**A framework for investigating the interactions between climate, dust, solar power generation and water desalination processes in Desert Climate**

**Abstract**

The increasing water demand in the future, driven by the rapid population growth in Saudi Arabia, encourages the expansion of the water desalination plants in the Kingdom. The solar-powered desalination plants provide an opportunity to increase the water desalination capacities in sustainable manner without relying on fossil fuels energy, particularly as Saudi Arabia has a huge potential for solar energy. However, the desert climate of Saudi Arabia and potential locations of the solar-powered desalination plants imposes several challenges to the expansion and sustainability of these plants. For example, the frequent and intense dust storms pose a serious issue for the efficiency of solar panels as it can be significantly reduced due to dust. In addition, the high salinity discharge from the desalination plants back to the Arabian Gulf, which can alter the salinity, temperature and movement of the water in the Arabian Gulf. Thus, the quality of water intake back to the desalination plant will be reduced. Here, we propose a framework to investigate the different interactions between climate, dust, solar power generation and water desalination processes. This framework integrates different numerical models, which include regional climate, hydrodynamics, Photovoltaics (PV) and Photovoltaic-Reverse Osmosis (PV-RO) models that are used to investigate these interactions for solar-powered desalination plant at AlKhafji site on the Northeastern coast of Saudi Arabia. The proposed framework also provides an opportunity for planning of the solar-powered desalination plants by optimizing the locations and the capacities of these plants by exploring the potential locations with maximum solar energy, minimum dust deposition and impact on the water quality of the water source.