Global Inventory for Blue Green Good practices and Integrated Solutions (GIBGIS)

Case: **COASTAR - COastal Aquifer STorage And Recovery**

Location: Netherlands

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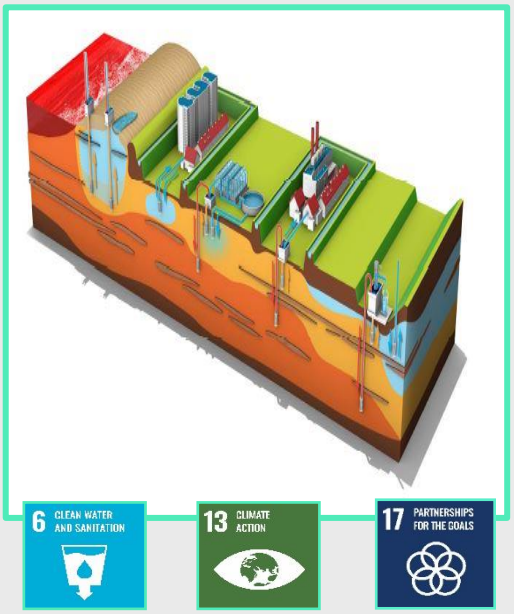
Topic: Using brackish groundwater for fresh water production

Sustainable Development Goals:

SDG 6 (Clean Water and Sanitation),

SDG 13 (Climate action)

SDG 17 (Partnerships for the goals)



About the Project:

Climate change, the growing world population and economic development put enormous pressure on the freshwater resources in coastal zones. Increasing water demand, decreasing fresh water availability in combination with higher water quality demands often result in increased groundwater use, salinization and land subsidence, which combined with sea level rise, leads to additional stresses.

COASTAR concepts are developed to increase year-round water availability in coastal zones and other environments with saline groundwater. Important elements of COASTAR concepts are the use of subsurface to store fresh water for future recovery and to prevent salinization by smart abstraction and use of brackish groundwater.

COASTAR concepts contribute to all project phases, from ideas, via construction and/ or implementation in national -water-related- policy to the operational phase.

Project Objectives:

1. To increase year-round water availability in coastal zones and other environments with saline groundwater
2. The use of subsurface to store fresh water for future recovery
3. To prevent salinization by smart abstraction

Process of implementation:

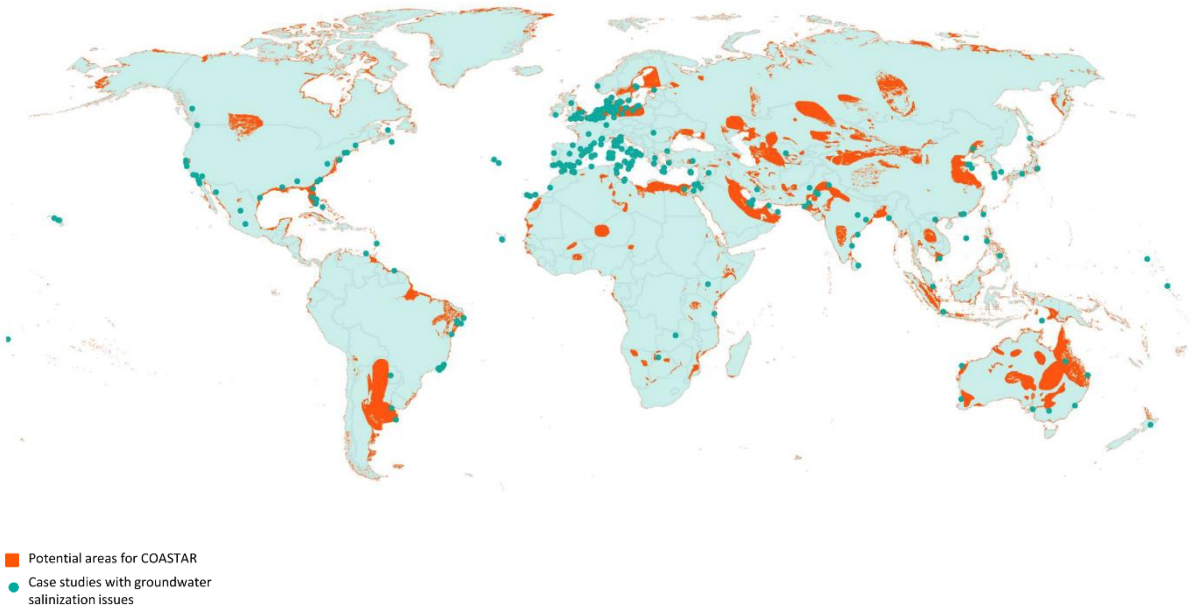
The process starts with identifying the COASTAR possibilities in a specific region or location. The design of a site-specific COASTAR system is usually running for about a year. Our COASTAR cases combine different concepts in an integral approach, that incorporates environmental, societal and economic impact as well as governance aspects. Involvement of stakeholders is an important aspect of the COASTAR approach to ensure commitment for defined solutions. Implementing a fully operational COASTAR system takes at least a few years. Design and construction takes time, but after startup it also takes time to establish a balanced and sustainable operational water management system of storage and recovery.

Site-specific initiatives include setting up a fresh-salt ground water model to perform scenario analysis on the effects and feasibility of solutions like brackish groundwater abstraction and Aquifer Storage and Recovery (ASR) applications. Usually field surveys are needed to collect data and insights in the subsurface and existing groundwater situation. This data is, combined with other existing hydrogeological data, used to setup and calibrate the model.

Workshops with local stakeholders are used to identify potential measures to decrease the gap between water demand and supply. Typically, these measures include infiltration of surplus fresh water (Managed Aquifer Recharge) and / or brackish groundwater extraction.

Models are used to analyse feasibility and effects of the identified measures. The model result can then be used to gain insights in the middle and long-term effects of the measure. Based on these analyses the detailed (engineering) design of a COASTAR system can start, followed by construction activities and an initial operational periode to balance the systems.

In addition to site-specific initiatives, the COASTAR program also comprehends studies to map the potential of the COASTAR solutions on the regional or national scale. Hydrogeological characteristics of the subsoil are combined with expert knowledge in a region to retain insight in new areas potentially interesting for applying the COASTAR solutions.

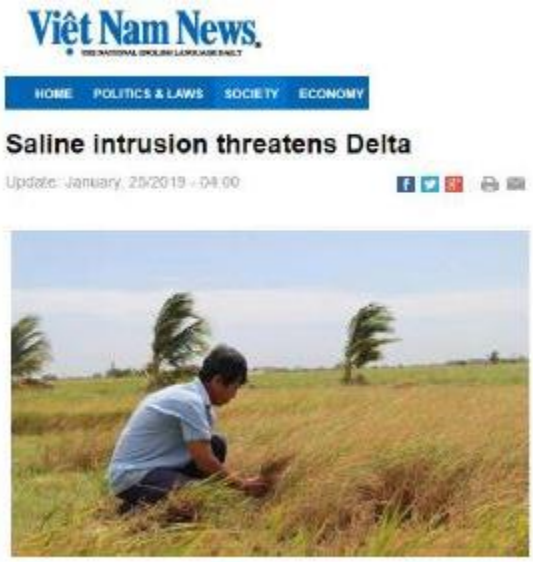


The integrated COASTAR approach can be applied in many areas around the world. For instance, a project is running in Chili, but similar concepts are applicable in many coastal areas worldwide – from urban delta's to small islands. In all these potential COASTAR cases, the COASTAR program opts for regional scale implementation of water resources management strategies to secure freshwater supply for agricultural, industrial and domestic use in coastal areas and other areas with saline groundwater.

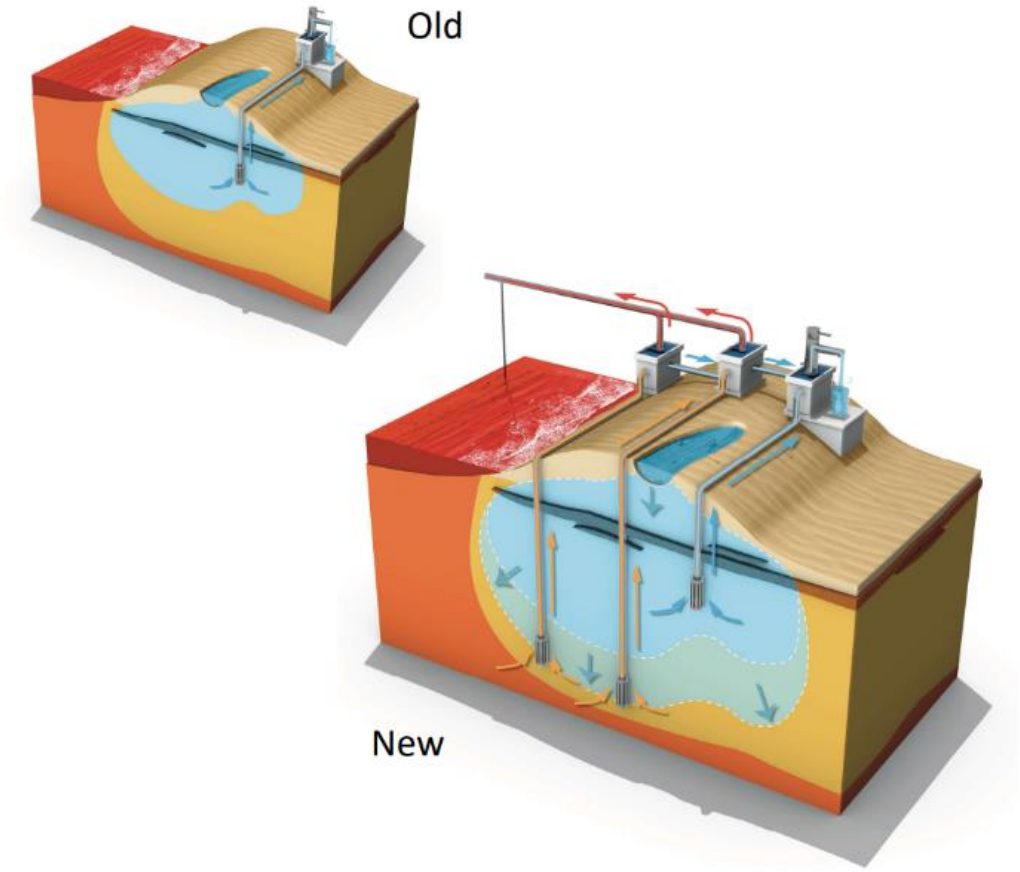
Justification of the project:

Growing population and urbanisation have led to over extraction of groundwater for multiple uses within formal and informal economies. With higher population, regions face higher demand for water of better quality. Climate change also exacerbates the impact of sea level rise and drought on the availability of fresh water in coastal areas.

Example of areas with growing coastal water challenges can be found all over the world. In the Mekong delta for example, recurring droughts have made news and saline intrusion is a major challenge in the deltas of Vietnam.



Well managed groundwater plays a key role in an integrated solution to address to the coastal challenges and at the same time creates an fresh water resource. COASTAR's approach and groundwater modelling can be used to asses different mitigation strategies. For example, the extraction of brackish groundwater and an increased infiltration of surface water to the aquifer.



Challenges in implementation:

COASTAR solutions are innovative solutions involving different stakeholders and different technical disciplines to design, construct, manage and maintain the system. As is the case with any innovation there are many challenges to overcome for a solution to become mainstream.

One of the challenges in the early stages is to bring together the right stakeholders (water users, water managers, researchers and engineers). In some cases laws and regulations with regard to infiltration of water and the disposal of brine (in case of using brackish water) are not suited to facilitate innovations such as COASTAR.

In the feasibility stage the lack of data and information on the hydro(geo)logical setting can be challenging and may have implications down the line if not addressed properly.

The engineering and construction stage requires specific expertise to properly design infiltration and recovery systems, as does the operation and management of such systems.

A hard lesson we learned from a case in the Netherlands is that the efficiency of the system is not easy to predict, but a really important factor for the feasibility of such a system. We unfortunately found out after implementation. Measurements and numerical models help to decrease uncertainty, but it is impossible to get 100% certainty before implementation.

Lessons learnt:

The main lesson learnt within the COASTAR program is that it takes time to get stakeholders to support these types of integral solutions, but it is necessary for commitment. Patience is the key in waiting for the right moment (creating momentum) that stakeholders are open for new concepts. It is important to find ambassadors within the stakeholder groups that help spreading the word "COASTAR as part of the solution for salinization problems and fresh water scarcity".

There is a serious pressure from society to implement many more COASTAR projects as soon as possible, while there is also a firm request to keep the costs on research on feasibility, installation and maintenance, etc. as low as possible. At the same time, we are not ready yet to implement successful COASTAR solutions without serious efforts in the (pre)feasibility phase which includes local geological surveys, modelling and monitoring. As every COASTAR solution is just another complex solution. We believe the implementation must be tailormade (e.g. as geology and salinity conditions differs over tens of meters, and long-term effects need a serious consideration). It is a major challenge to make a long-lasting technically sound plan for a COASTAR solution while keeping costs as low as stakeholders think is reasonable.

Project impacts:

The results of a COASTAR study help (local) government and decisionmakers in two ways: it helps them to increase their understanding of potential solutions that can help minimizing (future) fresh water scarcity and it gives them insights in the possible mitigation measures that can decrease the water gap. The fact that stakeholders are involved in the COASTAR process, for instance in defining possible mitigation measures, contributes to this outcome.

By this, COASTAR helps decisionmakers to select the right solutions for their specific situation. The groundwater model, workshops and feasibility studies that are part COASTAR, are used to explore if the COASTAR solutions can be part of ensuring a future proof drinking water strategy, a reduction of salt water in aquifers, or an increase of fresh water reserves in the subsurface in a specific area.

With the help of COASTAR, stakeholders work on water availability for now and the generation to come. The project therefore contributes to the SDG 6: clean water and sanitation.

Scaling-up opportunities of the project:

The approach of COASTAR can be used in any situation where salinity is limiting the availability of fresh groundwater for use by the society. This situation is present in most Delates of the world and the area where the approach can be applied will increase due to climate change as well as increasing use of groundwater for economic development.

The COASTAR approach is already scaled up. It was initially created and used for several locations in The Netherlands (Zeeland, Westland, Solleveld and other locations). Here it was proven to be a useful and value-adding approach. This led to more COASTAR studies around the world, for example in Chile, Vietnam and Mexico.

In Chile, the project began in 2021 by deploying infiltration system, involving local authorities and analyzing water authorities.

Because COASTAR is more a flexible approach rather than a rigid tool, it is possible to adjust the approach to different situations in new locations.

Scope for improvement:

To make this kind of integral solution a success, the different stakeholders have to work closely together and commit to the solution. This takes time and this should be clear in the project planning.

A successful COASTAR solution starts with a firm background on the local invisible hydrogeological circumstances. Without a clear idea about how the groundwater system in stressed areas with additional climate stresses (sea-level rise) works, the chances for failure increase seriously. So, monitoring and modelling the COASTAR solution during operational and disaster situation are needed.

For more information visit: https://www.coastar.nl/over-coastar/