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Geophysical techniques for monitoring the climate change effects on groundwater availability and quality

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The objective of the research is applying geophysical techniques (including seismic noise interferometry) to investigate the effects of climate change on groundwater resource availability and quality.

The research area is the lower Val Magra alluvial plain, in the Ligurian region (Italy), between the Municipality of S. Stefano Magra and the Tirrenian seacoast. It is an intensely urbanised area, with widespread industries that are potential sources of contaminants.

The main aquifer of the Val Magra is qualitatively and quantitatively vulnerable to the effects of climate change. It is an unconfined aquifer in coarse alluvial deposits, characterized by high permeability. The water table is generally very close to ground level (3-7 m in depth). The aquifer is closely connected to the Magra river and continuously exchanges between the surface water and groundwater exist. Furthermore, near the seacoast, the aquifer is influenced by interaction with seawater. In this area, periods of drought favor marine intrusion phenomenon, which occurs through the rising upstream of salt-water along the Magra river. Seawater intrusion is the main responsible of the deterioration of the groundwater quality in this lower part of the Val Magra.

An integrated approach of hydrogeological survey methods and geophysical techniques will be used to achieve the objective of the research. This allows a redundancy of data from a multidisciplinary approach and new monitoring surveys with less invasive and more efficient methods.

The traditional hydrogeological used methods are: continuous piezometric level measurements of groundwater (wells), electrical conductivity measurements of groundwater (wells) and surface water (river Magra) and isotopic analyses (Oxygen and Deuterium).

The geophysical techniques used are: 2-D geoelectrical surveys (SEV), active and passive geoseismic surveys (1-D and 2-D) and seismic noise interferometry (SNI).

Groundwater storage is estimated by monitoring the piezometric surface changes over time. The groundwater surface is interpolated from direct groundwater head measurements (wells and river) and indirect measurements from geoseismic and geoelectric surveys and the SNI technique.

Isotopic measurements of water samples are used as tracers to evaluate the groundwater-surface water exchanges. The data confirm that the main source of recharge of the aquifer is the River Magra.

In the area, groundwater quality, that could be compromise mainly by marine intrusion phenomenon, is evaluated by the monitoring of the physics and chemical parameters. Geoelectrical surveys and water electrical conductivity measurements allow to investigate underground the presence of the salt water and to define the extent of the marine intrusion phenomenon. Preliminary water electrical conductivity result highlights that, during the strong drought period in the last summer, the marine intrusion reached the Romito groundwater well field by rising upstream for 7 km along the Magra river from the coastline.