Hydro-climatological trends in Texas

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Question

The following question is asked:

Is there any detectable increasing or decreasing trend in rainfall, streamflow, temperature, and evaporation at different time scales in different parts of Texas?
Trends in Hydrologic and Hydrometeorological Variables

- Rainfall
- Temperature
- Evaporation
- Stream flow
Time Scales

- Monthly
- Seasonal
- Yearly
- Decadal
## Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of stations</th>
<th>Period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td>44</td>
<td>1925-2005</td>
<td>United States Historical Climatology Network (USHCN)</td>
</tr>
<tr>
<td>Streamflow</td>
<td>30</td>
<td>1926-2007</td>
<td>USGS</td>
</tr>
<tr>
<td>Temperature</td>
<td>39</td>
<td>1925-2005</td>
<td>USHCN</td>
</tr>
<tr>
<td>Evaporation</td>
<td>30</td>
<td>1954-2004</td>
<td>National Weather Service and the Texas Water Development Board</td>
</tr>
</tbody>
</table>
Basic Statistics

- **Rainfall:** Average annual precipitation ranges from over 55 inches in Beaumont to less than 10 inches in El Paso.
- **Temperature:** Average annual maximum daily temperature in the state generally varies from about 70°F in the northern Panhandle to about 82°F in the Lower Rio Grande Valley.
- **Evaporation:** Average annual gross lake surface evaporation ranges from less than 45 inches in East Texas to more than 90 inches in Far West Texas.
Station # 415618

Annual Precipitation (Inch)

Years
Annual mean precipitation contours and precipitation trends (O: no trend, ↑: increasing trend, and ↓: decreasing trend) for Texas.
Seasonal Precipitation trends
Annual and seasonal precipitation trends

- The number of stations following upward trends in summer are much smaller (only 10) than in autumn.

- Almost half of the stations, especially those that are in north and west, do not follow any trend on an annual basis.

- Winter and spring have a tendency to have no trends, except for a few stations in the central part.

- Annual upward trends indicate an increase in summer and autumn precipitation in the central and eastern parts.
Monthly precipitation trends (O: no trend, ↑: increasing trend, and ↓: decreasing trend) for January to April for Texas.
Monthly precipitation trends for May to August
Trends in number of rainy days on a monthly basin for January to June
Trends in number of rainy days on a monthly basin for July to December.
Monthly precipitation trends

- The February and March trends are similar in the spatial pattern, with a large number of uptrends (especially in February).
- February is the anomalous month, with 21 uptrends, almost all of which are clustered in the central part of the state.
- There is relatively a large number of stations (20%) with downtrends in April; these stations are spread across much of the interior of the state.
Mean Annual Streamflow (Cubic feet/sec)

Station #8098000

Years


0 1000 2000 3000 4000 5000

-100 -104 -102 -100 -98 -96 -94

Streamflow sites

26 28 30 32 34 36 82 10000 8028500 8030500 8033500 8041000 8190000 8183500 8167500 8161000 8158000 8147000 8136500 8136000 8134000 8126380 8110500 8106500 8102500 8096500 8095000 8091000 8089000 8085500 8084000 8082500 8066500 8065000 8057000 8055500 8047500
COALS

Winter streamflow

Spring streamflow

Summer streamflow

Fall streamflow

Streamflow persistency

Seasonal and Annual Streamflow

Persistent region
Annual and seasonal streamflow trends

- In general, **downward trends are** apparent in spring and fall seasons and cover the north central part of the state.

- **Upward trends** concentrate in the south central and eastern parts.
Trends in streamflow from January to June
Trends in streamflow from July to December
Monthly streamflow trends

- January shows uptrends in the south-central part, while a band of downtrends exists in the central part.
- February and March show sparse groups of uptrends in the central part of the state.
- There is a significant pattern of downtrends in streamflow beginning in April and persisting through June in the central part.
- July also shows a downward trend in north-central part as well as an upward trend in the eastern part.
- From September to November, there are uptrends clustered in the south-central part of the state.
Annual and Seasonal Temperature
Annual and seasonal temperature trends

- Downtrends are generally concentrated in central Texas
- There are a few upward trends
- Most parts of the state except the central part show no trend
- Decreasing temperatures in summer cause most of the downward trends on an annual basis
Trends in monthly temperature from January to July
Trends in monthly temperature for August to December
Monthly temperature trends

- January shows uptrends and downtrends through the state.
- The **unchanged situation** is dominant in February.
- March exhibits a grouping of **downward** trends in the central part.
- April and May show sparse groups of downward and upward trends in the western, central and eastern parts of the state.
- June shows many downtrends clustered in the central and eastern parts.
- July and August show similar patterns in the south-central part.
- Stable conditions are dominant and a few singular trends exist for October and November.
- In December, **almost 35 percent** of the stations show significant uptrends.
Annual and Seasonal Evaporation
Annual and seasonal evaporation trends

- North-western part of the state has an increasing trend.

- This increasing trend is persistent for all seasons.

- Eastern part shows an upward trend.

- Central, western and southern parts show no trend.
Monthly evaporation for January to July
Trends in monthly evaporation for August to December
Conclusions

- Trends are observed in hydrologic and hydro-meteorological variables at annual, seasonal and monthly time scales.

- Annual Precipitation: Upward trends in precipitation indicate an increase in summer and autumn precipitation in the central and eastern parts.
Annual Streamflow: Downward trends are apparent in spring and fall seasons and cover the north central part of the state. Upward trends concentrate in the south central and eastern parts.

Annual Temperature: Very few upward trends. Downtrends are generally concentrated in central Texas. Decreasing temperatures in summer cause most of the downward trends on an annual basis.
- **Annual Evaporation**: North-western and eastern parts of the state have increasing trends. These increasing trends are persistent for all seasons.

- **Drought**: Annual drought severity trend increases for climatic divisions 5 and 10. Other climatic divisions do not seem to follow any trend.