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Impact of climate change for the period 2021-2050 in the hydrogeological section Artemisa-Quivicán

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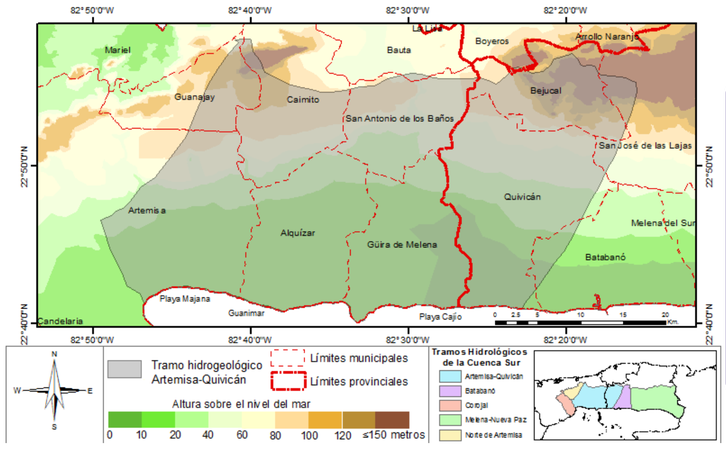
Climate change is one of the main threats to humanity today, in the context of a world deeply transformed by human action. Historical records and climate projections provide much evidence indicating that freshwater resources are vulnerable and that they will potentially be heavily impacted by climate change, with consequences for society and ecosystems. Cuba is no exception, and many projects and actions are being developed within the framework of a national strategy to confront this phenomenon.

The Artemisa-Quivicán hydrogeological section is located within the Cuenca Sur, south of the province of Havana, on the border between the Artemisa and Mayabeque provinces. It constitutes one of the most important agricultural zones of the country and fundaental in the feeding of the population. The study area is located in one of the most important aqueducts that supplies water to Havana: the Southern Waters Aqueduct.



Hydrogeological description

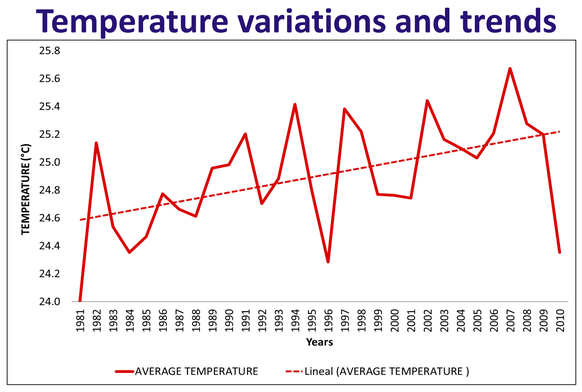
FREE AQUIFER IN A CARSIAN PLAIN

- Poor surface water network
- Very permeable ferralitic soil
- Great cracking and cavernosity

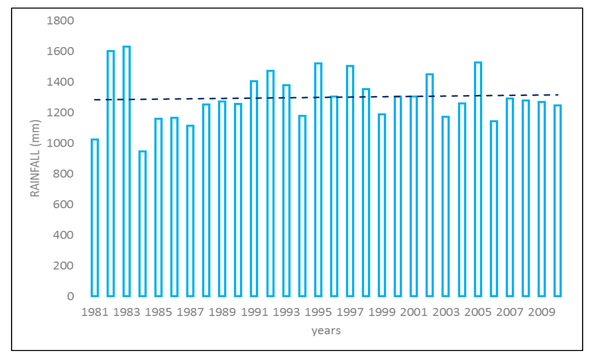
78.9 % OF ANNUAL PRECIPITATIONS ARE INFILTRATED

High effective porosity (**29 %** of the total volume of rock has holes).

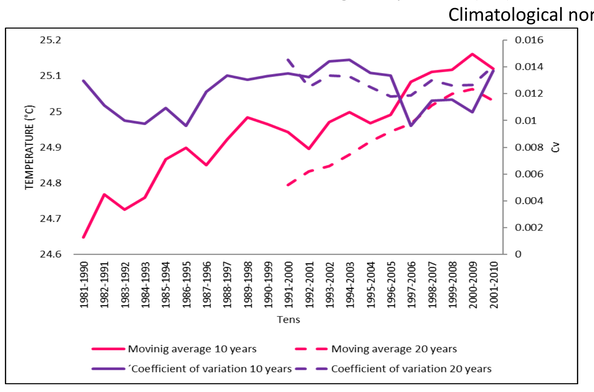
Temperature variations and trends

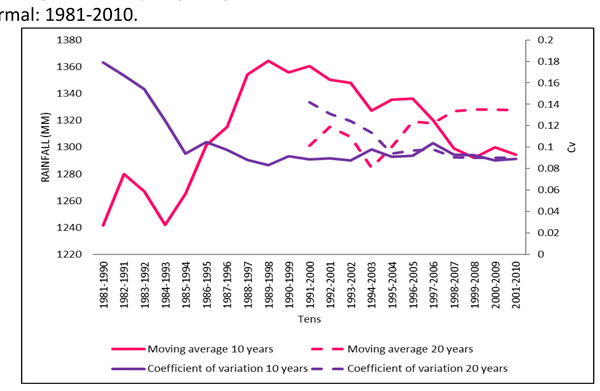


Rainfall variations and trends



Behavior of the annual average temperature (left) and rainfall (right) in the hydrogeological section Artemisa-Quivicán. Climatological normal: 1981-2010.





Moving average for periods of 10 and 20 years and the corresponding Coefficient of variation of the annual temperature (left) and rainfall (right) in hydrogeological section Artemisa-Quivicán . Period 1981-2010.

Models and scenarios used

Global Climate Model ECHAM4

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Regional Modeling System PRECIS

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Scenario SRES A2 | Scenario SRES B2

↓

Future period 2021-2050

Rain gauges and meteorological stations used

ID	H	DESCRIPTION	LON	LAT
PULIDO	5	Pluviómetro	22.768500	-82.593106
SAN AGUSTÍN	20	Pluviómetro	22.768736	-82.369132
SAN MATEO	55	Pluviómetro	22.845778	-82.335785
SANTA LUCÍA	12	Pluviómetro	22.741009	-82.336731
CUENCA SUR	20	Pluviómetro	22.796975	-82.445381
LA PAZ	28	Pluviómetro	22.823296	-82.622957
SAN DIMAS	90	Pluviómetro	22.907153	-82.680470
GÜIRA DE MELENA	15	Meteorológical stations	22.779728	-82.512511

Trend of temperatures and rainfall (1981-2010)

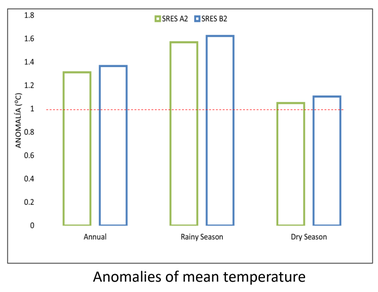
VARIABLE	SEASON	TAU DE KENDALL	P-VALUE
AVERAGE TEMPERATURE	Rainy Season	***0.424***	***0.002***
	Dry Season	0.145	0.284
MAXIMUM TEMPERATURE	Rainy Season	***0.521***	***0***
	Dry Season	0.070	0.621
MINIMUM TEMPERATURE	Rainy Season	***0.608***	***0***
	Dry Season	0.141	0.312
RAINFALL	Rainy Season	-0.0765	0.4451
	Dry Season	0.0967	0.3371

FUTURE CLIMATE AND HYDROLOGICAL SCENARIOS 2021-2050 IN THE HYDROGEOLOGICAL SECTION ARTEMISA-QUIVICÁN

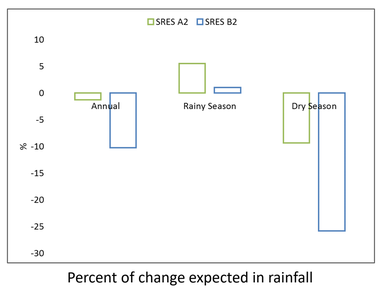
Rise in sea level (27cm / 8) + Decreace rain fall + Pumping increase for water extraction =

Saline intrusion

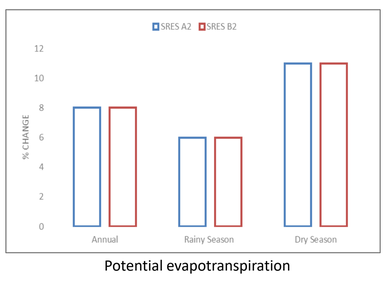
Case 1	Case 2	Case 3
New sea level position	New sea level position	New sea level position
Average rain around the norm	Rainfall deficit in the order of 10-20%	Average rain around the norm
Normal extraction	Average extraction	Normal extraction
10-12 m	**14-16 m** (rainfall reduce 10%) **18-20 m** (rainfall reduce 20%)	**16 m** (rain falll reduce 0%) **20 m** (rain fall reduce 20%)



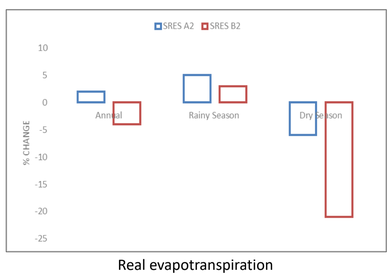
Anomalies of mean temperature



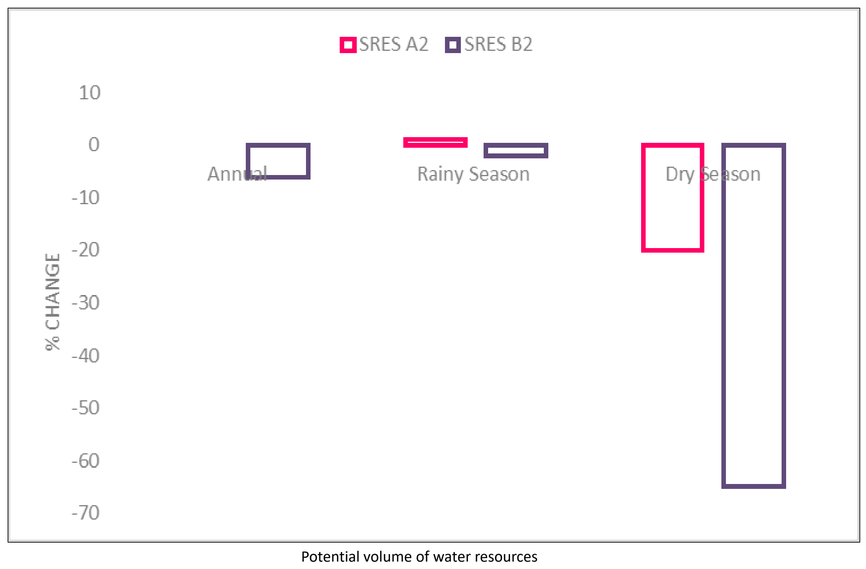
Percent of change expected in rainfall



Potential evapotranspiration

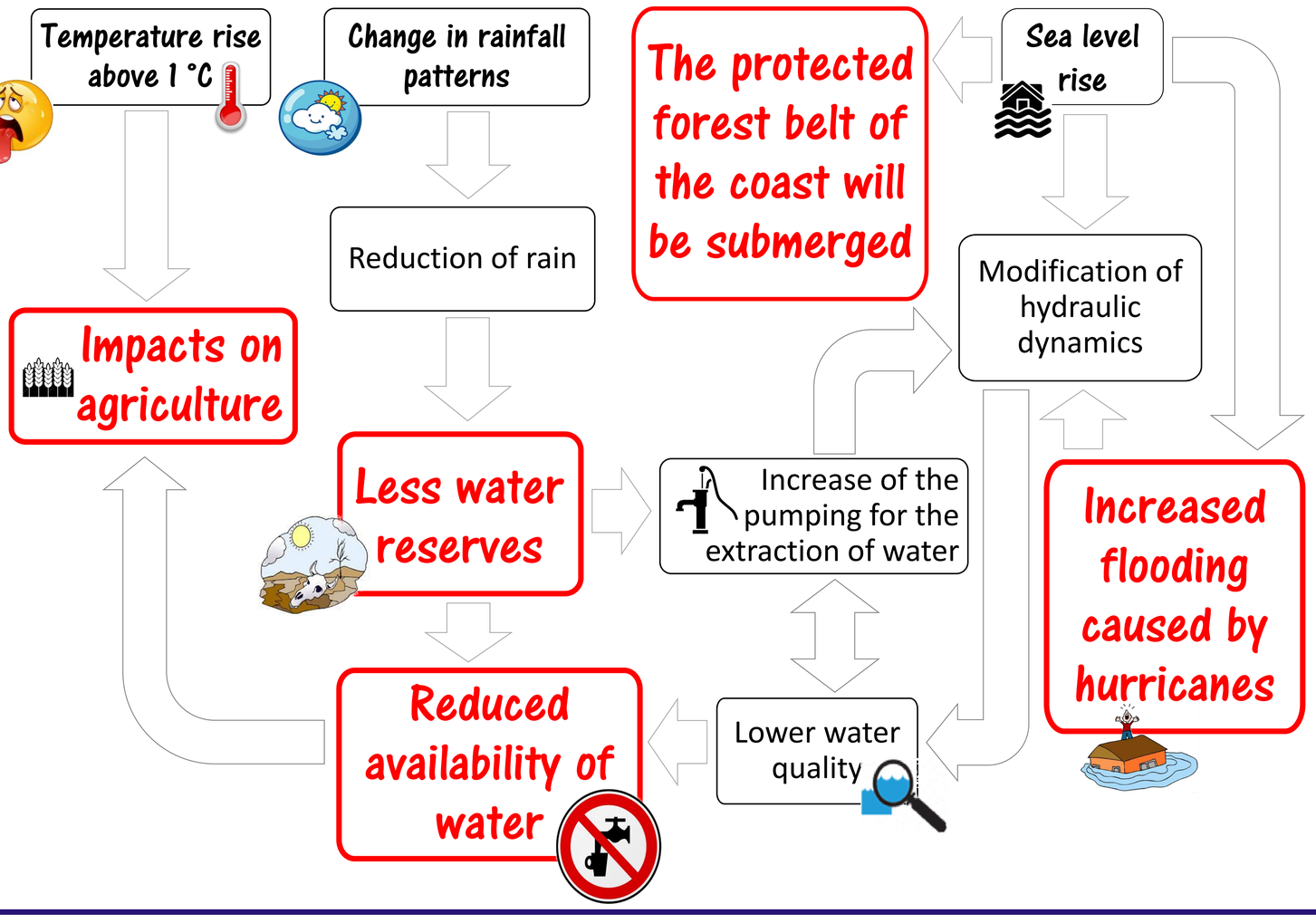


Real evapotranspiration



Potential volume of water resources

IMPACT OF CLIMATE CHANGE *IN THE HYDROGEOLOGICAL SECTION ARTEMISA-QUIVICÁN*



The average temperature will increase 1.3 °C, as a result of the increase in extreme temperatures, mainly the minimum temperatures, which will have a direct impact on agriculture.

A change is expected in the precipitation patterns that will cause changes in the recharge zones and in the distribution and dynamics of surface and ground runoff; in addition to a reduction of annual rainfall of between 1 and 10%, with a greater importance in the dry season (between 9 and 26%), season of the year in which the cold sowing season is carried out.

These rain reductions also have an immediate impact on the volume of water reserves in the aquifers and surface reserves, altering the runoff regime and, consequently, the potential volume of water resources, although in the dry season the impact Is not representative for annual totals.

Reduced precipitation, increased evapotranspiration and increased mean sea level will facilitate the process of marine intrusion. There will be severe damages in the hydraulic mechanisms that lead to the sea, as a consequence of the change of the hydrological regime and the dynamics of the circulation of the water flows. This implies significant reductions in groundwater abstraction and in poorly powered coastal aquifers could represent the cessation of pumping by the definitive salinization of their reserves.

With the occurrence of extreme hydrometeorological events, the invasion of the sea waves can exceed the height of the South Dyke being trapped the salt water with a more rapid salinization of the aquifer. All this will reduce the availability of water.

Due to the increase in the average sea level, people living in the lowest part of the study area, resulting from the shift of the coastline will be affected.