FREEWAT

Free and Open Source Software Tools for Water Resource Management

EU HORIZON 2020 Project

Policy Brief N. 5/7

Modeling tools for EU water-related Directives

Key Policy Messages

- ✓ Digital tools may help simplifying the application of EU water-related Directives
- ✓ The FREEWAT platform was successully applied to a wide range of groundwater management issues
- ✓ The FREEWAT platform allowed advancing groundwater management in public authorities and private companies

WHAT H2020 FREEWAT is

FREEWAT is an HORIZON 2020 project financed by the EU Commission, aiming at promoting water resource management through innovative ICT tools and participatory approach.

Main result of the project is the free and open-source FREEWAT software: a QGIS integrated environment, where several simulation codes, based on the hydrological cycle, hydrochemical or economic-social processes, are integrated in a unique GIS project for conjunctive use of surface- & ground-water.

This Policy Brief is part of series of seven whose goal is to illustrate the FREEWAT approach and achievements.

European Commission

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Digital tools may help simplifying the application of EU water-related Directives

The EU Water Framework Directive (WFD; EU, 2000) and the Groundwater Directive (EU, 2006) introduced an innovative and holistic approach to the protection and management of water resources and the need for new methodologies and tools required to support implementation of the policies. At the same time, the central concept of the WFD is the integration among the various expertise and disciplines aiming at a better water management. Hence, a better understanding of the whole hydrological cycle and improved awareness of multi-disciplinary scientific developments is required by all the stakeholders for the establishment of a common framework in the management tools.

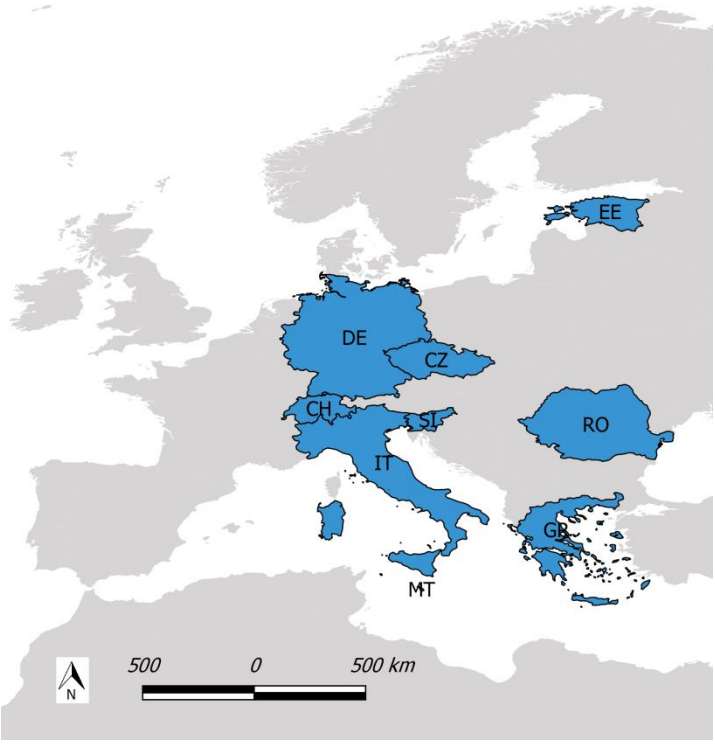
The DPSIR (Driving forces-Pressure-State-Impact-Response) framework, introduced by the Article 5 and along the guidelines of Annex II of the WFD, expresses the need for modelling to integrate pressures and impacts as valuable tools to face challenges posed by policies application. Model-supported implementation of the WFD is first mentioned within the Guidance Document No. 11 (GD 11) on Planning Process produced in the framework of the Common Implementation Strategy for the implementation of the WFD. The GD 11 states that models exemplify the systems approach to water resources planning.

GD 11 observes that models permit a definition and evaluation of alternatives representing possible compromises among conflicting groups, values, and management objectives (such as options for engineering structures, operating and allocating policies, and different assumptions made in the analysis). In this sense, models can be used in a two-way process: they produce information to be channelled into decision making (formulation of plans) or they produce information fed back to aid in redefining the problem.

To this scope, a GIS-integrated simulation environment such the FREEWAT solution may provide reliable tools to evaluate phenomena in space and time and to address water management issues.

In the framework of adopting innovative ICT (Innovation and Communication Technology) tools for simplifying the application of water-related Directives, capabilities integrated within the FREEWAT platform have been tested and applied to nine case studies, in EU and non-EU Countries (Romania, Estonia, Greece, Slovenia, Czech Republic, Germany, Italy, Malta and Switzerland).

The case studies are specifically targeting the requirements of the above-mentioned Directives on selected issues. Links to the application of Directives were established by testing the feasibility and effectiveness of measures foreseen within RBMPs for achieving the environmental objectives of the WFD and other water-related Directives.



FREEWAT case studies devoted to the application of EU water-related Directives.

The FREEWAT platform was successully applied to a wide range of groundwater management issues

FREEWAT application dealt with a wide range of issues such, as: seawater intrusion, effects of climate change on groundwater bodies, groundwater pumping zones allocation, transboundary water bodies management, groundwater-dependent ecosystems.

Groundwater overexploitation for human activities is a matter of concern in most of the case studies, causing depletion of freshwater resources and worsening of groundwater quality. In coastal aquifers, this is mostly due to incoming salinization. In ***Lavrion*** (Greece, 50 km south-eat of Athens), over-pumping is mostly due to irrigation needs, which primarily rely on a superficial alluvial aquifer, threatened also by nitrate contamination. On the other hand, the ***Follonica-Scarlino*** sandy aquifer (southern Tuscany, central Italy) lays in an area deeply exploited in the past for mining and metallurgical activities, where drinking water supply is a relevant issue during the summer touristic season. The mean sea level aquifer underlying the ***Gozo Island*** of the Maltese archipelago represents a particular case of coastal aquifer, where groundwater in the island floats upon seawater in the shape of a freshwater lens. The aquifer is largely exploited for drinking and agriculture supply.

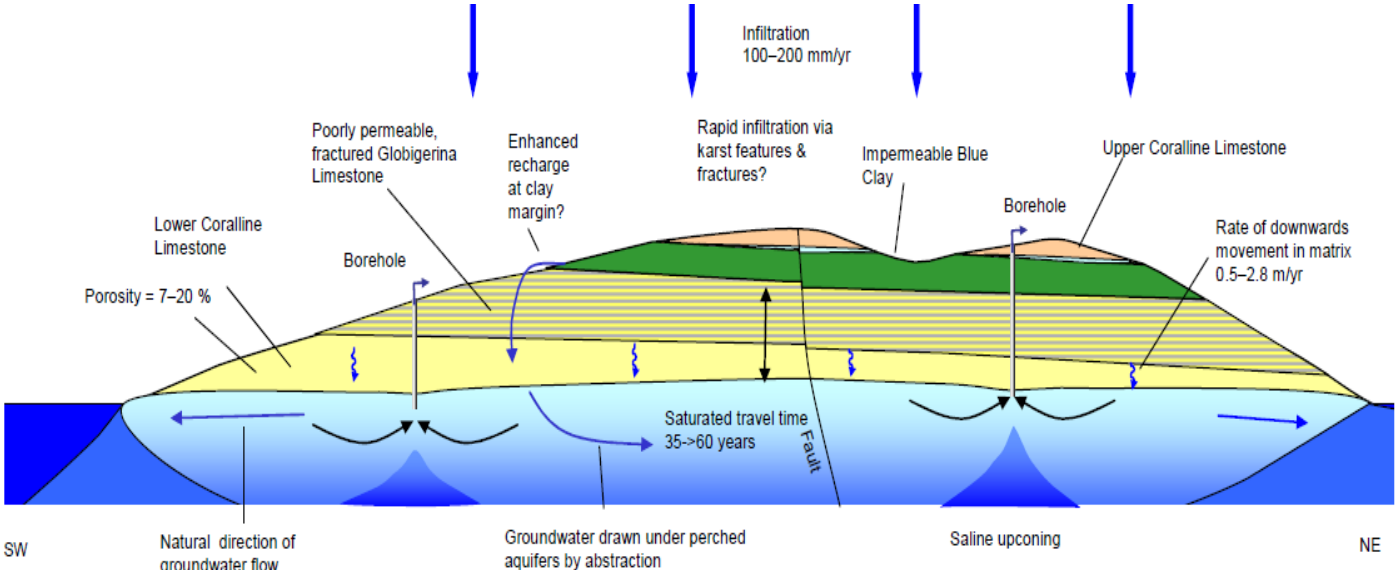
Groundwater salinization potentially driven by climate change is a matter of concern for groundwater resources in ***Bremerhaven*** (northern Germany), nearby the North Sea. There, the sandy aquifer is connected to the Weser estuary and it is heavily affected by tidal influence causing saltwater intrusion along the coastline.

Pressures due to climate change are relevant also for ground- and surface- water resources in the ***Banat plain*** (western Romania), where the shallow phreatic aquifer, which at present is in a good quantitative status, is considered as an alternative source of freshwater for public supply.

Ground- and surface-water interaction is a key aspect in the ***Vrbanski plato*** (north-western Slovenia), where an induced riverbank filtration Managed Aquifer Recharge scheme was set in operation for exploiting the aquifer hydraulically connected to the Drava river.

Relationships with surface water bodies have been investigated also at the ***Lugano lake*** watershed, a transboundary aquifer located at the border between Italy and Switzerland. Here, the scope of FREEWAT application was to increase the understanding on the trophic status of the lake, and to quantify the amount of phosphorous reaching it via groundwater flow.

Regarding the groundwater-dependant ecosystem topic, the ***Selisoo*** bog (north-eastern Estonia) is modeled to assess the impact of underground mining activities on the groundwater regime and on the wetland water balance. Another case study falling within this thematic area is the pilot site of ***Velké Žernoseky*** (north of Lovosice, Czech Republic), which embeds an open pit connected with the Elbe river.



Conceptual model of the Mean Sea Level Aquifer of the Gozo island.

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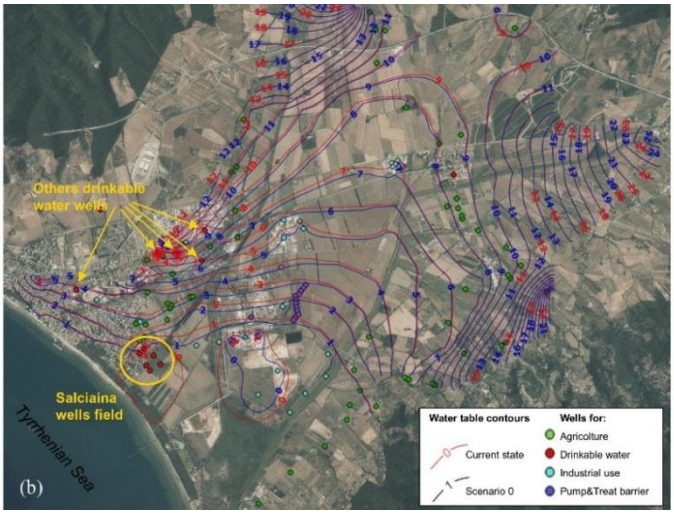
Advancing groundwater resource management

In the FREEWAT project water management scenarios were analysed to understand hydrosystems' response to different climate change and exploitation conditions, while focusing on WFD issues. Results of three of the above-mentioned case studies are presented.

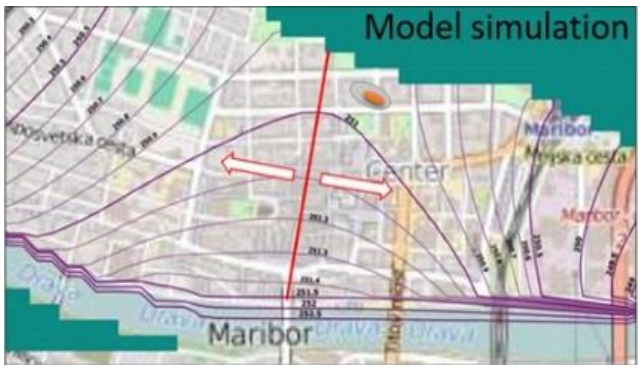


Simulation of different scenarios of exploitation of the Follonica aquifer.

FREEWAT application to the ***Follonica aquifer*** (Italy) aimed at assessing the effects of alternative water management strategies on the quantitative status of the groundwater body. A groundwater model was developed to simulate management scenarios for evaluating the effectiveness of measures foreseen in the RBMP. Alternative sources of water supply were simulated in lieu of pumping wells. Rise of the water table and reduction of local cones of depression were evaluated as result of setting in place a desalination plant for drinking water supply or reusing mine drainage water for industrial purposes. Such results were then discussed in term of cost feasibility versus effectiveness.

Different scenarios of recharge and pumping rates were simulated at ***Vrbanski plato*** (Slovenia) in order to analyse their effects on the spreading of pollutant plume. Two pumping wells were simulated for remediation purposes, after a large spill of heating oil from the Maribor city. The direction of the oil spillage was foreseen at each scenario depending on the potential shift of a groundwater divide close to the Maribor city. Results demonstrated that a shift of the divide westwards would occur, consequently redirecting the oil spillage towards the pumping station, where the contaminant would be contained within a local cone of depression.

Preventing saltwater intrusion is one of the main targets of the strategy for climate adaption in ***Bremerhaven*** (Germany). Scenarios predicting changes in groundwater recharge and seawater level until 2100 have been addressed with FREEWAT. Model outcomes demonstrate that the groundwater budget is mainly affected by groundwater recharge and the tidal effects, each of them accounting for about one half of the total inflow to the system. Some groundwater management measures, such as rainwater harvesting in extreme rainfall events and moving abstraction wells inland far from the coastline, were also tested to prevent lowering of the groundwater table and the occurrence of saltwater intrusion.



Groundwater dynamics at Vrbanski plato.

The FREEWAT case studies demonstrated the importance of the application of the WFD based on data and rigorous technical scientific analysis along with participatory approach. This procedure allows disclosing to all the authorities involved potential critical situations (such as data scarcity or poor data quality). Conversely, new data acquisition (or improvement of existing dataset) under the open data paradigm allows maximizing the data value and share it with the interested stakeholders. Further models are now being implemented, given the open-source and free nature of the code.

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Authors: G. De Filippis[a], R. Rossetto[a]
Affiliations: [a] Scuola Superiore Sant'Anna, Pisa, Italy

More info at: www.freewat.eu

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