

## Abstract

The challenges of water resources management in the Lake Chad (LC) region are multifaceted. At the regional scale, the frequent severe drought in the Sahel region - of which LC is part - has been attributed to the complexity in atmospheric dynamics that control precipitation. Locally, the pressure of human needs for water resources compounds the problem. Linked human and climatic actions force the shrinking of LC. It is thus imperative to examine this connection.

The anthropogenic hotspot map generated from this study is a useful tool for policy makers to target areas of rapid change with the greatest impact on the size of LC. A reversal of the shrinking of LC by inter-basin transfer presents a 'bright spot' that can prevent the worsening socio-economic crisis from reaching a flashpoint.

## Lake Chad Basin hydrology and demography

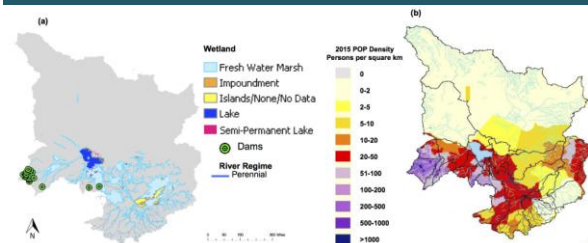


Figure 1. (a) LCB surface water hydrology showing the Lake Chad (blue), the semi-permanent lakes (red), islands and dams. (b) 2015 population density showing the number of persons per square km for LCB

- Extremely uneven distribution of population and surface water bodies in the LCB
- Dams as anthropogenic footprint

## The problem

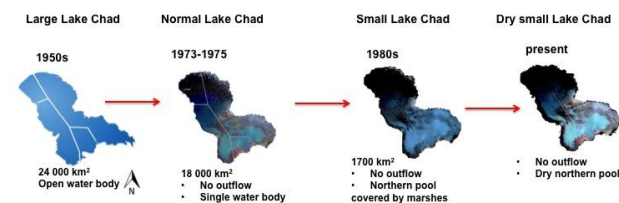


Figure 2. Schematics of the state of Lake Chad showing the decrease in size (modified from Landsat 5 images; Courtesy of NASA).

- Dramatic decrease in the size of the lake from about 24000 km² in the 1950s (Large Lake Chad) to about 18 000 km² in early 1970s
- The impact of desiccation of LC has been devastating due to the dependence of local economies on agriculture, fishing, and livestock production

## Approach

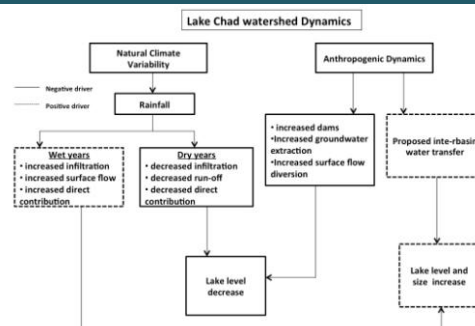


Figure 3. Simplified flow chart of natural and anthropogenic dynamics at play in LCB

- Flow chart conceptualizes interplay of natural climate variability represented by rainfall and anthropogenic externalities.
- Two mechanisms are nevertheless strongly linked in the hydrologic cycle

## Results: combined effect of AMO and ENSO

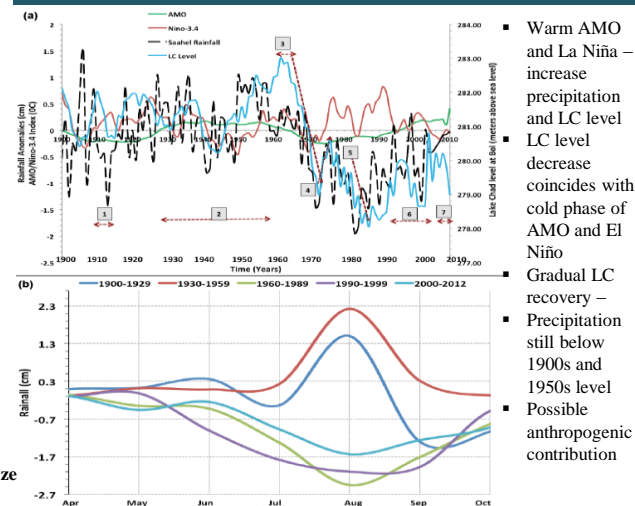


Figure 4. (a) Evolution of Atlantic multi-decadal oscillation (AMO) index (blue) shown together with ENSO (red) and LC level variability (green) and Sahel rainfall (black). (b) Plot of April to October western Sahel rainfall (cm) anomalies for different cold and warm periods of AMO. The Sahel rainfall anomalies are with respect to 1950-1979.

## Result: anthropogenic 'hotspots'.

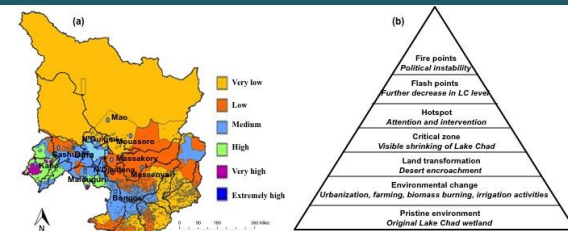


Figure 5. (a) LCB anthropogenic hotspot model output (modified from Glantz, 2003)

- An integration analysis of burnt are and population density identified anthropogenic hotspots
- A useful tool for policy makers to target areas of rapid change with the greatest impact on the size of LC.

## Lake Chad today and tomorrow

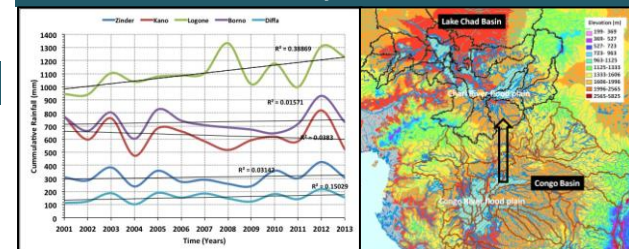


Figure 6. (a) Precipitation time series from rainfall stations within LCB (b) Lake Chad Basin and Congo Basin elevation and hydrology map showing possible inter-basin water transfer path (black arrow)

- Increase in precipitation in 2012 in response to the La Nina episode
- Negative impact of El Niño on precipitation even in the warm phase of AMO
- Inter-basin water transfer as a policy option

## Summary

- The spatial characteristic of the anthropogenic footprint shows that sustaining water services will continue to be a problem.
- This understanding of the AMO-ENSO-rainfall-LC level association will help in forecasting the impacts of similar combined episodes in the future
- The proposed inter-basin water transfer will require the most comprehensive urgent policy responses

## Acknowledgement

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