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Exceedance probability map: a tool helping the definition of arsenic Natural Background Level (NBL) within the Drainage Basin to the Venice Lagoon (NE Italy)

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Arsenic groundwater contamination affects worldwide shallower groundwater bodies. Starting from the actual knowledges around arsenic origin into groundwater, we know that the major part of dissolved arsenic is naturally occurring through the dissolution of As-bearing minerals and ores. Several studies on the shallow aquifers of both the regional Venetian Plain (NE Italy) and the local Drainage Basin to the Venice Lagoon (DBVL) show local high arsenic concentration related to peculiar geochemical conditions, which drive arsenic mobilization. The uncertainty of arsenic spatial distribution makes difficult both the evaluation of the processes involved in arsenic mobilization and the stakeholders' decision about environmental management. Considering the latter aspect, the present study treats the problem of the Natural Background Level (NBL) definition as the threshold discriminating the natural contamination from the anthropogenic pollution. Actually, the UE's Directive 2006/118/EC suggests the procedures and criteria to set up the water quality standards guaranteeing a healthy status and reversing any contamination trends. In addition, the UE's BRIDGE project proposes some criteria, based on the 90th percentile of the contaminant's concentrations dataset, to estimate the NBL. Nevertheless, these methods provides just a statistical NBL for the whole area without considering the spatial variation of the contaminant's concentration. In this sense, we would reinforce the NBL concept using a geostatistical approach, which is able to give some detailed information about the distribution of arsenic concentrations and unveiling zones with high concentrations referred to the Italian drinking water standard (IDWS = 10 μg/liter). Once obtained the spatial information about arsenic distribution, we can apply the 90th percentile methods to estimate some Local NBL referring to every zones with arsenic higher than IDWS. The indicator kriging method was considered because it estimates the spatial distribution of the exceedance probabilities respect some pre-defined thresholds. This approach is largely mentioned in literature to face similar environmental problems. To test the validity of the procedure, we used the dataset from "A.Li.Na" project (founded by the Regional Environmental Agency) that defined regional NBLs of As, Fe, Mn and NH4+ into DBVL's groundwater. Primarily, we defined two thresholds corresponding respectively to the IDWS and the median of the data over the IDWS. These values were decided basing on the dataset's statistical structure and the quality criteria of the GWD 2006/118/EC. Subsequently, we evaluated the spatial distribution of the probability to exceed the defined thresholds using the Indicator kriging. The results highlight different zones with high exceedance probability ranging from 75% to 95% respect both the IDWS and the median value. Considering the geological setting of the DBVL, these probability values correspond with the occurrence of both organic matter and reducing conditions. In conclusion, the spatial prediction of the exceedance probability could be useful to define the areas in which estimate the local NBLs, enhancing the procedure of NBL definition. In that way, the NBL estimation could be more realistic because it considers the spatial distribution of the studied contaminant, distinguishing areas with high natural concentrations from polluted ones.