

# Sustainable use of groundwater, and groundwater pumping in a dynamic environment



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## Introduction

Groundwater is an important water resource in Finland. Its use is promoted by its high quality, low purification need, and lower contamination risks than surface waters.

## Justification for study

Groundwater abstraction may cause groundwater deterioration which could be prevented by regulating groundwater pumping rates e.g. during droughts [1,2]. For this we need numerical groundwater models to simulate the response of groundwater withdraw to groundwater systems [3,4].

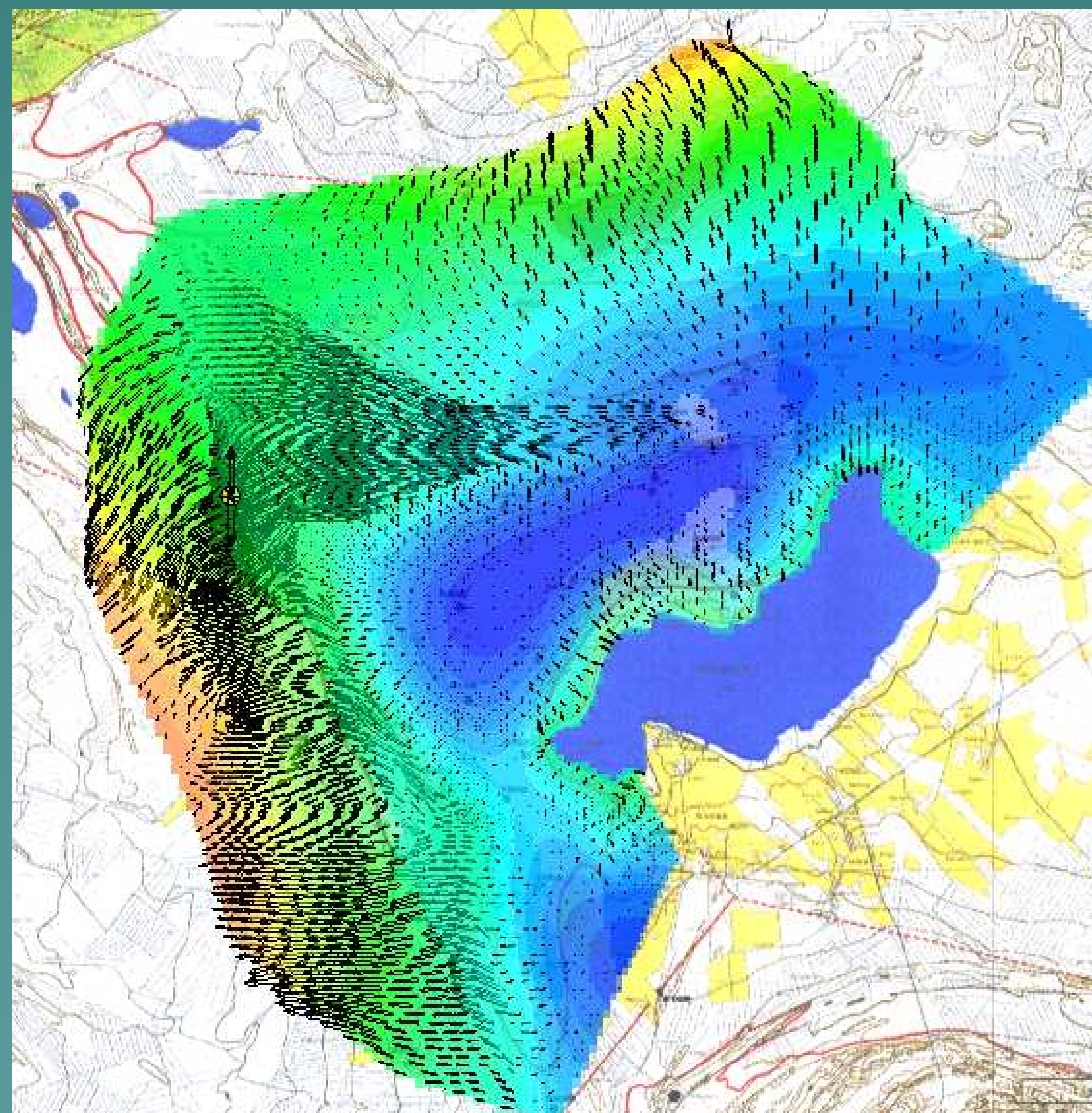


Figure 1. The Groundwater flow model in the Ahmaskangas (Utajärvi-Muhos) groundwater esker.

In this research, we will estimate the effects of climate change impacts to groundwater systems. This will be accomplished by developing modelling approach where predicted climate change scenarios can be included hydrological recharge models which are further applied in the groundwater models. We will also estimate the effects of the groundwater pumping and climate change to the terrestrial and aquatic ecosystems which are hydraulically connected to groundwaters.

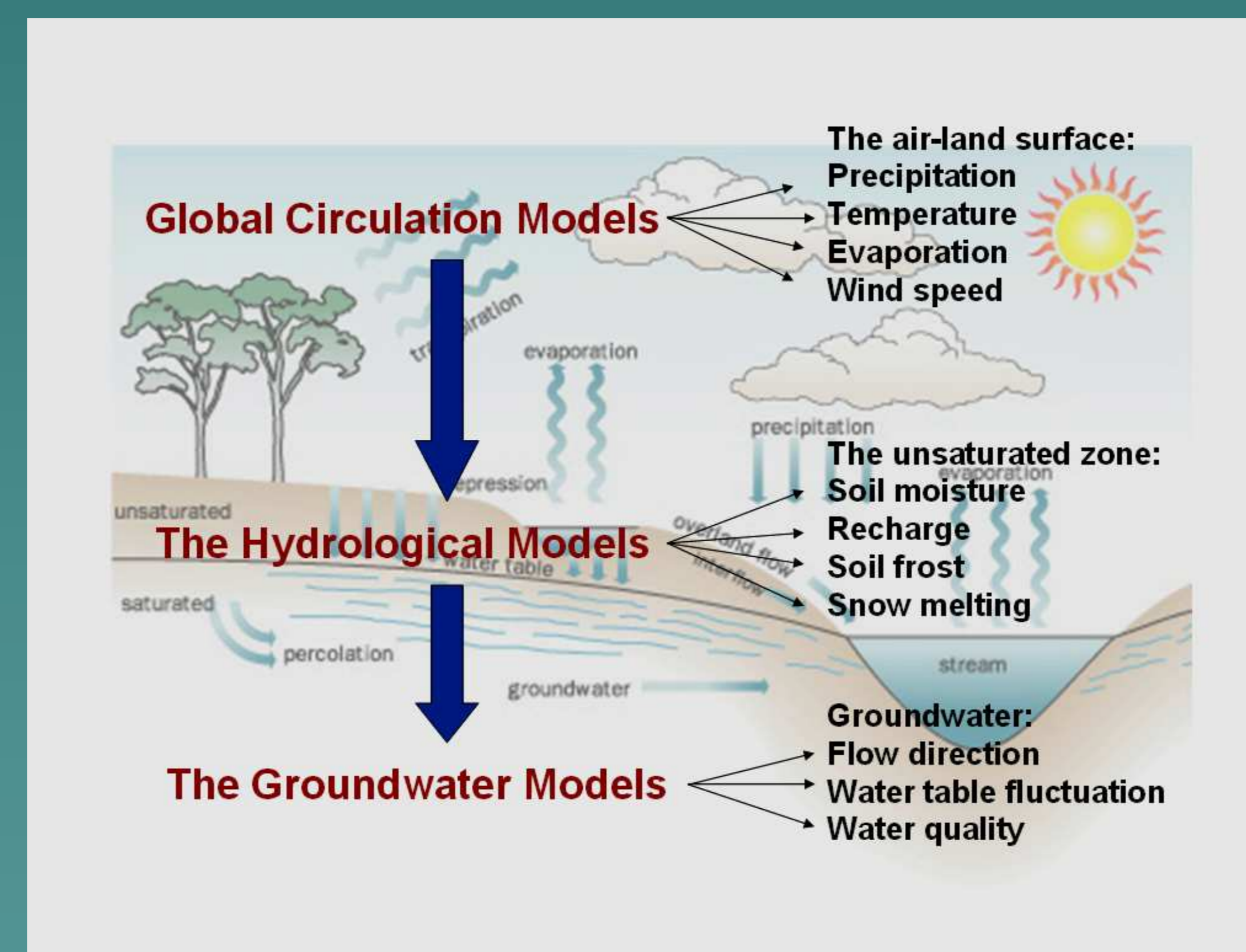


Figure 2. The Modeling approach

## Methods

This research will be executed in three phases:

1. Interviewing water companies, and the literature review about climate change impacts on shallow unconfined aquifers.
2. Developing methods and techniques to estimate water movement and water balance in groundwater systems.
3. Collecting information from the part 1 and 2, and estimate the sustainable use of groundwater using numerical models.

## Objectives

The goal of the research is find new methods to estimate sustainable use of groundwater. We are also improving measurement techniques to evaluate the bulk water movement in eskers, and the interactions between surface water bodies and the groundwater. The modelling approach, which will be developed in this study, can be used to estimate the effects of the long-term water abstraction and climate change impacts to groundwater systems.



Figure 3. Preparing seismic measurements in the Ahmaskangas groundwater area.

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## References

- [1] Alley, W.M., Reilly, T.E. and Franke, O.L., 1999. Sustainability of ground-water resources. U.S. Geological Survey Circular 1186.
- [2] Llamas R., 2004. Water and Ethics. Unesco, France, Series on Water and Ethics, Essay 7, 33 pp.
- [2] Alley, W.M., 2001. Ground Water and Climate. Ground Water 39(2).
- [4] Kalf K.R.P. and Woolly, D.R., 2005. Applicability and methodology of determining sustainable yield in groundwater systems. Hydrogeol J 13:295-312