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FREEWAT - OPEN SOURCE INTEGRATED MODELLING ENVIRONMENT (SURFACE- AND GROUNDWATER)

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SUMMARY: FREEWAT is new EU project within Horizon 2020. It is in his first steps and aims at promoting water management and planning by simplifying the application of the Water Framework Directive and other EU water related Directives. FREEWAT will be an open source and public domain GIS integrated modelling environment for the simulation of water quantity and quality in surface water and groundwater with an integrated water management and planning module. FREEWAT will initiate a process aimed at filling the gap between EU and US on widerspead-standardised ICT tools and models for management of water quantity and quality and will set a well recognizable and flagship initiative. The open source characteristic of the platform allow to consider this initiative "ad includendum" (looking for inclusion of other entities), as further research institutions, private developers etc. may contribute to the platform development. The Consortium is constituted by partners from various sectors from 10 EU countries (Italy, Germany, Spain, France, Czech Republic, Slovenia, Greece, Rumania, Estonia, Malta), plus Turkey and Ukraine. Synergies with the UNESCO HOPE initiative on free and open source software in water management greatly boost the value of the project. Large stakeholders' involvement guarantees results dissemination and exploitation.

KEY WORDS: GIS integrated water management modeling, water resource management, implementation of EU water related policies, open source and public domain software, Horizon 2020

FREEWAT - OPEN SOURCE INTEGRALNI OKOLIŠ ZA MODELI-RANJE (POVRŠINSKE I PODZEMNE VODE)

SAŽETAK: FREEWAT je novi projekt u okviru programa Europske unije za istraživanje i inovacije Obzor 2020. (Horizon 2020). Projekt je tek započeo s ciljem promicanja upravljanja vodama i planiranja pojednostavnjenjem primjene Okvirne direktive o vodama i drugih direktiva EU na području voda. FREEWAT će biti *open source* GIS integralni okoliš za modeliranje iz javne domene za simulacije količina i kakvoće vode u površinskim i podzemnim vodama, s modulom za integralno upravljanje vodama i planiranje. FREEWAT će pokrenuti proces čiji je cilj popunjavanje praznina među rasprostranjenim, standardiziranim informatičkim alatima i modelima za upravljanje količinom

i kakvoćom vode iz Europske unije i Sjedinjenih američkih država, a predstavljat će prepoznatljivu, vodeću inicijativu. Open source karakter platforme omogućit će da se ova inicijativa shvati kao napor na uključenju drugih subjekata, *"ad includendum"*, stoga što buduće istraživačke institucije, privatni programeri itd. mogu dati doprinos razvoju platforme. Konzorcij se sastoji od partnera iz različitih sektora 10 zemalja Europske unije (Italija, Njemačka, Španjolska, Francuska, Češka Republika, Slovenija, Grčka, Rumunjska, Estonija, Malta), te Turska i Ukrajina. Sinergija s UNESCO-vom inicijativom HOPE za osiguranje besplatnog, open source kompjuterskog softvera na području upravljanja vodama u velikoj će mjeri povećati vrijednost projekta. Uključenost velikih dionika jamstvo je širenja i korištenja rezultata.

KLJUČNE RIJEČI: GIS integralno modeliranje na području upravljanja vodama, upravljanje vodnim resursima, provedba politika EU na području voda, *open source* kompjuterski softver iz javne domene, Obzori 2020.

1. INTRODUCTION

The FREEWAT project general objective is to promote water management and planning by simplifying the application of the Water Framework Directive, Groundwater Directive, Nitrate Directive and other water related Directives. The simplification is achieved through the FREEWAT platform and its relative participatory approach. FREEWAT will be an open source and public domain GIS integrated modelling environment for the simulation of water quantity and quality in surface water and groundwater with an integrated water management and planning module.

The FREEWAT project aim at improving Water Resource Management (WRM) by achieving the following specific objectives:

- to coordinate previous EU and national funded research to integrate existing software modules for water management in a single environment into the GIS based FREE-WAT environment;

- to support the FREEWAT application in an innovative participatory approach gathering technical staff, and relevant stakeholders (*in primis* policy and decision makers) in scenario creation and simulations to apply and develop appropriate water policies. This will provide EU Governing Bodies, Authorities and Water Utilities and environmental companies/water professionals with innovative, free and open source software tools having high accuracy level and friendly usability;

- starting a process aimed at filling the gap between EU and US on widespread-standardized ICT tools and models for management of water quantity and quality setting a well recognizable and flagship initiative. The open source characteristics of the codes and platform allow to consider this an initiative *"ad includendum"* (looking for inclusion of other entities), allowing further research institutions, private developers etc. not only within the EU to contribute to the platform development and uptake. Such a process will also rely on the collaboration with eminent scientific and technical staff of USGS, a leading public organization in US for what concerns environmental ICT tools distribution and application (see attached Letter of Support to the present proposal). Moreover an important collaboration with the UNESCO-IHP HOPE-Initiative (http://www.hope-initiative.net/) further boost the proposal potentialities;

- building knowledge and capacity in the use of scientific software technologies, by improving the professional level of technical and managerial personnel involved in WRM issues in public institutions and private companies;
- applying these innovative software instruments to 10 case studies within the EU, 2 case studies in neighbouring countries (Turkey and Ukraine) and to a large transboundary aquifer in Africa, creating synergies with the UNESCO-IHP HOPE program;
- optimizing the use of water resource monitoring data, by obtaining trough simulations results distributed in space and time, useful to the solutions of issues such as: water availability and quality, groundwater pollution monitoring and remediation, and coping with seawater intrusion;
- providing MSc and PhD students, researchers and professors of a free and open source software to be trained on various issues related to water management;
- involving relevant stakeholders in the application of the FREEWAT platform by means of regular focus group meetings to enable a participatory process;
- building a web based community of users and developers of the free and open source FREEWAT platform;
- contributing to the creation of innovative companies and work places that will exploit and continue the integration, development and training on the FREEWAT platform.

The FREEWAT project and partners are linked to past and ongoing national and EU funded research activities; they aim at capitalizing and coordinating these projects results. The main of this research activities are the **SID&GRID** research project (**EU-POR FSE 2007-2013 Regione Toscana** - Italy, partner involved Scuola Superiore Sant'Anna several stakeholders; Rossetto et al., 2013; Borsi et al., 2013) and the ongoing **EU FPVII** project **MARSOL** (*MARSOL, 2014*, partner involved Technische Universitet Darmstadt, Scuola Superiore Sant'Anna, Tea Sistemi Spa, Paragon). The SID&GRID research project developed a 3D-distributed physically based and GIS integrated numerical hydrological model based on open source and public domain solutions, to produce spatial and temporal analysis to get quantitative results for water resource management. The SID&GRID approach was based on a solution, which allows simulating the groundwater flow (GWF) only, or the GWF and the unsaturated zone (USZ) or the whole hydrological cycle, by coupling surface water processes to USZ and GWF. In building the hydrological model, the project choice was: i) to analyze and select existing open source and public domain codes, in terms of their proven capability to simulate hydrological processes and to store, manage and analyze spatial data, ii) to develop new codes for selected hydrological processes; iii) to couple the selected codes along with newly developed ones, iv) to integrate the resulting coupled codes within a GIS interface, applications and library, to manage all the input and output data by means of Data Base Management System. A series of test applications were developed by authorities and companies involved in the SID&GRID project. The outcomes of the project are freely available to final users (e.g. river basin authorities, water utilities, water service companies, etc.) at: http://ut11.isti.cnr.it/SIDGRID/ and an Italian User Group on the LinkedIn exists. Regione Toscana is now further financing the development of the software by supporting its porting from the original GVsig GIS desktop to QGIS, including a new approach to the database linking.

Within the project MARSOL the capability for solute transport in groundwater will be added to the SID&GRID framework.

2. GIS INTEGRATED WATER MANAGEMENT MODELLING PLATFORM

Project FREEWAT relates to the EU programme topic ***WATER-4a-2014 Dissemination and exploitation, ICT, gaps, research needs, etc...*** in addition, aims to coordinate and support previous research funded by EU and national entities in order to disseminate and exploit relevant ICT-based tools and platforms. In particular the FREEWAT proposal suggests an approach based on capacity building and on the participative use of an ICT water management platform (derived coordinating already developed computer programs and solutions) for simplifying the application of the Water Framework Directive (WFD) and water related Directives (EC, 1991, 2000, 2006 and 2013).

An EU publication (*Science-policy interface in support of the WFD*; EU, 2013) from the Activity on the water Science-Policy Interface (SPI) within the Common Implementation Strategy of the WFD underlined the need to transfer research results, which are available and relevant to the implementation of the WFD, to policies development and application. At the same time, the effective market uptake is often limited by lack of extensive testing of the results applicability and of continuous large-scale dissemination. This is strongly connected to the problem of general lack of funding for the testing and dissemination activities on the results achieved by research projects. Often this challenges the capability of spreading innovative water research results among policy makers, public Institutions, private sector and general public. The FREEWAT proposal aims at addressing the above-mentioned challenges.

The year 2015 is a first year of the project and its main work include software integration and preliminary training and training of trainers. Year 2016 is intended for local courses and training for stakeholders organized by case study partners. In year 2017 the project will be ended with local workshops and final conference and workshop.

2.1. FREEWAT concept and approach

The overall approach of the FREEWAT project is based on a circular process (Fig. 1.):

- coordinating previous EU and national funded research to integrate existing selected software modules for water management in a single open source and public domain model-based GIS integrated platform (that will be called FREEWAT);
- building capacity around the FREEWAT platform by means of dedicated training and case studies implementation, in partner's country and at the international level;
- supporting the FREEWAT application in an innovative participatory approach, that gathers technical staff, and relevant stakeholders in the development and simulation of scenarios for the application of appropriate water policies;
- actively disseminating and exploiting the FREEWAT activities and results at international level thanks to in order to foster its wide application at EU scale and beyond.
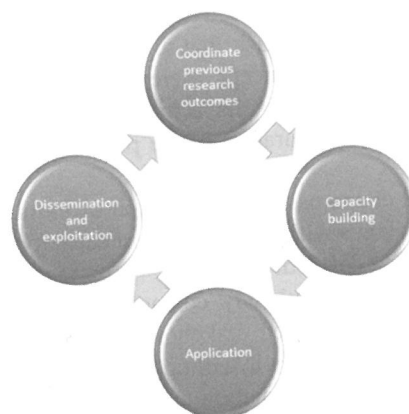
Figure 1. Circular process at base of the FREEWAT project

While setting up the project idea, a questionnaire was circulated among potential partners and stakeholders, to highlight needs in terms of ICT-tools for the application of the WFD and water related Directives. The results helped understanding currently used and still maintained open source and public domain ICT-tools. With this feedback, the coordinating approach results in the integration of existing and maintained codes and pieces of software deriving from previous national and EU funded projects into a single open source and public domain model-based GIS integrated platform. The following tools are expected to be integrated:

- a whole module for calibration and sensitivity analysis;
- a set of tools for groundwater quality issues;
- a set of tools for the analysis, interpretation and visualization of hydrogeological data;
- a module for solute transport in the unsaturated zone;
- a module for crop growth and water requirements in agriculture;
- a dedicated module for water management and planning that will help to aggregate and manage all the distributed data coming from the simulation scenarios.

FREEWAT will have a modular structure and each module will provide tools for the application of the WFD, Groundwater Directives, Nitrate Directives and water related Directives as well as particular greening aspects of the Common Agricultural Policy.

2.2. Measures to maximize impact

Impact of FREEWAT will be maximized by a dedicated plan for dissemination and exploitation, and communication of project activities and results. All these are issues addressed within the Work Package 8,"*Dissemination/Communication & Exploitation of results*". Because of the importance of the activities of this WP, SSSA, coordinator of the proposal, will lead it and will appoint a "*Dissemination and Innovation Manager*". One project partner with strong capabilities in dissemination and exploitation issues, will collaborate with SSSA to strengthen the WP activities. All the Consortium members will

have to perform dedicated dissemination activities at their country level.

Awareness raising is considered any task that aims at disseminating the results of the project, promoting the FREEWAT concept, increasing the visibility of the project and supporting the exploitation of the results achieved. These supporting activities for FREEWAT will last for the entire duration of the project and are expected to continue beyond it.

The training activities will encompass the production of training materials and training courses as well as training events with the objective of capacity building on the use of the FREEWAT platform for about 850 individuals.

About 50 stakeholders have been already contacted within the FREEWAT partners countries and beyond them (interested stakeholders have been informed in Jordan, UK, US, Portugal) and they express their willing to participate in the project activities, especially in capacity building, dissemination and exploitation activities. All in all 180 stakeholders from various sectors (river basin authorities, local or national governmental authorities, water utilities, environmental protection agencies, water related private companies, irrigation and drainage companies and authorities, farmers associations, associations for the protection of the environment, etc...) have been already identified in the stage of the project preparation. The type of authority and their area of interest is shown in Fig. 2. and Fig.3.
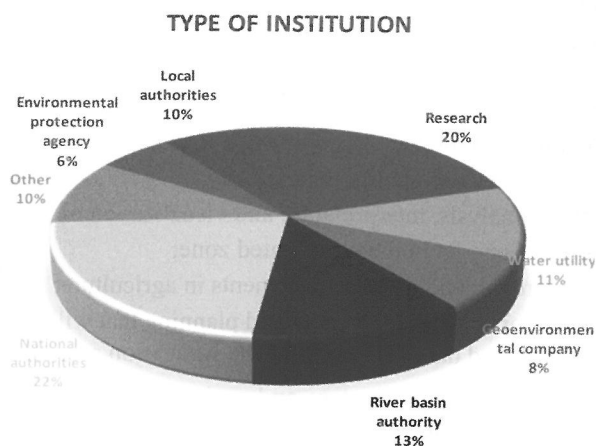
TYPE OF INSTITUTION

Figure 2. Type of interest of identified stakeholders
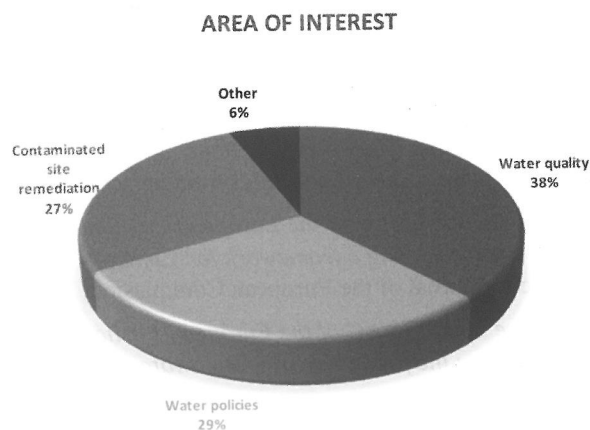
AREA OF INTEREST

Figure 3. Area of interest of identified stakeholders

Stakeholders will be divided in specific target groups. A tailored strategy with targeted messages, means and language will be used to address each of them.

CONCLUSION

The FREEWAT Consortium is constituted by 17 partners from 10 European countries (Italy, Germany, Spain, France, Greece, Estonia, Romania, Malta, Czech Republic, Slovenia) plus Turkey and Ukraine. UNESCO international organization is also member of the partnership. The consortium is composed of a broad spectrum of research, private companies and authority institutions, including 6 SMEs, 2 authorities, 5 universities, 2 research institutes, 1 not-for-profit research and international training centre and 1 International organization. The value of using advanced technologies (often referred as "complex" in WFD related documents) in water management is often diminished by the fact that only well-trained practitioners and professionals are involved in the study and present the results to stakeholders. The later are not actively involved in the model development and have to rely and trust who performed the analysis (Refsgaard et al., 2010). Through creating a common environment among water research/professionals, policy makers and implementers, FREEWAT main impact will be on enhancing science- and participatory approach and evidence-based decision making in water resource management, hence producing relevant and appropriate outcomes for policy implementation.

ACKNOWLEDGMENTS

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