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Modeling the impacts of climate change on water resources in Mediterranean and Atlantic hydraulic basins of Morocco

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Extended Abstract

This research work investigates the climate change variability and its impact on water resources in hydraulic basins located in both Mediterranean and Atlantic fronts of Morocco, using climate and hydrological modeling. Several climate parameters and their projections in the future have been analyzed to assess climate changes, including wet and dry periods with focus on intensity and frequency. Furthermore, modeling of the impact of this climate change on water resources based on climate scenarios is also studied to evaluate water balance components in the basin/aquifer, in addition to drawdown lowering, water table depletion and seawater intrusion extents into the coastal aquifer.

The Ghis-Nekkor plain, located in the north of Morocco, is a vulnerable area for climate changes, due to its influence by the Mediterranean front to the north and its strong urbanization. In fact, a reduction in precipitation and increase of temperature due to climate change will affect the severity of drought in the plain. In this study, the influence of the decrease of precipitation (about 18%) and increase in average temperature (0.5°C) on future drought conditions is assessed by the SPI index. This SPI is basically calculated for the period (1963–2013) at two-time scales (6 and 12 months), then it is used to assess future drought events in the study area under the Representative Concentrations Pathways (RCP 4.5) climate change scenario. The projected change in precipitation for the period (2020–2070) was simulated by the Regional Climate Model (RCM) Hirham5 from the Cordex Project. The results indicated that the Ghis-Nekkor plain experienced a dry period from 1980 to 1987. For the period 2040–2070, the drought severity and duration will increase under the RCP 4.5 scenario with 19% of severe dry. The rate predicted for the drought condition is about 12%, which represents the double compared with the reference period (1965–2013). The analysis of drought intensity showed that the study area is more prone to both moderate and severe droughts but less prone to extreme drought.

The Oum Er-Rbia hydraulic basin, located in the mid-west part of morocco (Atlas and Atlantic front), is one of the largest watersheds in the country (4,800 km²). Its strategic importance with economic activities and the rapid demographic change make it vulnerable to any fluid imbalance, especially climate change. Hence, the assessment of drought is crucial for many aspects notably water sectors. Thus, the objective of the present study is the estimation of the regional characteristics of drought, frequency and duration using the SPI index.

The results show that during these last 40 years, the Oum Er-Rbia basin experienced dry periods from 1980 to 1987, from 1991 to 1995, from 1997 to 2002 and from 2006 to 2008, and their intensity varies from moderate to severe. They are remarkably composed of three, four and five consecutive dry years. Finally, based on the obtained results from the SPI mapping that the moderate and severe droughts occurred in the North East of the study area, characterized by topographic and geological conditions that are not in favorable conditions as for water storage for long time. The results

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show also a relatively high frequency and large spatial extent of drought in the basin. During these periods, surface water and groundwater resources suffered from significant deficits, such as reduced water storage in dam reservoirs and groundwater table depletion in several aquifers.

Generally, the Oum Er-Rbia basin was affected by 53% of dry periods. The most dominant type of droughts is moderate (38%), while 15% is of severe droughts, and took place especially in North East of the study area. We can conclude that, based on the SPI values and their mapping, the Oum E-rRbia basin is highly vulnerable to drought for which the duration and intensity vary considerably. Drought is, therefore, a recurrent phenomenon but difficult to predict over time for its mitigation. When it occurs, it has negative impact on water resources with less water storage causing water scarcity in several areas of the catchment. However, the results obtained from this study is of great importance for water resources management in the Oum Er-Rbia basin, as it will assist the regional water managers for water resources planning, protection and rational management. Further research work in the catchment is going on to assess the impact of climate change on water resources using climate modeling projections.

The Rmel-O. Ogbane is unconfined coastal aquifer situated near Larache city in the north of Morocco and is a part of the main sub-Atlantic coastal aquifers. The aquifer supplies good quality groundwater that is easily accessible. This favorable situation has increased pumping, and caused environmental problems, such as water table decline and saltwater intrusion. Moreover, the future precipitation decline is due to the impacts of CC and causes longer and more frequent droughts and less groundwater recharge, which directly affect the groundwater level. An integrated approach is developed for linking climate models and groundwater models to investigate future impacts of climate change on groundwater resources. Projected temperature and precipitation values are obtained, respectively, from (RACMO22T and HIRHAM5) Regional Climate Models (RCMs) under Representative Concentration Pathways (RCP) 4.5 scenario. Those projections show an increase in temperature of about 0.45°C and a reduction in precipitation of 16.7% for the period 2016–2040. Based on these results, the input parameters for the groundwater model are calculated, such as evapotranspiration and aquifer recharge, in addition to sea level rise variation, which rises up from ~6.45 cm by 2017 to ~21.3 cm by 2040. The simulation results show that groundwater extraction is the predominant driver of seawater intrusion in the study area. The aquifer area will be contaminated in the NW sector of the coastal part, where the toe interface will reach 5.8 km inland and will be intruded with high salinity concentrations ranging from 15 to 25 g/L by 2040. Beyond these zones, the contamination of the aquifer is limited, but the drawdowns remain significant in some sectors of the study area. Hence, implementation of efficient strategies by decision makers for groundwater development and management in this coastal aquifer are necessary to protect freshwater aquifers against seawater intrusion and groundwater overexploitation.