



# **FREEWAT**

Free and Open Source Software Tools for Water Resource Management  
EU HORIZON 2020 Project



 **ict4water.eu**

# Open Workshop 1st FREEWAT User and Developers International Workshop

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IDAEA. CID - CSIC

16 Jordi Girona. 08034 Barcelona

## Application of the FREEWAT platform in Lavrio, Greece

Christos Pouliaris,  
PetroKofakis, Andreas  
Kallioras (NTUA)

**EIP Water** Online Market Place  
Matchmaking for water Innovation

**MAR Solutions - Managed Aquifer  
Recharge Strategies and Actions  
(AG128)**



# Presentation contents

- Presentation of the study area.
- Conceptual model.
- Modelling structure.
- Results.
- Pros n' Cons.
- Trainings.
- Further developments.

# Introduction

Lavrion is 50 km SE of the city of Athens. The geology consists mainly of alterations of schist and marble formations, while igneous rocks are also present in the area. All these formations are covered by Quaternary deposits. Two types of aquifers are developed, one in the Quaternary alluvial deposits (granular aquifer) and one in the Upper Marble formation (karstic aquifer).

The site offers a typical hydrogeological setting for a Mediterranean coastal aquifer system. The entire aquifer system suffers from:

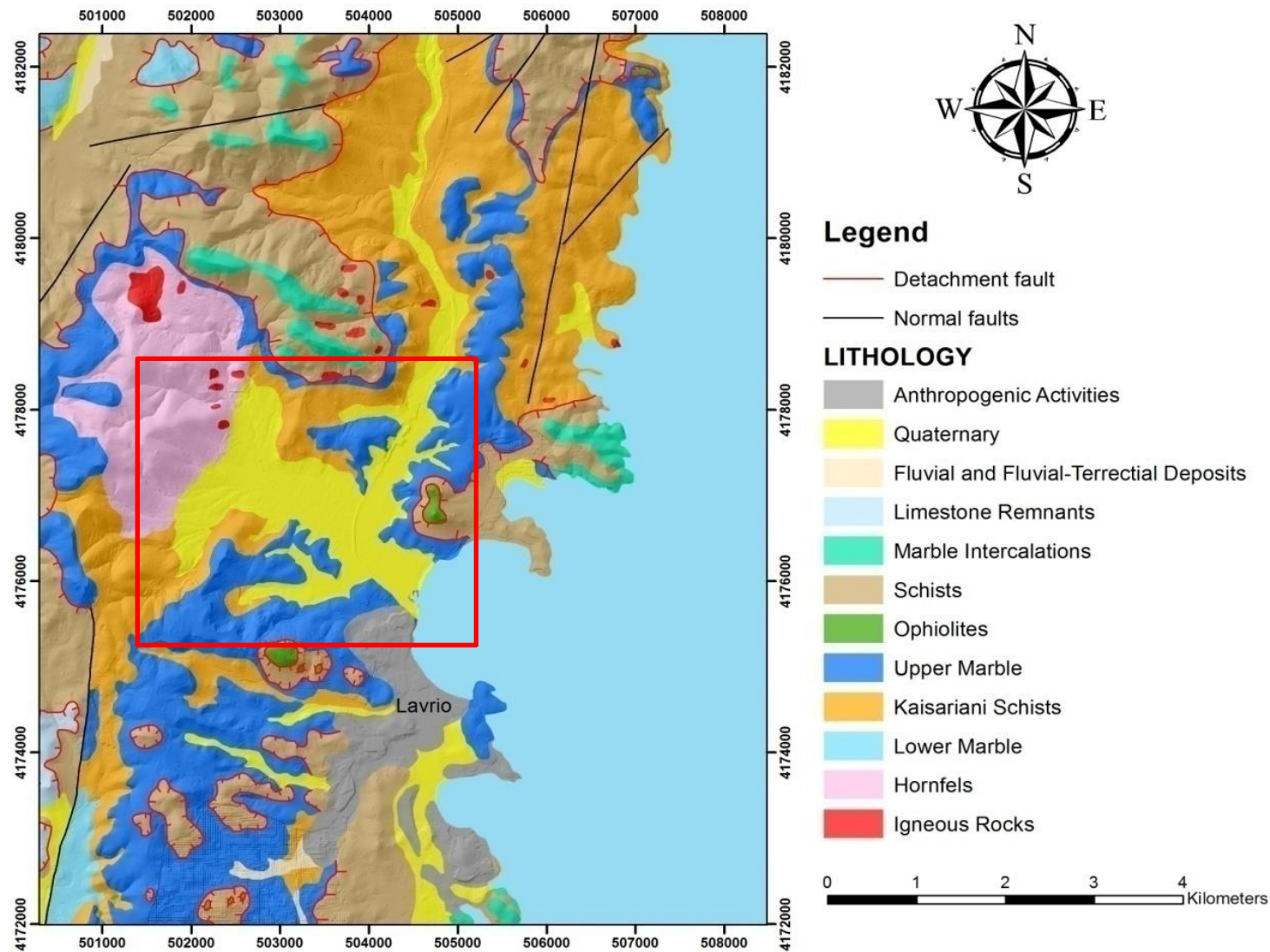
- (i) water shortage resulting from both anthropogenic activities (overexploitation) and natural conditions (low precipitation records)
- (ii) contamination due to the intrusion of seawater

and Managed Aquifer Recharge (MAR) applications are envisaged to combat all those.

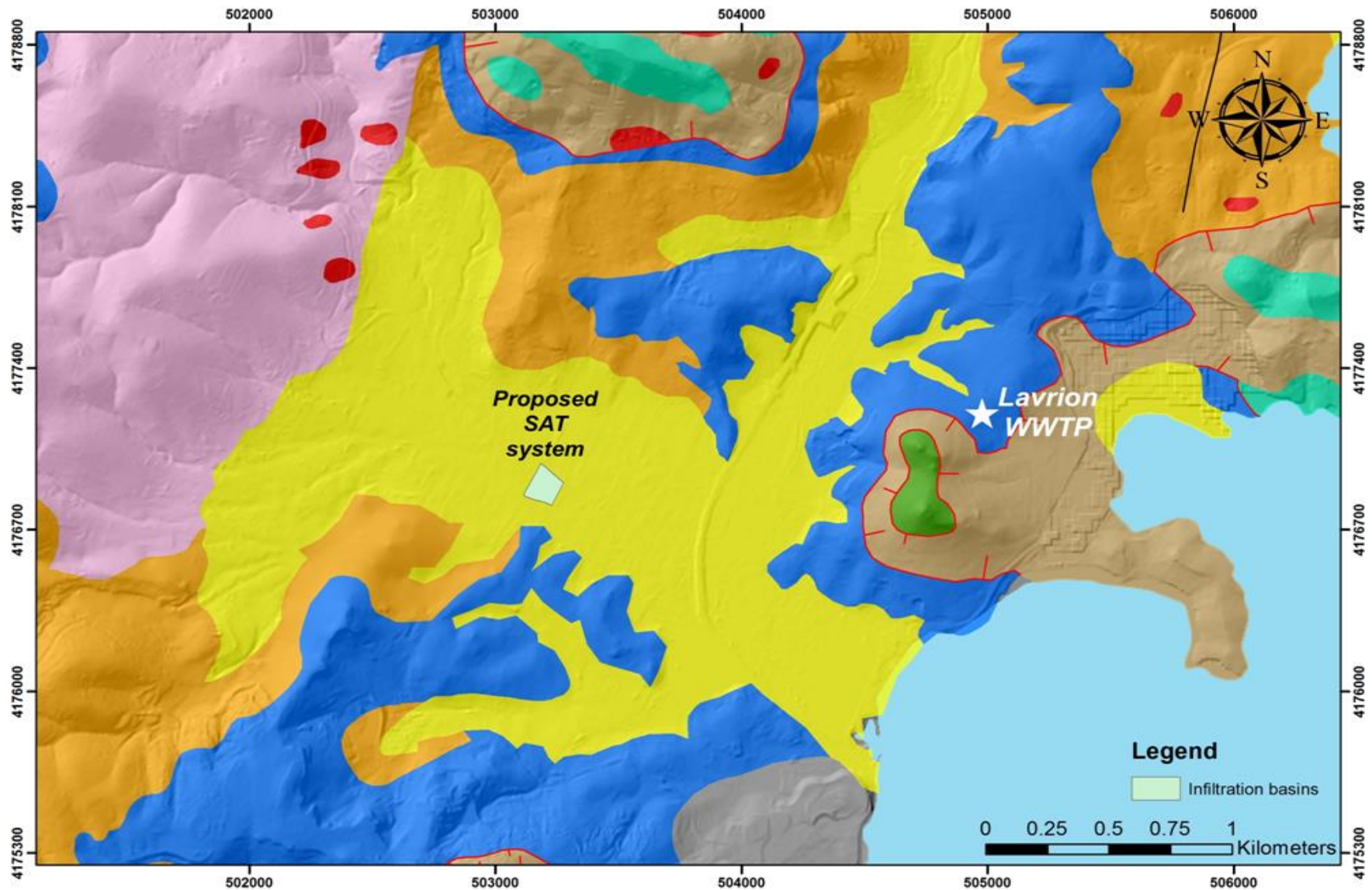
The approach, as developed by the local Municipal Company for Water Supply and Sewerage of Lavrion (DEYATIL S.A.), is to use the treated wastewater that is daily produced by the wastewater treatment plant of the Municipality as a recharge water source in order to artificially recharge the unconsolidated aquifer formation. The proposed SAT system is supported by the local wastewater treatment plant (WWTP) which is capable of continuously providing recharge water with minimal energy costs. The quality of the treated wastewater meets the requirements of the National Legislation for wastewater reuse, through artificial recharge by applying Soil Aquifer Treatment technologies in this specific area.



# Geological information

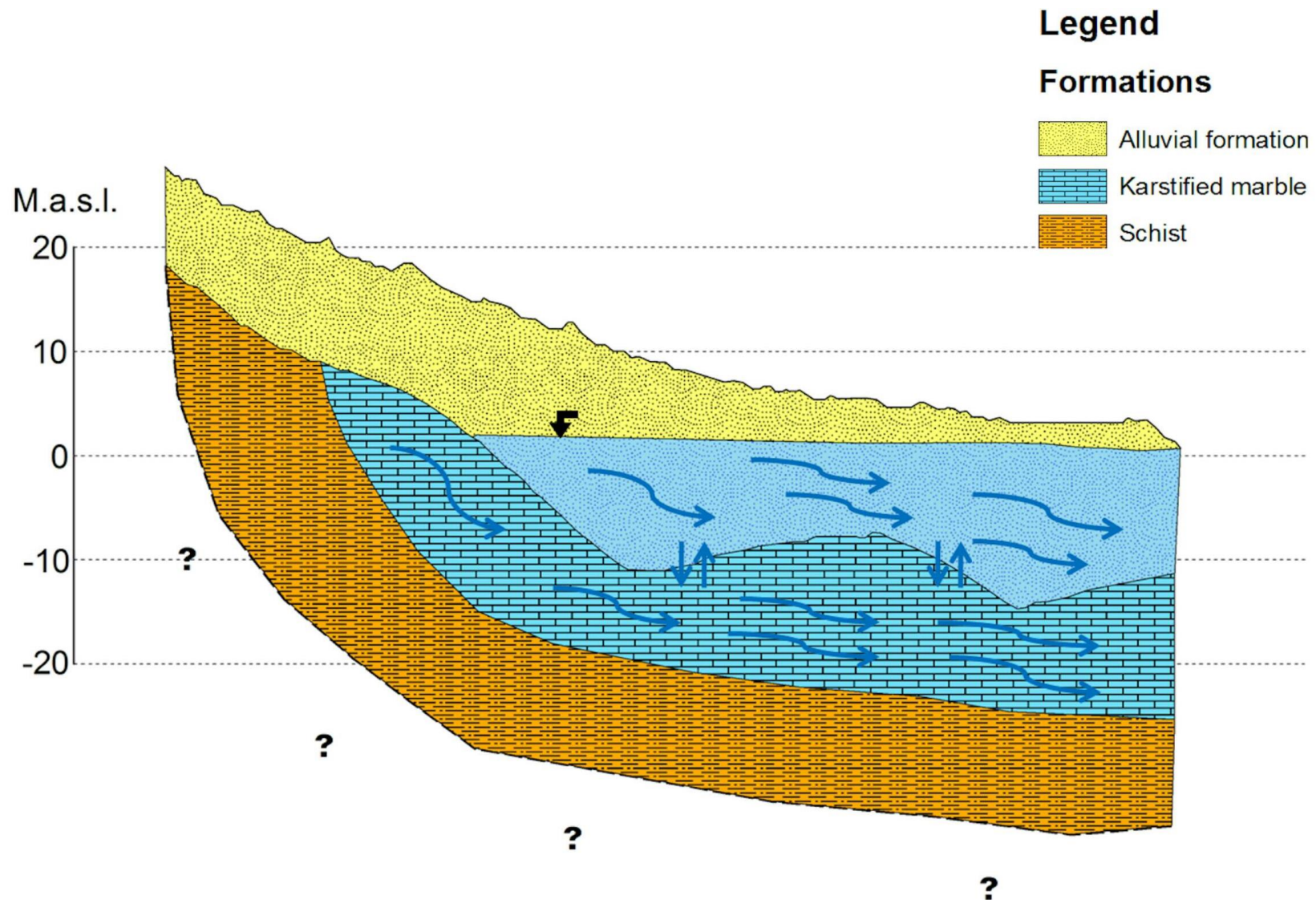


# MAR system





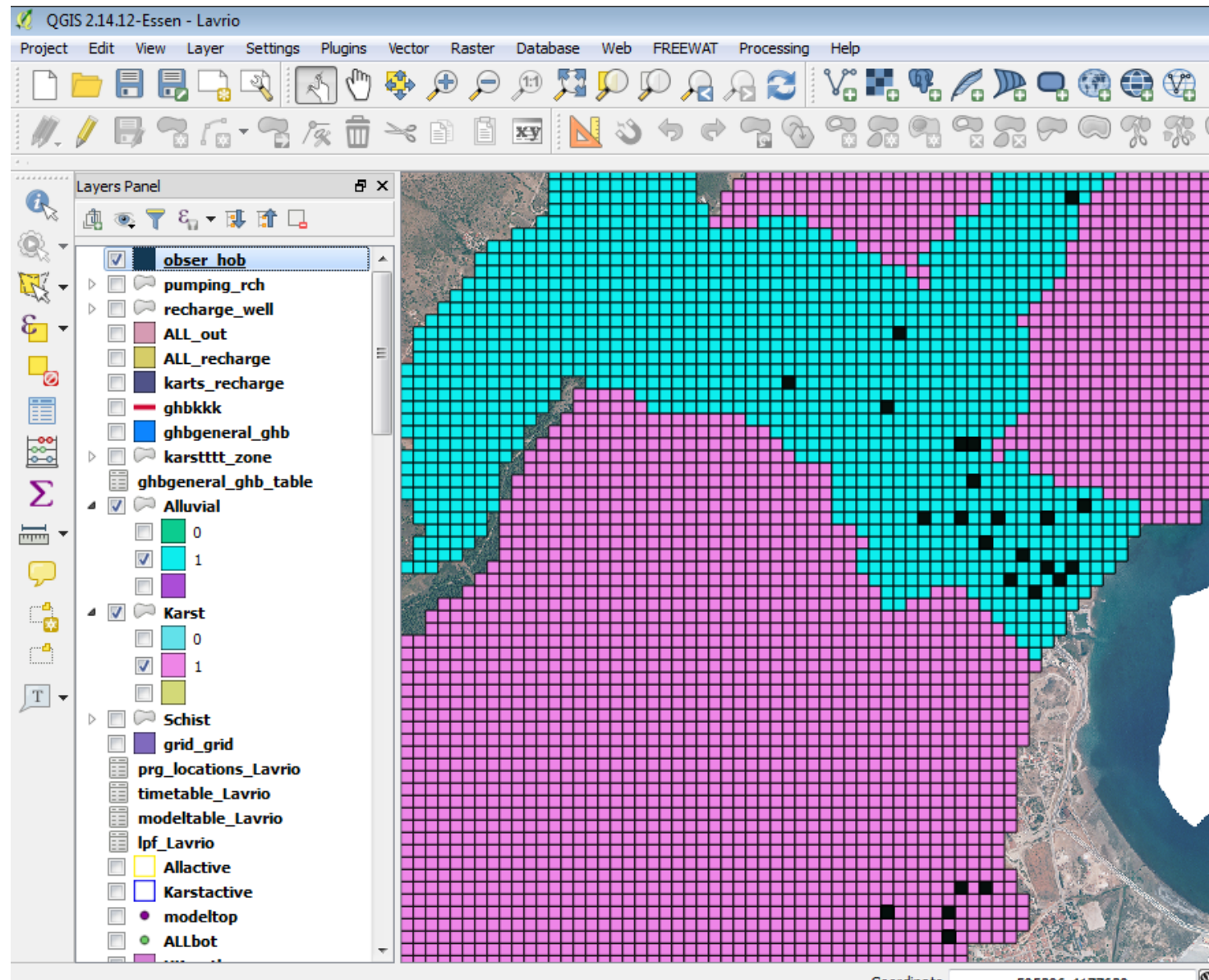
# Conceptual model of the study area



# Modelling activities

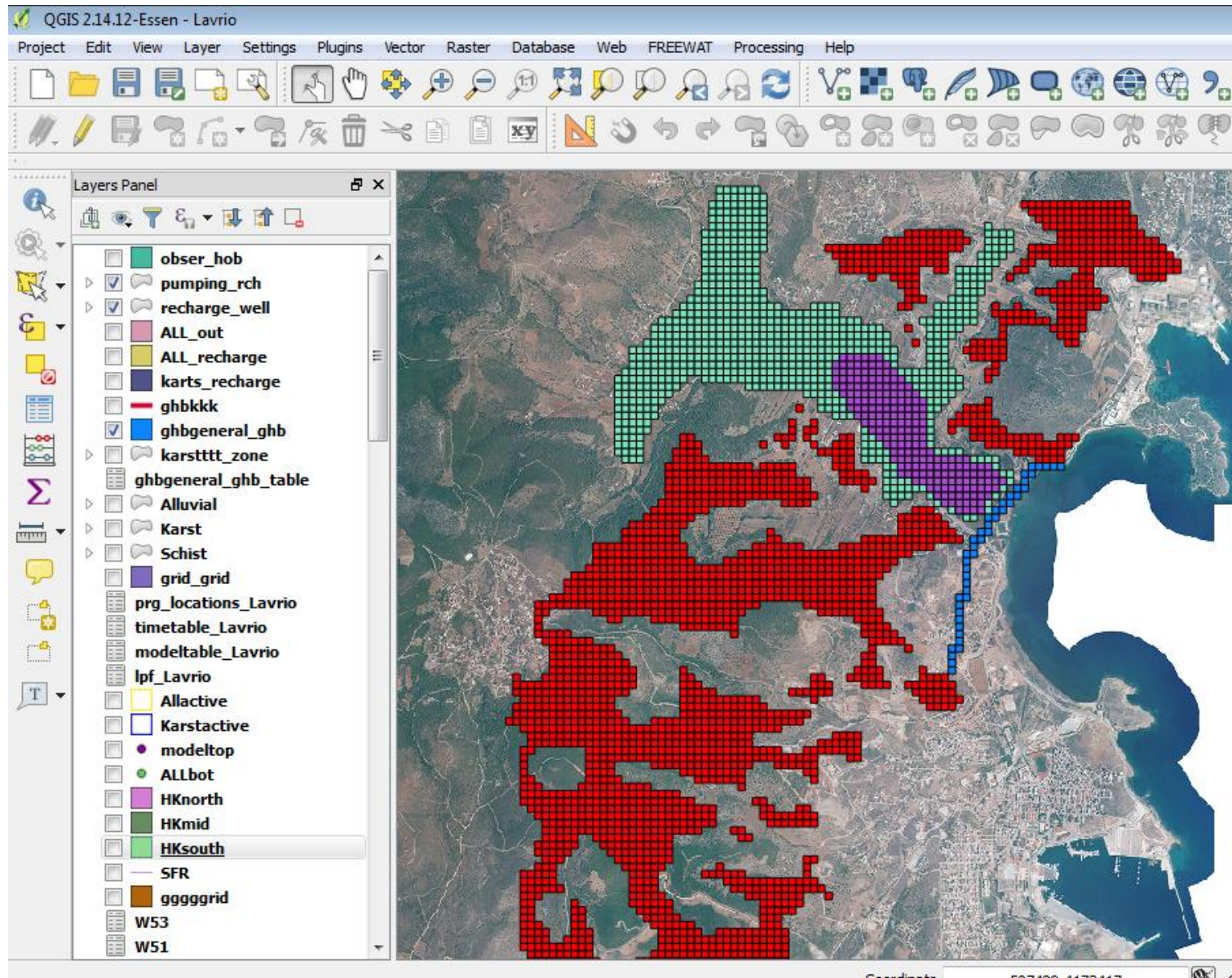
- The groundwater flow model for the Lavrio area has been developed in previous steps, so the aim was to adjust it in the FREEWAT platform.
- The code used is MODFLOW-2005 with the PCG solver.
- The model has two convertible layers representing the two aquifers, and the simulation is in transient state.
- The simulation is run for 2.5 years.

# Layers and HOBs



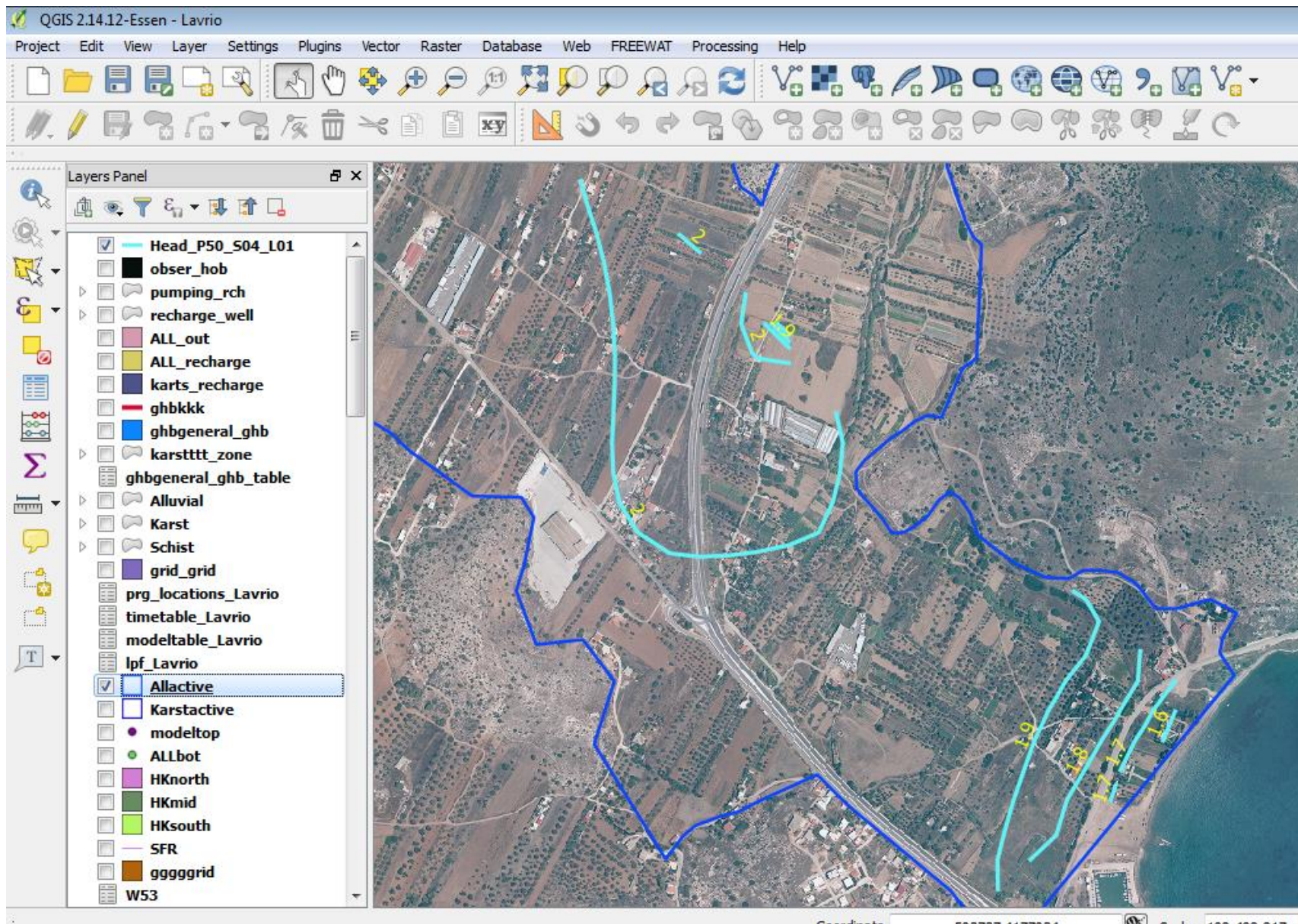


# Recharge, pumping and coastal boundaries



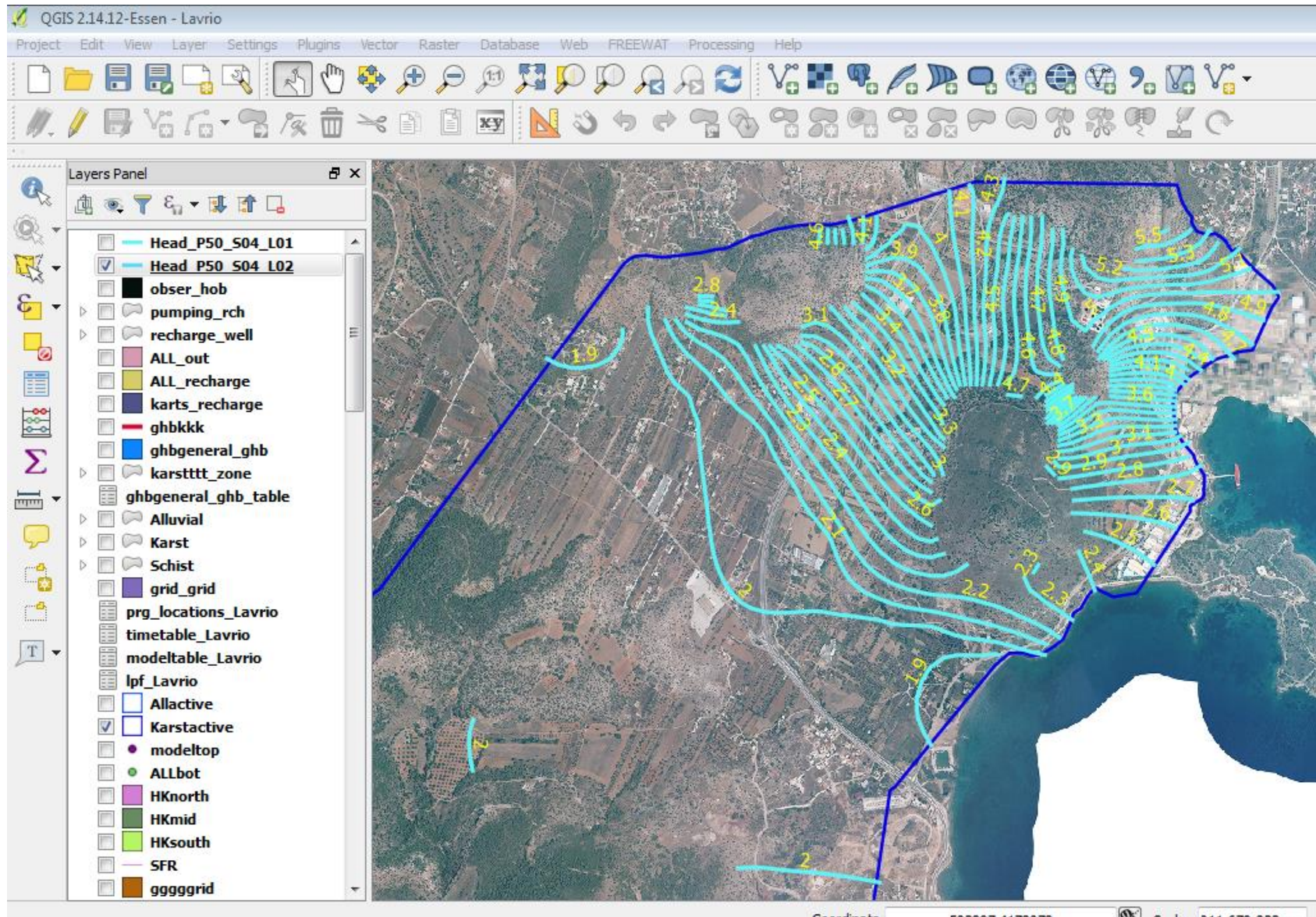


# Results (1<sup>st</sup> layer)



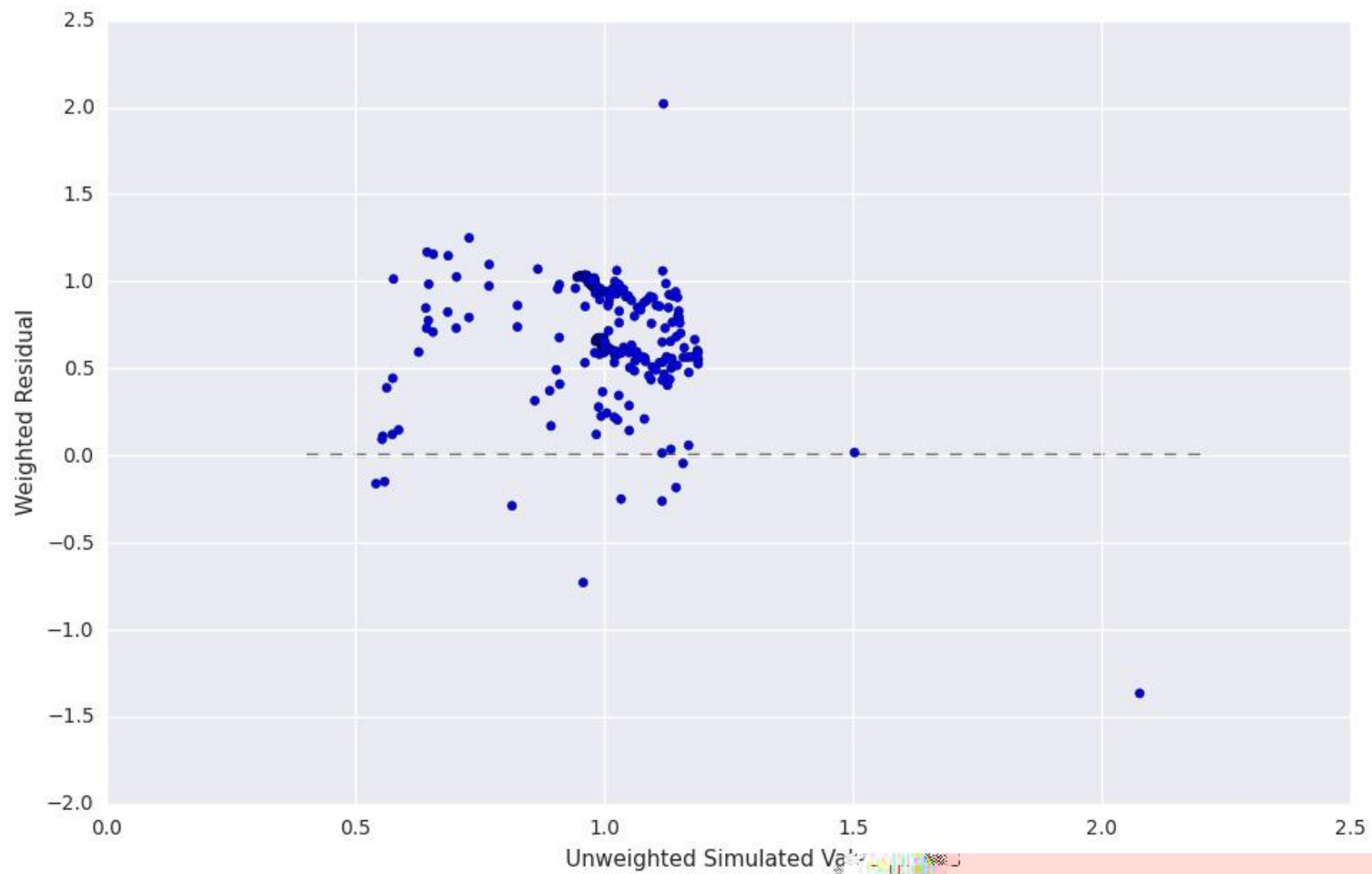


# Results (2<sup>nd</sup> layer)





# Results (Obs vs. Sim Heads)



# FREEWAT Pros n' Cons – A user's perspective

The groundwaterflow model was successfully transferred to the FREEWAT platform. The following remarks could be made:

- Model building is fast and accurate.
- Large models (layers, cell number, boundary conditions) can be dealt with without problems.
- GIS capabilities can be used for pre – and post – processing.
- Model built was comparable to the original model in all aspects (water budgets, simulated heads etc).

Yet, some more points should be mentioned:

- Bugs that are potentially still there.
- Local grid refinement.
- Model development might be problematic sometimes due to different representation/structure between conventional MODFLOW GUIs and FREEWAT.

# Training

Within FREEWAT almost 70 were trained and 60 have seen a FREEWAT presentation in 2 international conference.

This has provided some experience and ideas on how to improve the training activities, both for trainers and trainee



# No installation alternatives – FREEWAT portable

- *FREEWAT Portable* is a packaged, ready to use FREEWAT portable installation (you can run without having to run an installer).
- Intended for users that do not want to install QGIS, or create and keep any data folders (*!user!qgis2* folder) in their user (home) folder.
- It does not write to the Windows registry or store its configuration files in the user's profile; instead, it stores its configuration files in the portable directory.
- The FREEWAT Portable folder can be stored on any storage facility, including internal mass storage, a file share, or external storage such as USB drives.

# FREEWAT portable / 2

It contains QGIS (version 2.18 LTR) + FREEWAT plug-in (version 0.5).

## USB drive

You can create USB flash drives ready to use that can be distributed to the trainees, thus accelerate the training process.



## Installation – Execution

- Copy freewat\_portable.7z archive to the destination folder (or external USB drive).
- Use 7-Zip (or any other compression software) to extract the freewat\_portable folder and its contents.
- Double click the *qgis.bat* to start QGIS with FREEWAT plug-in.

# FREEWAT portable / 3

- The *qgis.bat* file that launches FREEWAT portable:

```
1 REM This causes the command interpreter (command.com or cmd.exe),
2 REM to suppress the display of all following commands in your .bat file.
3 @ECHO OFF
4
5 REM The %~dp0 (that's a zero) variable when referenced within a Windows batch file
6 REM will expand to the drive letter and path of that batch file.
7 SET DRV_LTR=%~dp0
8
9 REM Set a specific Qgis variable with a variable setting before
10 SET OSGEO4W_ROOT=%DRV_LTR%qgis
11 REM add a new path to the system path
12 echo %OSGEO4W_ROOT%
13 echo "-----"
14 REM qgis-ltr --> qgis
15 path %PATH%;%OSGEO4W_ROOT%\apps\qgis\bin;%OSGEO4W_ROOT%\apps;%OSGEO4W_ROOT%\bin
16 REM %1 is the first argument on the command line.
17 REM If the bat file finds one argument (project name), open it.
18 REM Else open a Qgis program with a new empty project
19 IF "%1" == "" (start "Quantum GIS" /B %OSGEO4W_ROOT%\bin\qgis.bat --configpath %DRV_LTR%qgisconfig)
20 ELSE (start "Quantum GIS" /B %OSGEO4W_ROOT%\bin\qgis.bat --configpath %DRV_LTR%qgisconfig --project %1)
```



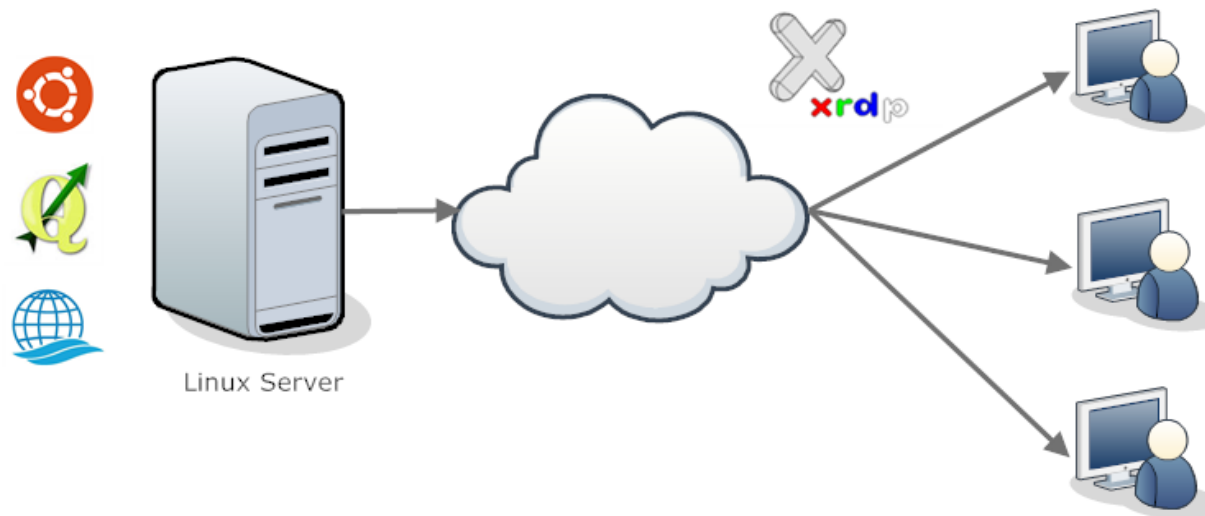
# Linux XRDP

## Linux Ubuntu Server 16.04 LTS + XRDP + QGIS ver 2.18

The idea is to provide many remote desktops from one physical server to many students that connect remotely from a client (RDP).

**Pros:** no need to set up anything on the client computer, each student has his own account and project setup.

**Cons:** the graphics rendering is slow if you are not connected on the same local network (e.g. University) and are connected remotely (e.g. via ADSL from home).



# Mac OSX

One possible option for users that use Mac which will not receive the support the FREEWAT group :

The preparation of a Linux virtual machine image (e.g. *VirtualBox*) that the user could run in his host computer

**Pros:** The user is working in his own environment (e.g. Mac OS). No need to install QGIS.

**Cons:** requires the installation of *VirtualBox* or other virtualization software. Might be a bit slower, although we have not noticed any performance problem running a *VirtualBox* Linux image. The RAM memory use is low.

# Mac OSX / 2

Another option is:

The preparation of a **live Linux image** that the user could boot and run e.g. from a USB memory stick.

**Pros:** The rendering of graphics should be faster. In the case of a workshop you can distribute the USB flash memory sticks to each participant/student.

**Cons:** The user is not working in his own environment.

***Thank you for your  
attention !!!***