Time dynamic pollution risk modelling of groundwater at the pan-African scale

Issoufou Ouedraogo , Pierre Defourny, Arthur Girard, and Marnik Vanclooster
Earth and Life Institute, Université Catholique de Louvain, Croix du Sud 2, Box 2, B-1348 Louvain-la-Neuve, Belgium. issoufou.ouedraogo@uclouvain.be

1.Introduction

In a previous study, we proposed a method for mapping groundwater vulnerability and pollution risk at the pan-African scale based on a "static" hypothesis (Ouedraogo et al. 2016). However, some of the parameters taken into account by this method may vary significantly over time such as recharge, land use, etc. In this present study, we assess the time dynamic behaviour of groundwater pollution risk at the continental scale, using the parametric DRASTIC model. We use the most recent continental scale data on soil, topography, land use, geology, hydrogeology, and climate in a Geographical Information System at the resolution of 15x15 km^2 to implement the approach. We compared continental scale groundwater pollution risk for the years 1990, 2000 and 2010. The elaborated pollution risk maps show important variations of the spatial distribution of pollution risk between the three years.

2.Methodology

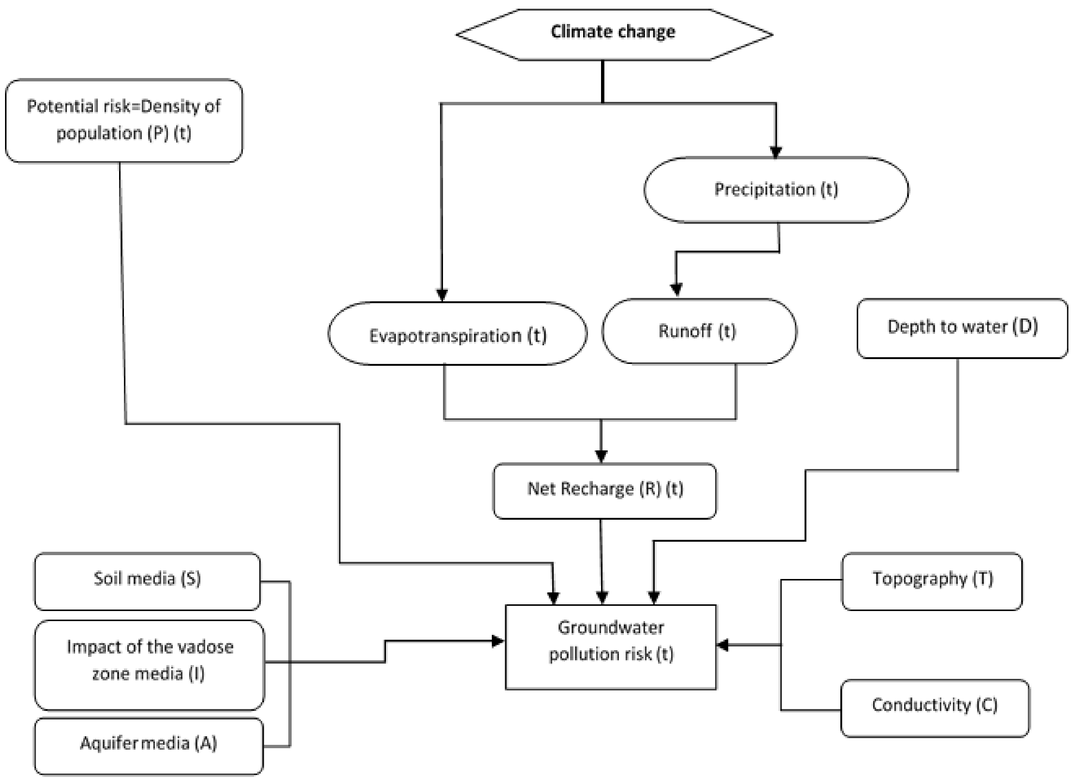

Fig.1 Impact of climate change, land use change, and environmental factors on groundwater (modified from Huang et al. 2016)

3.Dynamic Input Data

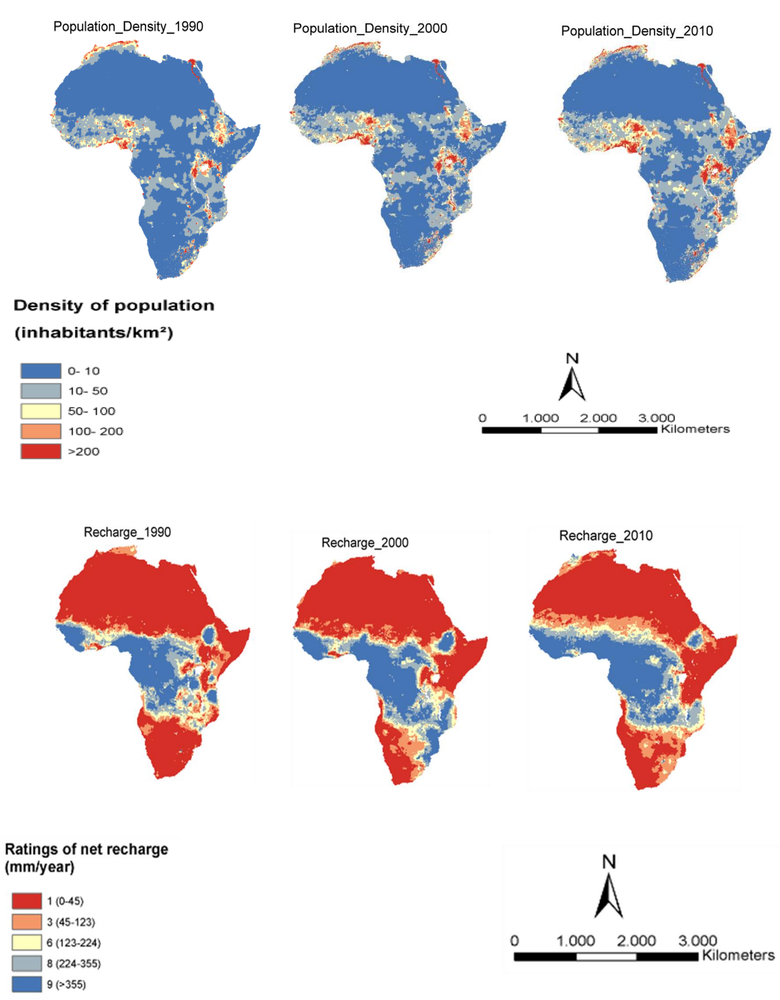

Fig.2 Density of Population (P) map in Africa for 1990, 2000, and for 2010

Fig.3 Rating of Recharge (R) map in Africa for 1990, 2000, and for 2010

4.Results

The results of the spatial pattern of pollution risk are presented in Fig.4, and divided into five equal interval classes ranging from very low to very high. The pollution risk exhibits significant space and temporal variability. Areas of higher vulnerability are shown in red with areas of lower vulnerability in green. We observe that pollution risk is significant in North Africa, West Africa (mainly Nigeria), the Lake Victoria or Great Lakes Regions in East Africa, Horn of Africa (Ethiopia) and the Nile Delta in Egypt.
The absolute change in pollution risk is given in Fig.5.

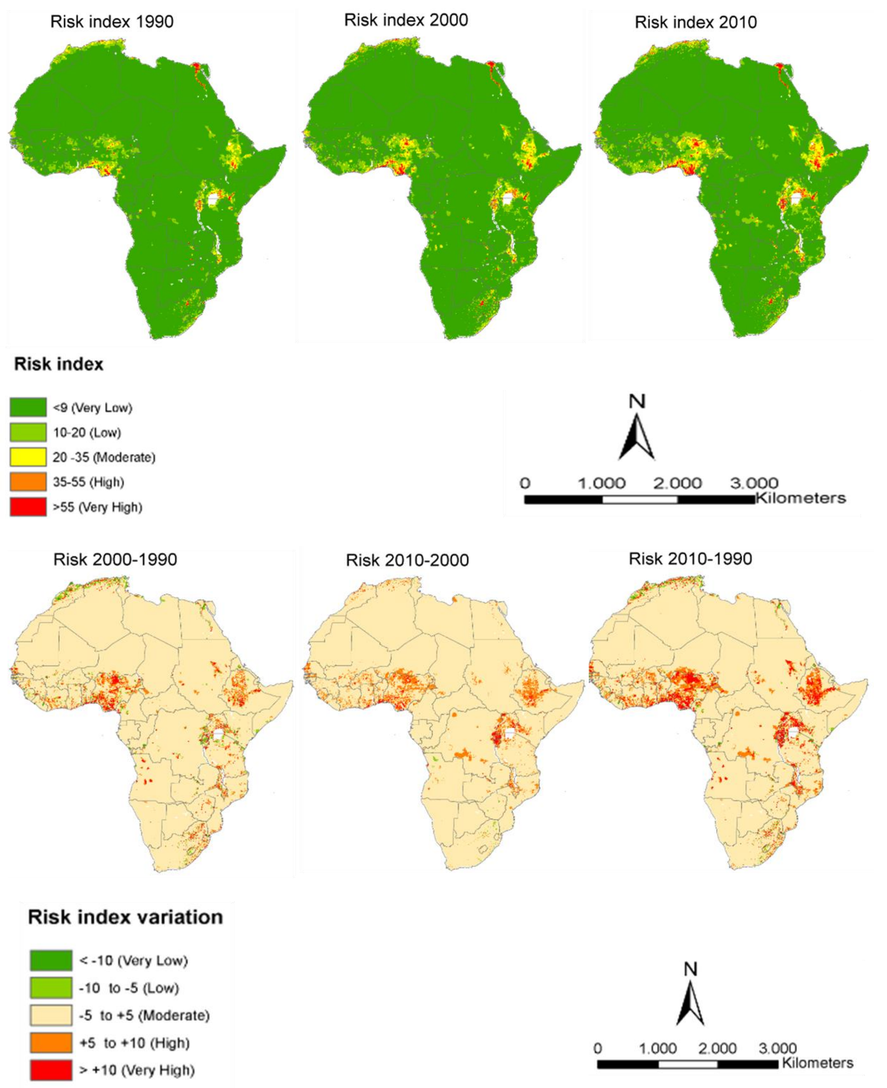

Fig.4. Groundwater pollution risk for 1990, 2000, and 2010

Fig.5. Absolute comparison of groundwater pollution risk for 1990, 2000, and 2010

Table 1 presents the results of the increasing trend from low to very high pollution risk during the period of 20 years computed from the figure 4. The values in this table confirm that the pollution risk for groundwater in Africa increased considerably.

Table 1. Percent of different pollution risk classes

	Pollution risk class				
Year/period	Very low	Low	Moderate	High	Very high
Year 1990	91.98 %	5.5 %	1.66 %	0.55 %	0.29 %
Year 2000	81.63 %	6.49 %	2.50 %	0.87 %	0.48 %
Year 2010	86.79 %	7.94 %	3.22 %	1.26 %	0.76 %

5.Discussion and conclusion

The pollution risk degree of African groundwater varies from very low to very high. We observed that the spatial pattern of pollution risk at the pan-African scale has changed over the time between 1990, 2000 and 2010. Groundwater vulnerability to pollution greatly varies across Africa. This variation was clearly visualized for example in North Africa, in the Nile Delta, and in West Africa. This is consistent with the previous findings of Ouedraogo et al. (2016). The zone with the highest pollution risk at the scale of the continent is the Western Africa area, which is highly urbanized and densely populated.

The proposed method for modelling the time dynamic groundwater pollution risk can support the monitoring of SDG Goal 6 which includes a focus on preserving our freshwater resources for potential future threats.

References

Ouedraogo, I. Defourny, P. and Vanclooster, M.(2016). Mapping the groundwater Vulnerability for pollution at the pan-African scale**.** Science of the Total Environment, Vol. 544, p. 939-953.
Huang, L., Zeng, G., Liang, J., Hua, S., Yuan, Y., Li, X., & Liu, J. (2017). Combined Impacts of Land Use and Climate Change in the Modeling of Future Groundwater Vulnerability. Journal of Hydrologic Engineering, 22(7), 05017007.

Acknowledgments: This research is supported by the Université Catholique de Louvain (UCL, Belgium) and Islamic Development Bank(IDB) in Djeddah.