FREEWAT

Free and Open Source Software Tools for Water Resource Management

EU HORIZON 2020 Project

Policy Brief N. 6/7

FREEWAT for water resource management in rural areas

Key Policy Messages

- ✓ EU regulations highlight the importance of adopting modeling solutions for rural water management
- ✓ A modeling approach based on FREEWAT was adopted at case studies devoted to rural water management
- ✓ The FREEWAT platform allowed to investigate water management scenarios

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.

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Conjunctive use and optimization solutions in the rural environment

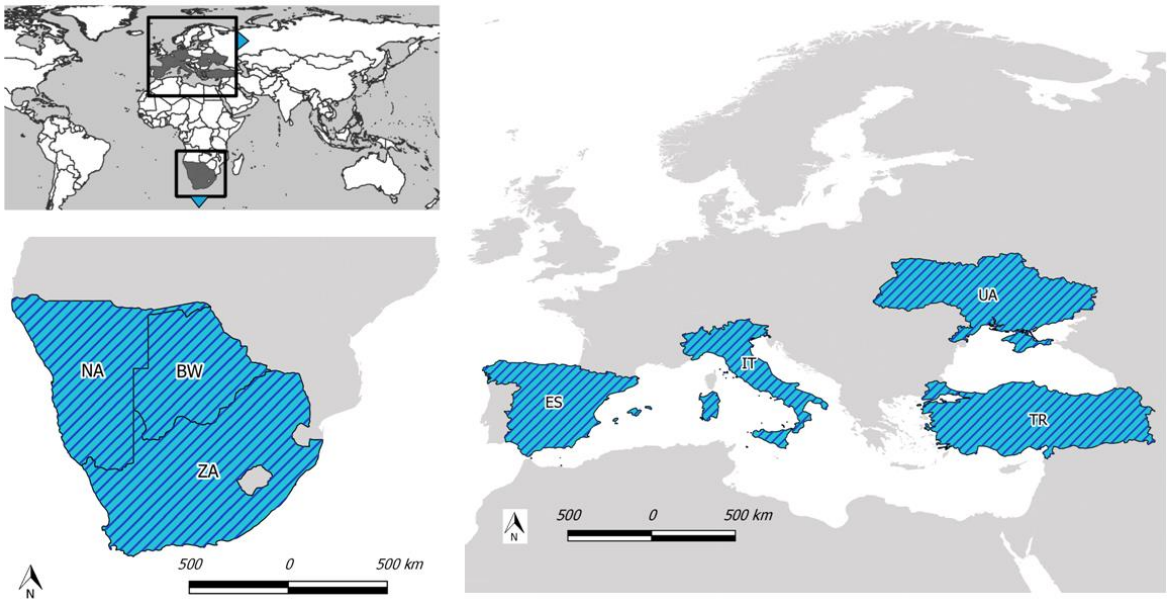
During the last decades, groundwater resources have been facing growing pressure, due either to climate change and human overexploitation. This holds especially in Mediterranean or semi-arid rural areas, where the bulk of water consumption takes place. As such, water management and planning activities in the rural environment are needed, in order to detect and possibly restore critical situations related to water scarcity and/or water quality deterioration.

Speaking about water scarcity, conjunctive use of ground- and surface-water in agriculture is of outmost importance in many rural areas of Europe and beyond.

Nitrates are currently the main source of diffuse pollution of ground- and surface-water. The EU Nitrates Directive aims at preventing nitrates pollution from agricultural sources and at promoting the adoption of good farming practices. It is required that Member States foresee monitoring and prevention practices in local Action Programs.

In the framework of rural water management, tools for simulating optimization of ground- and surface-water have been integrated in FREEWAT.

Such tools were tested and applied to five case studies, in EU and Africa (Italy, Spain, Ukraine, Turkey, Namibia, Botswana and South Africa). Issues dealt within these case studies related to water and land management, to reduce water consumption in irrigation areas and nitrates pollution of groundwater.



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Application of the FREEWAT platform for rural water management

The aim of applying the FREEWAT platform to case studies devoted to rural water management is to adopt a modeling-based approach to evaluate (i) conjunctive use of ground- and surface-water to address water scarcity, and (ii) the risk of nitrate pollution in Nitrate Vulnerable Zones (NVZs), due to agricultural practices.

Diffuse nitrates pollution of water resource due to leaching of fertilizers within the soil is the main issue in the *Tudela-Cortes* NVZ (Navarra, Spain). The objective of this case study is to set up a modeling-based approach to estimate the reliability of measures eventually considered in the Nitrates Directive Action Plans.

The major limiting factor for crop productivity in the *Bakumivka river catchment* (northern Ukraine) is the water regime, which is subject to extreme variations in space and time, resulting in extremely wet-to-dry conditions. The need to regulate this issue lead to building of a drainage-irrigation system in 1968-69, which resulted in change of landcover patterns, crop composition and agro-technologies. As the drainage-irrigation system is currently unsuitable to support more water-demanding commercial crops, proper regulation on water use is needed.

Overexploitation of freshwater resources for irrigation purposes in a major concern in the *Palas basin* (central Anatolia, Turkey), a semi-arid closed basin where agriculture represents the main economic activity. Here, the intensive use of ground- and surface-water resources threatens the hydrologic sustainability of the Tuzla lake ecosystem located within the basin. As such, understanding the relationships between agricultural water uses in the Palas basin and water flows to the Tuzla lake is a major issue for water management in the area.

The *Massaciuccoli lake basin* (central Italy) is a coastal lacustrine area largely drained by 1930 for agriculture purposes. Since land reclamation activities started, the area has been undergoing environmental issues, including land subsidence, water salinization and eutrophication, and severe water stress conditions, especially in the dry season. The main objectives of this case study include: (i) estimating water volumes raised to the lake by the land reclamation areas; (ii) evaluating the water balance during the summer period; (iii) evaluating the consistency of water supply with respect to the actual water need of crops.

The modeling-based approach has also been adopted to foster the establishment of a multi-Country cooperation mechanism among governments of Namibia, Botswana and South-Africa for managing the *Stampriet Transboundary Aquifer System* (STAS), which represents the only permanent source of freshwater for irrigation in the area. The modeling activities have been devoted to produce a shared understanding of the STAS, by filling existing knowledge gaps and harmonizing existing databases.

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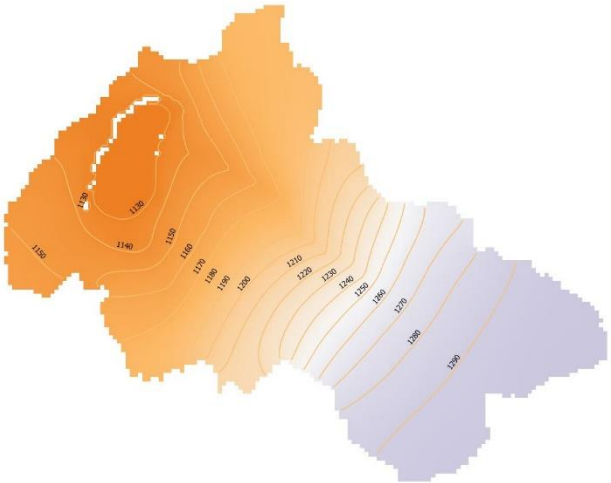
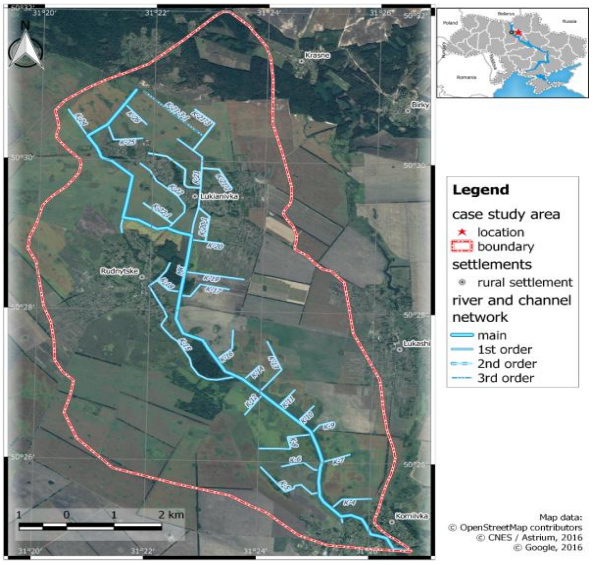
Advances in water resource management

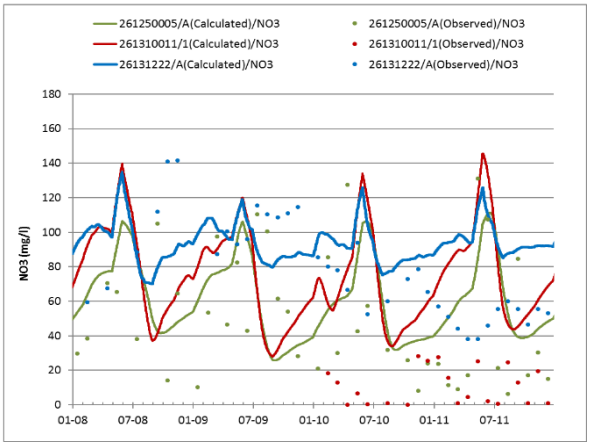
The modeling-based approach aimed at supporting decision makers in designing measures to be included in Action Programs, as instructed by the EU Nitrates Directive, as well as to evaluate the reliability of measures foreseen in the WFD for rural management.
Water management scenarios were modeled to analyze hydrosystems' response to different agriculture practices and land use conditions. Results of three of the above-mentioned case studies are presented.
Different groundwater abstraction rates were input to design scenarios at ***Palas basin*** (Turkey), in order to understand how aquifer exploitation affects the lake hydrology. Water flows to the Tuzla lake resulted to be significantly related to pumping rates. As an example, a complete stop of groundwater pumping would increase discharge to the Tuzla lake by 0.61 Mm^3/y. Furthermore, a raise of 0.46 m of the average lake level would be recorded. On the other hand, increasing groundwater pumping by 50% with respect to the reference situation would make discharge to the Tuzla lake to decrease by 0.31 Mm^3/y, while the average lake stage would drop 0.31 m lower than that recorded at the current condition.



Spatial pattern of land cover is essential in water management within the ***Bakumivka river basin*** (Ukraine). Three water management scenarios were simulated, in order to compare different spatial patterns of land cover and water distribution. The scenarios were set assuming: (i) crops used in the last five years in forest-steppe zones Ukraine, (ii) 70% of the arable lands are occupied by the most economically profitable crops, (iii) organization of landscape in compliance with the principles of landscape ecological planning. Maps identifying areas with optimal water balance for specific crops were produced, based on the difference between the simulated water head and the optimal water head laying within the active root zone.



Water management scenarios in ***Tudela-Cortes*** (Spain) were devoted to evaluate measures foreseen in the Agronomic Action Program for reducing fertilization doses. The following was simulated: (i) hypothetical abandonment of agricultural activity, with crops replaced by non-irrigated pasture; (ii) reduction of the applied fertilization doses by 10%; (iii) improving efficiency of the irrigation systems, to evaluate the contribution of reducing irrigation water on nitrogen leaching. Besides the abandonment scenario is the only that would effectively reduce nitrate concentration at the short-medium term, reducing fertilization is the most suitable measure.



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