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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A review of seawater intrusion in the Nile Delta groundwater system – the basis for assessing impacts due to climate changes and water resources development" *by* M. B. Mabrouk et al.

Anonymous Referee #3

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General comments

The paper by Mabrouk et al. compiles numerous studies of the Nile delta groundwater system. The authors evaluate state of the art and suggest modelling efforts that would lead to a comprehensive understanding of the current and future evolution of the delta aquifer, focussing on seawater intrusion issue.

I found the paper well structured and quite clear. Numerous reference about the Nile delta are compiled, especially a number of universitary works, which are often difficult

to know and access. Particularly useful is table 1 that reports hydraulic parameters available for the Nile delta aquifer.

Overall, I found that the review, which aims to provide the basis for further avenues of research, is too superficial. The authors repeatedly point out that previous studies on groundwater salinization in the Nile delta were too much local and did not take into account either sea level rise, Nile flow changes, spatial heterogeneity of the aquifer, or groundwater abstractions impacts. However, in my view, recommendations simply suggest that further research should, obviously, take into account those parameters. Although I am not working in the specialisation of the manuscript modelisation of coastal aquifer), I found that the feasibility of the three-dimensional groundwater modelling of the Nile delta aquifer, which intend to integrate both internal parameters (hydrologic and geologic), external forcing (sea level, Nile flow, abstractions), socio-economic changes, and adaptation and mitigation measures, need much further details, critics and discussion.

- The paper assesses that sea level rise, Nile river flows changes and groundwater abstraction are the main external factors that would force the evolution of groundwater salinization in the northern delta. Additionnally, I suggest that subsidence processes are also a very important forcing of relative sea level changes in deltaic areas, especially in the Nile delta (e.g. Marriner et al., 2012). Furthermore, Psimoulis et al. (2006) demonstrated that the Thessaloniki plain (Greece), composed by deltaic and fluvial sediments, has subsided in the last 50 years up to 3.5 m, resulting from hydrocompaction due to intense pumping superimposed on the plain-wide subsidence. Given that increasing groundwater abstractions has occurred in the Nile delta, as demonstrated in the paper (fig. 3), subsidence processes shoud be discussed in the paper. Lastly, seawater intrusion may also be induced by the retreat of the Nile delta shoreline. Since the construction of the Aswan High Dam and development of a very dense irrigation network in the delta, a sharp decline in the sediment load reaching the Nile coast has been recorded. This favors marine ingression at the Nile coast and may

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impact the position of the transition zone between seawater and freshwater.

Marriner, N., Flaux, C., Kaniewski, D., Morhange, 2012. The Nile delta's sinking past: Quantifiable links with Holocene compaction and climate-driven changes in sediment supply? Geology 40(12), 1083-1086. Psimoulis, P., Ghilardi, M., Fouache, E., Stiros S., 2006. Subsidence and evolution of the Thessaloniki plain, Greece, based on historical leveling and GPS data. Engineering Geology 90, 55-70.

- The paper evidences the complexity to model properly the whole Nile delta aquifer, because it must include a number of hydraulic and geologic parameters which are only poorly constrained through the available dataset. However, recommandations made by the authors mostly provide a serie of obvious statements which could be summarize as: "the most complete dataset you have, the best model you will be able to draw". It is evidenced, for example, in the repetition troughout the manuscript of a call for the need of extensive and continue wells data monitoring: - P 10881, l. 26-28, these hydrological data should be always monitored and updated in order to be integrated in groundwater modeling and give reliable findings - P 10883, l. 1-2, and it is severely impaired by the lack of continuous monitoring data. - P 10883, l. 4-5, accompanied with continuous monitoring. - P 10890, l. 23, Continuous monitoring of data from all wells is also needed, - P 10890, l. 28-29 and P10891, l. 1, A continuous and comprehensive monitoring system of all groundwater data integrated with existing monitoring network of meteorological and hydrological data is therefore crucial challenge for the future. - P 10891, l. 20-23, the adaptation and mitigation measures need to be analyzed within an integrated regional plan accompanied with effective monitoring, evaluation and assessment system. - P 10892, l. 14-15, Strict monitoring and assessment strategy should be incorporated as a separate component of the DSS to be used by the authorities.

- The authors recommand the use of SEAWAT, regarding the fact that it is the most popular code used in recent years (P 10883, l. 20). This statement is followed by a series of SEAWAT applications. However, it is not argued why others models presented in table 2 (P. 10906) would not be adaptated to the Nile delta aquifer. Consequently,

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table 2 is not useful in our view and section 4 (“brief overview of available models”, P 10883) is improperly named.

Short and technical remarks

- P 10877, l. 21-23, see also Sivitsky et al., 2009. Syvitski, J.P.M., Kettner, A.J., Overeem, I., Hutton, E.W.H., Hannon, M.T., Brakenridge, G.R., Day, J., Vŝrŝsmarty, C., Saito, Y., Giosan, L., and Nicholls, R.J., 2009, Sinking deltas due to human activities: Nature Geoscience, v. 2, p. 681–686.

- P 10877, l.26-27, "In their studies they used different climate models to predict sea level rise." Stanley (1990) and Emery (1988) have not used climate models. Sea level rise estimation by these authors were respectively based upon bio-sedimentological indicators and tide gauge data.

- P 10878, l.1, "The most common estimate that is repeated in many reviews is 60 cm (Essink and Kleef, 1993)." Isn’t there a more recent review? The recent report of the IPCC (2013) may updated this estimate.

- P 10878, l. 23-24, "The above mentioned climate change studies also identify the impact of sea level rise on increased seawater intrusion", appears to contradict the following statement (P 10885, l. 17-20): "Given that the potential sea level rise impact on salinization of the Nile Delta aquifer have been only recently recognized, most of the developed variable density models in the past were focused on determining the impact of increased groundwater abstractions on the salinization of the aquifer."

- P 10878, l.25-29, "In the Nile Delta, extensive groundwater abstraction is also a very significant factor that increases seawater intrusion." Kotb et al. (2000) added that the recycling of sewage water have engendered soil salinization in the northern delta.

- P 10882, l. 16-18, "He found that the groundwater heads were increasing during this period and he attributed that to the construction of High Aswan Dam." Because perennial freshwaters were delivered to the delta throughout the whole year? Please

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specify.

- P 10882, l.14-15Âă, "He mentioned that from 1957 till 1984, the water salinity records showed that it was enhanced and the freshwater was dominating and overcoming sea-water intrusion." Does "it" refers to canals level? Please clarify.

- P 10885, l.11-15, "in case of the Nile Delta the transition zone is relatively large." A map showing the transition area and location of wells in which salinity measurements were made could be useful, as this transition zone dynamic is the main topic of the paper.

- Figures 1 and 2, depth unity must be mentionned.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 10873, 2013.