AGEDI
مبادرة أبوظبي العالمية للبيانات البيئية
Abu Dhabi Global Environmental Data Initiative

CONCEPTUAL OVERVIEW

Al Ain Water Resources & Climate Change

Given its distinctly different climatic conditions relative to the rest of the UAE, there is no place within the country that is more climatically vulnerable than Al Ain. Also known as the Garden City due to its greenery, Al Ain is the second largest city of the Abu Dhabi Emirate and the fourth largest city in the United Arab Emirates. The region has been continuously inhabited for more than four thousand years and is considered central to the cultural heritage of the country. It is the birthplace of Shaikh Zayed bin Sultan Al Nahyan, the first president and founding father of the UAE. It is one of the only locations in the UAE with renewable groundwater, although as a percentage of overall water use, it is quite small. Water use in the region has exploded in the modern era, with the development of thousands of groundwater wells.

The challenge of effective water resource and agricultural management in Al Ain will be affected by climate change. Climate change is likely to alter patterns and cycles of water supply, with profound implications for water resource management. Specifically, two key trends suggest the importance of addressing water and agricultural management in the Al Ain region in holistic manner. First, climate change has already begun to affect rainfall and temperature patterns across the region, and while the country is characterized as a typically warm, arid region, future warming and changing rainfall, wind, humidity, cloud cover, and CO_2 concentrations could change patterns of surface water flow and groundwater recharge. Second, socioeconomic growth patterns indicate that the population in the country's arid environment is likely to continue to increase and will require additional resource capacity to satisfy increasing water demands, with interest in increasing food security through increased local food production.

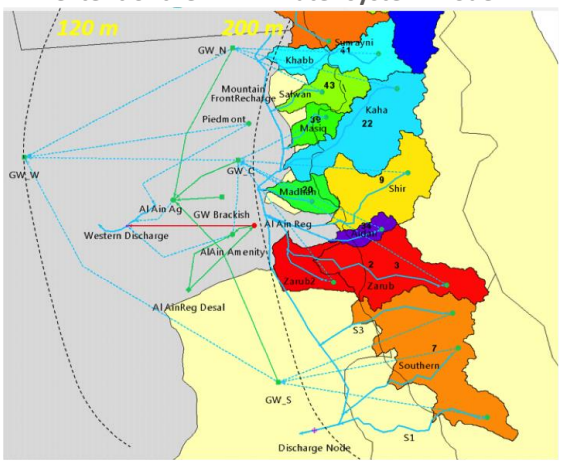
The overall goal of the sub-project is to better understand Al Ain's water and agricultural management challenges in the face of climate change and socioeconomic development. The major research questions underlying the methodological approach were twofold. First, how will climate change affect the water resources of the Al Ain Region that support direct human use and uses for a forestry sector and an agriculture sector that have grown considerably over the past few decades supported primarily with fossil groundwater? Second, what water management strategies could be explored - as measured in water savings associated with various scenarios - that aim to promote efficiency and conserve natural resources under climate change?

Addressing the goal and research questions required an analytical framework capable of accounting for the water and agriculture systems of the region in an integrated manner. The Water Evaluation And Planning (WEAP) system was used for this analysis. WEAP is an integrated modeling tool that can track water resource stocks and flows associated with extraction, production, and consumption, including seawater desalination, groundwater pumping, and the transmission of water. A model development period using historic data from 2005 – 2015 was used for model setup and configuration. Once the Al Ain WEAP model was calibrated and validated against the historic period, it was used to project forward into the 21st century under different assumptions of resource use and climate through 2060.

The structure of the Al Ain water system model accounts for the locations of all water supply sources and the magnitude of current and future demand for water. The spatial coverage encompasses the eastern region of the Abu Dhabi Emirate, which includes Al Ain and the wadis of the Oman Mountains, reflecting the shared aquifers between the UAE and Oman, where there is some renewable fresh groundwater. A plant growth model was incorporated to simulate the effects of climate change and elevated atmospheric CO_2 concentrations on cultivated plant's water use and crop yields. A schematic of the model is shown in Figure 1.

The validated water system model for the Al Ain region was used to analyze the impacts of policy scenarios aimed at promoting resilience of water and agriculture systems under climate change. Two Business-as-usual (BAU) scenarios were considered - one with climate change (hereafter "BAU"); the other without climate change (hereafter "BAU-RCP8.5"). Two policy scenarios were considered - one focused on climate-resilient agricultural development (hereafter "FallowFF"*)*; the other focused on maximizing renewable groundwater storage (hereafter "GWStabilize").

Figure 1: Schematic representation and spatial extent of the Al Ain water system model.



The results of analysis confirm that climate change will impact the region's water resources, although in a salutary way. Future groundwater storage of the alluvial aquifers for the Al Ain region is projected to increase slightly under climate change. This is primarily driven by the wetter conditions projected by the regional climate model under climate change leading to enhanced groundwater recharge. Also, the CO_2 fertilization effect will lead to more agricultural production over a shorter growing season. For date palms, a potential increase of almost 50,000 metric tonnes is possible, or about a 20% increase. Vegetables and other crops may experience production increases on the order of 24% and 17%, respectively. Fodder production increases marginally, by about 2%.

The results of scenario analysis confirm there are water resource management options that can promote climate resilience in the region. Under the *FallowFF* scenario, the fallowing of forests and fodder results in about 12 billion cubic meters of water savings over the fully 40-year analysis period. With these water savings, the total area in production of higher valued agricultural commodities, including date palm, vegetables, and other crops can grow by 2.5 times over the planning period. By using the water savings from the fallowing of fodder and forests, the production of date palms increases by 75%, vegetable and fruits and other commodities production by 73% in terms of production in units of metric tonnes. Under the *GWStabilize* scenario, groundwater levels can be stabilized by an annual increase in pumping from the alluvial groundwater aquifer by 4 - 6 million cubic meters through 2060, while offsetting annual desalinated water supply by an equivalent amount. It is important to note that wetter conditions in the Al Ain region under climate change is not a guaranteed condition

under climate change due to uncertainties inherent in GHG emission scenarios, general circulation modeling frameworks, and regional downscaling methods.