Assessment of the impacts of phyto-remediation on water quality of the Litani River by means of two wetland plants (*Sparganium erectum and Phragmites australis*)

Évaluation des impacts de la phyto-assainissement sur la qualité de l'eau du Litani au moyen de deux plantes des zones humides (*Sparganium erectum* et *Phragmites australis*)

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Problem

Conventional wastewater treatment is a series challenge for many development country

Solution

Constructed wetlands :

- Green
- Cost-effective
- Mimic the treatment processes of natural wetlands

To address the deteriorated water quality of the Litani River the LRBMS constructed a wetland system between 2012 and 2013

The Litani River is Lebanon's largest river

- **Suffers from:**
  - Widespread sewage disposal
  - Direct drainage of unregulated industrial wastewater
  - Lack of river bed protection
  - Illegal diversion

- Located in a publicity own site by the LRA center in Kherbet Qanafar in the western plains of the Bekaa Valley
- Free Water Surface (FWS) Wetland
- Oval-shaped basin

- Average N-S length: 240 m
- Average W-E width: 125 m
- Average perimeter: 730 m

- Average area: 30,000 m²
- Average depth: 1.5 m
- Average storage capacity: 45000 m³

Things to worry about during the construction of a wetland

- A compromise should be made between ‘too-deep’ water in some areas *vs*. too shallow when we set a wetland depth with stop logs
- The “too deep” issue is less problematic than the “too shallow” issue. We choose deeper depths of water, 50 cm or so.
- Each stop log is 15 cm height, this makes. This makes for the wetland surface area (30000 m^2) a water volume of 4500 m^3)

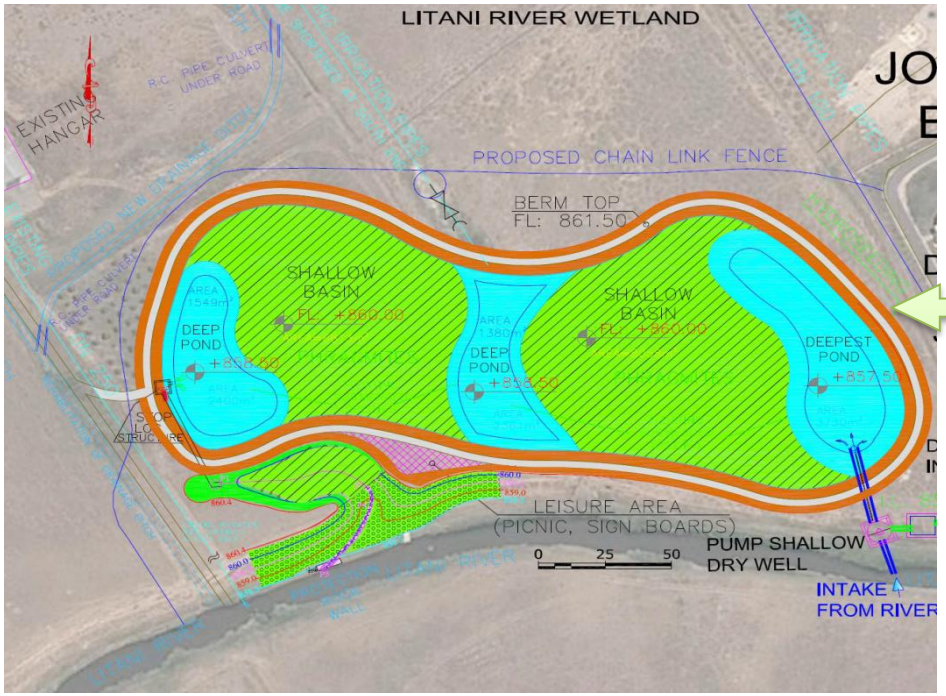
Litani River Banks

- The Litani River stream banks surrounding the discharge channel connection to the river are planted with *Salix* or willow trees to stabilize them

Vegetation types

Phragmites australis

Sparganium erectum



Water flow:
30 L/s dry season
60 L/s during the rest of the year

From the inlet to the outlet, water will spend 5 days in the wetland site for treatment purposes

Time residency corresponds to BOD_5-days

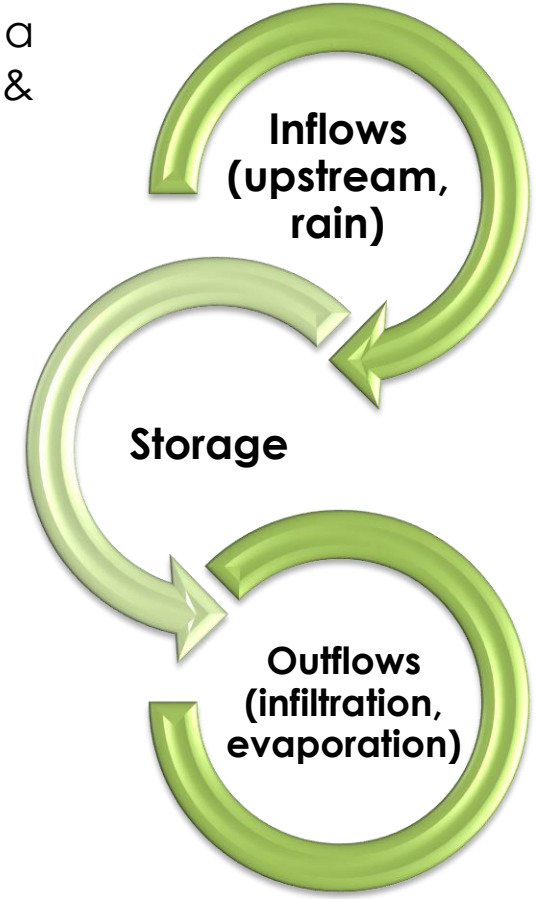
A few hydraulic considerations – Conceptual Reservoir Model

A catchment surface is conceptualized as a 'Reservoir' with inflows (upstream contributions) & outflows (evaporation, infiltration & surface runoff).

The storage is conceptualized as the difference between inflows & outflows:

$$Q_{in} - Q_{out} = \frac{dV}{dt}$$

Q_{in} = inflow (m^3/s)
Q_{out} = outflow (m^3/s)
V = storage (m^3)
T= time (s)



Évaluation des avantages environnementaux d'une zone humide construite le long du fleuve Litani dans le Bekaa occidentale

- Water samples were collected weekly during the period of **15 June 2020** through **15 September 2020**

Inlet

Outlet

- Samples were collected in **glass labeled bottles** and placed at **4°C** during transport to laboratory

- **Physical**, **chemical** and **biological** parameter analysis were performed on water samples

The following parameters were measured directly on site:

« **EC (µS/cm)**
TDS (mg/L)

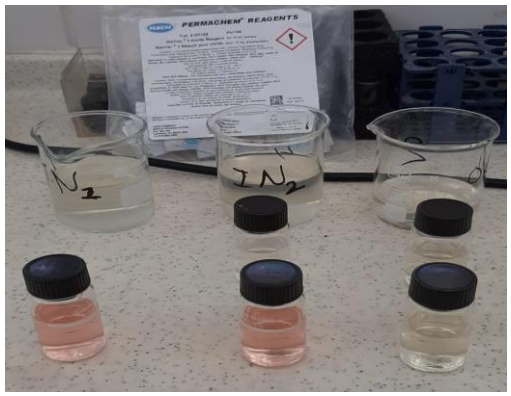
« **pH**

« **T (◦ C)**

« **DO (mg/L)**

Nitrate - Nitrite- Phosphate – Sulfate

Reagent Powder Pillow ✚ **Water sample cell**



Analysis takes place by using a spectrophotometer

COD

Dichromate solution + 2mL water sample

150 ºC for 2 hr.

Analyse in a spectrophotometer

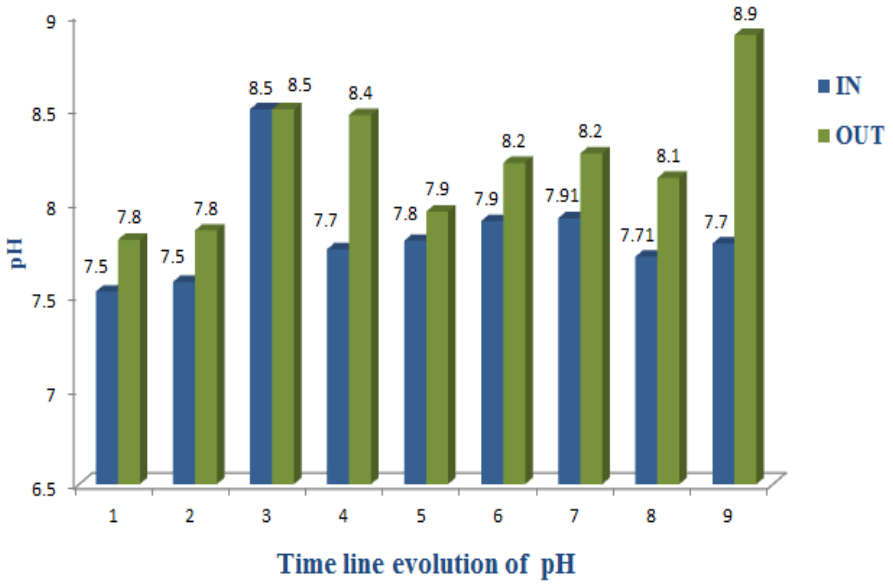
BOD

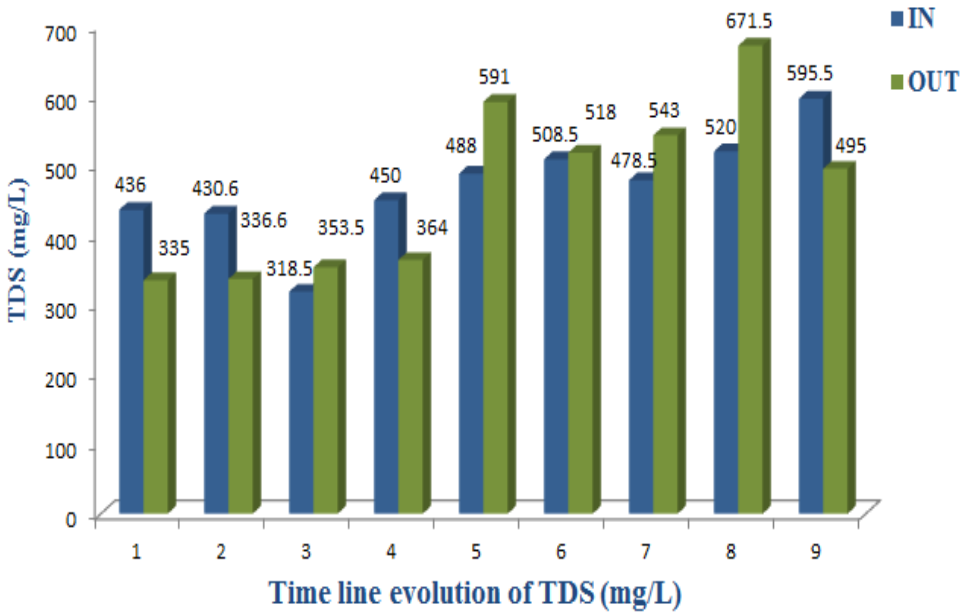
250 mL of water sample
+
Nitrification inhibitor
+
Sodium hydroxide
+
Stirring bar
+
VELP BOD Sensor

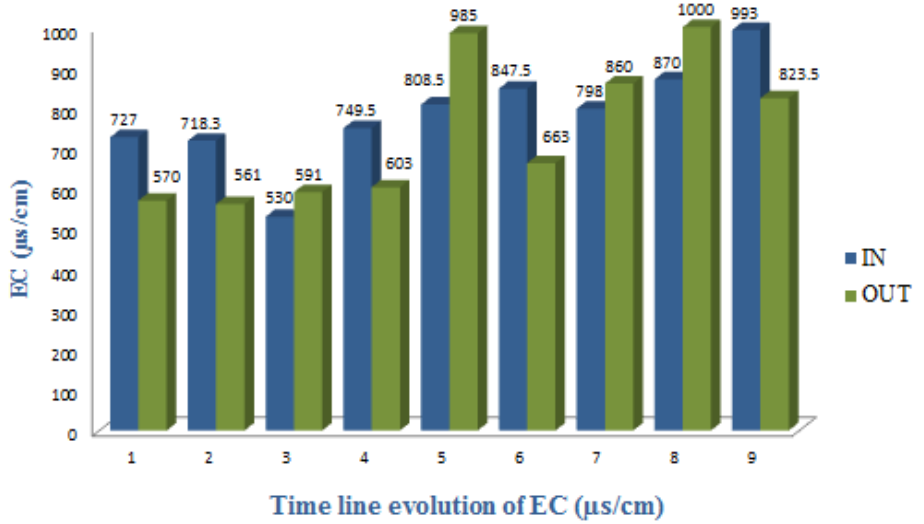
Refrigerated thermostat at 20 ºC for 5 days

Results of physical analyses of the constructed wetland influents and effluents

- Conductivity is ranging from **10** to **1000 *µs/cm***
- Ideal pH range of **6** to **9** in surface water
- TDS concentration less than **1000 mg/L**



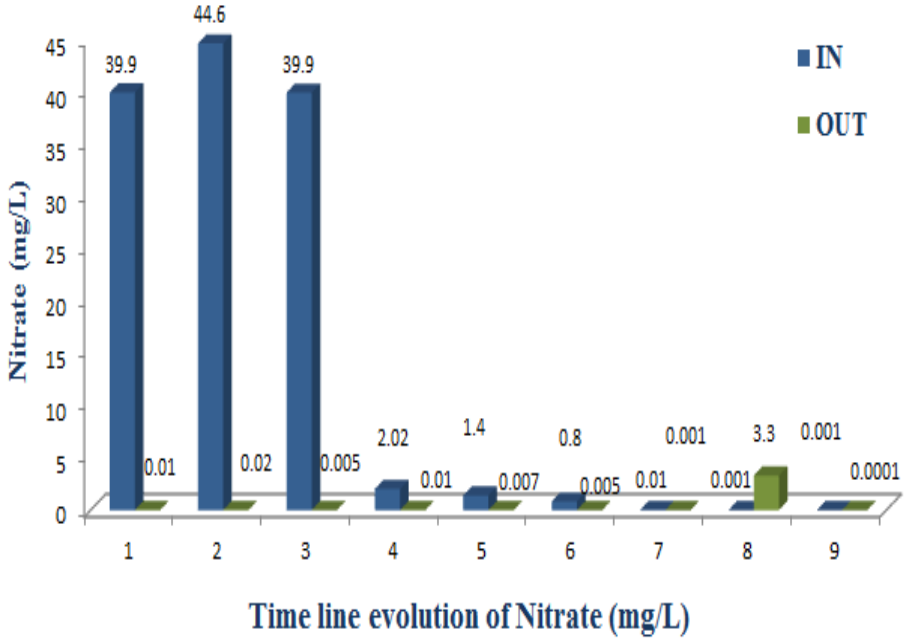


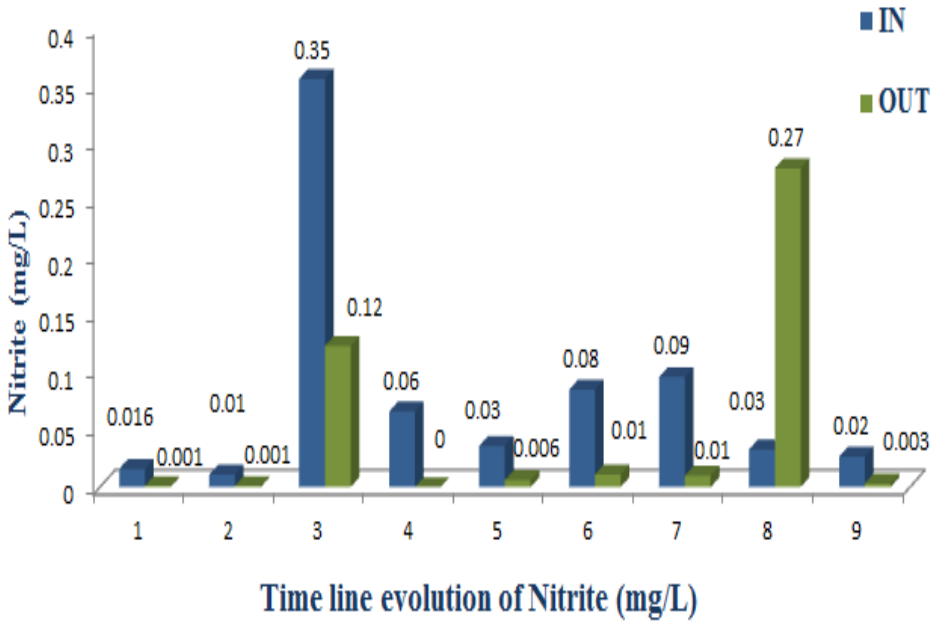


Results of chemical analyses of the constructed wetland influents and effluents

- [NO_3^-] < **90 mg/L**
- Removal Rate
  - NO_3^-: **97.39 %**
  - NO_2^-: **40.27%**

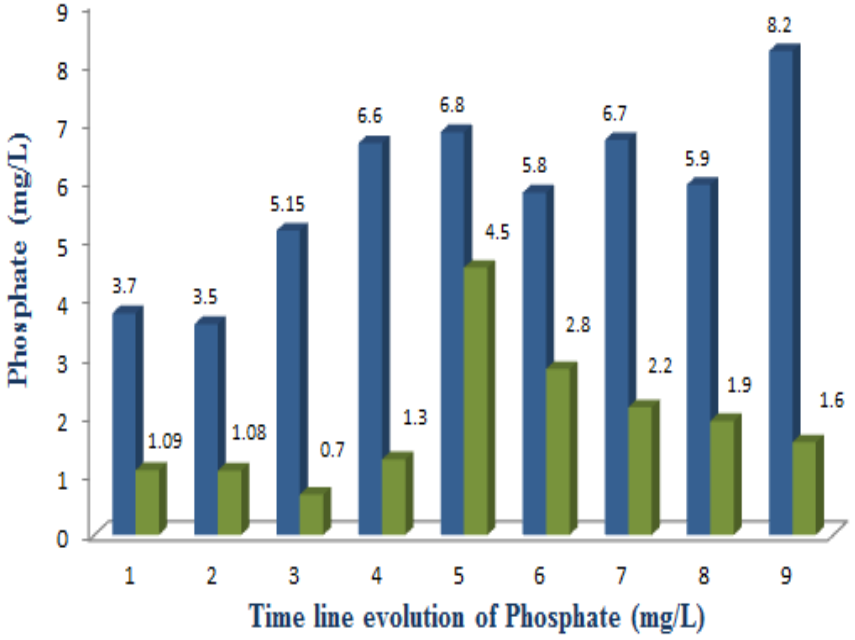
- Growth of the late-in-season potato & The wake of COVID19 pandemic

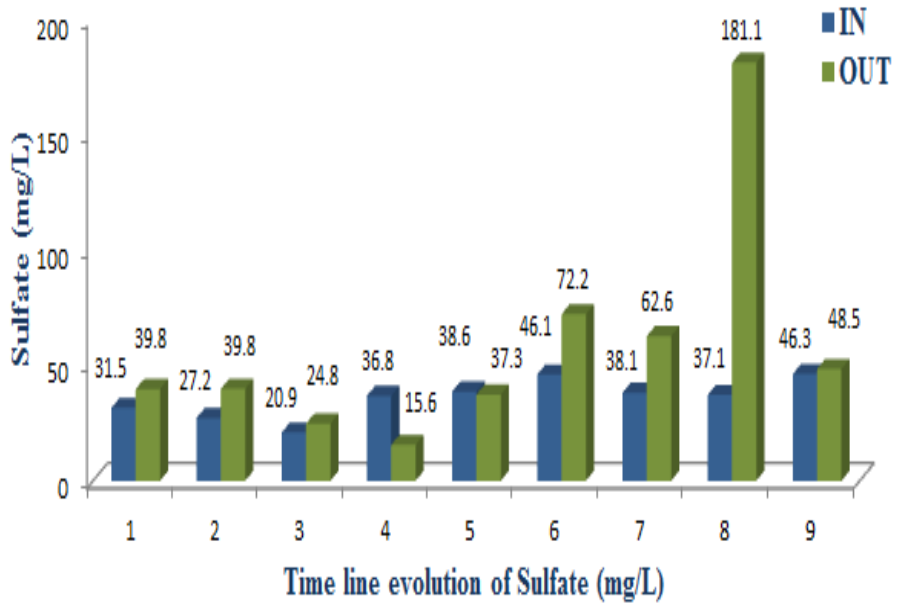




- $[PO_4^{3-}]$ < **5 mg/L**
- Removal Rate of **66.9%**

- $[SO_4^{2-}]$ < **1000 mg/L**
- Removal Rate **-61.67 %**
- Sulfide can be oxidized to SO_4^{2-} during denitrification by nitrate-reducing and S-oxidizing bacteria

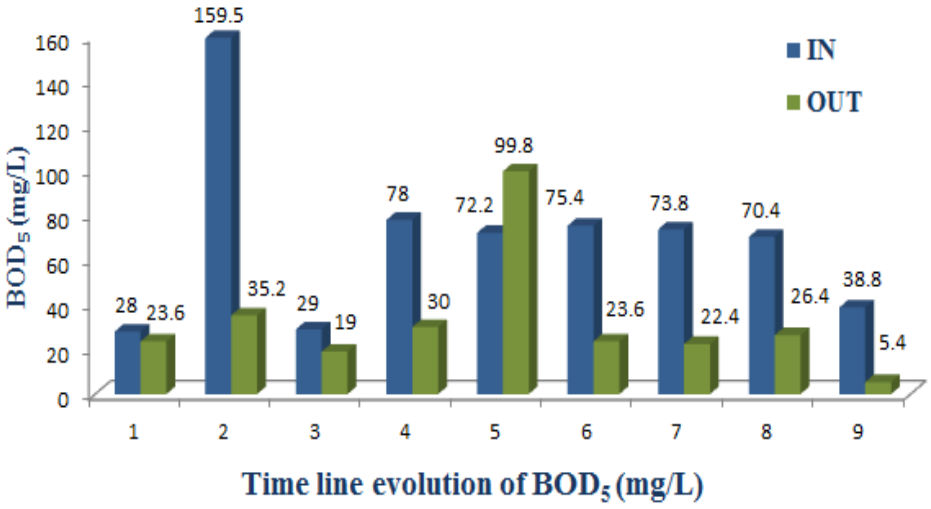


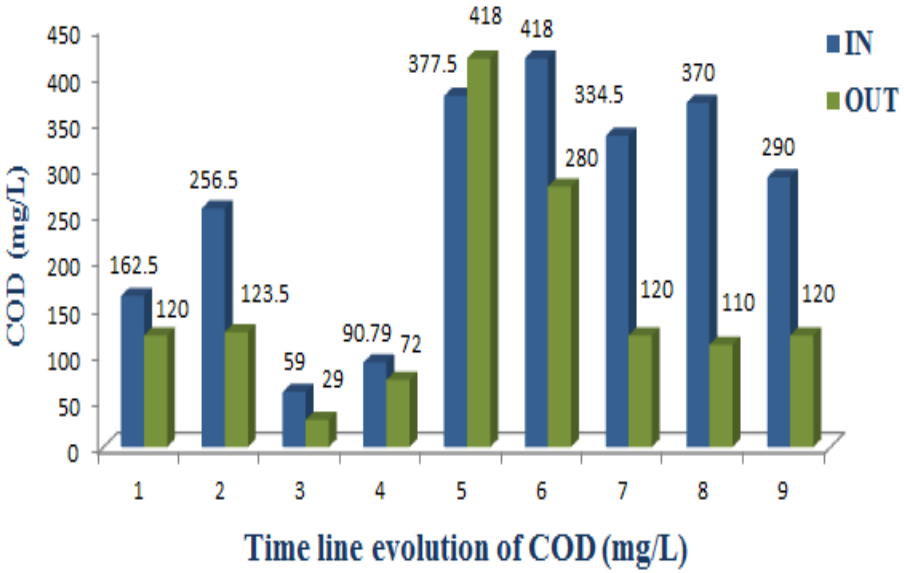


Results of biological analyses of the constructed wetland influents and effluents

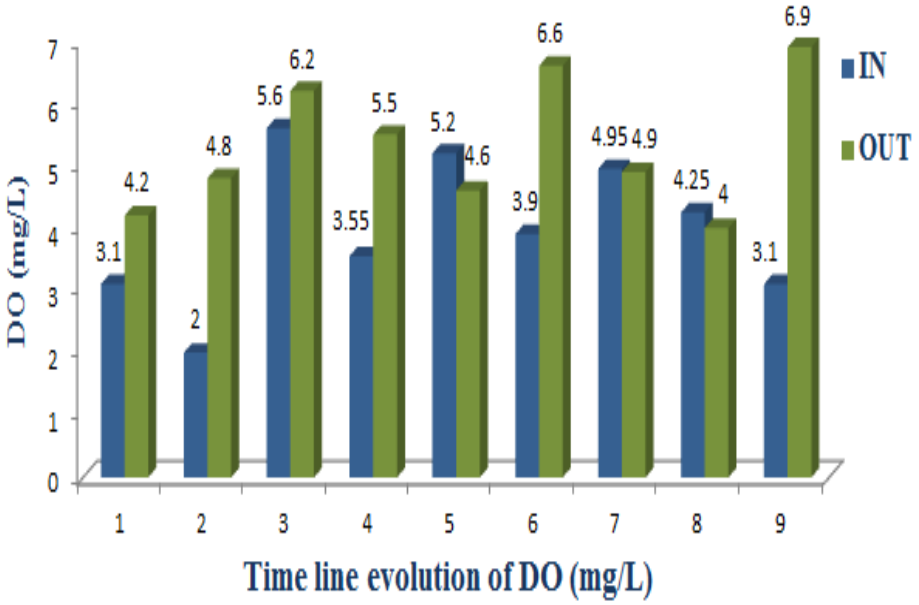
- BOD5 is the amount of O required by bacteria to degrade the organic matter components in water
- [BOD5] < **25mg/L**
- Removal Rate of **54.3 %**

- COD is the amount of O required to chemically oxidize organic compounds
- [COD] < **125mg/L**
- Removal Rate of **42 %**

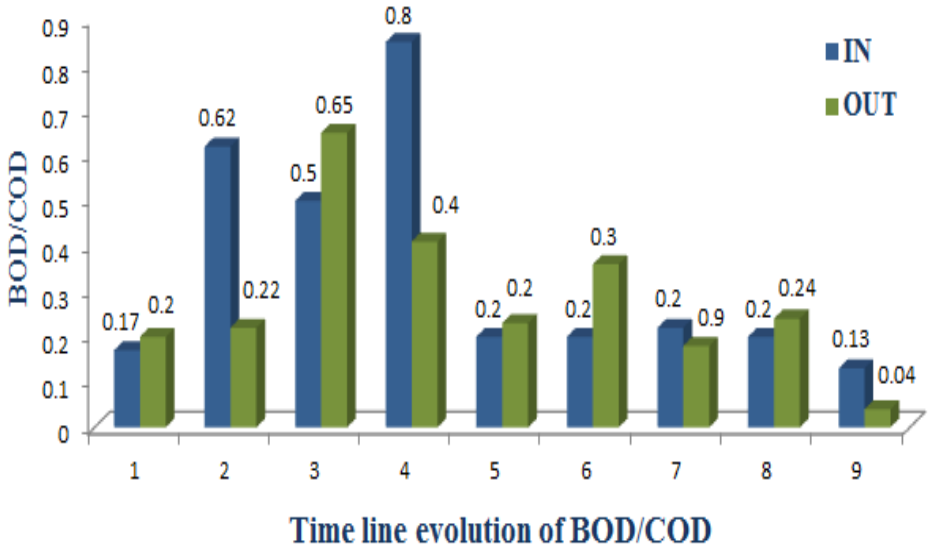




- DO Less than **2 mg/l** poor, greater than **9 mg/L** excellent

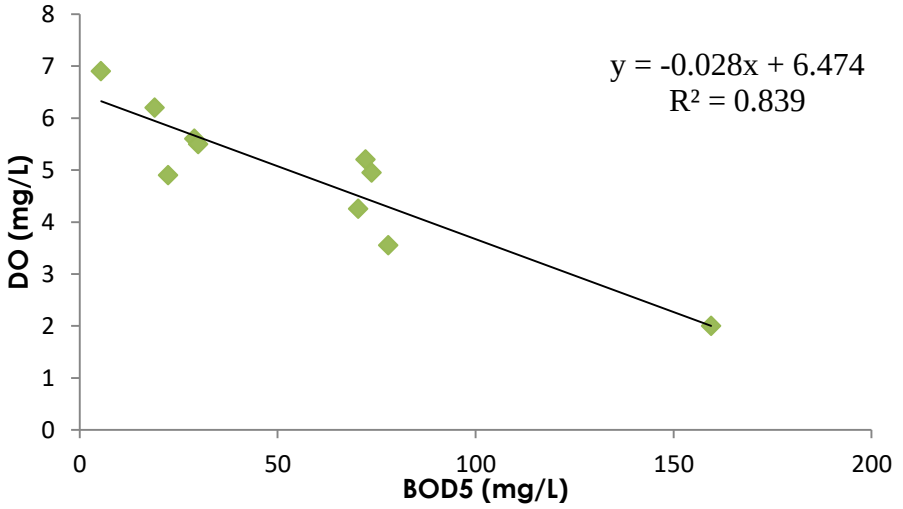


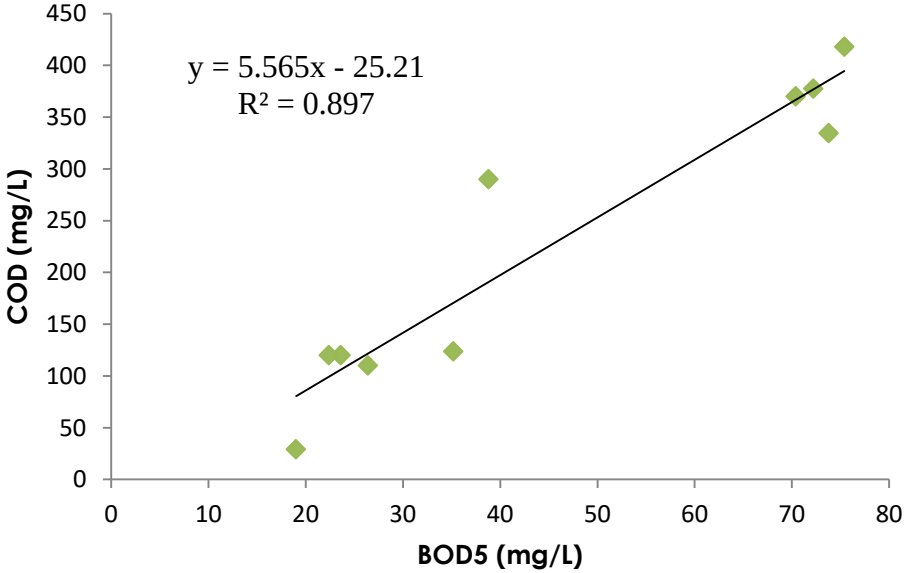
- BOD/COD ratio can be categorized into toxic, biodegradable and acceptable or stable zones

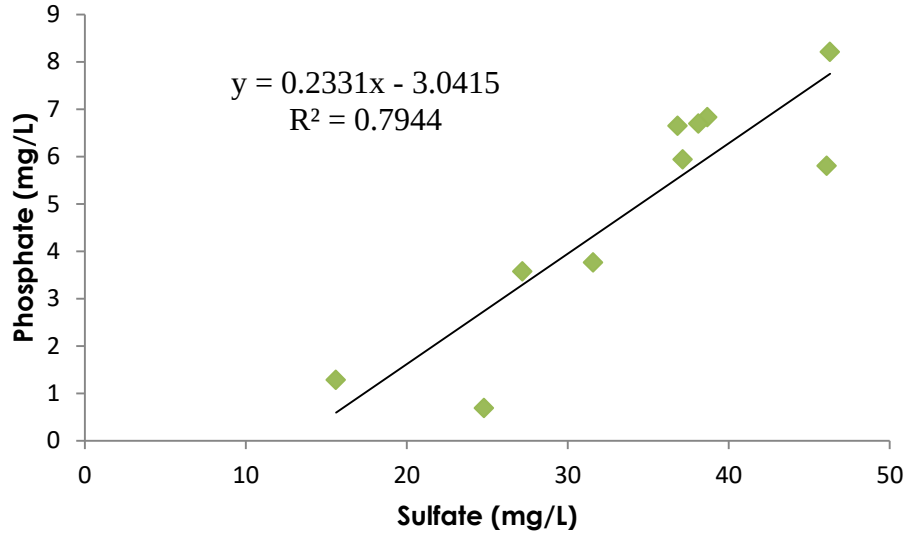


Results of chemical analyses of the constructed wetland influents and effluents

- **COD *versus* BOD:** significant positive correlation
- **DO *versus* BOD5 :** significant negatif correlatipon
- **Sulfate *versus* Phosphate:** significant positive correlation







- Obtained results clearly demonstrate that the constructed wetland along the Litani River has a **high removal capacity of nutrients**, especially for **nitrate.**

- Implementation of an artificial aerated system :
  ⟶ increase **[DO]** ⟶ increase **BOD** and **COD** removal efficiency

- Further comprehensive studies to better illustrate the role **of aquatic plants** in the remediation process are needed.

Proposition Future

Un module mathématique:

pour évaluer la pollution: DBO et DCO

en tenant compte de la variation: température et du niveau d'eau

du fleuve Litani

Merci de votre écoute, et à la prochaine réunion le mois de mai 2021 en Algérie, inshallah!!!