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Study of physico-chemical characteristics of Iron and Manganese in Smir Lake Dam (Morocco)

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Abstract
The study of Iron and Manganese, key factors responsible for the deterioration of the water quality in an aquatic environment has been undertaken to assess the potential mobility of these elements on the surface and at the bottom of Lake Dam Smir. Levels of Iron and Manganese recorded during campaigns during 2007 -2008 analyzes are generally variables, on the one hand according to the season (time) and the other in space (vertical variation). The mean levels in the dam area are relatively low and do not exceed the limit values of 0.2 and 0.05 mg /L for Iron and Manganese (quality standards for surface waters Moroccan). Moreover, the highest values were found at the bottom sometimes exceeding standards and at the same time raising the difficulties of treatment and drinking water. The analyses of Iron and Manganese in Smir dam in addition to the temporal evolution taking into account the factors that determine their presence shows a double origin is linked to their release from the sediment deoxygenated or due to the transfer by runoff of these two metals in the watershed of the Smir River to the dam.

Keywords: Iron - Manganese - Smir Dam - spatio-temporal evolution - Morocco.

1. Introduction
The rapid increase in water demand due to demographic changes and needs of economic and social development of the entire region of Tétouan, led with increasing water mobilization both ground and surface. Closely related, these resources are generally multi-use (drinking water, agriculture, industry, etc...). Their preservation is a key issue because human activities and natural life are dependent.
To meet the recurrent droughts and increased water demand, several dams were constructed and in this area primarily Smir dam. But this source water collides with pollution caused by undesirable substances, including iron and Manganese, if their levels exceed standard [1-6].
This work is to determine the origin of Iron and Manganese in Lake Smir dam, behavior and the factors that control the presence of Iron and Manganese and finally their seasonal fluctuations in the water column.
To address this issue we have shown through this study analyses the situation of these element in the tank by experimental study and discussion of the temporal evolution of Iron and Manganese in Lake Smir dam.

2- Materials and methods
2.1. Description of the study site
Smir Dam, impoundment in 1991, is located about 30 km from the city of Tetouan (Figure 1). Its construction has been designed to meet the drinking water needs of the city Tetouan and around particularly summering centers (Martil, M'diq, Fnideq, Capo Negro, etc..). A normal rating the reservoir volume is 43 million m^3 and

area is 4.7 km^2 (Table I). The dam is located in a watershed that little vegetation favors thrusting huge amounts of suspended solids and nutrients [7].

Plain Smir is located immediately north of M'diq. It is bounded to the west by Paleozoic ridges and link Haouz, on the north by the Zem Zem jbel and south by Koudiat Taifor. It has an area of 12 km^2 [8] and its slope is usually less than 1.5% [9].

As characterized by rocky terraces of the Quaternary, this plain is traversed by the river Smir and ends with an open water merja said Smir which plays an important ecological role in the méditerranean context. [10-12].

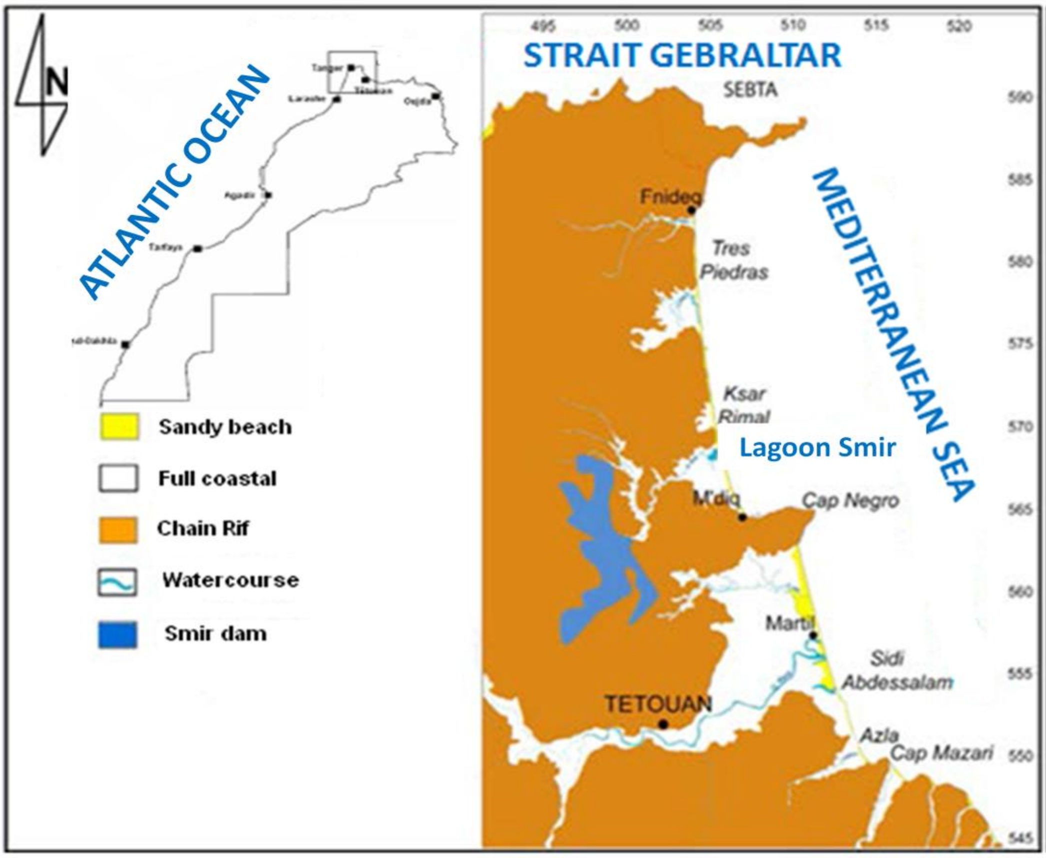

Figure 1: Geographical location of lake Smir dam

Table I: Morphometric and hydrological characteristics of the dam lake Smir (Source: State Secretariat for Water and Environment, Research and Planning Directorate of Water Rabat).

Features & books	Situation in figure
Date of impoundment	1991
Normal rating restraint	43.50NGM
Overall capacity of the reservoir	43 Mm^3
Average annual contributions	31Mm^3
Surface of the retaining	4.7 Km^2
Average depth of the reservoir	15m
function	drinking water
Watercourse	Smir
The nearest town	Tétouan
Item Type	land zoned
Height (m)	45m
Crest length (m)	600m
Crest width (m)	8m
Area of the reservoir	475 Ha

2-2-Hydrological regime of the study area recorded during 2007/2008

The evolution of average contributions hydrological waters recorded in the years 2007 and 2008 Smir Dam shows seasonal and interannual fluctuations irregular (Fig. 2). The minimum intake was recorded during 2007 and during 2008 the maximum especially was obtained during the wet season.

Indeed, the 2007 water year was characterized by drought as reflected water intake, however in 2008 is dominated by moisture. Thus, the minimum is reached at the end of the fall season and a very rapid rise more or less progressive during the transition to winter flooding. This irregularity allows the lake to receive the majority of its annual contributions in a few months or weeks and a long stability of the body of water, a factor favoring the phenomenon of thermal stratification [13].

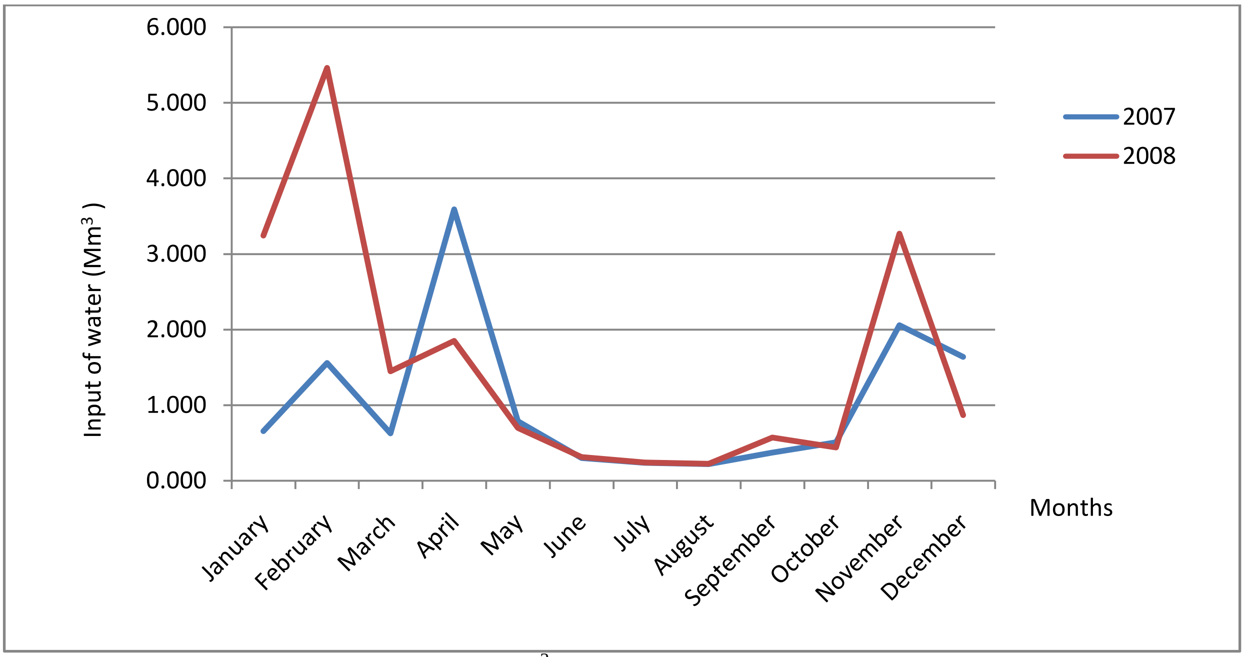

Figure 2: Hydrological contributions waters Mm^3 recorded during 2007 and 2008 Years in Dam Smir

2-3. analytical protocol

For the analysis of trace metals Iron and Manganese, raw water samples are taken at the surface and bottom of the reservoir dam lake during the two years hydrological 2007 and 2008 at the National Water Intake Office of Drinking Water (the deepest lake in point). The analyses were performed in the National Office Drinking Water. Sampling of water were collected in polyethylene bottles specially washed with hydrochloric acid (10%) and then rinsed with distilled water. They are then fixed by nitric acid at 2% and transported at low temperature (+4°C) to the national office of drinking water laboratory where the analyses were performed. The determination of Manganèse was detected by Spectrophotometry of Atomic Absorption (SAA) with graphite (Varian AA240Z GTA 120) and Iron by SAA with furnace (VARIAN AA 20).

3- Results and Discussion

3.1. Interannual variations in the Iron Smir dam recorded in 2007 and 2008

Changes in levels of iron in the surface waters and bottom of the reservoir shows Smir remarkable seasonal variations nearly parallel except for some points during the two years 2007 and 2008. Non periodicity of changing levels of iron in the waters of the reservoir is due to succession of two different extremes characterized by drought and moisture in 2007 and 2008.

The peaks stored 0.47 and 0.18 mg/L during the time of evolution of 25-01-2007 iron levels in the bottom waters and surface respectively could be explained by erosion which is caused by the strong very irregular precipitation caused by drought bare soil used for growing crops.

3.2. Interannual variations of Manganese in Smir dam recorded in 2007 and 2008

Changes in levels of manganese in surface waters and bottom of the reservoir Smir shows seasonally irregular.

Manganese concentrations in the bottom waters are higher equal to that recorded on the surface. On the other hand, they are also generally higher to the value determined by the curve which corresponds to the requirement that water must satisfy surface used for the production of drinking water (standard quality Moroccan). Not periodicity of changing levels of manganese in surface waters and bottom is due to the succession of two different extremes characterized by drought and humidity respectively recorded in 2007 and 2008.

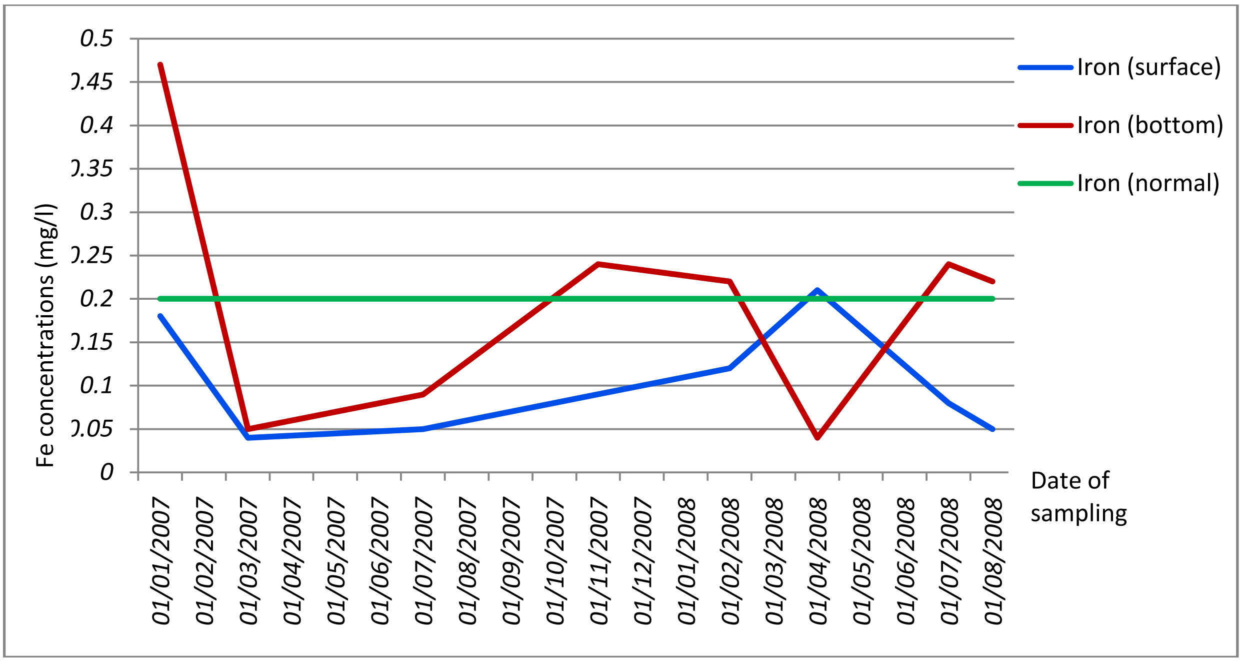

Figure 3: Comparison of interannual changes in levels of iron in the Smir dam water surface and bottom during 2007 and 2008.

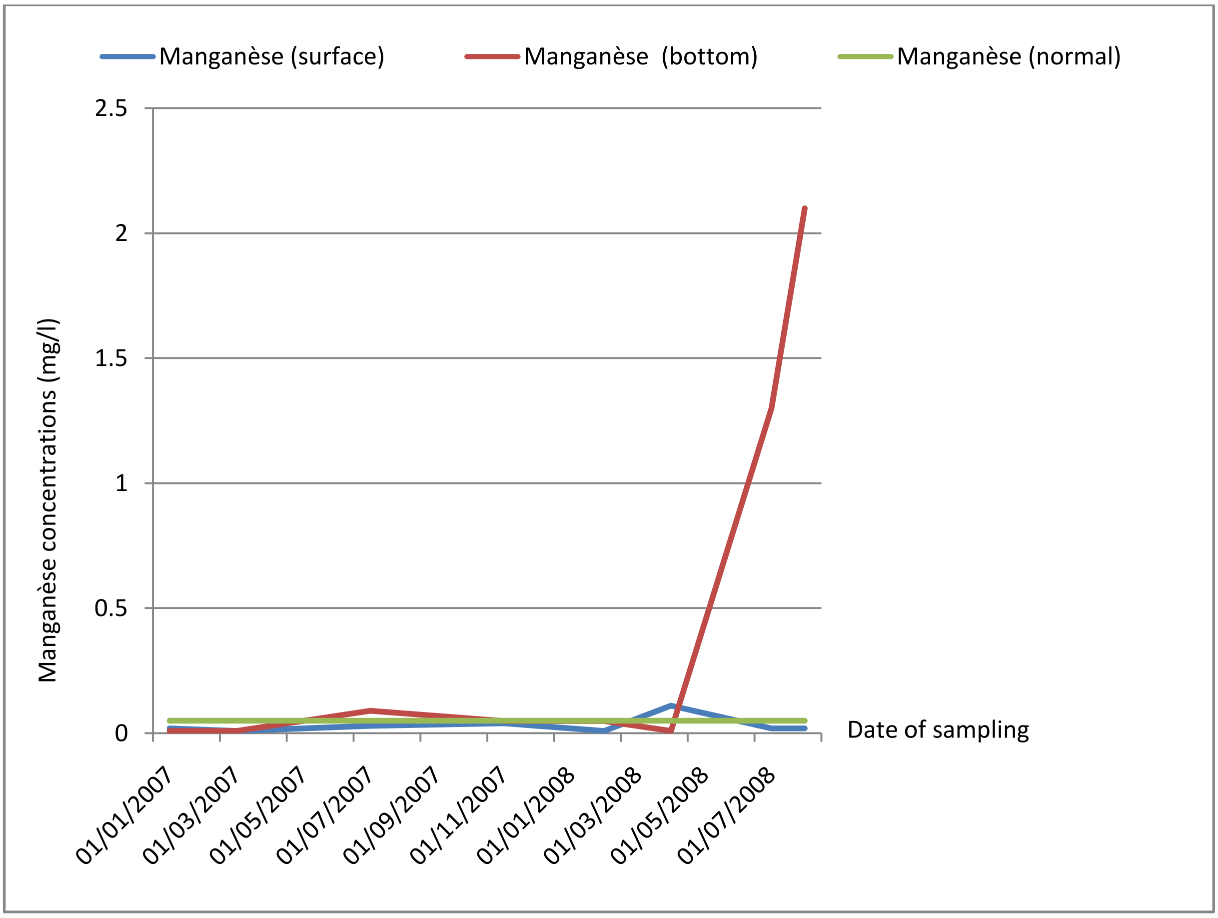

Figure 4: Interannual comparison of changes in levels of Manganese in Smir dam water surface and bottom during 2007 and 2008.

3-3. Behavior of Fe and Mn in the dam Smir

The change in temperature between the surface water with those of the background for each hydrological year highlights the formation of three layers of water behavior very different.

- The upper layer is aerated or epilimnion, lighter received and heated during the summer. It is the seat of an intense life. Green algae proliferate, consume dissolved CO_2 and release oxygen O_2;
- The transition layer or metalimnion whose dissolved oxygen content decreases from the top and bottom of this zone. Living species aerobic therefore gradually disappear to other less demanding or strictly anaerobic;
- The deep layer or hypolimnion which is totally devoid of oxygen, this area is the seat of anaerobic fermentation. Some bacteria free hydrogen sulfide and others, such as methane from the decomposition of plants that accumulate at the bottom.

Under this vertical cutting, organic matter decomposition of endogenous origin or exogenous at the hypolimnion environment requires dissolved oxygen consumption and subsequently makes the background devoid of oxygen. Moreover anaerobic fermentation promotes the release of unwanted items at the bottom, including iron, manganese and hydrogen sulphide [14].

As against, the iron and manganese can easily oxidize in the layer epilimnion is more oxygenated and under the effect of atomic mass, they converge to the background to rush.

In autumn, as and when the contents of Iron and Manganese are declining due firstly to oxidation by oxygen and other homogenisation system through winds and the mixing of the dam. When the temperature of the water surface down, the waters of the epilimnion down while on the contrary, the deep layers back to the surface.

In winter, the contents in question become important due to runoff from catchment to the dam. The events noted at the beginning and end of spring are similar to those recorded in the late winter and early summer in uccession.

These seasonal processes explain the flow caused by the temporal and spatial variation in the dam [15].

3.4. Typology of Iron and Manganese change in Smir dam the use of the PCA.

In order to synthesize the results and identify different trends, correlations and other phenomena Occurring in the packaging and the presence of iron and manganese in Smir dam and so generate a typological structure of the water quality of lake dam Smir, we used the Principal Component Analysis (PCA) on the data set collected at the dam falling on the study period 2007-2008 [16].

3.4.1 Types of variables: Correlations of variables with axes [F1] and [F2]

Correlations Iron surface, iron at the bottom, Manganese surface and Manganese background on the axes [F1] and [F2] are used to represent these variables on correlation cycle variables (Table II and Fig. 5).

Table II: Correlations of variables with axes [F1] and [F2].

Variables	Code	Axe F1	Axe F2
Fer On	Feo	0.393	0.889
Fer bottom	Feb	-0.713	0.612
Manganèse on	Mno	0.825	0.441
Manganèse bottom	Mnb	-0.743	0.372

The projection plane F1xF2 (Figure 5) shows that the levels of iron and manganese in surface and bottom are well represented on the circle of correlation, in fact:

- The factorial axis [F1] is more or less correlated with manganese at the bottom and surface and secondarily with Iron at the bottom;
- The factorial axis [F2] is well correlated with the iron surface. A moderate correlation with iron background.

These two axis define two different gradients:

- Gradient enrichment of manganese at the bottom and the surface along the axis[F1] ;
- The second gradient reflecting the enrichment of iron in Lake Surface along the axis [F2].

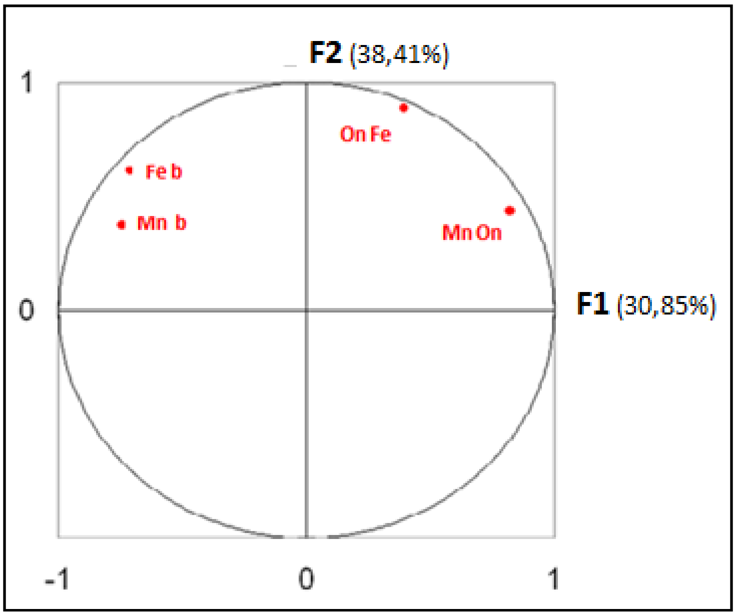

Figure 5: Circle of correlation variables**.**

3.4.2 Type of records

For each type of variables, is a type of survey that identifies more clearly the trends likely to dominate the annual and interannual situation in 2007 and 2008. The analysis of the factorial map (Figures 6, 7 and 8) reveals the following structures:

- ❖ A different trend between the two years 2007-2008 (figure 6);
- ❖ And individualization of four groups of seasonal samples for 2007 and three groups of seasonal levies for the year 2008 according to their degree of enrichment Iron and Manganese in surface and depth (Fig. 7 and 8)

Indeed, in 2007 shows overload Iron surface and bottom during winter season and low levels of manganese at the bottom.

Against by 2008 seem more enriching Manganese bottom and low levels of Iron surface. This is orrelated with a number of environmental factor particularly hydrology and water intake important during the year 2008 compared to 2007.

Moreover, the spatio-temporal analysis of the hydrology with seasonal variations important but different depending on the year.

Analysis of Figure 7 shows a succession of seasons based contents Iron and Manganese. Quality is a rich winter Iron surface and bottom to a spring poor Iron surface. Autumn and summer show intermediate situations.

This condition may be correlated with the wet season to the original intake waters allow good oxygenation of the water column and thus to maintain the Iron the bottom of the dam [17].

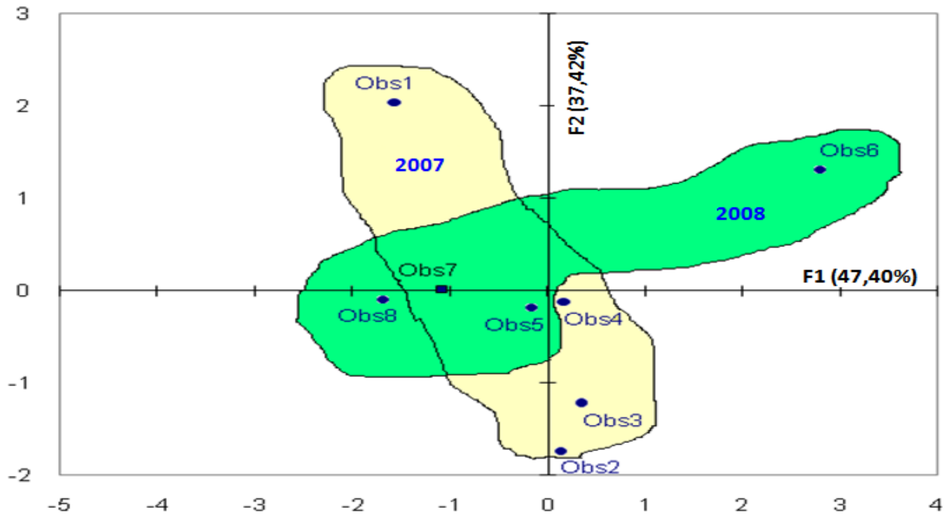

Figure 6: Distribution of records of Iron and Manganese contents in the plane F1xF2 during 2007 and 2008.

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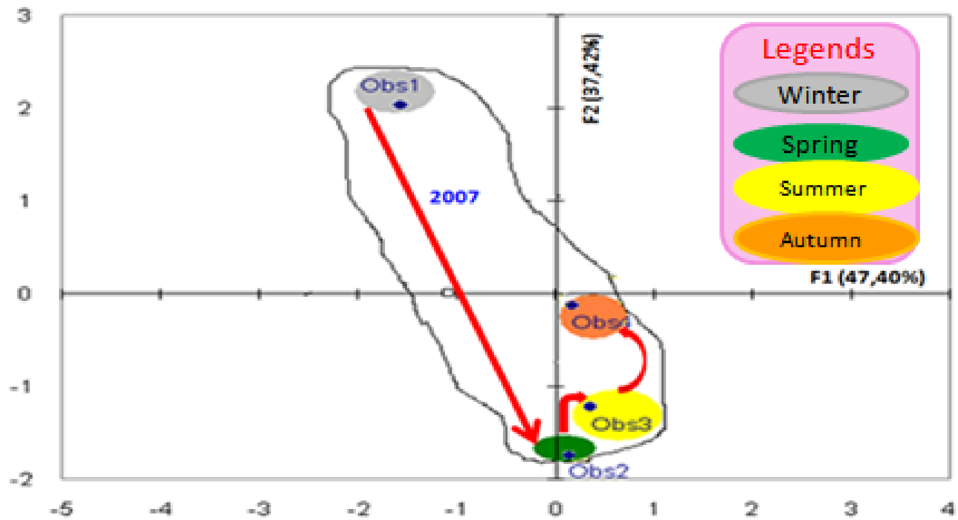

Figure 7: Seasonal distribution of surveys contents Iron and Manganese in F1xF2 Plan for 2007.

The analysis of the situation in 2008 (Figure 8) shows a succession of different seasons of that obtained for 2007, which is characterized stability and average quality during the winter and in the summer against we identified a manganese surface overload. These results could be due to two phenomena or to a reduction of oxygen in the water column during this period either for the homogenization of the dam by the auction effect of turbulence by the violent winds [18].

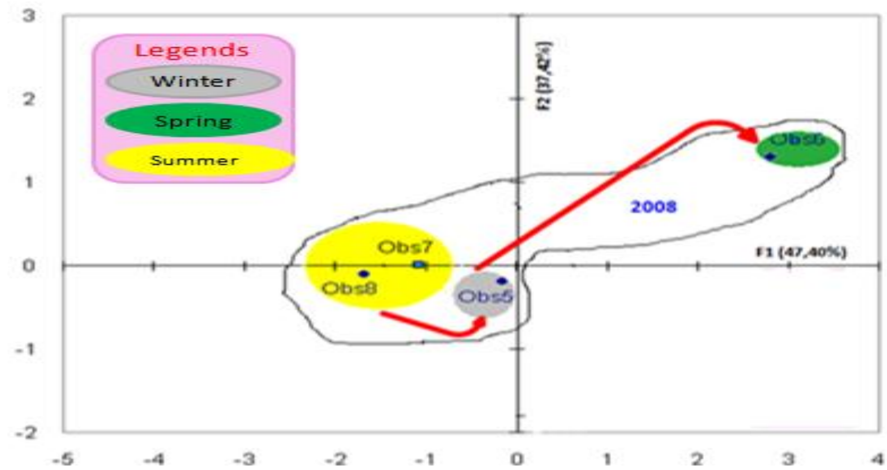

Figure 8: Seasonal distribution of statements Iron and manganese contents in the plane F1xF2 during 2008.

Conclusion

1. This work led to the dam lake Smir was designed to study the behavior of iron and Manganese in surface and depth during the years 2007 and 2008. All data showed that iron surface shows little significant seasonal variations and are outstanding at the bottom of which the most significant values are identified in the spring.
2. By cons, Manganese in surface waters of the retention shows variations seasonally important and they are irregular at the bottom.
3. In 2008, Iron in surface waters shows little seasonal variation moderately important and are remarkable at the bottom whose values most appreciable are identified during the late winter and early spring and during the season the fall.
4. Moreover, the contents of Manganese in surface waters of these show restraint seasonal variations unimportant except for a few points where it has identified. Unlike values for surface waters, deep waters show significant values Manganese sometimes exceeding the standard of water quality surface.
5. However, the synthesis of all observations and data by the use of PCA allowed us to reach a different hydrological functioning by years observation.
6. Indeed, 2007 is less humid than 2008 was characterized by conditions significant seasonal and behavior of Iron and Manganese dependent on this evolution.
7. By cons, 2008 wettest shows some stability and an average load Iron and Manganese for all seasons. This fact raises the role of hydrological condition, water intakes and conditions climate in the behavior of abiotic factors and chemicals in lakesin general and in particular Smir.

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