto de la gran necesidad de encontrar soluciones para el futuro suministro de agua en Baja California, es esencial asegurar que están al corriente de las alternativas disponibles y sus ventajas e inconvenientes para poder tomar decisiones que se adecuen a las necesidades y al marco económico e institucional del área.

Proceso adecuado

Será fundamental elaborar un proceso adecuado antes de tomar una decisión y poder asegurar un proceso legítimo y eficiente con el respaldo y cooperación locales y encon-trar, de ese modo, una solución y detalles concretos de implementación que se ajusten a los recursos y necesidades locales dentro del marco institucional. Esto comprende asegurar que todos los dirigentes e inversores están debidamente informados sobre las alternativas y sus ventajas e inconvenientes, que sus preocupaciones se abordarán con la información adecuada y que participarán en un debate sobre las soluciones que llevar a cabo. La Evaluación de Tecnología Participativa (pTA, Participatory Technology Assessment en inglés] supone una metodología eficiente para poner de acuerdo las necesidades de soluciones de agua locales con las capacidades y llegar al diálogo requ-erido.

El proyecto SUBSOL

SUBSOL aborda un avance de mercado de SWS como una imponente respuesta a los retos de recursos de agua dulce en las zonas de costa mediante la demostración, réplica del mercado, estandarización y comercialización. SUBSOL compartirá las experiencias y resultados con los grupos de inversores a través de una plataforma online vinculada a las redes existentes.

El consorcio SUBSOL combina proveedores de conocimiento, expertos en materia tecnológica, asesores y usuarios finales de toda Europa. Nuestra meta consiste en mostrar una nueva forma de pensar desde el punto de vista de los recursos de agua a través de la promoción del desarrollo sostenible de las áreas costeras de todo el mundo.

Créditos y descargo de responsabilidad

Este informe político fue elaborado por Teknologirådet, Consejo danés de tecnología, (Dinamarca] de acuerdo con la investigación y análisis de Adelphi (Alemania] y Arcadis (Países Bajos]. El trabajo cuenta con reuniones y entrevistas con informantes relevantes, un estudio preliminar y un taller con depositarios en Maneadero.

El proyecto SUBSOL fue fundado por Horizon 2020, el programa de innovación de la Unión Europea. Las opiniones expresadas en este informe no reflejan la opinión oficial de la Unión Europea.

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ARCADIS Design & Consultancy for natural and built assets

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FONDEN TEKNOLOGI RÅDET
DANISH BOARD OF TECHNOLOGY FOUNDATION

Safeguarding the water reserves of Ho Chi Minh City

Water management is a growing issue in Ho Chi Minh City, Vietnam. Based on an analysis of the water supply issues and the legal and policy framework in Ho Chi Minh City, partners in the EU H2020 project **'SUBSOL – bringing coastal SUBsurface water SOLutions to the market'** have developed a set of recommendations to safeguard the future supply of freshwater.

RECOMMENDATIONS

- Subsurface Water Solutions (SWS) are capable of addressing the water management issues of Ho Chi Minh City. Moreover, they are low-cost, low-tech and fit the local institutional capacity. In Ho chi Minh City projects may focus on sustainable water supply for SAWACO or within industrial zones by means of rainwater harvesting and temporary subsurface storage of freshwater. Furthermore, the wider Mekong Delta holds great potential for SWSs, particularly to ensure sustainable water supply in agriculture. Local stakeholders have also proposed Can Gio, Nha Be and District 9 as regions for SWS implementation.
- The local authorities are aware of the urgency of the issue and positive towards SWS schemes. A pilot project is however needed to demonstrate the benefits and potential of a full scale implementation of SWS technologies.
- There are few official laws and policy measures specific to groundwater management. Hence, the legal framework for implementation of SWSs remains unclear. Specific legal aspects relevant to implementing SWS schemes in Vietnam require further investigation.
- In order to ensure an efficient and legitimate process with local support and cooperation and a solution that is adjusted to local needs and resources, dialogue with local authorities and stakeholders prior to decision making and implementation is core.

SUBSOL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642228

WATER SUPPLY CHALLENGES IN HO CHI MINH CITY

Placed along the Mekong Delta Ho Chi Minh City (HCMC) has too much water in the wet season and too little during the dry season. Moreover, escalating groundwater extraction due to rapid urbanization and population growth since the 1980's has led to a steady decline of groundwater levels in the HCMC region. The low groundwater levels have led to saltwater intrusion, forcing HCMC's water supply company Saigon Water Cooperation (SAWACO) to occasionally halt drinking water production from river water during dry periods. Additionally, groundwater over-exploitation has contributed to land subsidence, increasing the risk of urban flooding in the rainy season.

The looming water scarcity as a result of depletion of aquifers and saltwater intrusion is fully recognized as a major challenge among stakeholders in the region. A National Water Resources Council has been established to commission and supervise an action plan for water resources. HCMC has a master plan for water resource management in place which includes target volumes for groundwater abstraction. This master plan foresees to replace private abstraction of water with piped water supply by 2025. In some districts of HCMC, groundwater abstraction has been prohibited and a maximum withdrawal volume of 100,000m^3 is in place. Private wells are not allowed in private households, in urban areas and in areas with significantly declining groundwater table.[1]

SUBSURFACE WATER SOLUTIONS

Subsurface Water Solutions (SWS) offer a series of solutions to freshwater resources problems in coastal areas by means of advanced groundwater management (pumping, infiltrating, controlling) which enables protection, enlargement and sustainable utilization of fresh water resources. Combinations of wells extracting brackish water and infiltration (ponds) or injection (wells) of fresh water are used to control the position of the interface between fresh and brackish water, thereby creating a barrier against further saltwater intrusion and securing the freshwater wells inwards.

Moreover, it enables storage of large volumes of run-off or recycled water in the underground to ensure a stable water supply year-round, irrespective of seasons and shifting levels of exploitation, e.g. from agriculture and tourism. Finally, by reducing the yearly decline of groundwater levels, SWS technologies can eventually reduce the issue of land subsidence caused by groundwater decline and hence reduce the risk of urban flooding.

SWS systems address all the main water issues of HCMC and the wider region. Moreover, while SWS systems work by stimulating natural infiltration, and as they require little energy to run compared to for example desalination technologies, they provide environmentally sustainable and low-cost alternatives for water management. Finally, as SWS systems require little operation and maintenance, they can be implemented with the existing institutional and economic capacities of authorities in HCMC. SWS systems can be combined with other solutions.

1. adelphi: Lessons learned from trust building activities. Report from the EU H2020 SUBSOL project. December 2017.

2. Vietnam's Law on Water Resources - 17/2012/QH13,2012

3. Phu Le Vo (2007): Urbanization and water management in Ho Chi Minh City, Vietnam-issues, challenges and perspectives. GeoJournal (2007)

PERSPECTIVES FOR THE UPTAKE OF SWS SYSTEMS

The authorities are aware of the seriousness of water management issues in HCMC. Vietnam's Law on Water Resources[1] establishes effective institutions and instruments for the comprehensive management practices of water resources[2], including the National Water Resources Council to commission and supervise a National Water Resource Strategy and Action Plan, River Basin Organisations for water resources planning on the basis of major river basins, a system of water allocation through licenses and water rights, a system of wastewater discharge permits for key water users and an inspection system for the safety of dams and other hydraulic works. Moreover, Vietnam has recently addressed urban flooding in HCMC with a huge 4.4 billion USD investment.

The recommendations for exploring and implementing SWS solutions in HCMC four main issues:

Clarification of legal framework for SWS implementation

There are few official laws and policy measures specific to groundwater management. Hence, the legal framework for implementation of SWSs remains unclear. Specific legal aspects relevant to implementing SWS schemes in Vietnam require further investigation.

Potential projects in HCMC and the wider Mekong Delta

Potential issues and sites for SWS projects need to be identified. In HCMC projects may focus on sustainable water supply for SAWACO or within industrial zones (e.g. Hiep Phuoc) by means of rainwater harvesting and temporary subsurface storage of freshwater. Furthermore, the wider Mekong Delta holds great potential for SWSs particularly with regard to sustainable water supply in agriculture. Local stakeholders have also proposed Can Gio, Nha Be and District 9 as regions for SWS implementation.

Pilot SWS projects

To provide the needed documentation for the technical, economic and sanitary feasibility of artificial recharge with SWS schemes, and to demonstrate the ability of the aquifer to purify recharged water, an important first step could be to allow for a pilot study. In order to ensure that a pilot project addresses the interests and concerns of local government authorities, a pre-proposal should be developed together with local authorities and other stakeholders.

Various institutions have expressed tangible interest to cooperate within a joint research project to pilot SWS systems in Vietnam. Among those particularly committed is Center of Water Management and Climate Change as well as University of Technology, both part of the Vietnam National University in HCMC.

Proper process

As water supply is a major issue for households as well as for industry and environment, there are many stakes involved. For example, any attempt to ensure a more stable supply of clean water will require investments, better enforcement of regulation and eventually fees. In order to ensure an efficient and legitimate process with local support and cooperation, and in order to ensure that the solution and particular details of implementation address the actual local needs, resources and institutional framework, it is vital to have a proper, inclusive process prior to decision making and implementation.

The SUBSOL project

SUBSOL targets a market breakthrough of SWS as robust answers to freshwater resources challenges in coastal areas, by demonstration, market replication, standardization and commercialization. The route to market includes business cases, market scans, capacity building and adaptive solution development in selected regions in Europe (Mediterranean, Northwestern Europe) and worldwide (USA, Brazil, China, Vietnam). SUB-SOL will share experiences and outcomes with stakeholder groups through an online platform which will be linked to existing networks, including EIP on Water.

The SUBSOL consortium combines knowledge providers, technology SMEs, consultants, and end-users from across Europe. Our ambition is to introduce a new way of thinking in terms of water resources management, promoting the sustainable development of coastal areas worldwide. This will stimulate economic growth by ensuring a safe and cost efficient water supply.

Credits and disclaimer

This policy brief was produced by the Danish Board of Technology (DK) on the basis of the research and analysis by adelphi (GE) and ARCADIS (NL). The work involves meetings and interviews with key informants and a desk study.

The SUBSOL project is funded by the European Union's Horizon 2020 research and innovation programme. The views expressed in this brief do in no way reflect official opinion of the European Union.

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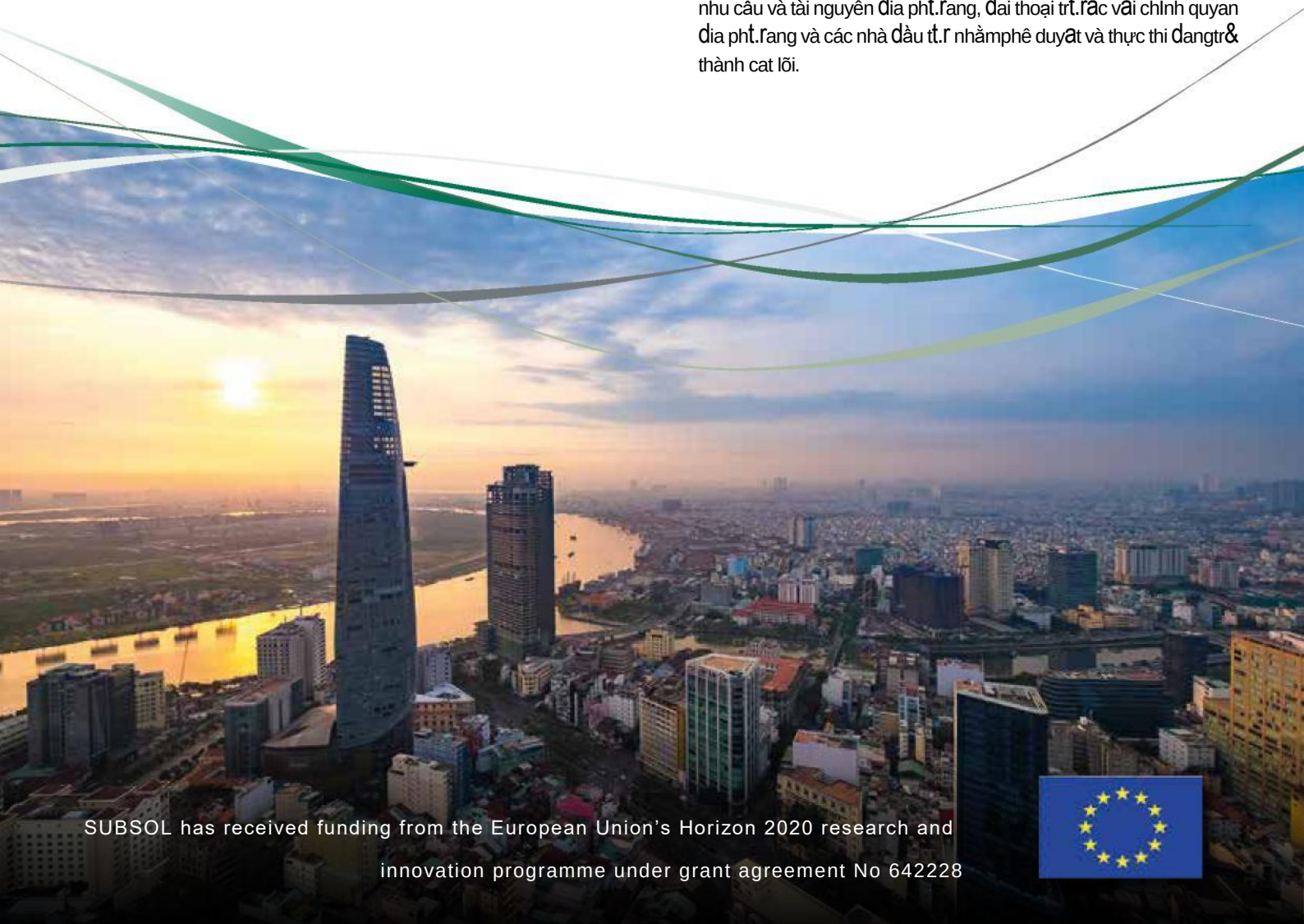
Đảm bảo dự trữ nước ở thành phố Hồ Chí Minh

Quản lý nước đang là một vấn đề đáng báo động tại thành phố Hồ Chí Minh (TP. HCM). Dựa trên một phân tích về các vấn đề cấp nước và cơ cấu chính sách pháp luật ở TP. HCM, các đối tác trong dự án Chương trình Khung về Nghiên cứu và Đổi mới, Sáng tạo - Horizon 2020 của Liên minh châu Âu (EU) 'SUBSOL(SUBsurface Water SOLutions) – mang giải pháp nước dưới mặt đất ở ven biển đến thị trường' đã phát triển một gói các đề xuất để đảm bảo nguồn nước ngọt cho tương lai.

ĐE XUẤT

- Subsurface Water Solutions (SWS)là giai pháp nt.rac dt.rai mặt dat có the dáp trng các van da về quan lý nt.rac & TP. HCM. Ngoài ra, ha th6ng này còn có chi phi thap, công ngha dan gian và phù hap vai nguein lực quan lý cap địa pht.rang.Các dự án tạiTP. HCM so tập trung vào viac On dinhcap nt.rac cho SAWA-CO vàcho các khu công nghiap bằng cách thu thập nt.rac mt.ra và trữ nt.rac ngot dt.rai mặt dat tạm thai. Ngoài ra, khu vực Đang bằng Sông CCru Long rang lan là khu vực rat có trien vong cho ha th6ng SWS, đặc biat là dam bao cung cap nt.rac On dinh cho nông nghiap. Các nhà dầu tt.r địa pht.rang cling da xuat Cần Gia, Nhà Bè và Quận 9 là những khu vực de thực hian SWS.
- Chinh quyan dia pht.rang dã nhận thtrc dt.rac sự khan cap cCia van da và có nhiau dang thái tich cựcd6i vai các dự án SWS.Tuy nhiên, cần có mat dự án thi diem de chtrng minh lai ich và tiam nang thực thi công ngha SWS trên quy mô lan toàn dian.
- Đã có mat sadiều luật và chinh sách chinh thtrc quy dinh cu the viac quan lý nt.rac ngầm. Nht.rng ca cau pháp luật de áp dung các giai pháp SWS vẫn cht.ra rõ ràng. Các khia cạnh pháp luật cu the liên quan dan viac áp dung SWS & Viat Nam cần sự nghiên cCru sâu rang han nữa.
- Đe dam bao mat quy trình hap pháp và hiau qua vai sự hap tác và Cing ho tCr chinh quyan dia pht.rangvà mat giai pháp phù hap vai nhu cầu và tài nguyên dia pht.rang, dai thoại trt.rac vai chinh quyan dia pht.rang và các nhà dầu tt.r nhằmphê duyat và thực thi dangtr& thành cat lõi.



SUBSOL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642228

THÁCH THỨC VỀ CẤP NƯỚC Ở THÀNH PHỐ HỒ CHÍ MINH

Các tỉnh Đồng bằng Sông Cửu Long và TP. HCM có quá nhiều nước vào mùa mưa và khan hiếm nước vào mùa khô. Hơn nữa, việc khai thác nước ngầm gia tăng ở mức báo động do quá trình đô thị hoá và gia tăng dân số diễn ra nhanh chóng kể từ thập niên 1980đã khiến mực nước ngầm ở khu vực TP. HCM suy giảm liên tục. Mực nước ngầm thấp đã dẫn đến tình trạng xâm nhập mặn, khiến cho Tổng Công Ty Cấp Nước Sài Gòn (SAWACO) của TP. HCM thỉnh thoảng phải ngưng việc sản xuất nước uống từ nước sông trong mùa khô. Thêm vào đó, sự khai thác nước ngầm quá độ đã góp phần dẫn đến hiện tượng sụt lún đất, gia tăng nguy cơ lũ lụt trong đô thị vào mùa mưa.

Báo động về tình trạng khan hiếm nước do sự cạn kiệt ở tầng chứa nước và xâm nhập mặn đã được các nhà đầu tư trong khu vực nhìn nhận như một thách thức lớn. Hội Đồng Quốc gia về Tài nguyên nước đã được thành lập để điềuthác và giám sát kế hoạch hành động về tài nguyên nước.TP. HCM đã có sẵn một kế hoạch tổng thể về quản lý tài nguyên nước, bao gồm cả chỉ tiêu cần đạt được về lượng nước ngầm có thể khai thác. Kế hoạch tổng thể này dự báo sẽ thay thế việc khai thác nước ngầm ở các cá thể hộ dân bằng việc lắp đặt đường ống cấp nước trước năm 2025. Ở một vài quận của TP. HCM, khai thác nước ngầm đã bị cấm và quy định lượng khai thác tối thiểu được cho phép là 100.000m^3. Giếng tư nhân bị cấm trong hộ gia đình, khu vực đô thị và các khu vực có mực nước ngầm giảm sút lớn.[1]

GIẢI PHÁP NƯỚC DƯỚI MẶT ĐẤT (SUBSURFACE WATER SOLUTIONS)

Subsurface Water Solutions (SWS) – Giải pháp Nước dưới mặt Đất cung cấp một chuỗi các giải pháp cho vấn đề tài nguyên nước ngọt trong các khu vực ven biển thông quacác phương pháp quản lý nước ngầm tiên tiến (bơm, lọc, quản lý), giúp bảo vệ, mở rộng và phòng chống việc khai thác tài nguyên nước ngọt. Sự kết hợp của các giếng khai thác nước lợ và lọc (hị) hay chêm (giếng) nước ngọt được áp dụng để quản lý vị trí mặt phân cách giữa nước ngọt và nước lợ, bằng cách đó tạo ra một lớp chắn chống lại xâm nhập mặn và bảo vệ giếng nước ngọt bên trong. Hơn nữa, việc này cho phép trữ một lượng lớn dòng nước mặt hay nước tái chế dưới mặt đất để đảm bảo nguồn cung cấp nước ổn định tất cả các mùa trong năm và chuyển dịch mức độ khai tháctrong nông nghiệp và du lịch v.v... Cuối cùng, bằng việc phòng chống vấn đề giảm mực nước ngầm hằng năm, công nghệ SWS có thể giảm thiểu vấn đề về sụt lở đất gây ra do suy giảm nước ngầm, theo đó làm giảm nguy cơ lũ lụt trong đô thị.

Hệ thống SWS đề cập đến toàn bộ các vấn đề về nước chủ yếu của TP. HCM và toàn khu vực. Ngoài ra, do hoạt động bằng kích thích quá trình lọc tự nhiên nên hệ thống SWS không tốn nhiều năng lượng để vận hành so với các công nghệ khác, ví dụ như công nghệ khử muối, hệ thống cung cấp giải pháp quản lý nước với giá thành rẻ và bền vững với môi trường. Cuối cùng, do SWS không đòi hỏi vận hành và bảo dưỡng phức tạp nên SWS có thể đáp ứng điều kiện kinh tế và nguồn lực quản lý hiện nay của chính quyền thành phố. Hệ thống SWScòngcó thể kết hợp với các giải pháp khác.

1. adelphi: Lessons learned from trust building activities. Report from the EU H2020 SUBSOL project. December 2017.
2. Vietnam's Law on Water Resources - 17/2012/QH13,2012
3. Phu Le Vo (2007): Urbanization and water management in Ho Chi Minh City, Vietnam-issues, challenges and perspectives. GeoJournal (2007) 70:75–89.

TRIỂN VỆNG ÁP DỐNG HỆ THỐNG SWS

Các cơ quan chức nắng Ãã nhận thức ÂưỸ¢csự nghiêm trệng cãa vấn Ãề quản lý nưỹ¢c Ỹ¢ TP. HCM. Luật Tài nguyên Nưỹ¢c cãa Việt Nam quy Ãịnh các cơ quan quản lý và phương tiện hiệu quả Ãể thực hành quản lý toàn diện nguịn nưỹ¢c2, bao gịm Hội Ãịng Quốc gia về Tài nguyên nưỹ¢c Ãể ãythác và giám sát Kẽ Hoạch Hành Động và Chiến LưỸ¢c Quốc Gia về Tài nguyên nưỹ¢c, Các Tổ Chức Lưu Vực Sông Ãể lập kẽ hoạch quản lý tài nguyên nưỹ¢c trên nền tảng các lưu vực sông chính, hệ thống phân phối nưỹ¢c yêu cầu giấy phép và quyền hạn, hệ thống cấp giấy phép xả nưỹ¢c thải cho các tổ chức cá nhân theo quy Ãịnh và hệ thống giám sát an toàn các Ãập ngắn và công trình về nưỹ¢c khác. Trênhết, gần Ãây Việt Nam v□a Ãề xuất gói Ãầu tư trị giá rất lỵn 4,4 tỷ Ãô la Mỗ Ãể phòng chống lồ lụt Ỹ¢ Ãô thị.

Đề xuất về việc nghiên cứu và áp dụng các giải pháp SWS Ỹ¢ Hị Chí Minh bao gịm 4 vấn Ãề chính:

Làm rõ cơ cấu luật pháp cho việc áp dụng các giải pháp SWS

Đã có một sốÃiều luật và chính sách chính thức quy Ãịnh cụ thể việc quản lý nưỹ¢c ngầm. Nhưng cơ cấu pháp luật Ãể áp dụng các giải pháp SWS vẫn chưa rõ ràng. Các khía cạnh pháp luật cụ thể liên quan Ãến việc áp dụng SWS Ỹ¢ Việt Nam cần sự nghiên cứu sâu rộng hơn nữa.

Di, án triển vọng tại TP. HCM và khu vi,c Bồng bằng Sông Cửu Long

Cần xác Ãịnh rõ các vấn Ãề và Ãịa bàn tiềm nắng cho các dự án SWS.Các dự ántại TP. HCM sẻ tập trung vào việc cấp nưỹ¢c ổn Ãịnh cho SAWACO hay các khu công nghiệp (ví dụ như KCN Hiệp Phưỹ¢c) bằng cách thức thu thập nưỹ¢c mưa và trữ nưỹ¢c ngệt dưỹ¡i mặt Ãất tạm thời. Ngoài ra, Địng bằng Sông Cậu Long rộng lỵn là khu vực có triển vệng cho hệ thống SWS, chú trệng Ãặc biệt vào việc cung cấp nưỹ¢c ổn Ãịnh cho nông nghiệp. Các nhà Ãầu tư Ãịa phương cồng Ãề xuất Cần Giờ, Nhà Bè và Quận 9 là những khu vực Ãể thực hiện SWS.

Thí điểm các di, án SWS

Để có thể cung cấp tài liệu cần thiết thể hiện mức Ãộ khả thi về mặt kỗ thuật, kinh tế và an toàn cãa quá trình tái nạp nhân tạo bằng hệ thống SWS, và chứng minh khả nắng làm sạch nưỹ¢c tái nạp cãa tầng chứa nưỹ¢c, thực hiện nghiên cứu thí Ãiểm là bưỹ¢c Ãầu tiên vô cùng quan trệng. Để bảo Ãảm dự án thí Ãiểm sẻ thu hút ÂưỸ¢c sự quan tâm và chú ý cãa chính quyền nhà nưỹ¢c Ãịa phương, cần phát triển một bản Ãề xuất vỹ¡i sự hỸ¢p tác cãa chính quyền và các nhà Ãầu tư.

Nhiều tổ chức Ãã thể hiện sự quan tâm rõ rệt về việc hỸ¢p tác trong một dự án nghiên cứu Ãể thí Ãiểm hệ thống SWS Ỹ¢ Việt Nam. Trong số Ãó, Ãáng chú ý nhất là có sự tham gia cãa Trung tâm Quản lý nưỹ¢c và Biến Ãổi khí hậu, cồng như Đại Hệc Bách Khoa, cả hai Ãều trực thuộc Đại hệc Quốc gia Việt Nam Ỹ¢ HCM.

Lộtrình phùhợp

Cấp nưỹ¢c là một vấn Ãề quan trệng vỹ¡i các hộ gia Ãình,ngành công nghiệp và môi trường nên có nhiều yếu tố liên quan. Mệi nỗ lực Ãể Ãảm bảo cung cấp nưỹ¢c sạch ổn Ãịnh hơn Ãều Ãòi hỏi sự Ãầu tư, thực thi quy Ãịnh nghiêm ngặt hơn và saucùng là chi phí. Để Ãảm bảo một lộ trình hỸ¢p pháp và hiệu quả vỹ¡i sự hỸ¢p tác và ãng hộ t□ chính quyền Ãịa phương, Ãảm bảo giải pháp cùngcác chi tiết Ãặc thù khi áp dụng sẻ Ãáp ứng ÂưỸ¢c nhu cầu thực tế, tài nguyên và cơ cấu quản lýtại Ãịa phương, việc xây dựng lộtrình chuyên biệtvà phùhỸ¢p Ãể phê duyệt và thực thi là cực kồ trệng yếu.

Dự án SUBSOL

Dự án SUBSOL nhắm Ȧẽn sự Ȧột phá thị trường cũa SWS –giải pháp thiẽt thực cho các thách thức về tài nguyên nưǖc ngọt ῾Ọ khu vực ven biển, thông qua thí Ȧiểm, nhân rộng thị trường, tiêu chuẩn hoá và thương mại hoá. Quy trình Ȧầu ra thị trường bao gịm các Ȧề án kinh doanh, nghiên cứu và thẩm dò thị trường, xây dựng kiẽn thức – kỗ năng và phát triển giải pháp phù hỖp tại các khu vực ȦưỖc lựa chện ῾Ọ Châu Âu (Địa Trung Hải, Tây Bắc Châu Âu) và thẽ giǖi (Mỗ, Brazil, Trung Quốc, Việt Nam). SUBSOL sẻ chia sẻ kinh nghiệm và kẽt quả vǖi các nhóm Ȧầu tư thông qua một kênh online ȦưỖc kẽt nối vǖi các hệ thống mạng sẵn có, bao gịm cả trang HỖp tác cải cách Châu Âu về tài nguyên nưǖc (EIP Water).

Hiệp hội SUBSOL là sự kẽt hỖp cũa các nhà cung ứng kiẽn thức, các doanh nghiệp công nghệ nhỏ và v□a, các nhà tư vấn và người dùng cuối t□ khắp Châu Âu. Tham vệng cũa chúng tôi là giǖi thiệu một cách nghĩE mǖi về Ȧịnh nghĩEa quản lý tài nguyên nưǖc, thúc Ȧẩy phát triển bền vững ῾Ọ các khu vực ven biển trên thẽ giǖi. Việc này sẻ góp phần cho phát triển kinh tẽ thông qua Ȧảm bảo việc cung cấp nưǖc antoàn và tiẽt kiệm chi phí.

Bản quyền và miễn trừ trách nhiệm

Bản báo cáo tóm tắt này ȦưỖc phát hành b῾Ọi Ban Công nghệ Đan Mạch, dựa trên các nghiên cứu và phân tích cũa tổ chức tư vấn adelphi (Đức) và ARCADIS (Hà Lan). Công trình này bao gịm các cuộc hệp và phỏng vấn vǖi những nguịn cung cấp thông tin chũ chốt và nghiên cứu trên các dữ liệu Ȧã có.

Dự án SUBSOL ȦưỖc gây quỗ b῾Ọi Chương trình Khung về Nghiên cứu và Đổi mǖi, Sáng tạo - Horizon 2020 cũa Liên minh châu Âu (EU). Các auan Ȧiểm thể hiện trong bài viẽt này không phản ánh quan Ȧiểm chính thức cũa Liên minh châu Âu.

LIÊN HỆ:

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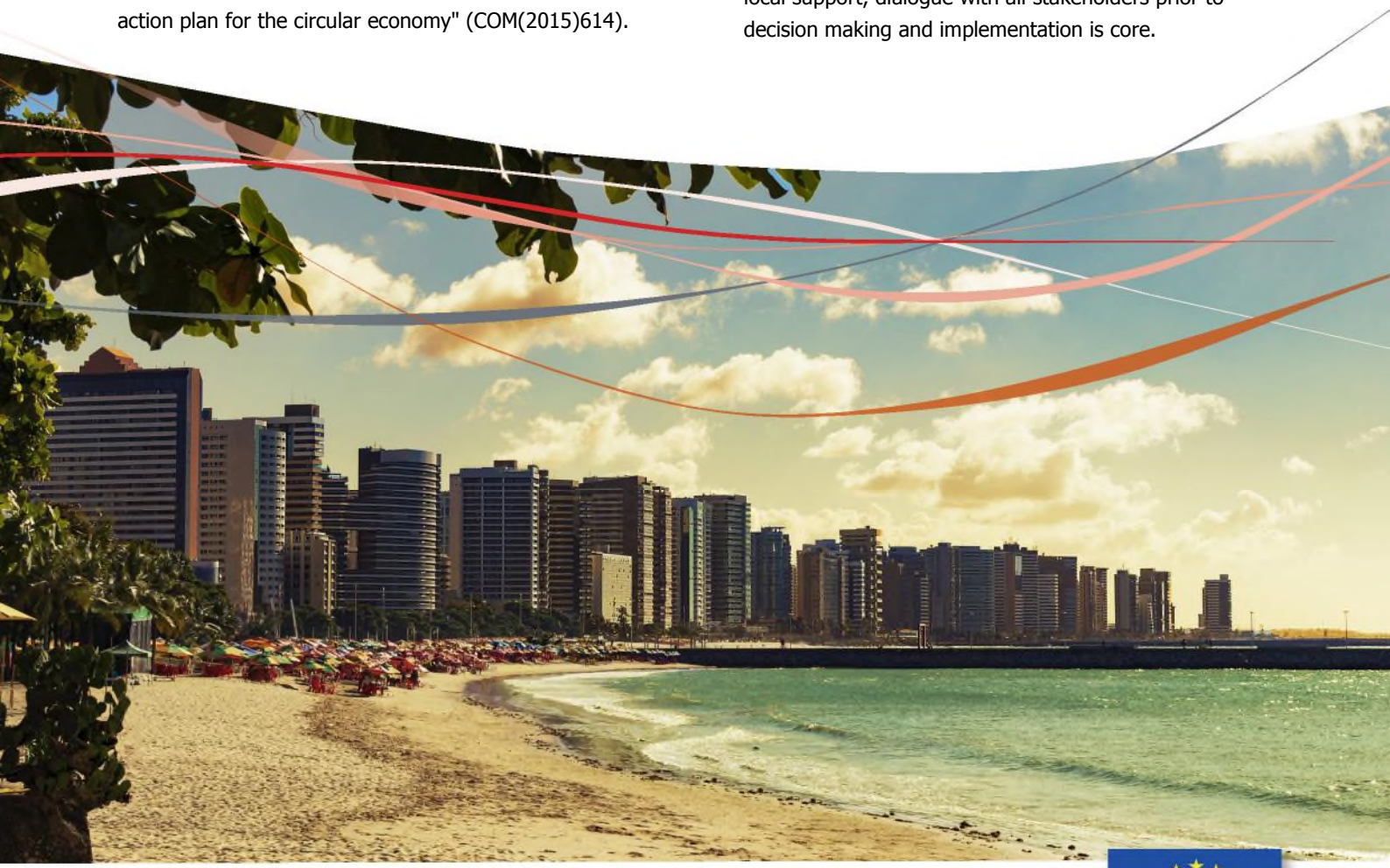
www.subsol.org

Safeguarding the water reserves of Europe

Water management is a growing issue in the coastal areas of Europe. On the background of an analysis of the water supply issues and the legal and policy framework in Europe, partners in the EU H2020 project **'SUBSOL – bringing coastal SUB-surface water SOLutions to the market'** have developed a set of recommendations to safeguard the future supply of freshwater.

RECOMMENDATIONS

- Subsurface Water Solutions (SWS) are capable of addressing the water management issues in coastal areas of Europe. Moreover, they are low-cost, low-tech and fit the local institutional capacity of Member States.
- SWS implementation assists the European Commission in realizing its agenda to safeguard Europe's water resources and secure freshwater supply, in line with EU communications "A Blueprint to Safeguard Europe's Water Resources" (COM(2012)673) and "Closing the loop – An EU action plan for the circular economy" (COM(2015)614).
- The European WFD and GWD provide the overarching legal framework for SWS. Each Member State converts these directives into their own national legislation following their local insights and interpretations. This may lead to considerate differences in the way SWS is valued in policies and regulations in different Member States.
- Reducing uncertainty about the effects on groundwater quality is key to the acceptance of SWS. It is crucial to actively involve local policy makers in demonstration. In order to ensure an efficient and legitimate process with local support, dialogue with all stakeholders prior to decision making and implementation is core.



SUBSOL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642228

WATER RESOURCES CHALLENGES AND ACTIONS IN EUROPE

Coastal areas are the most densely populated, productive and economically dominant regions of the world. The associated high water demand, however, puts tremendous pressure on the freshwater resources and the coastal ecosystems. Securing freshwater supply – at all times – is vital for economic activities such as energy production, industry, agriculture and tourism, for nature and to guarantee safe and sufficient drinking water.

The European Commission has been taken action to secure freshwater supply in Europe. Communications such as "A Blueprint to Safeguard Europe's Water Resources" (COM(2012)673) and "Closing the loop – An EU action plan for the circular economy" (COM(2015)614) have been setting the water agenda in the past decade. Developing and promoting solutions for integrated sustainable water resource management are important actions.

Advanced groundwater management can enable water reuse, as demonstrated at the SUBSOL replication site in Dinteloord, the Netherlands[1]. Reuse water from a sugar factory is made available for greenhouse farmers following aquifer storage and recovery (ASR) to balance water demand and supply in time. Agricultural irrigation and aquifer recharge have been identified as main potential sources of demand for reclaimed water, and the Commission is drawing up legislative frameworks on artificial recharge of reclaimed water. Experiences from the SUBSOL project, summarized in this policy brief, support this process.

SUBSURFACE WATER SOLUTIONS

Subsurface Water Solutions (SWS) offer a series of solutions to freshwater resources problems in coastal areas by means of advanced groundwater management (pumping, infiltrating, controlling) which enables protection, enlargement and sustainable utilization of fresh water resources. Combinations of wells extracting brackish water and infiltration (ponds) or injection (wells) of fresh water are used to control the position of the interface between fresh and brackish water, thereby creating a barrier against further saltwater intrusion and securing the freshwater wells inwards. Moreover, it enables storage of large volumes of run-off or recycled water in the underground in order to ensure a stable water supply year-round, irrespective of seasons and shifting levels of exploitation, e.g. from agriculture and tourism.

SWS systems address many of the water issues in coastal areas in Europe. Moreover, while SWS systems work by stimulating natural infiltration to secure the availability of freshwater at all times, and as they require little energy to run compared to for example desalination technologies, they provide environmentally sustainable and low-cost alternatives for water management. Finally, as SWS systems require little operation and maintenance, and they can be easily implemented with the existing institutional and economic capacities of authorities in Europe.

[1]Zuurbier et al., 2018. Guide on using ASR-Coastal with treated wastewater for irrigation. SUBSOL deliverable D2.6. www.subsol.org

European policy and directives on infiltration

Infiltration and temporal storage of freshwater, e.g. harvested rainwater, surface water or reuse water, is an essential element of Subsurface Water Solutions (SWS) concepts. The EU Water Framework Directive (WFD) and the underlying Groundwater Directive (GWD) provide the overarching legal framework. Current and future SWS applications have to comply with the GWD and its 'prevent and limit' principle. Infiltration can contribute to the achievement of WFD objectives, as long as the water is of sufficient quality. Neither the WFD nor the GWD excludes, in principle, a direct injection of alternative water sources for managed aquifer recharge.

Each Member State, however, has converted these overarching directives into their own national legislation following local insights and interpretations. This has led to considerate differences in the way infiltration is valued in policies and regulations in different Member States. For example, in the Netherlands there is a positive mindset towards aquifer recharge, resulting from the long-term application of aquifer recharge in the coastal dunes to supply cities like Amsterdam and The Hague with high-quality drinking water. In contrast, in Flanders, where similar salinization problems occur as in the Netherlands, authorities are hesitant towards aquifer recharge and thus towards granting permits for SWS, even for pilots. Differing policies amongst different Member States is a barrier for the effective rollout of SWS across Europe.

Brackish water interception and disposal

Brackish groundwater is an alternative freshwater resource with great potential. It is widely available in coastal areas and generally of excellent quality, except for the relatively high salinity levels. Reverse osmosis of brackish groundwater (BWRO) is available at acceptable capital and operational (energy) costs, comparable to costs for purification of surface water.

Interception of brackish groundwater is applied in the SWS Freshkeeper concept, as an effective remedy against water well or aquifer salinization. Disposal of this water, or its BWRO concentrate when subsequent desalination is applied, is the Achilles heel of this concept. Direct (piped) disposal to sea has the lowest environmental impact, but may involve high costs for construction of pipelines. Deep-well injection is a low-cost alternative with relatively low environmental impact compared to, for example, discharge to surface waters or wastewater treatment plants.

The WFD and GWD provide a legal instrument to allow for deep-well injections. Individual exemptions may be granted, provided that the injected water is of similar quality as the receiving groundwater body, and that adequate monitoring is applied. Following these guidelines, many temporary permits have been granted for BWRO concentrate deep-well injections in the Netherlands. However, debate on legislation and permitting is ongoing. It is clear that disposal through deep-well injection is not feasible at every place and in every groundwater system. There is a strong need to further develop policy guidelines, at national and European levels, building on experiences from SUBSOL reference sites and other locations in the Netherlands.

Piloting and policy development go hand-in-hand

Reducing uncertainty about the effects on groundwater quality is key to the acceptance of SWS by authorities and other stakeholders. In order to provide documentation of the efficiency of SWS schemes and of the resulting water quality – and in order to adjust a potential implementation of SWS schemes to the local hydrogeology, water use, needs and legal framework – it is recommended to further develop pilot projects across Europe. It is crucial to actively involve local and national policy makers in these demonstration, to assure that questions related to policy and regulations are addresses from the very beginning. Piloting and policy evaluation and development must go hand-in-hand.

Proper process

In order to ensure an efficient and legitimate process with local support and cooperation, and in order to ensure that the solution and particular details of implementation address the actual local needs, resources and institutional framework, it is vital to have a proper, inclusive process prior to decision making and implementation. That is, that all stakeholders and decision makers are properly informed about the alternatives and their pros and cons, that their concerns are addressed with proper information, and that they are involved in a debate about solutions. This may also prevent or reduce potential conflicts, for example about charging additional fees on users for irrigation water. Participatory Technology Assessment (pTA) is an efficient methodology to align water solutions with local needs and capacities and obtain the required dialogue.

The SUBSOL project

SUBSOL targets a market breakthrough of SWS as robust answers to freshwater resources challenges in coastal areas, by demonstration, market replication, standardization and commercialization. The route to market includes business cases, market scans and capacity building in selected regions in Europe [Mediterranean, Northwestern Europe) and worldwide [USA, Brazil, China, Vietnam). SUBSOL will share experiences and outcomes with stakeholder groups through an on-line platform which will be linked to existing networks, including EIP on Water.

The SUBSOL consortium combines knowledge providers, technology SMEs, consultants, and end-users from across Europe. Our ambition is to introduce a new way of thinking in terms of water resources management, promoting the sustainable development of coastal areas worldwide. This will stimulate economic growth and will create market opportunities and jobs for the European industry and SMEs.

Credits and disclaimer

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