

Fixing the most representative physicochemical and biological variables of Medellín's Parque Norte lake, as a basis for a math modeling of the bioremediation

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- Approach to the problem
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Introduction

Approach to the problem



- ▶ In Medellin, Colombia pollution levels are increasing in recent years regarding total suspended particles (TSP), whose levels exceed $100\mu\text{g}/\text{m}^3$, well above precautionary levels for health defined by the World Health Organization Health - OMS ($35\mu\text{g}/\text{m}^3$).

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- ▶ Pollution affects water quality in lakes and other freshwater resources around the globe.
- ▶ The Parque Norte lake is still highly contaminated making it difficult to use the lake for sports and recreational activities; the lake has problems such as water hardness, high concentrations of iron that it confers considerable smell and taste, besides presence of compounds that could be toxic as arsenic.



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- ▶ The models of aquatic ecosystems have had a boom in recent decades and have found a wide range of applications in the management of lakes and reservoirs



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Specific To select appropriate quantitative data describing the aquatic ecosystem from previous research
To suggest significant variables to structure the dynamic model that modulates the ecological functioning of the Parque Norte Lake.



Table 2 contains the abbreviations of the terms that were used in the article.

Term	Abbreviation
Transparency	Tr
Conductivity	Cd
Water temperature	wT
pH	pH
Dissolved Oxygen	DO
Nitrogen as nitrate	Nn
Total Phosphate	tP
Total hardness	tH
Chlorides	chl

Table: Parameters data



ρ/s	Tr	Cd	wT	pH	DO	Nn	tP	tH	Chl
1	0.22	2.6e+03	22	8.8	1.2	0.05	0.37	1.2e+02	0
2	0.2	2.6e+03	22	8.7	1.2	0.02	0.45	1.3e+02	0
3	0.4	2.4e+03	23	8.7	2.6	0.05	0.47	1.3e+02	0
4	0.4	2.4e+03	24	8.3	1	0.12	0.2	1.4e+02	6.2e+02
5	0.35	2.4e+03	24	7.9	4	0.1	0.2	1.3e+02	5.8e+02
6	0.44	2.4e+03	25	8	3.6	0.09	0.3	1.1e+02	5.9e+02
7	0.3	2.4e+03	24	7.9	3.6	0.06	0.3	1.2e+02	6.1e+02
8	0.3	2.5e+03	24	8.5	2.9	0.02	0.8	1.1e+02	7.6e+02
9	0.25	2.5e+03	26	6.9	0.8	0.05	0	1.2e+02	5.5e+02

Table: Parameters data



Searching correlations

Evaluate basic statistical estimators such as

- ▶ Average
- ▶ Variance
- ▶ Analyze the correlation between them.



The purpose of this process lies in finding the most representative and key variables in the ecological functioning of the lake, and understand the relationship between them.
For this research the PCA is made only.

Result analysis

Scattering analysis



In the first step it was found that the vast majority of data is highly concentrated as shown in the figure 1.

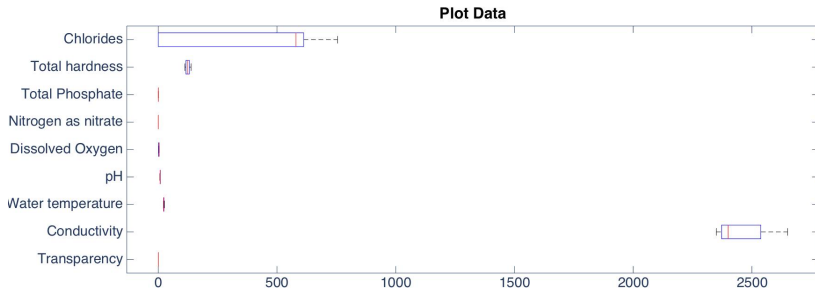


Figure: Box Plot all parameters



However when an individual analysis does not identify outliers, in the figure 2

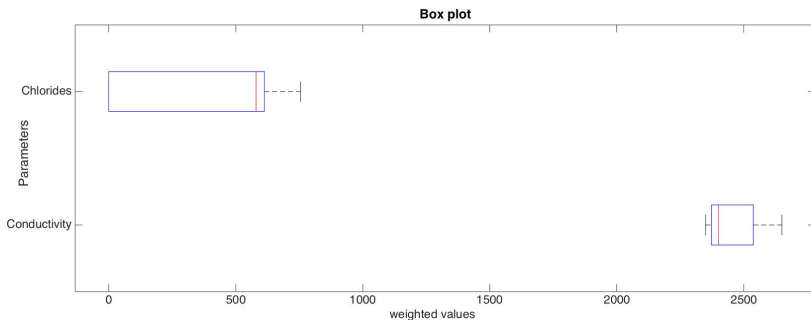


Figure: Box plot some parameters



If we evaluate only the first two principal components collect data centered notes and scaled projected onto the first two principal components. ACP calculated the scores have mean zero. By plotting these components must identify the points of the periphery in the right half of the plot 2.

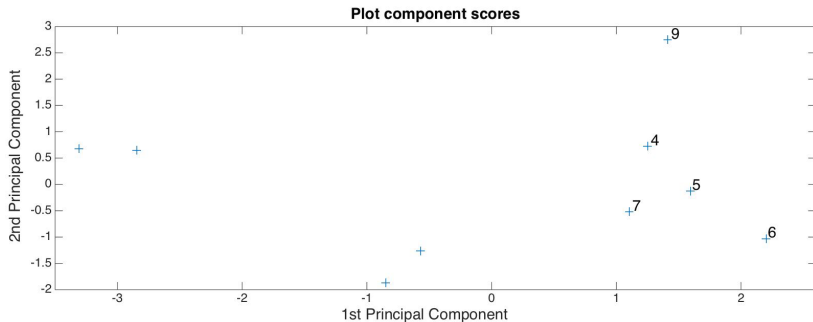


Figure: Plot component scores



Scree plot of the percent variability explained by each principal component

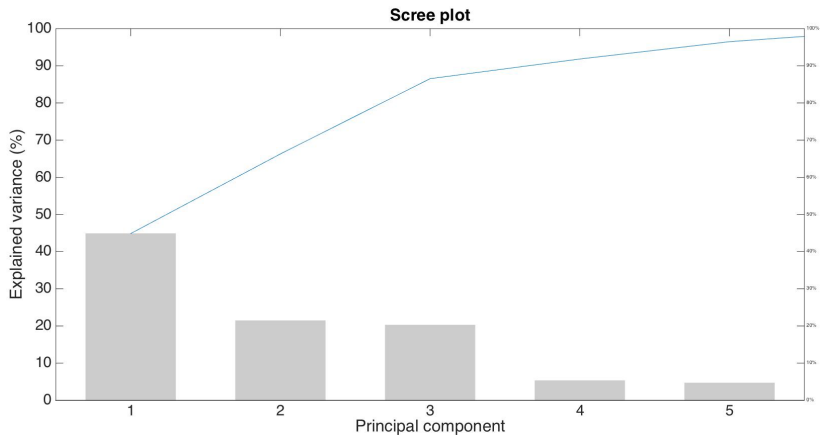


Figure: Scree plot

Result analysis

PCA



Orthonormal principal component coefficients for each variable and the principal component scores for each observation in a single plot

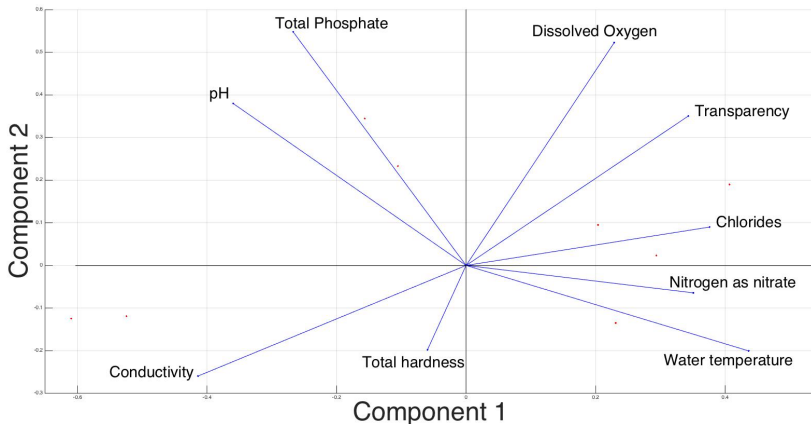


Figure: Scores for each observation



Hypotheses are proposed to characterize the resulting components:

- ▶ The first component indicates the productive capacity of the system and its availability of dissolved oxygen for which the nitrogen is mineralized and reaches nitrates forms, reason why named as Photosynthetic rate component.



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- ▶ The first component indicates the productive capacity of the system and its availability of dissolved oxygen for which the nitrogen is mineralized and reaches nitrates forms, reason why named as Photosynthetic rate component.
- ▶ The second component indicates the compounds concentration that are mineralized; considering chlorides have a very low contribution, this component is named as water mineralization.



From the results are open questions to resolve issues that resources in this investigation are not resolved:

- ▶ How chlorides behave with respect to high temperature, dissolved oxygen and nitrates.



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- ▶ How chlorides behave with respect to high temperature, dissolved oxygen and nitrates.
- ▶ It can be classified Parque Norte lake as a wetland in their limnological atypical behavior compared to other water bodies in the sector.
- ▶ The relationship of pH and total phosphates indicate good nutrient availability.



The following link is a folder with references, sketches, graphs obtained and code in Matlab R2014b: <https://goo.gl/uQjfU7>



Thanks for your attention