Hydrologic variations in the Gulf of California Watershed in the context of climate change: Investigations of the recurrence of extraordinary events and their possible consequences

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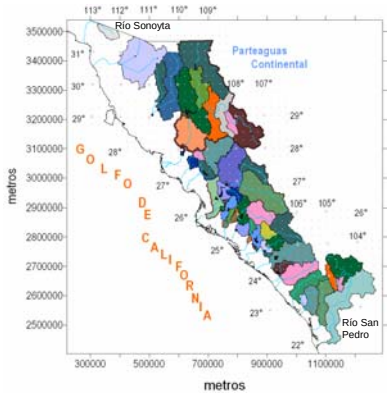
Brief Description

The information concerning climate change in several regions of the world is quite large, but in Mexico the studies dealing with this kind of investigations are scarce. The air surface temperature has been the variable that best fitted the predictions (Easterling et al., 1997; Temperature Trends in the Lower Armosphere: Steps for Understanding and Reconciling Differences, 2006), because of its rapid response to greenhouse effect. The studies examining minimum air surface temperatures revealed that, in Sonora, a warm trend is observed to the west, but cold trend to the east (Weiss & Overpeck, 2005). Portions of Zacatecas State, in Mexico, display an asymmetry in the tendencies of maximum and minimum temperatures, a differing result from than expected behind a global warming (Brito-Castillo and Díaz, 2006). These results imply the necessity to investigate the ecological response to regional climatic perturbations such as the extreme hydrometeorological events: heavy or scarce rainfalls, flash floods, extremely high and low temperatures, etc. In Mexico, the lack of detailed studies focusing on the effects and the causes of such events over the ecosystems has motivated the preparation of this proposal; our main goal is to try to document the regional climate change and its ecological consequences, such as the migration or invasion of species, and extinction and/or severe damage to their habitats.

Zone of Study

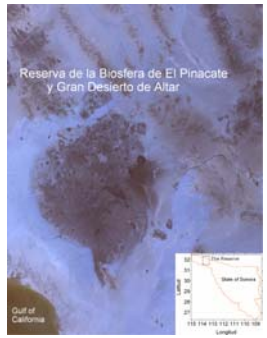
For this research, the Gulf of California watershed (GCW) has been chosen as the zone of study, from the Sonoyta river basin in the north to the San Pedro river basin in the south (Figure 1), and the Pinacate and Gran Desierto de Altar biosphere reserve (the reserve, Figure 2), as a specific case study, due to its high ecological value, where the endemic or with some degree of taxonomic differentiation, flora and fauna, or with some category of protection, represent one of the most important biological and taxonomic values.

Figure 1. The Gulf of California Watershed



In colors are shown the basins related to each gage station with streamflow data

Figure 2. Portion of the Pinacate and Gran Desierto de Altar Biosphere Reserve



Note MacDougal Crater upper left, Mexico Highway 2 across north end of lava field, and road south from Pinacate Junction to Tezontle cinder mine and Elegant Crater. Composite Landsat courtesy of The Reserve's base camp.

Main goals

1. The study of interannual and interdecadal variations in different climatic variables, like streamflow, rainfall and temperature in the Gulf of California Watershed, with emphasis in the frequency and magnitud of extraordinary events and long-term periods (Figure 3).
2. The exploration of empirical links between ENSO, PDO, SST, NATO and large-scale atmospheric circulation patterns which strength could be used to select the best predictors of these variations.
3. As part of a doctoral project, the exploration of proofs of climate change in the Reserve, for its characteristics of being a natural protected area with minimum and restricted anthropogenic perturbations.

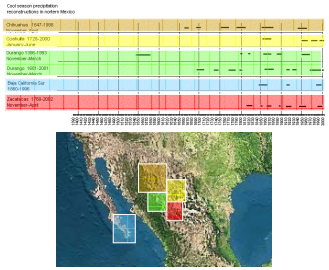
Methodology

For methodological reasons, the study is aim to focus from the generality (the GCW) to the specificity (the reserve), taking up our previous investigations in the GCW where we reported rainfall and streamflow reconstruction (Brito-Castillo et al., 2003a, Díaz et al., 2001 and 2002); the 700 mb atmospheric flow patterns related to moisture transportation toward hydrologic basins (Brito-Castillo et al., 2003b); and the ENSO modulation effect and the modulating influence by the tropics and adjoining waters (Gochis et al., 2006). Also, because it results easier to first understand the climatic effects of global and synoptic scales and then focusing on a specific region, the reserve, where most of the information necessary to understand the climate changes results insufficient.

This is the reason why we maintain using dendrochronological techniques to reconstruct the current available information in the reserve (Figure 4), and to take field samples to understand the changes in plant structure and/or reductions in the genetic homogeneity of the species, to support more global analysis results.

To accomplish these goals a data base of the entire zone of study will be created, that includes climatic variables (rainfall, air surface temperatures, streamflow), maps (vector data files) and plant species (samplings and reference works at museums); and by searching correlative mechanisms with different indices of climate variability which help understand the origin of the changes.

Figure 3. Cool season precipitation reconstructions in northern Mexico



The study of annual rings (Dendrochronology) has been established as a tool to obtain constant paleoclimatic records of annual precipitation. Some trees from western USA and northern Mexico grow wider rings in response to greater precipitation primarily during the winter or cooler season, and narrow rings in response to drought.

Contribution of the project

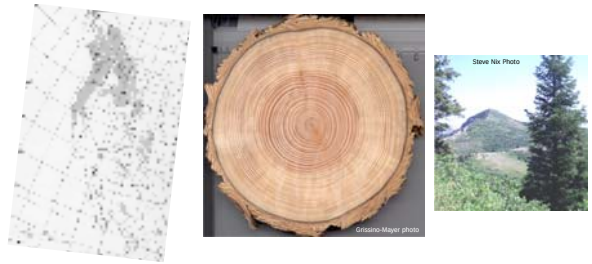
This project will try to give answer to questions like:

1. Extreme climate events in the zone of study are part of the natural climate variability or are a consequence of the climate change process in the same sense as it has been reported in other regions?
2. Are we prepared to face the consequences of these changes?
3. What kind of actions will be necessary to be done to attenuate the negative effects of these changes in protected areas, such as the reserve?.

Figure 4

Douglas-fir

(*Pseudotsuga menziesii*)



Douglas-fir (Pseudotsuga menziesii (Mirb) Franco), has demostrated its sensitivity to precipitation in northern Mexico. The Douglas-fir ring is anatomicaly divided into two distinct zones, influenced by climate during different season, the first light-colored called earlywood (EW), can be easily differentiated from the darker latewood (LW).

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