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Appraisal of the groundwater conceptual model of the gypsum coastal karst of Lesina Marina (Puglia, Southern Italy) aiming at density-dependent modeling.

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Inhabited coastal areas are site of many risks, because in terms of geomorphology, hydraulics, hydrogeology and mass transport, they are at the lowest level of potential energy. Moreover, considering that at land-sea interface brackish/salt waters enhance in general the effects of water-rock interactions, the number of possible risks increases. This is the case of the gypsum coastal karst of Lesina Marina (Puglia, Southern Italy), where, starting from 1993, a number of sinkholes developed mostly along an artificial canal, excavated in 1927 to connect a brackish lagoon with the sea. The excavation diverted groundwater flow, with increase of hydraulic gradients and filtration velocity, amplitude of the groundwater level oscillations and, locally, tidal efficiency, causing continuous “flooding and draining” cycles, largely controlled by tides. These factors, on the whole, favored internal erosion and flushing of cave deposits, and amplified, due to increased hydraulic connectivity between fresh and brackish/salt water, gypsum dissolution. After many years it is still not likely to assess the relative role played by internal erosion and dissolutional enlargement of cavities in the sinkhole development. With the final aim of defining the subsidence risk in the Lesina Marina area, recently the Puglia River Basin Authority realized new bore-holes, geophysical logs and a continuous piezometric monitoring. To the aims of the reconstruction of the aquifer conceptual model and of the identification of key factors for a reliable numerical density-dependent modeling (of flow, solute-transport and reactions), in the period from September to December 2011 we realized Electrical Conductivity and Temperature logs, samplings (at different depths) and chemical analyses along two transects perpendicular to the canal. Apart from the recognition of the main water-rock interaction processes (as gypsum solution and inverse Na/Ca ion-exchange), and the reconstruction of the trends of convective thermal field and EC distribution, the survey along transects highlighted the presence of ground waters with TDS higher than expected from simple conservative mixing between fresh- and sea-water, mainly due to gypsum solution. This occurrence poses questions about the influence of solute concentration variations due to reactions on the fluid density field and, as a consequence, on groundwater flow. Under isothermal conditions, it is known that fluid density is a function of solute concentration and fluid pore pressure; the effects of the latter, in the governing equation for variable-density groundwater flow, are included in the storage term, while the effects of concentration are usually accounted by means of empirical relations between and C. These relations should be updated if, as in the study-case, groundwater composition highly differs from conservative seawater-freshwater mixing.