APPLICATION OF MANN-KENDALL TREND TEST AND NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI) IN HYDROCLIMATOLOGICAL CHANGE DETECTION – A CASE STUDY OF URMIA LAKE WATERSHED, IRAN

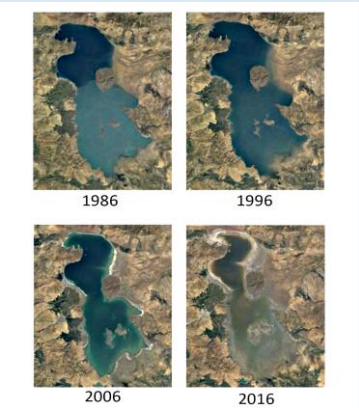
Roshanak Tootoonchi[1], Vahid Nourani[1,2], Soghra Andaryani[1], Faranak Tootoonchi[3]

[1] University of Tabriz, Tabriz, Iran; [2] Near East University, North Cyprus; [3] Uppsala University, Uppsala, Sweden

I. BACKGROUND

• Urmia lake (UL) in northwestern Iran, the Largest inland lake of the country, at its greatest extent was one of the largest hyper saline lakes in the world, the largest lake in the Middle East with a surface area of approximately 5,200 km^2 [1].

• UL watershed has been gradually desiccated throughout last decades.



• Changes in UL watershed could Have been provoked by:
- ▪Anthropogenic activities, land use
- ▪Booming urbanization
- ▪Unauthorized exploitations of UL
- ▪Climate Change

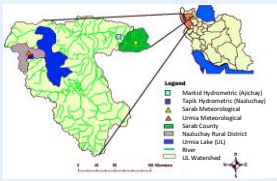
• There exist hydroclimatological changes that need to be investigated thoroughly.
This study aims to analyze the possible changes in precipitation, temperature, UL water level elevation and discharge. Vegetation change detection is also Considered to address the leap in agricultural activities.

II. METHODS

• Study area: Urmia Lake watershed, located in two provinces; East Azerbaijan and West Azerbaijan.

• The hydroclimatological variables are: total monthly precipitation, mean monthly discharge and temperature from 1990 to 2019.

• Considered hydrometric stations are located on two of the main rivers of the the UL watershed; Ajichay and Nazluchay.



• Remotely sensed data of Landsat 5 TM satellite from 1990-2013 and Landsat 8 OLI/TIRS satellite from 2013-2019 are collected and processed with ArcGIS and ENVI software.

• Normalized difference vegetation index (NDVI)-based models for two sub-basins in East Azerbaijan province and West Azerbaijan province are developed by an ensemble of satellite data from 1990 to 2019.

$$NDVI = \frac{NIR-RED}{NIR+RED}$$

• Non-parametric Mann-Kendall (MK) trend tests are applied to NDVI-based models and long term hydrological time series.

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \mathrm{sgn}(Xj - Xi)$$

$$sgn(x_j - x_i) = \begin{cases} 1 & if x_j - x_i > 0 \\ 0 & if x_j - x_i = 0 \\ -1 & if x_j - x_i > 0 \end{cases}$$

III. RESULTS

• Analyzing remotely sensed images for calculating the NDVI of two subsets; Sarab county and Nazluchay rural district (RD) had the following results:

☑ The sum of pixels with NDVI > 0.2 revealed that the growing season of NDVI in UL watershed starts mid-May and ends at the end of July.

☑ Based on the number of available images suitable for processing (scene/land cloud cover less than 10%); June, July and August, having the most number of recorded images throughout 30 years, were chosen and annual time series were developed.

☑ MK trend test was adopted to estimate the long term trends of vegetation cover (VC) in both subsets (indexed by NDVI) in months June, July and August.

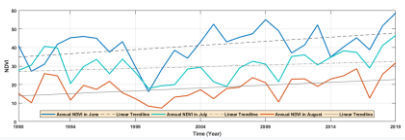
☑ Z values of the annual NDVI time series for Sarab county in months June, July and August are 1.77, 1.43 and 1.68, respectivley.

☑ Z values of the annual NDVI time series for Nazluchay RD in months June, Juy and August are 2.17, 1.75 and 1.87, repectively.

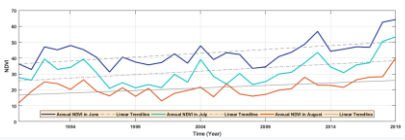
• MK trend tests were also applied on total precipitation, mean temperature and mean discharge annual time series in June (Z1), July (Z2), August (Z3) and their annnual time series (Z) from 1990 to 2019 for considered stations and UL water level elevation.

Variable	Station	Z1	Z2	Z3	Z
Precipitation	Sarab	-0.46	-0.79	2.3	-0.25
Temperature	Sarab	2.78	2.89	1.82	3.14
Discharge	AjiChay	-2.84	-1.15	-1.49	-2.91
Precipitation	NazluChay RD	0.48	-1.15	1.75	0.79
Temperature	NazluChay RD	2.43	2.99	1.85	2.81
Discharge	NazluChay	-2.4	-2.38	-3.04	-3.21
UL Water level elevation	Urmia	-6.01	-6.02	-6.02	-6.01

Annual NDVI of Sarab county in June, July and August



Annual NDVI of Nazluchay RD in June, July and August



IV. CONCLUSION

☑ MK test results reveal that there are significant increasing trends of VC (indexed by NDVI) at the 95% confidence level in both subsets. In comparison, the studied sub-basin in West Azerbaijan province (Nazluchay RD) has a higher level of increasing trend than the studied sub-basin in East Azerbaijan province (Sarab county).

☑ Discharge time series of considered stations in UL watershed show strong decreasing trends compatible and consistent with UL water level elevation [2].

☑ An evaluation of precipitation time series in June, July and August reveals that different trends are taking place at each month. And this result is consistent with recent studies which indicated that monthly rainfall at each station is more correlated with its previous year amount than that of previous month [1].

☑ As it is shown in the table of Z values, MK statistics of annual precipitation from 1990 to 2019 in Nazluchay RD and Sarab county are 0.79 and -0.25, respectively, which suggest insignificant increasing trend of precipitation in Nazluchay RD and insignificant decreasing trend of precipitation in Sarab.

References:

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[2] Nourani, V., Ghasemzade, M., Danande Mehr, A., Sharghi, E., (2019) Investigating the effect of hydroclimatological variables on Urmia Lake water level using wavelet coherence measure. *Journal of Water and Climate Change*. 10.1:13

Contact:

✉Roshanaktootoonchi94@gmail.com

@Roshanak_t

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EGU General Assembly 2020