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Contribution of EM airborne geophysics to characterize seawater intrusion within a Plio-Quaternary coastal Mediterranean aquifer in order of improving management and early warning systems

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The coastal areas in the Mediterranean basin constitute fragile environment for various issues, one of those is the seawater encroachment in coastal aquifers, major water resources for water supply as well as for agriculture. The functioning and the size of the seawater intrusion are function of the geometry, lithology, hydrodynamic properties of the aquifer, as well as of the water management. The seawater intrusion can be localized and variable with the time, or also more regionalized. Without adequate management and warning systems, this phenomenon may have serious and major environmental and economic consequences. Classically point measures of salinity allow to identify, but not to anticipate the risk on the groundwater resources. Only a systemic approach based on the knowledge of coastal aquifers with data acquisition, may allow suggesting management and warning systems. The ANR GRAIN D'SEL project has the following objectives: develop and validate new approaches to improve the knowledge and the monitoring of coastal detritic aquifers at various scales, from regional with airborne geophysics to local with borehole monitoring observatories. The scale of the airborne geophysical data allows an enough detailed characterisation to map local features and covers quite large areas in order to characterize most of the various processes that may be involved.
The airborne electromagnetism (AEM) method, widely used in the field of mineral prospecting, has been used on the pilot area located in the Roussillon basin (Plio-Quaternary multi-layers aquifer) in Southern France, near Perpignan, in the framework of the EUFAR project; it was carried out by the Joint Airborne-Geoscience Capability (JAC) established between the Geological Survey of Finland (GTK) and the British Geological Survey (BGS) in September 2008, covering a 40kmx 10km area (100 N-S direction lines with 100 m line spacing and five cross lines in an E-W direction with 10 km line spacing).
A 2D multi-layer laterally constrained inversion was applied to the airborne electromagnetic datasets to produce layered earth inversion models. The interpretation of the inversion results gives us a complete mapping of the conductivity of soils and subsoils in the area that was not known until now. This mapping is characterised by conductivity variations, laterally up to 100 m depth. Areas of high conductivity values according to salty water in the Leucates and Canet lagoons can be observed. Around the lagoons, there is a transition zone that can clearly delineate the area of salt water intrusion within the subsurface aquifer. Low values of conductivity are observed in the northern part of the studied area corresponding to the limestone of the Corbières. These results can be validated by comparing to boreholes measurements of salinity. The inversion results of airborne geophysical datasets and geological knowledge will be used to first set boreholes geophysics observatories and then to establish a 3D hydrodynamic model with density effect and unsteady state to develop a monitoring system and a preventive system of salt intrusions, at local scale.