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Effect of Climate Change and anthropogenic pressures on the European eel *Anguilla anguilla* from Ramsar Wetland Ichkeul Lake: Prediction from the Random Forest model

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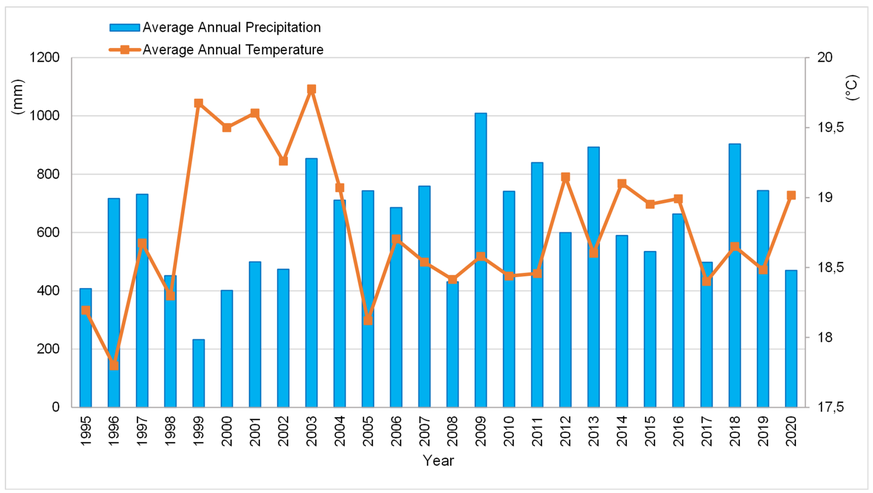
Study Site: Ichkeul Wetland Ecosystem

- Located in North Africa, Bizerte, Tunisia.
- An important international natural site: RAMSAR Wetland/ National Park/ UNESCO World Heritage/ UNESCO Biosphere Reserve.
- A site of cross-continental importance in North Africa.
- Suitable site for European eels' growth.

Pressures: Climate Change and human activities

- Increase in water warming of +0.4°C/decade and decrease in precipitation of -3% since the 1970s.
- Pollution from human related activities, urbanization, damming.



Changes in average annual precipitation and annual temperature in Ichkeul Watershed, 1995-2020

Materials and Methods

❖ Dataset:

- Historical data + Sampling campaign.
- 120 observations of 13 predictors and target variable (Eels landing) for the period 2010-2020 (with 18 % of missing values).

❖ Models:

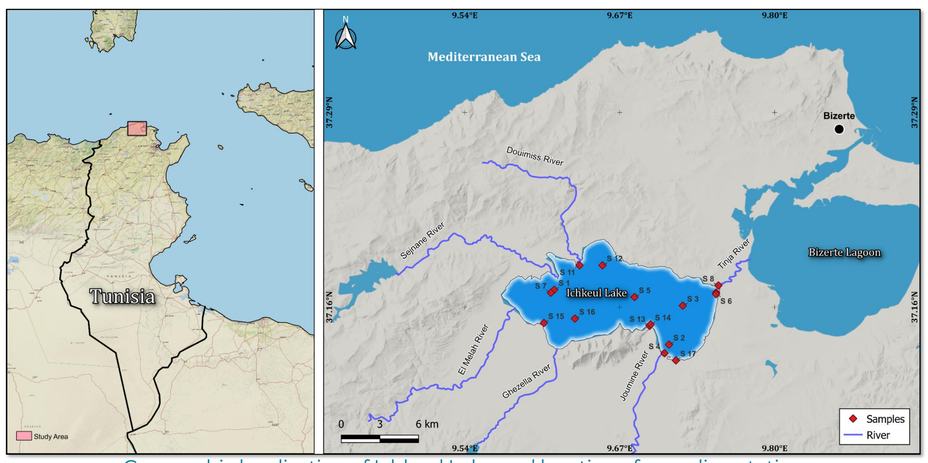
✓ **MissForest algorithm**: to handle the missing data.

- Performance evaluation**:** NRMSE.

✓ **Trophic IndeX (TRIX)** : to provide the degree of trophic status of the lake.

✓ **Random Forest model (RF):** to predict the effect of climate change and anthropogenic pressures on European eels.

- Performance evaluation: R^2.



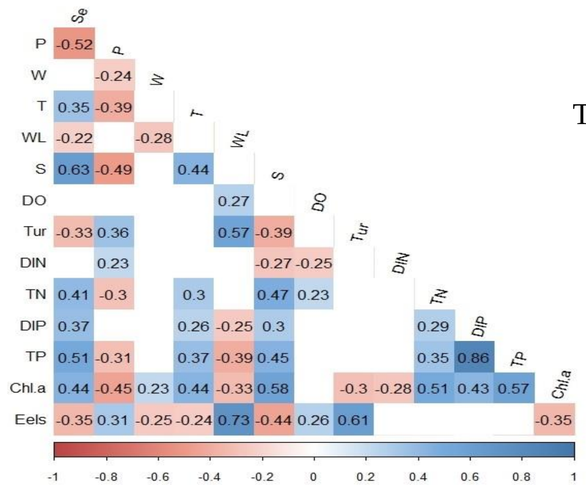
Geographic localization of Ichkeul Lake and location of sampling stations.

Results: Seasonal Variability of Parameters

Summary of The Ichkeul Lake parameters in for the period 2010-2020

PARAMETERS	ABREVIATION & UNIT	MEAN	
		DRY PERIOD	WET PERIOD
Season	Se	Spring, Summer	Autumn, Winter
Precipitation	P (mm)	15,96	82,61
Wind Intensity	W ($m.s^{-1}$)	6,01	5,22
Temperature	T (°C)	21,11	15,39
Water Level	WL (cm)	44,29	67,44
Salinity	S (psu)	44,68	21,42
Dissolved Oxygen	DO ($mg.\ l^{-1}$)	7,29	7,13
Turbidity	Tur (NTU)	18,90	27,34
Dissolved Inorganic Nitrogen	DIN (µM)	22,05	29,46
Total Nitrogen	TN (µM)	22,66	20,97
Dissolved Inorganic Phosphorus	DIP (µM)	2,08	1,06
Total Phosphorus	TP (µM)	12,80	7,60
Chlorophyll a	Chl.a ($\mu g.\ l^{-1}$)	6,80	3,36
Eels Landing	Eels (tons)	1,986	9,036

Results: Pearson Correlation



The eels landing was strongly correlated with : WL, Tur and S.

Lower triangular correlation matrix of the predictors and Eels landing in Ichkeul Lake for the period 2010-2020

Results: Models outcomes

✓ **MissForest algorithm:**

- NRMSE= 0.22 close to 0

➢ Indicates the good performance of the MissForest algorithm.

✓ **TRIX index values in the lake ecosystem:**

- Non-uniform distribution and a variation between seasons:
  - In dry season: poor water quality, high values in the eastern part of the lake.
  - In wet season, water quality was better, high values in the northern and eastern parts.

➢ The high eutrophication on the eastern and northern sides is mainly due to rural settlements without sewage treatment systems and extensive agricultural activity.

✓ **RF model:**

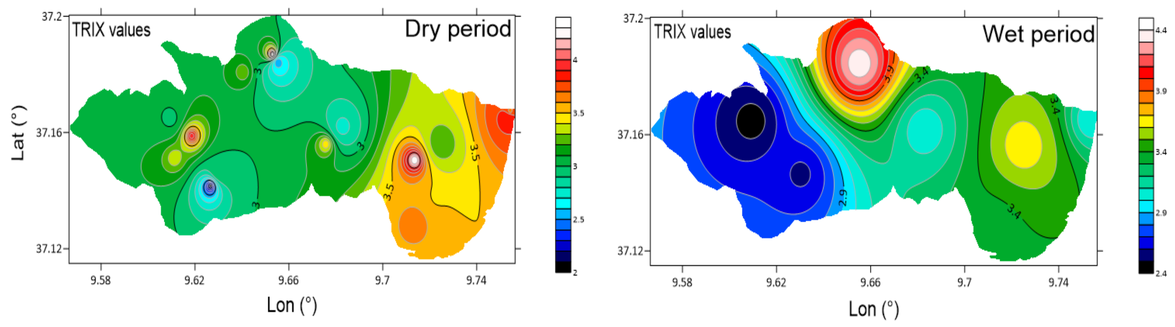
- R^2 equal to 58.4 %
- The most important predictors were WL followed by Tur and S.
- In decreasing the order of importance of predictors, the other descriptors were dissolved oxygen, season, and nutrients

➢ The RF model result is consistent with the relationships found with Pearson correlation.

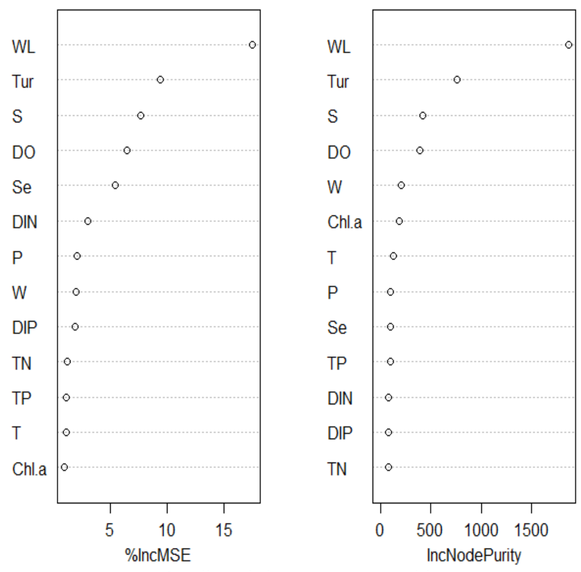
✓ **Multivariate linear regression on the same data:**

- R^2 egal to 47.4 %

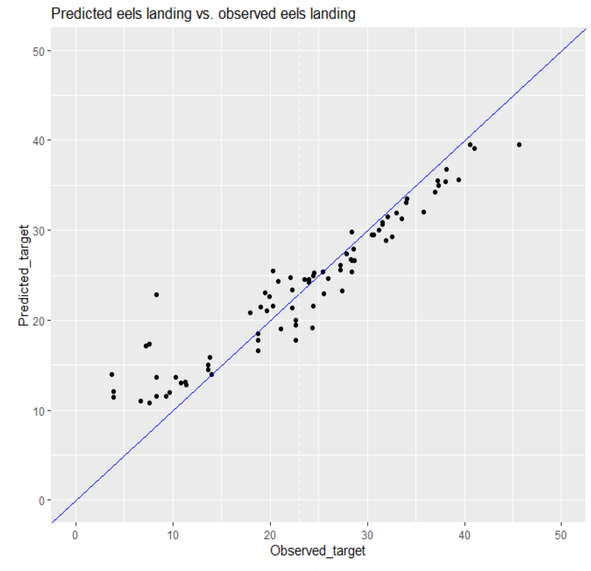
➢ Confirms the high performance of the RF model compared to the MLR model.



Distribution of TRIX values in Ichkeul Lake



Predictor's importance ranking of the RF model



Prediction of Eels landing by RF model

Conclusion and Recommendation

- ❑ The presence of European eels in coastal ecosystems is principally dependent on Water Level.
- ❑ The Ichkeul Lake has reached a mesotrophic status due to the organic waste from human activities.
- ❑ The best procedures to control localized eutrophication would be improved management of water flows and organic waste from the towns and villages bordering the lake.
- ❑ The combination between RF model and TRIX index could be used in decision making by civil authorities and other interested stakeholders.