PHYSICOCHEMICAL CHARACTERISTICS OF MARINE SEDIMENTS AND DAMS SEDIMENTS: A COMPARATIVE STUDY

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ABSTRACT

The dredging practices are a major challenge for the development and maintenance of port and dams activities. Dredging dams have become essential to prolong the life of the structure and recover the amount of water lost by the filling of the tank in the bottom of the reservoir. Marine sediments are often contaminated by human and urban activity. For hydraulic reasons (draft) and nuisance reasons, port dredging or dissection become necessary. Millions of cubic meters of dam sediments and marine sediments are regularly extracted from Algerian ports and dams, it is necessary to characterize them before their valorization.

This study focuses on the physicochemical characterization of marine sediments from the Bethioua port, from Oran port and from Algiers port. Physicochemical characterizations have been determened of dam sediments from Fergoug dam, from Bouhnifia dam and from Gargar dam. This study was also determened the comparison between the physicochemical of marine sediments and dam sediments.

The physical characterization revealed that marine sediments are spread particle size materials and their main constituents are sand and silt, their chemical characterization has shown high salinity content and the presence of pollution by hydrocarbons and heavy metals. The physicochemical characterization of dam sediments has shown a presence of silts and clays and the absence of pollution by heavy metals and hydrocarbons.

Keywords: marine sediments, dam sediments, dredging, characterization.

INTRODUCTION

The dredging of dams has become indispensable for prolonging the life of the dam and recovers the amount of water lost by the filling of the sediment in the bottom of the reservoir. Siltation in Algeria is characterized by an accelerating pace. The harmful effects of this phenomenon are many from the considerable reduction of the storage capacity of the dam, the degradation of water quality and plugging outlet gates and irrigation canals. [1] In some countries, the dredging operation is especially necessary when the dam is threatened by the strong pushed sediments. The accumulation of sediment in streams or lakes can reduce the depth of the water, making navigation difficult or even impossible. It may need to be dredged sediment part to ensure access to a river or harbor, which can release contaminants into the environment. Therefore, the removal of sediments is a major problem for managers of ports and waterways. [2]

EXPERIMENTAL

The studied sediments were collected from Bethioua port which is today dedicated exclusively to oil activities. The studied sediments were collected using a mechanical dredge which is basically an excavator mounted on a pontoon in the port of "Bethioua" .The dredged material was stored in clean waterproof bags and transferred the same day of dredging to the different laboratories. The study includes a set of physical properties (state parameters and nature, water content, granular distribution), chemical properties (pH, organic matter and hydrocarbons). [3]

Indeed the results helped to identify a combination of two other different results from two Algerian ports obtained by other work and make a comparison between these results and the work results of the three dams sediments. This work allow to join the work results of (Kazi et al. 2012) to the Oran port, the work of (Atroune. 2015) to the Algiers port and the work of (Benyerou et al. 2014)

to the Bethioua Port with the work results of (Semcha. 2006) to the Fergoug dam, the work of (Remini. 2006) to the Bouhnifia dam and the work of (Meskine. 2012) the Gargar dam.

The Oran port is considered as the largest port on the west coastline of Algeria, but the silting of its docks represents a real obstacle to the development of economic activity. The bottom of cleaning becomes a necessary maintenance operation to navigation and restoration of port facilities. This raises the question of the fate of dredged sediments which should provide solutions respectful of the environment [4].

The port of Algiers is located in the west part that comes in form of a crescent 10 miles from corded and 4000 boom, largely open to the north. (Figure 1) [5].

Fig.1 : Sampling Site of marine sediments

The Fergoug dam located 20 km upstream of the road Perregaux of Mascara, is built upon installation of the first settlers in this region. [6]

The Bouhnifia dam located 400 km north west of Algiers. It was put into operation in 1945 and is intended for the irrigation of surrounding agricultural land and to feed the reservoir of Fergoug dam by periodic released. [7]

The Gargar dam is located in the wilaya of Relizane 5 km southwest of the town of Oued Rhiou and 3 km upstream from the national road N° 04. The Gargar dam in order to store a volume of 450 Hm^3 annually and regulating a volume of 120 Hm^3. It was intended primarily to supply water for irrigation of 16000 Ha bottom tray Chéliff Oued Rhiou with 40 Hm^3 / year and incidental to the water supply of the different local communities (Figure 2) [8].

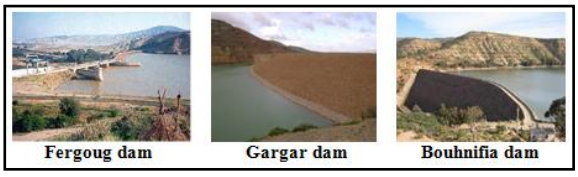

Fig.2 : Sampling Site of dam sediments

Results and discussion

2.1 Physical Properties

The water content was determined according to standard NF P94-050 and the density was determined according to the NF P94-054 standard. The activity of the clay fraction measured by the methylene blue value was determined according to the standard (NF P 94-068). The results in Table 1 shows the physical properties of Bethioua port sediments, of Oran port sediments and of algiers port sediments. The results in Table 2 show the physical properties of Fergoug dam sediments, of Bouhnifia dam sediments and of Gargar dam sediments. Particle size analysis was conducted by laser granulometry. Particle size study of marine sediments show that the overall size of the Algerian ports dredged sediment has high sand fraction, average silt fraction and low clay fraction. However Granulometric study of dam sediment has a different size relative to marine sediments and shows that the overall size of dredged Algerian dam sediments has great presence of silt and clay fraction and low sand fraction.

Table 1: physicochemical parameters of marine sediments.

Marine sediment parameters	Bethioua port	Oran port
density (g/cm^3)	2.2	2.5
water content at 105°C (%)	58	59.9
Clay (%)	2	1
Limon (%)	20	41
Sand (%)	78	58
VBS (%)	1.56	0.6
O M (%)	1.88	3.1
pH	8.7	9.1

Table 2: physico-chemical parameters of dam sediments.

Dam sediment parameters	Fergoug dam	Bouhnifia dam	Gargar dam
density (g/cm^3)	2.65	2.58	2.68
water content at 105°C (%)	46.40	45	
Clay (%)	2	10	60
Limon (%)	62	68	15
Sand (%)	36	22	25
VBS (%)	-	-	2.9

2.2 Chemical Properties

To have a more precise idea about the chemical composition of the materials studied, we were proceeded by X-ray fluorescence for the oxides. The results are grouped in (Table 3and 4). This detailed analysis of the results is based on the comparison of different levels for oxides and expressed in mass percentage. Table 3 shows the chemical properties of Bethioua port sediments, of Oran port sediments and of Algiers port sediments. Table 4 shows the

chemical properties of Fergoug dam sediment, of Bouhnifia dam and of Gargar dam sediments. These results show that the presence of alumina (Al_2O_3) and silica (SiO_2) in marine sediments is low compared to their presence in the dam sediments. Lime (CaO) content in marine sediments is higher than their presence in dam sediment. Additional chemical characteristics were also determined such that the organic matter (OM), pH and fire loss for marine sediments. Note that the LOI present in marine sediments is higher than for dam sediment because of the large presence of organic matter that has been measured by calcination at 450 ° C according to XP P94-047 standard for marine sediments.

Table 3: Chemical composition of major elements in marine sediments.

Parameters in% (%)	Symbole	Bethioua port	Oran port
silica	S_iO_2	27.9	45
alumina	Al_2O_3	6.1	4.1
Iron oxide	Fe_2O_3	4.01	0.5
lime	CaO	29.4	25
magnesite	MgO	2.71	0.3
chloride	Cl	0.02	1.7
Fire loss	PAF	28.9	25.5

Table 4: Chemical composition of major elements in dams sediments.

Parameters in (%)	Symbole	Fergoug dam	Bouhnifia dam	Gargar dam
silica	S_iO_2	53.30	52	44.12
alumina	Al_2O_3	6.29	10.6	15.37
Iron oxide	Fe_2O_3	1.76	4.8	6.10
lime	CaO	16.64	10.6	9.78
magnesite	MgO	0.21	0.5	1.71
chloride	Cl	-	-	-
Potassium	K2O	2.30	-	2.36
Sodium oxide	Na2O	1.25	-	0.22
phosphorus	P2O5	0.18	-	-
sulphate	SO3	0.11	-	-
Fire loss	PAF	18.91	15.2	18.32

The (Table 5 and 6) gathers the pollution parameters such as trace elements. These elements were determined by atomic absorption spectrometry. Comparing the degree of contamination of heavy metals in marine sediments of the three chosen ports show that the Oran port and Algiers port are the most polluted compared with the Bethioua port. Note that the three ports present contamination by heavy metals and hydrocarbons. This pollution could be by port activity of boat maintenance and due to discharges of domestic and industrial affluents in ports. However the results obtained for the three dams sediments show clearly that there is an absence of heavy metals and hydrocarbons.

Table 5: chemical composition of minor elements in marine sediments.

Metals	units	Bethioua port	Oran Port	Algiers Port
Lead (Pb)	mg/kg	< 0.01	87	87
Mercury (Hg)	mg/kg	< 0.01	1.64	0.84
Chromium (Cr)	mg/kg	<0.005	76	-
Cadmium (Cd)	mg/kg	< 0.01	0.16	0.21
total hydrocarbons	mg/kg	67–940	1500-17000	1900-31000

Table 6: chemical composition of minor elements in dams sediments.

Metals	units	Fergoug dam	Bouhnifia dam	Gargar dam
Lead (Pb)	mg/kg	10	-	-
Mercury (Hg)	mg/kg	-	-	-
Chromium (Cr)	mg/kg	23	-	-
Cadmium (Cd)	mg/kg	-	-	-
total hydrocarbons	mg/kg	-	-	-

CONCLUSION

Significant quantities are removed periodically by the bottom gates of dams. Millions of cubic meters are regularly extracted from Algerian ports.

The physical characterization of port dredging sediments revealed that the main constituents of these sediments are sand and silt. The physical characterization of dams dredged sediments shows that their main constituents are silt and clays.

The physico-chemical characterization of the sediments was used to evaluate its potential for use. By comparing Algerian ports and dams sediment, we can see that the results of the physicochemical analyzes of sediment collected from the Bethioua port, the Oran port and Algiers port shows a presence of pollution by hydrocarbons and heavy metals. However the physicochemical characterization of the sediments collected from Fergoug dam, Bouhnifia dam and Gargar dam shows the abscence of pollution by heavy metals and hydrocarbons.

Finally we can conclude that dams sediment have physico-chemical properties very satisfactory for valorise these sediment easily without any inconvenience or consequence of pollution. Marine sediments from the Oran port and Algiers port are the most polluted compared to the Bethioua port. From these results it is necessary to treat these sediments before their valorization.

The skills of control and pollution management national and international level must take the necessary measures to reduce the phenomenon of pollution. The treatment of urban wastewater and industrial wastewater must meet strict standards before the discharge into the sea.

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REFERENCES

[1] Nougar B, Magister Thesis, Normal hight school From the Technological Educational Oran, 2009, Algeria.
[2] N Tran, PhD Thesis, University of Artois, 2009, France.
[3] Kazi F, M HACINI, Semcha A, B Mekerta, J. Paralia XIIth National Days Coastal Engineering - Civil Engineering Cherbourg, 12-14 June 2012 DOI: 10.5150 / jngcgc.2012.112-K.
[4] Atroune F, J.Paralia, Coastal and Maritime Mediterranean Conference Edition 3, Ferrara, Italia (2015) Coastal And Offshore Mediterranean Conference.
[5] Benyerou D, Boudjenane N, Belhadri M, J. Mater. About. Sci. 7 (4) (2016) 1317-1327
[6] Semcha A, PhD Thesis, University Of Reims Champagne-Ardenne, 2006, France.
[7] Remini B, Larhyss Journal Issn 1112-3680, No. 05, June 2006, Pp.75-89.
[8] Meskin A, Magister Thesis From University Of Science And Technology of Oran, 2012 Algeria.