CLIMATE AND FRESHWATER RESOURCES
IN NORTHERN MEXICO: SONORA, A CASE STUDY

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Abstract. An analysis of current trends in water availability in the Mexican border state of Sonora is presented to illustrate what may be faced under climate change conditions. Precipitation, streamflow and even dam levels data are examined to estimate what changes have been experienced in recent decades. There are indications that the more frequent occurrence of EL Niño/Southern Oscillation (ENSO) events have resulted in more winter precipitation and consequently in a slight increase in water availability in northwestern Mexico. However, water demands grow much faster than such trends in water availability, mainly due to a rapid increase in population in urban areas and in socio-economic activities such as those related to agriculture, industry and power generation. Some strategies to adapt or mitigate climate change conditions are proposed.

Key words: water availability, ENSO, precipitation, streamflow, Sonora, Mexico.

1. Introduction

One of the major problems that semiarid and arid regions face is related to water availability. Climatologically, the USA-Mexican border is located around the northern hemisphere desert belt. Here, precipitation rarely exceeds 400 mm/year in the western region and 600 mm/yr in the eastern region, making water availability a problem of major concern.

The large interannual variability in precipitation, mainly related to El Niño/Southern Oscillation (ENSO), makes the problem of climate forecasting for this region an important one. For instance, from the meteorological point of view, the North American monsoon determines precipitation in northwestern Mexico and the southwestern USA. Years of weak monsoon usually translate into years of drought and low water availability, although the relationship between ENSO and the North American monsoon is still an open question.

As the skill of coupled models increases to simulate large-scale atmospheric circulations and climate variability, methodologies aimed at using such simulations and forecasts to predict regional and even local climate anomalies on an interannual basis have developed. Current ENSO predictions may help to define plans of action against anomalous climate conditions around the world.

Another issue of major concern in freshwater management is the future of the hydrological cycle under climate change conditions. Most General Circulation Model (GCM)
simulations for carbon dioxide \((CO_2)\) doubling indicate that surface temperatures will increase. Along the border regions, such numerical simulations indicate an increase of surface temperature of the order of 2°C. However, there is no certainty on what the changes in precipitation will be, especially at a regional level. While some models predict a decrease in precipitation for the USA-Mexico border region, others predict an increase.

Given the current trends in water demand, it is necessary to define strategies that consider climate variability, as well as climate change, in water management and adaptation plans.

Rapid population growth associated with industrial development along the border has increased the demand for water. On the Mexican side of the border, maquiladoras (factories) compete for water with agriculturists and populations in border towns. These problems become particularly serious when taking into account water resources management within the USA-Mexico border watershed, which involves significant social, economic and cultural differences between the two countries. In recent years, the problem of drought and water availability in northern Mexico has also led to national and international disputes.

This study presents scenarios of the impact of climate variability and climate change on water resources, in view of the current uses and trends in water availability and water demands along the border region in northwestern Mexico. The case of the State of Sonora (Fig. 1) is used as an example of what most northern Mexican states face in terms of water availability, population welfare and economic growth. Among border states, Sonora is the most important agriculture producer (Fig. 2). It is expected that as economic and population growth continue, the demand for water will substantially increase, making necessary the establishment of new water use policies.

![Figure 1](image_url)

*Figure 1.* Northern states and rivers along the Mexico-USA border. The largest dams in Sonora, Mexico, are labeled.