Long-term differential water level responses of a group of tropical maar lakes in a semi-arid basin (Cuenca Serdán Oriental, México)

This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

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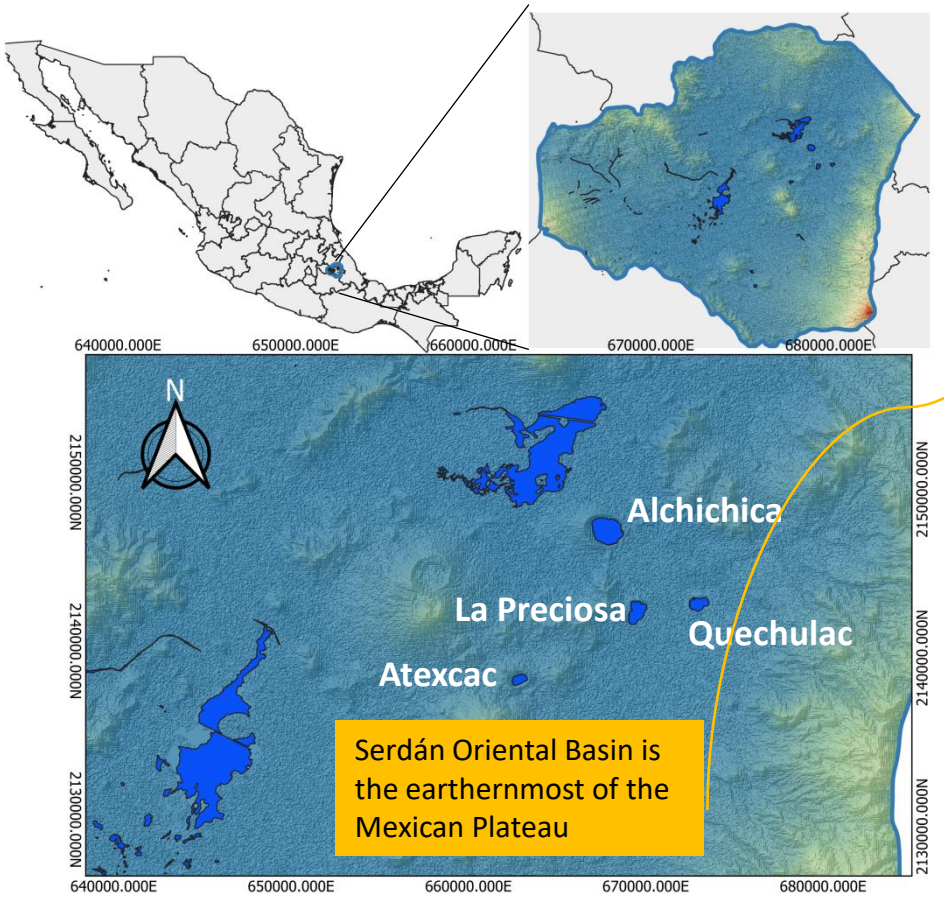
1. Introduction



- Quaternary monogenetic **volcanic field** composed of tuff rings, scoria cones and dome complexes
- **Crater lakes** (maars) formed by **phreatic explosions**
- Subhumid to **semiarid** climate
- **Endorheic** with no surface runoff.
- **Groundwater** plays a vital role in the **water balance** and the lakes' **water chemistry** | alkaline – slightly saline.

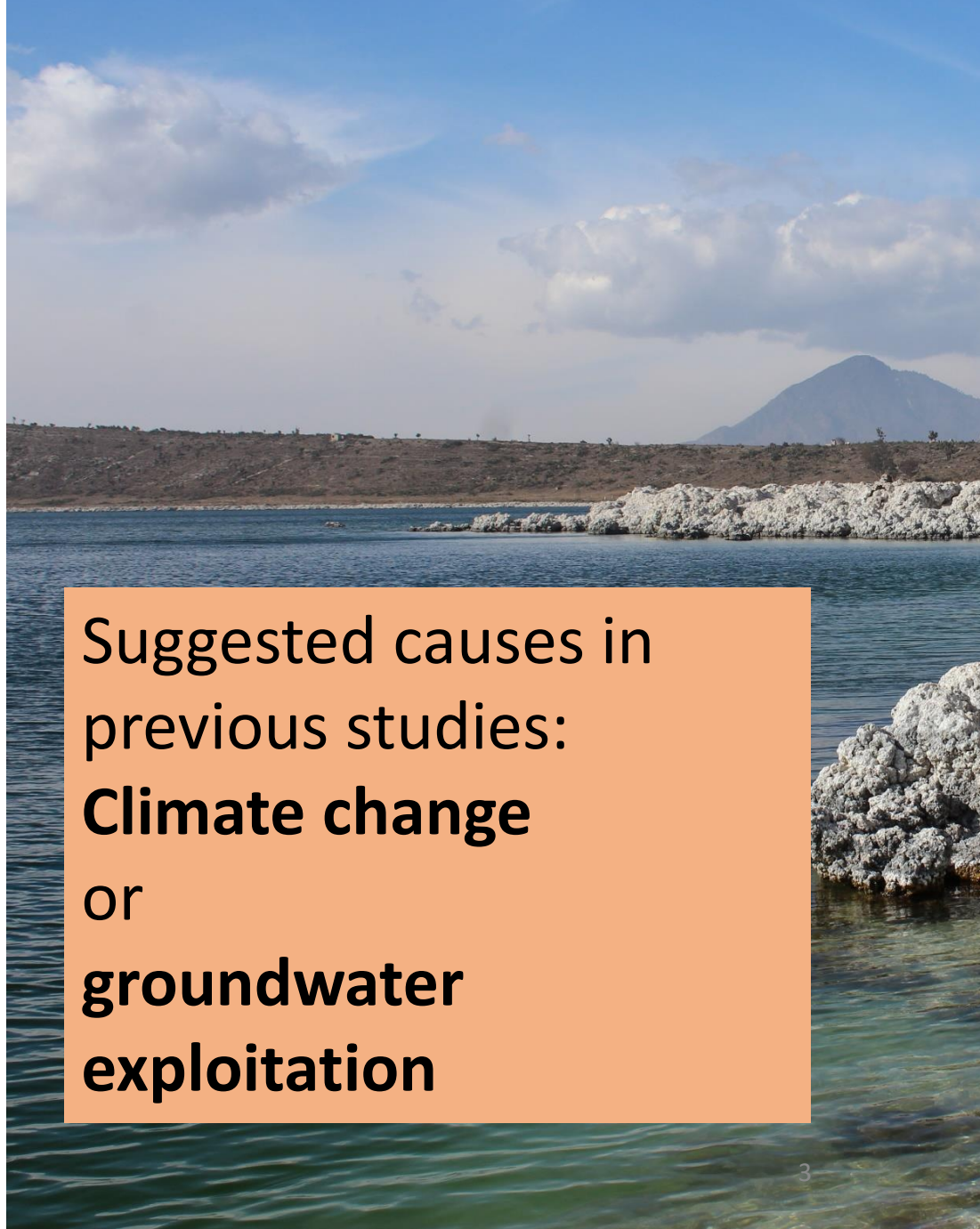
- **Microendemic** species and **ecosystem** services.
- Subjected to **groundwater exploitation** for agriculture in recend decades

2. Research questions

Study time frame: 1959 to 1992

Which factors affected water levels variability?

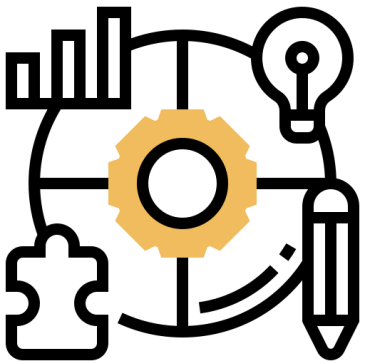
How water level differential responses among lakes can be explained?



Suggested causes in previous studies:
Climate change
or
groundwater exploitation

3. Method synthesis

To **characterize water levels (WL)** behaviour and its **association** to climate and **groundwater**



Datasets

- Lakes water levels
- Air temperature and rainfall (Climate Research Unit, CRU)
- Teleconnection indices ONI, PDO and AMO (NOAA)
- Groundwater piezometric data for the year 1966

Data analysis approaches

- Time series decomposition
- Trend estimation through Mann Kendall and Sen's slope tests
- Cross correlation analysis
- Covariance linear models
- Groundwater flownet

4. Results and discussion

WL = water level

- Air temperature and rainfall showed **no significant trends**.
- We found that total declines and rates **correlate** to lakes **surface areas**
- WLs evolution include: interannual **variability + general decreasing trends**

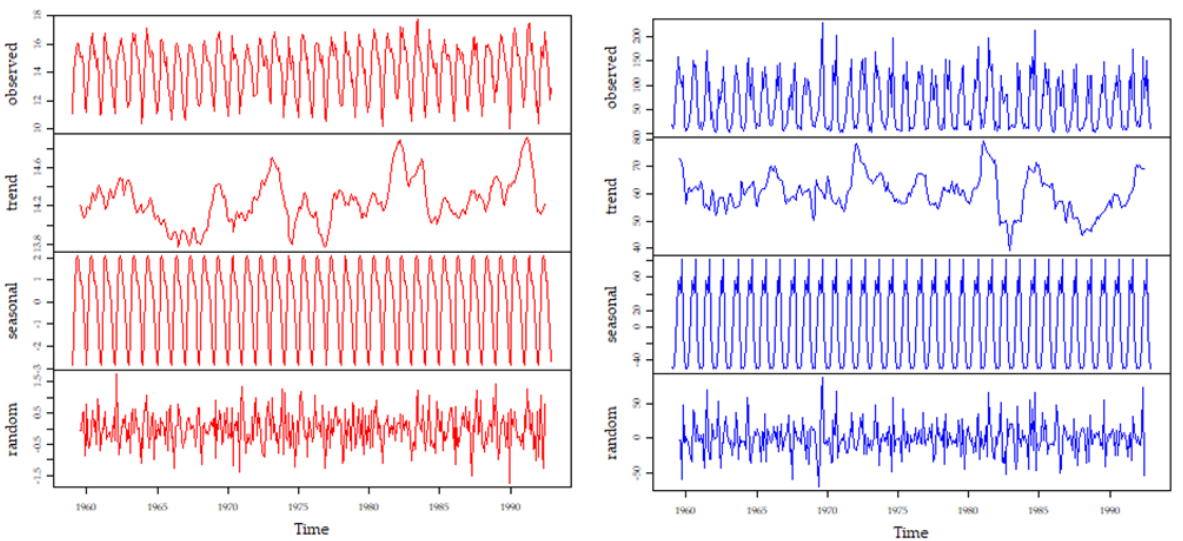


Fig. Decomposition of additive time series of CRU monthly temperature (a) and rainfall (b) values for the 1959 to 1992 period

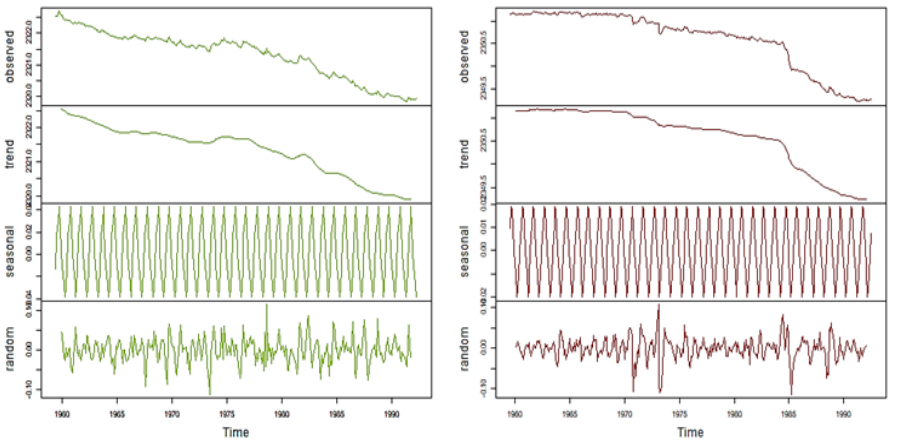


Fig. Time series decomposition of the water levels for two of the lakes

4. Results and discussion

- All the lakes had water **deficit by evaporation** outflow
- Detrended records evidenced **similarities** between pair of lakes: AL – AX & Q - LP
- Water levels variability can be partially explained by **rainfall** and **global teleconnections**.

Lake	AVR (m3)	AVE (m3)
AL	0.72	3.15
AX	0.15	0.46
QC	0.19	0.97
LP	0.30	1.52

Table. Average volumes of water entering to the lakes by rainfall (AVR) and lost by evaporation (AVE).

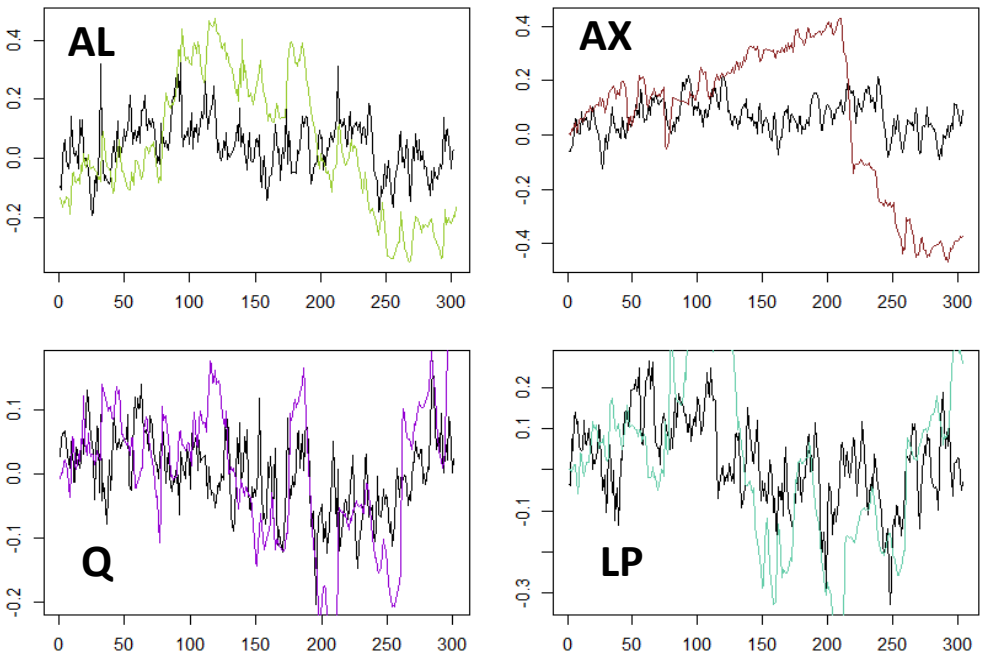


Fig. Detrended WL records (colored curves) and fitted linear models (black curves)

4. Results and discussion

- **Groundwater** flows from the regional and local **recharge zones** to the discharge zone
- All the lakes had **interconnectivity** with the **groundwater flow system**
- Most of the **piezometric levels** of the wells surrounding the lakes **decreased**
- The average piezometric decrease rate **coincides** with that of the lakes WLs ~ **7 cm year^-1**

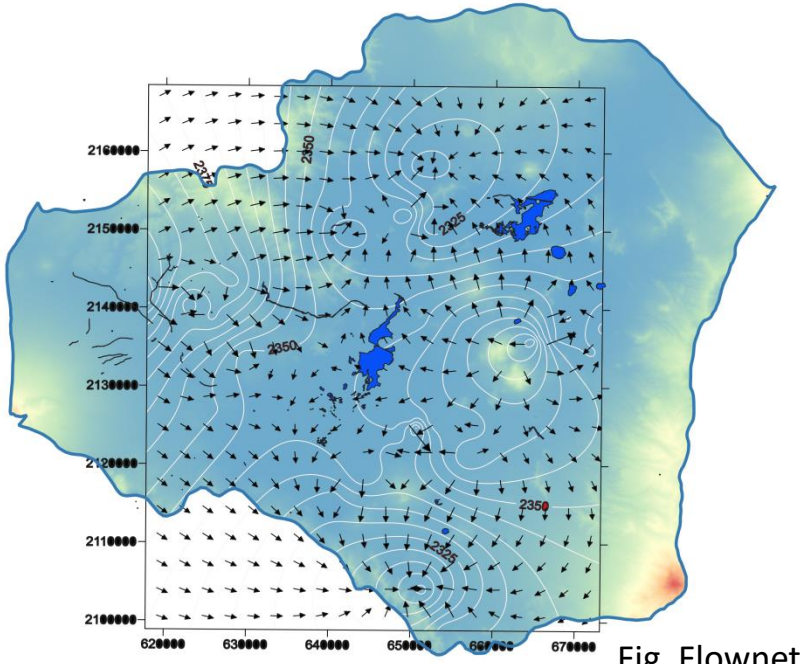


Fig. Flownet built with 1966 piezometric data

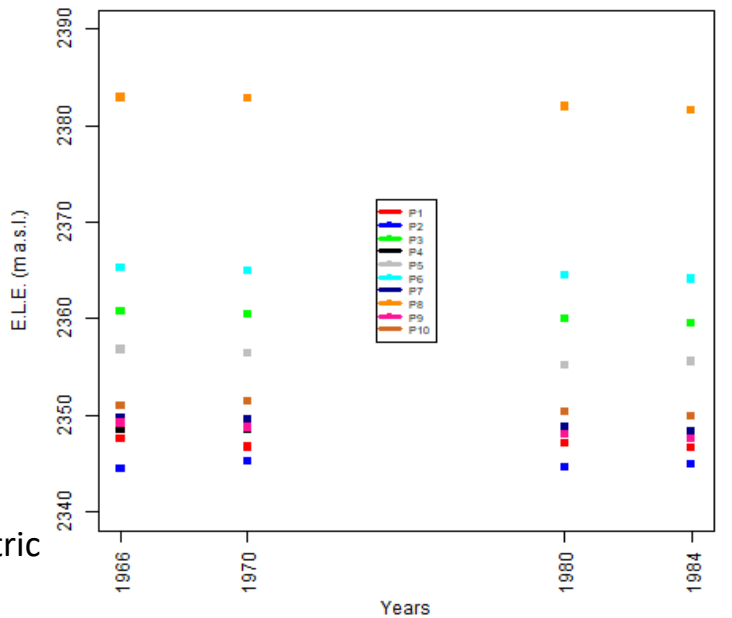


Fig Decreasing piezometric levels

5. Conclusions

- Difference in **climate subtypes** and lakes **surface areas** defined differential WL responses between lakes
- WL **interannual variability** showed association to **rainfall** and **teleconnections**
- WL decrease trends might be caused by 1) **evaporation deficit** and 2) a **decrease in groundwater inflow**
- **WL decrease started EVEN before** intensive groundwater **exploitation** in SOB during the 80's.
- **THEREFORE…** the decreasing piezometric trends are probably a **lagged effect** of regional **groundwater recharge decrease** (when?)