Dottorato di ricerca in Fisica – VIII Ciclo – II Serie

Investigation of the groundwater-river interaction, using Radon-222 as a natural tracer, in a karst Mediterranean environment like in the case study of the Bussento river basin

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ABSTRACT

The naturally-occurring radionuclides have proven to be powerful tools for assessing the time dependency of GSI processes. The radionuclide ^{222}Rn (referred to as radon) has the advantage of being a radioactive noble gas, i.e. a (short-lived) radionuclide that is chemically inert and can easily be detected on site.
Since radon is produced in every mineral matrix and is soluble in water, it occurs ubiquitously in all natural waters. Radon concentrations that are usually found in groundwater are about three to four orders of magnitude higher than radon concentrations typical for surface waters.
The aim of this thesis work is to use radon as a tracer to investigate the groundwater-river interaction, in particular to perform an useful methodology for the localization of the contributions of groundwater to the riverbed, in a typical karst environment, the Bussento river basin.
The Bussento river basin, located in the south-east of Campania region, shows interesting issues related to water assessment and management. Complex interactions and exchanges between surface and groundwater exist, influencing also on-shore and off-shore submarine springs.
Therefore, gaining river segments from karst groundwater and losing river segments towards the aquifer are recognized. Groundwater protection for drinking domestic use, riverine wild-life conservation and coastal water quality require a progressively optimized knowledge of these interactions.
This thesis work comes at the end of a two years and a half experimentation and investigation about the surface and groundwater bodies in the Bussento river basin.
The implementation of the radon measurement techniques has confirmed the perspective of using these methodologies in a karst Mediterranean environment to investigate the complex interactions and exchanges between streamflow and groundwater.
Experimental data about radon concentrations, in addition to physical-chemical data and streamflow rate, have been acquired during monthly measurement campaigns.
Different measurement techniques have been tested and compared allowing to determine a precise protocol for sample collection and for laboratory measurements.
From the data analysis, it has been established the possibility of localizing groundwater influx in riverbed. In fact, superficial waters have been shown to have a markedly different radon content from groundwater, the latter differing in radon concentrations if originating from different karst typologies.
In order to provide a physical scheme of the complex recharge, storage and routing system of the river karst area, a preliminary, physicallybased, conceptual model has been built-up.
The data have also enabled to individuate a spatial and temporal variability of the radon activity concentration along the river, and to identify, as mentioned above, three typologies of karst springs assumed in the conceptual model.
It has been experimentally verified the possibility of making the hydrograph separation both on a seasonal scale and referring to a flood event.
Moreover, a preliminary investigation and modeling of radon diffusion from water to the atmosphere have been made along two selected segments of the river. In fact, analyzing the radon concentration gradients determined during different sampling campaigns, radon exchange rates according to three different models have been estimated.