Impact of El Abid River Basin Loads on Water Quality of the Bin El Ouidane Lake-Reservoir , Morocco

Cherifi O. and ***Loudiki M.***

Laboratoire d'Algologie, Département iolode Bgie, Faculté des Sciences Semlalia
P.O. Box 2390, 40000 Marrakech.
E-mail : ocherifi@yahoo.com or cherifi@ucam.ac.ma

Abstract: This study had two aims. Firstly, it aimed to analyze the transport of suspended matter (S.M.) and nutrients (nitrogen, phosphorus and silica) by flood water in the El Abid river basin and to establish the S.M. and nutrient loads discharged into the Bin El Ouidane lake. It then tried to assess the influence of flood transport on phytoplankton evolution and on physico-chemical parameters at the entrance of the Bin El Ouidane lake during three contrasting hydrological years ; 1995, 1996 and 1997 : 1995 had below average precipitation in 1995, 1996 was a very wet period while 1997 was a semi-humid period.

Flood periods affected the level of nutrients at the lake entrance through influencing sediment run-off rates and dilution levels, and consequently S.M. and nutrients.

Suspended and dissolved loads in the river influenced phytoplankton development. There was a greater density of algae in 1996 than in 1997. The absence of phytoplankton in 1995 was due to the dryness of this period.

Keywords : river basin, flood transport, nutrients, phytoplankton

1 Introduction

It is generally held that chemical parameter concentrations and river discharges are linked (Manczak and Florczyk, 1971 ; Meybeck, 1971 ; Haubert, 1975). Therefore, the lake entrance is more exposed to inputs of dissolved and suspended matters than sites downstream. Biotic parameters evolution is consequently compromised.

The aim of this study is to assess the influence of flood transport within the El Abid river basin on physico-chemical parameters and phytoplankton at the Bin El Ouidane lake entrance.

2 Description of the El abid river basin

The El Abid is the most important tributary in the Oum-Er-Rbia basin and drains a large proportion of the lend from the High Atlas watershed in the South to the middle Atlas watershed in the North. (Fig. 1).

The El Abid basin can be sub-divided into two sub-basins : the more important sub-basin (2,635 km^2) whose main tributary is the El Abid and the sub-basin drained by the Assif Melloul (2,030 km^2).

The snow-rainfall hydrological regime can be divided into two periods. The wet winter-spring season lasts from December to May when average monthly precipitation can reach 80 mm, with average monthly temperatures varying between 10°C and 17°C. The dry season lasts from June to October with an average monthly precipitation not exceeding 5 mm and average monthly temperatures between 17°C to 28°C.

Long term hydrological records for the El Abid (1970—1988) demonstrate the annual and seasonal variability in discharge with winter and spring periods typically representing 87% of the flow.

The Bin El Ouidane reservoir is the largest in the El Abid basin, with a capacity of $1.3\times10^9 m^3$. It is used for irrigation, electric power generation and drinking water supply.

The entrance of the lake is situated to approximately 18 km upstream of the dam.

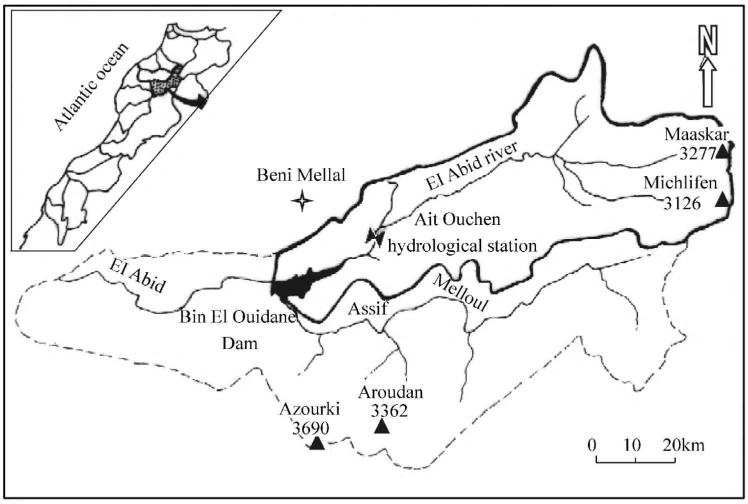

Fig.1 Location of El Abid river basin and Bin El Ouidane reservoir.

3 Material and methods

3.1 Techniques of analyses

Water samples were taken monthly and assessed using the following analytical techniques

3.1.1 Chemical parameters

Suspended matter (S.M.) was removed from water by centrifuge at 6000 r.p.m. and then dried in a desiccating oven at a temperature of 105°C. Total phosphorus (T.P.) and total dissolved phosphorus (T.D.P.) were determined after mineralization of unfiltered and filtered (GF/C) samples in the autoclave in the presence of sodium persulfate. The orthophosphates (PO_4^{3-}-P) obtained were measured according to the AFNOR method (T90-023). The total nitrogenus (T.N.) was measured after mineralization of the samples and transformation in nitrates (Rodier 1984). The nitrate (NO_3^--N) was determined according to the AFNOR method T90-010. Finally the silica (SiO_2^-) content was determined following the procedure described by Rodier (1984).

3.1.2 Phytoplankton

Phytoplankton samples were taken with a plankton net, with a mesh size of 37 µm. Cellular counts were undertaken with an inverted microscope (Nachet type) according to the Utermöl method (1958).

4 Results

4.1 Impact of flood loads on physico-chemical parameters

S.M. concentrations vary between 1.2 mg • l^{-1} and 7,750 mg • l^{-1} (Fig.2A). The high values were recorded during the flood and low water periods during the dry year 1995.

Orthophosphate concentrations vary between 0 and 52 µg • l^{-1} (Fig.2B). The total dissolved phosphorus correlated with PO_4^{3-} (r = 0.54). Generally there was a positive correlation between total phosphorus and S.M. ($r > 0.6$). Concentrations varied between 0 and 3,224 µg • l^{-1}.

Nitrate concentrations and total nitrogen varied in a similar way. High concentrations were observed during the high water period. They varied between 223 µg • l^{-1} and 4338 µg • l^{-1} (Fig. 2C).

Finally, the dissolved silica concentrations varied between 770 µg • l^{-1} and 9,816 µg • l^{-1} (Fig. 2D). The weak value for March 1997 was due to the proliferation of Diatoms and to the absence of loads of dissolved elements. The strong value for March 1996 coincided with a strong flood, with an average discharge of 193.57 $m^3 \cdot s^{-1}$.

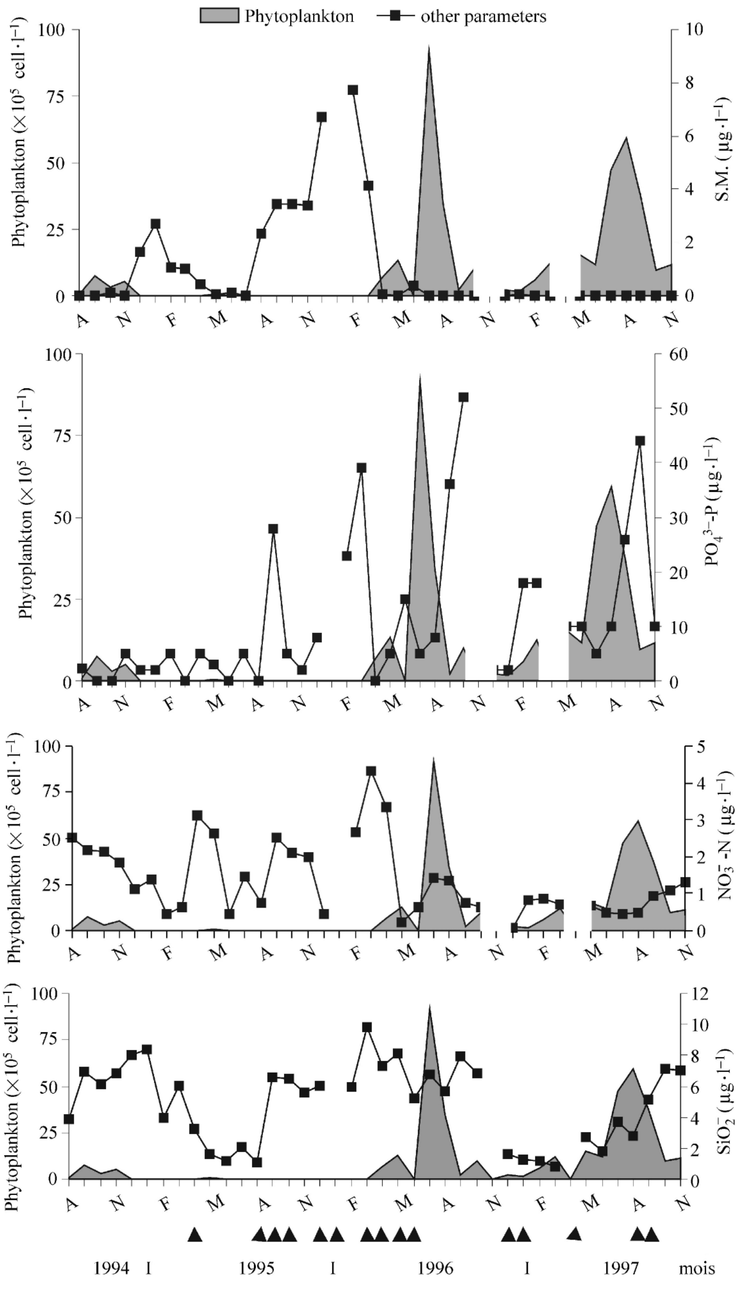

Fig.2 Phytoplankton evolution in function of S.M. (A), PO_4^{3-}-P(B), NO_3^--N(C) and of silica (D) at the lake entrance (arrows indicate the period of floods).

4.2 Impact of flood loads on phytoplankton

Seventy phytoplankton species were counted during the study period, including an important allochtone epiphyte species (41%) originating from high mountain areas, especially during flooding.

No phytoplankton species were observed during floods, following a period of drought in 1995. During these floods, sediments on the river bed were mobilized, raising concentrations of S.M.

During the rest of the study period, the variation in phytoplankton density was generally regular, with peaks particularly during summer in 1996 and 1997. The peak of phytoplankton in spring was less important. This spring peak exceeded 15.34×10^5 cell • l^{-1} in May 1997 (Fig. 2). The development of phytoplankton density was less marked in autumn and winter.

5 Discussion

Dynamic, chemical and biological lake characteristics are largely dependent on sediment loads (Meybeck, 1995). This influence is more important immediately downstream of the watershed.

5.1 Influence on abiotic parameters

In order to see the impact of flood loads on the lake's physico-chemistry , correlations were calculated between the discharge at Aït Ouchen hydrological station and some physico-chemical parameters of the lake entrance. Because of the particularity of the study period (exceptional dryness in 1995, important rains during the wet period 1996 and moderately important rains in 1997), The coefficient of the correlations had been calculated each year in order not to hide the importance of these hydrological conditions.

According to table 1, we noted that S.M. and T.P. did not correlate with discharge in 1995, but it did in 1996 and 1997 because of the low waters at the lake entrance in 1995 when the high concentrations of S.M. have been measured without having any flood flows. Indeed, according to Massio (1976), sediment may be mobilized by very weak discharges especially after long periods of dryness. During this period, sediments deposits lack cohesion and can be moved easily. However, during the rainy years (1996 and 1997), concentrations of these parameters at the lake entrance were influenced by El Abid river loads during floods. For T.N., nitrates and silica, correlations were more important in 1996 than in 1997. So, the floods of 1997 had a more diluting effect. The floods of 1996 had the effect of increasing run-off of dissolved elements.

Table 1 Correlations (r) between some physico-chemical concentrations at the lake entrance with the discharge (Q) at the Aït Ouchen hydrological station

	r in 1995	r in 1996	r in 1997
S.M./Q	0.16	0.75	0.89
T.P.Q	0.1	0.68	0.92
T.N./Q	0.46	0.6	0.05
NO_3^- -N/Q	0.5	0.84	0.49
SiO_2^-/Q	0.02	0.59	–0.45

5.2 Influence on phytoplankton

The physico-chemical aspect of flood transport had a direct effect on phytoplankton development. When mechanical erosion was more important than chemical erosion, the contribution of flood transport had a negative effect on the phytoplankton development. Fig. 2 shows the effect of S.M. and nutrients on the phytoplankton development at the lake entrance. The high concentrations of S.M. at the beginning of spring and in June 1996 had inhibited phytoplankton proliferation. After decantation of S.M. during the last period, the phytoplankton development started, using nutrients brought during floods. However, the peak of phytoplankton density was more important during the summer in 1996 due to the importance of nutrient loads during this humid year (Fig. 2B, C et D).

6 Conclusion

The study undertaken at the lake entry showed that physico-chemical parameters depended on the El Abid river basin loads and also on the climatic conditions. High nutrient concentrations were recorded during 1996, and high S.M. concentrations were recorded during 1995. The correlation coefficients calculated between some nutrients of the lake entry and the discharge at the Aït Ouchen hydrological station generally showed a positive correlations in 1996 as compared to 1997. This means that washing was more important in 1996 while dilution took place in 1997. The load contributions infected on phytoplankton development through changes of physico-chemical components. The density of algaes was more important in 1996 as compared to 1997. The absence of phytoplankton in 1995 on the lake entry was due the exceptional dryness of this period (El Abid river bed was almost dry) and also to the high S.M. concentrations recorded during summer-autumn flood flows.

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