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Entitled

Satellite-Based Spatial and Temporal Characterization of Rainfall Over the UAE

by

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Abstract

Studies on rainfall characteristics have been of particular interest in the arid and semi-arid regions, including the United Arab Emirates (UAE), due to its impact on the built and natural environment. Rainfall represents a vital water source and a potential threat to the built environment, particularly during flash rainfall. This thesis evaluates spatial and temporal variation of rainfall in the UAE. The UAE is classified into four ecosystems with a distinct distribution of precipitation (East Coast, Mountains, the Gravel Plains, and Desert Foreland). Satellite data on daily rainfall for the years starting from 2001 up to 2020 was obtained from the Global Precipitation Measurement (GPM) mission. Several rainfall characterization metrics and their trends are evaluated; these include rainfall patterns, the probability of occurrence, the severity of precipitation, rainfall Intensity-Duration-Frequency relationships (IDFs), Standard Precipitation Index (SPI), and Probable Maximum Precipitation (PMPs). The data is analyzed using statistical techniques to outline anomalies that may indicate climate change in the UAE. The outcome of this thesis will serve as baseline data for several activities, including irrigation scheduling, rehabilitation projects, and hydrological studies such as the mitigation of possible flood hazards and the design of dams. Moreover, satellite data will be beneficial in the case of insufficient ground data, mainly where rain gauges are generally scarce. Regions characterized by low population densities and remote locations and have a diminishing need to deploy a network of rain gauges and automated weather stations will benefit the most from this study. The findings indicate distinct patterns in rainfall distribution among the UAE's ecosystems. The desert region encounters fewer rainfall events, whereas the east coast has the highest rainfall frequency. Additionally, the thesis reveals similar rainfall patterns in the mountain and gravel plains regions. Notably, high-intensity rainfall events are more prevalent on the east coast compared to the mountain and gravel plains. Further examination of Probable Maximum Precipitation (PMP) unveils the east coast as having the highest PMP, compared with the gravel plains region's minimum PMP. This thesis makes significant contributions to the study of rainfall patterns in the UAE. Firstly, the open-source availability of our developed source code promotes collaboration and transparency, enabling fellow researchers to replicate and extend our analyses. Secondly, our meticulous two-decade spatial and temporal analysis enhances understanding of local climate dynamics, providing a comprehensive dataset for researchers and policymakers. Finally, the presentation of Intensity-Duration-Frequency (IDF) curves and spatial maps offers clear visual insights into rainfall characteristics, aiding decision-makers in water resource management and infrastructure planning. Together, these contributions advance not only our understanding of UAE's rainfall but also serve as a valuable resource for future research in similar climatic contexts.

Keywords: Rainfall Intensity, Probable Maximum Precipitation, Standard Precipitation Index, Intensity Duration Frequency, Global Precipitation Measurement, Integrated Multi-satellite Retrievals for the Global Precipitation Measurement (IMERG**)**.