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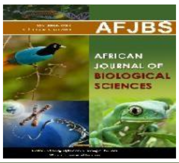

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A Structural Impacts of Solid Transport Phenomenon during floods, Jebha port of Morocco

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Abstract:

Several areas of the world and in Morocco are regularly threatened by the phenomenon of floods, and among the areas threatened by floods in Morocco, we find the area of Jebha Which is located on the Mediterranean coast, the phenomenon of flooding is not recent at the level of the city, except that it is felt today in an increasingly strong way because of the demographic, economic, urban and tourist development which the zone knows; It is characterized by fairly short rise times, very high peak flows and a significant load of solid batches increases downstream, which justifies the Total paralysis of economic and social activities, in particular those related to the port, also, the clogging of the work of art which ensures the crossing of the national road "RN16" and the overflows at this point, The port of Jebha is considered as the core for which the Jebha area was built, it is considered as the most sensitive area by floods and the transport of solids by bedloads The watershed of the Jebha area is of the peri-urban type, which manifests itself and presents behaviors of natural and urban type basins, this basin has been subjected to strong pressure, linked to the development of the urban part, and It is also subject to to natural factors and constraints

Keywords: *Floods, thrust, port, basin*

I. Introduction:

According to local characteristics, the phenomenon of flooding in the Jebha area results in significant rainfall runoff and consequent thrusting, Indeed the determination of solid transport remains one of the issues that have strategic importance for the Jebha area. and its port,

Because of several natural and artificial constraints, in particular: the strong irregularity of the hydrological regimes, the predominance of the mountainous relief, the nature of the terrain, the plant cover which are often impermeable; Jebha's streams generate large and violent floods. The latter sometimes cause flooding which has often caused significant damage to public infrastructure, the property of the population, agriculture, and also completely paralyzes the economic activities of the city, in particular activities related to the Jebha harbour.

Solid transport in the watercourse that penetrates the Jebha “Messibaa” area is often assimilated to the transport of suspended solids. The displacement of sediment carried on the bottom and of matter in solution is then neglected. The latter are deposited at the mouths of rivers and have no significant influence on the liquid flow; on the other hand, the carried sediments modify the shape and the depth of the watercourses, in particular at the level of the port. In addition, the mechanisms of sediment transport on the bottom are different from those of the transport of suspensions which have a different position, granulometry and speed of movement in the watercourse, In this sense, the application of remote sensing makes it possible to determine makes it possible to obtain maps of land use and land covers that are used to cope with modifications and changes arising from floods and solid materials.

Sediment transit by bedload depends on the regime of the watercourse and the tensile force of the sediments, that is to say, mainly on the morphology of the bed, the properties of the fluid and the size of the elements displaced. However, the spatial and temporal variations of these factors must be taken into account in the total assessment of solid flow.

- What are the main causes of the phenomenon of solid transport by bedload?
- What is the quantity of bedload sediments in relation to the flows?
- What are the impacts of the phenomenon of solid transport by bedload on the port of Jebha?

II. Materials and methods:

Moroccan port and seaside town , located on the Mediterranean coast at the limit of the eastern Rif and the western Rif . It is the urban center of the rural commune of M'Tioua the province of Chefchaouen (region of Tanger-Tétouan-Al Hoceima.

Figure 1: Panoramic view of the study area

It is located at coordinates 35° 13′ north, 4° 40′ west , about 140 km from Tetouan on the RN16 towards Al Hoceima.

Jebha Port is considered to be the core for which Jebha Center was built.

A study was carried out in 1970 for the construction of a fishing port. Following this study, the construction works of the port of Jebha began in 1975; the port began to receive fishing and pleasure boats from 1978.

The port has a 2.2 ha stretch of water and 2.4 ha of embankments housing a cold room, a fish market, a fuel station and the customs administration.

During the flood period, the activity at the level of the port experienced a complete paralysis, the negative impacts of which can exceed more than 5 days, according to the declarations of many local residents and professionals, and the solid materials accompanying the floods are the most major stopping factor for port activities; the port basin is very strongly affected by mud, which affects navigation

Figure 2: Images of flood impacts on Jebha Port

1. Operation, causes and mechanisms of solid transport

Bedload solids transport at the zone level is influenced by several factors and causes, including:

1. The morphology of the watershed of the study area,
2. The hydrological behavior of the watershed,
3. The mode of transport of solids,

a) The morphology of the watershed of the study area:

i. Surface

The surface of the watershed corresponds to the area delimited by all the highest points which constitute the watershed line. The area of the watershed, expressed in km2, can be determined using a planimeter or better still by digitalization techniques.

In our study, the area of the watershed which is approximately 16.00 km2 is determined from the topographic map (1/50,000) of the Jebha area.

ii. Main stream length

This is the distance measured along the main watercourse from the outlet to the watershed line of a catchment area. This distance traveled is expressed in km. The length of the watercourse in the study area is approximately 7.50 km.

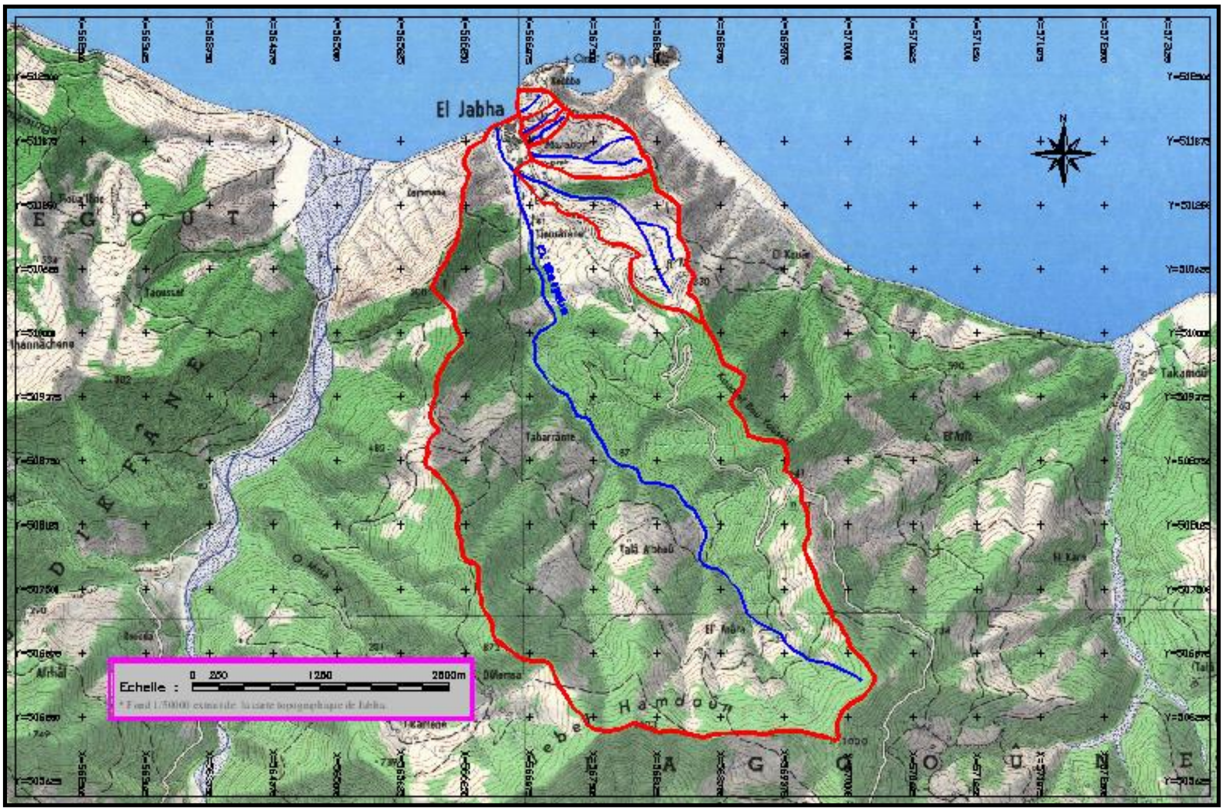


Figure 3: Delineation of watersheds in the study area

iii. Slope

Average slope is an important characteristic in runoff. It gives a good indication of the travel time of the direct runoff and therefore of the concentration time tc . It directly influences the peak flow during a downpour. The average slope is about 15%

b) The hydrological behavior of the watershed:

The hydrological behavior of the Jebha Port watershed is bound by the following characteristics:

Runoff , which is closely linked to the nature of the soil and its surface occupation, corresponds to the part of the water which has not been intercepted by the foliage, nor returned to the atmosphere by evaporation, and which does not could not infiltrate, or which reappears very quickly after infiltration and hypodermic or underground flow. It will therefore be all the lower when the plant cover is dense (trees, grasses and humus carpets) and when the soils are deep and unsaturated by recent rainy episodes. Conversely, soil sealing due to urbanization (infrastructure, buildings) will favor it. In addition, the intensity of the rain also plays a significant role by creating, beyond a certain value, a film of water on the surface of the ground, which will lead to maximum runoff.

The volume of material transported: This volume is commonly called "solid transport". These are materials (clays, silts, sands, gravels, pebbles, blocks, etc.) found in waterways, and which can be transported either by suspension in water or by displacement. on the bottom of the bed, due to the forces associated with the current. The term solid transport does not include the transport of floating materials (dead wood, etc.).

The peak flow passing through the catchment area has been assessed using the empirical approach, which will be based on empirical formulas involving regional factors and coefficients, such as: Mac-Math, Burkli -Ziegler, Rational, Mallet -Gauthier, Fuller II, and Regional….

The rational formula has several advantages and makes it possible to overcome the major uncertainties that weigh on the parameters of the other formulas.

This formula calculates the inflow of a catchment area taking into account the characteristics of the morphology of the basin, it is stated as follows:

$$Q(T) = CI(T, tc)\, A/3.6$$

With,

Q(T): Peak flood flow in m3/s

T: Return period (years)

C: Runoff coefficient (see table below)

I(T,tc): Intensity of rain in mm/h;

A: Area of the watershed in km².

Tc: Concentration time in min (by Kirpich 's formula)

$$tc = 0.019472 P^{-0.385} L^{0.77}$$

L: Length of the longest thalweg in (m),

P: Slope in (m/m).

The following tables summarize the results obtained:

Table 1: Rainfall intensity in mm/h

I10	I20	I50	I100
46	58	73	86

Table 2Peak flow in m3/s -Rational-

Q10 (m3/s)	Q20 (m3/s)	Q 50 (m3/s)	Q100 (m3/s)
105	132	167	195
Kp 10	Kp 10	kp 50	Kps 100
1.14	4.29	4.44	4.54

I10, 20; 50 and 100: Intensity for T=10, 20, 50 and 100 years (mm/h);

Q10, 20, 50 and 100: Peak flow for T=10, 20, 50 and 100 years (m3/s);

Kp10, 20, 50 and 100: Francou-Rodier coefficient for T=10, 20, 50 and 100 years.

2. Calculation of solid transport by bedload

transport in the waterways of Mesiaba is very high. However, it is poorly quantified due to the absence and lack of data concerning especially the concentration of fine particles and even the unavailability of gauging stations.

The calculation of solid transport by bedload will be obtained using empirical formulas, which take into account the point flow as a relevant element for the calculation:

a. Rickenman (1991):

Formula established experimentally to take into account the effects of the density of water on solid transport by bedload

Validity: Slope between 0.3% and 20%, with strong hydraulic conditions

4. $q_{SV}= \frac{12.60}{(S-1)^{1.6}}$x $(\frac{d_{90}}{d_{30}})^{0.2}$x (q- q_c) $x\ S_0^2$If S0> 3%
5. $q_{SV}= \frac{3.1}{(S-1)^{1.5}}$x $(\frac{d_{90}}{d_{30}})^{0.2}$x (q- q_c) $x\ S_0^{1.5}$If S0< 3%
6. q_c=0.065x$(s-1)^{1.67}\ g^{0.5}$x $d_{50}^{3/2}$x $x\ S_0^{-1.12}$If S0< 3%Bathurst, 1985

b. Schoklitsch (1962):

Validity: Steep slope ≥1 , strong floods (from Bathurst et al 1987)

7. $q_{SV}=\frac{2.50}{\rho_s/\rho}\ S_0^{\frac{3}{2}}(q-q_c)$
8. $q_c = 0.26\ (\frac{\rho_s}{\rho}-1)^{5/3}X\frac{d_{40}^{3/2}}{S_0^{7/6}}$

c. Lefort (1991):

Formula giving the total apparent solid flow from the total liquid flow, established from the Smart & Jaeggi formula with the assumption of a constant flow width to water height ratio (L/H=18)

Validity: rivers whose geometry varies freely, for slopes between 0.2 and 20%

9. $\frac{Q_{sv-app}}{Q} = 4.45\ (\frac{d_{50}}{d_{30}})^{\ 0.2}\ \frac{S_0^{1.5}}{s-1}\left[1-(\frac{Q_C}{Q})^{0.375}\right]$
10. $Q_c = 0.0776\sqrt{d_{50}^5\ \frac{(s-1)^{8/3}}{S_0^{13/6}}}\ (1-1.2S_0\ )^{8/3}$

d. Meyer- peter & Muller (1948)

Formula established experimentally, the k/Kr ratio is used to distinguish the part of the energy actually used by the transport of the total energy dissipated (turbulence, macroroughness of the bottom , etc.) K must be obtained from the setting of a water line or from an estimate based on known similar sites. The proposed formulation for Kr has been established experimentally for fixed and flat bed flows (Strickler 1923)

Validity: Slopes between 0.30 and 2.50%

$$q_{sv} = 8\ \left[\frac{1}{\rho_S-\rho}\right]\sqrt{\frac{g}{\rho}}\ \left[(\frac{K}{K_r})^{\frac{3}{2}}\rho SR - 0.047(\rho_S-\rho)d_{50}\right]^{3/2}$$

11. K= $\frac{U}{R^{2/3}S^{1/2}}$Total Strickler
12. $K_r = \frac{21}{d_{50}^{1/6}}$"Skin" Strickler

e. Miller (1991):

Simplified formula giving the total apparent flow from the total flow, Established from Rickenman data

Validity: Slopes greater than 5% and very high floods

13. $\frac{\boldsymbol{Q_{sv}-app}}{\boldsymbol{Q}}$= 8.20 $\boldsymbol{S_0^2}$

f. Recking (2006)

This formula was designed to take into account the interactions between friction and bedload

It is also distinguished from other formulas by its asymptotic behavior (q/qc≥100)

The form presented here is an approximation of the exact expression presented in Recking (2006)

In particular, the logarithmic friction law was approximated by a power law

The model makes a distinction between low and steep slope hydraulics (the limit being around 0.80%).

The median diameter d50 is used, but the arithmetic mean diameter dm= $\sum(\frac{d\Delta P}{P})$*would be more appropriate, if available*

Validity: slopes between 0.1% and 20%

14. $q_{sv} = \frac{15.60}{g^{1/6}(s-1)^{3/2}\sqrt{D}}\left[\frac{S_0}{A+Blog(S_0)}\right]^{4/3}(q^{2/3} - q_c^{\frac{2}{3}})^2$For area A

15. $q_c = 0.0715(s-1)^{1.09}\sqrt{g}\frac{A+Blog\,(S_0)}{S_0^{0.587}}\,D^{3/2}$(Use Bathurst if$S_0 > 10\%$)

Table 3: Condition of use of parameters of the Recking formula (2006)

	HAS	***B***
$S_0 < 1\%$	***1***	***-4.84***
$S_0 > 1\%$	***-3.7***	***-7.18***

16. $\boldsymbol{q_{sv}} = \frac{\boldsymbol{a}}{(\boldsymbol{s-1})^2}\frac{\boldsymbol{S_0^b}}{\boldsymbol{D^c}}\boldsymbol{q^d}$

The coefficients a , b, c and d come from the approximation of the logarithmic law in power law and it was necessary to define 3 sets of coefficients to take into account the properties of the flow at the different relative depths

$$2 < \frac{R}{D} < 8\ ,\ 8 < \frac{R}{D} < 17\ ,\ \text{and}\ 17 < \frac{R}{D}$$

The detail of the calculation of the coefficients is given in Recking (2006)

III. Results and Discussion

The results of the calculations are presented below:

1. Input of hydraulic parameters:

Table 4: Results of the hydrological study of the catchment area of the study area

Flow Q (m3/s)	Width W (m)	Slope S(m/m)	Rh0(Kg/m3)	K	q =Q/L
195	12	0.15	1000	40	16.25

2. Sediment parameters:

Table 5: some main sediment parameters

D30(m)	D40(m)	D50(m)	D90(m)	D90/d30	kr	Rhos	Rhos app
0.02	0.04	0.05	0.125	6.25	34.76	2650	2000

3. Condition of the formulas:

Table 6: Conditions of use of the formulas for the calculation of sediment flow

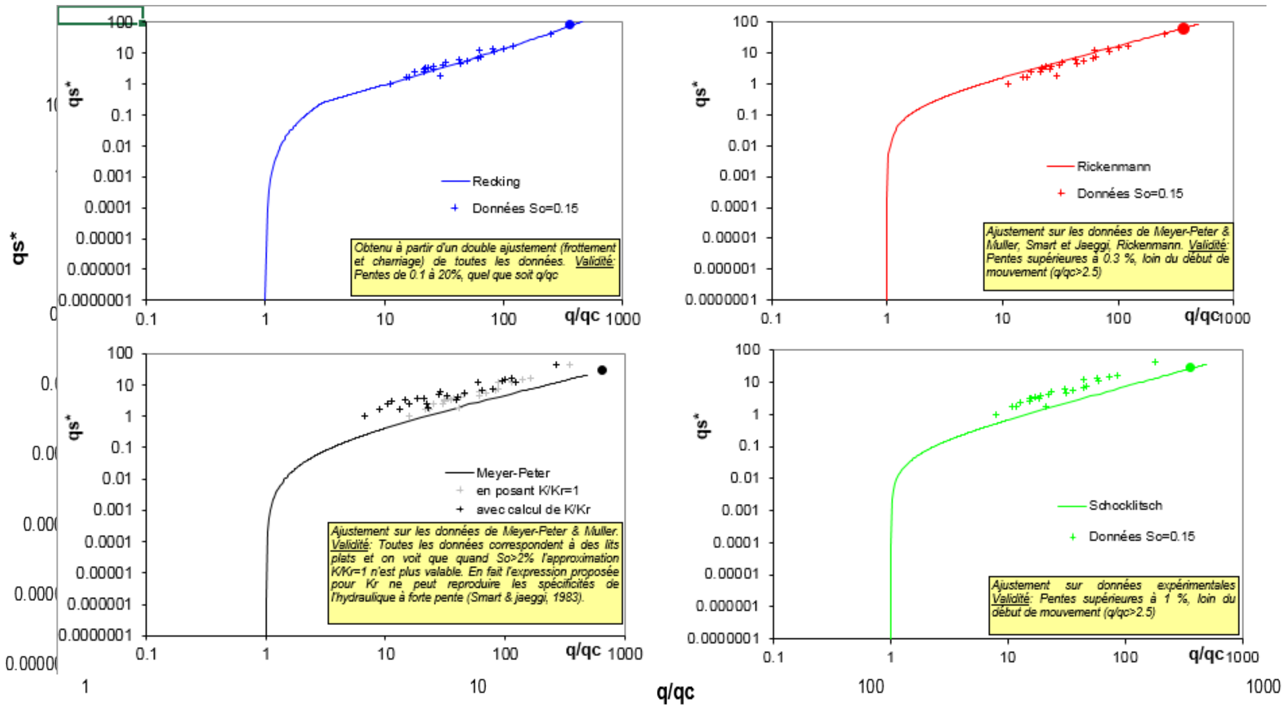
	QC (m²/s)	q / sth
Recking	0.0440	369.55
Ricknmann	0.0440	369.55
The strong	0.0015	10511.15
Shocklich	0.0438	370.76
Miller		

Meyer-Peter	0.0247	659.17

4. Solid flow:

Table 7: Summary of Solid Flow Calculation Results

	Qs (Kg/s)	VS (%)	Qs (m²/s)	Qs (m3/s)	qs *
Recking	113419.183	21.94	3.566	42.799	79.291
Ricknmann	94592.881	18.30	2.974	35.695	66.130
The strong	85420.225	16.53	2.686	32.234	59.717
Shocklich	28244.80	5.46	0.888	10.658	27.595
Miller	71955	13.92	2.262	27.152	50.303
Meyer-Peter	38851.828	7.51	1.224	14.661	27.161



5. Solid flow:

Formulas used outside their area of validity are marked with a red cross

6. Comparison of models with experimental data for slope (15%)

Each chart shows a model and the selection of data in an interval closest to the design slope.

The quantities represented are dimensionless, qs * and q are measured quantities. q is made dimensionless by the value of qc proposed by the author (to be consistent with the model), the models of Meunier (which does not define qc) and of Lefort (which calculates a total sediment flow with the hypothesis W /H= Cte) do not lend themselves to this type of presentation and are therefore not presented.

Generally our presentation makes it possible to appreciate the precision of each law for the slope of study

So when q/ qc < 1 there must be no transport

7. *Modes of transport of solids:*

In the Messiaba wadi watershed, the solid load carried by the wadi during floods is very high. It is made up of calcareous pebbles, clays, silt and organic debris from the steep slopes. These transported materials result both from the degradation of the slopes and from the remobilization of accumulated sediments, during periods of drought, in the bed of the wadi.

The Mesiaba wadi and its tributaries have an unstable bed. In times of flood, the flow erodes the banks.

The result is reflected in a significant load consisting of loose soil and blocks, which reduces the bridge flow rate on the RN16. The water overflows onto the road and stops traffic.

Erosion on the landforms of the Oued Messiaba watershed generates the production and transport of sediments, thalwegs and watercourses which are then subject to solid transport.

Solid transport mechanisms are very complex and ultimately still quite poorly understood. In practice, there are two different physical mechanisms, thrusting and suspension:

a. Transport by bedload (Movement of particles in contact with the bottom):

Transport by thrusting consists of movement by the pebbles which are dragged along the bed bottom if they do not settle, they are dragged into the structures (Bouvard, 1984).

b. Transport by suspension (transport over long distances in the mass of the flow):

Transport by suspension Concerning the elements which are maintained by the turbulence in suspension, one obviously finds a majority of very fine elements, such as for example, clays they represent the main part of the deposits of siltation of the works (Bouvard, 1984).

In nature, we can find the third intermediate mode, called saltation

This phenomenon is the cause of several problems related to the development of watercourses such as siltation of reservoirs, regressive and progressive erosion and lowering of water tables, among others. Hence the need to quantify and predetermine solid transport.

IV. *Conclusion:*

The port of Jebha is located on the right side downstream of the Messiaba wadi , and let us take into consideration that solid transport increases downstream. This explains the negative impact of bedload on the port, note that the port is not protected against flooding,

Generally the main damage and dangers caused by the bed load in the Jebha area , during the last decade

- Complete paralysis of economic activities in the city, in particular activities related to the port of Jebha.
- Many homes have suffered water damage and some families are helpless in the face of this disaster.
- The heavy rains were right and caused the untimely flooding of the Messiaba wadi which adjoins the village.
- Several houses too close to the river, about fifteen according to witnesses on the spot, were thus invaded by a surge of water which fell violently for more than 24 hours on this area.
- Within the city the water level has reached nearly 40 to 50 centimeters in some places, a large part of the roads is invaded by mud.

- The water level reached 50 centimeters in the heart of Jebha's "downtown".
- Interruption of the national road linking Tetouan to Al Hoceima.
- Rockfalls and the accumulation of thrusts at the level of the tracks and beds of wadi and Chaabas
- The inhabitants of Jebha are unhappy, they organized a demonstration, to protest against the slowness of the repair works

Reference :

1. Andrews, ED, Entrainment of gravel from naturally sorted riverbed material, Geological Society of America Bulletin, 94, (10), 1225-1231, 1983
2. Rassi Walid, Technical synthesis, solid transport, estimation and measurement, February 2004
3. Maurice Bouvard, Mobile dams diversion works, from rivers transporting solid materials, 1984
4. Chabane Rabah, LABBAOUI Thanina : flood protection study for the city of el Bayadh , 2016
5. Alain Recking (Cemagref , UR ETNA): Evaluation of solid transport formulas in rivers taking into account the time scale, Research program 2008, Funded by the General Council of Isère
6. Water Agency, director of the study: Rhône - Mediterranean - Corsica agency, Management of rivers solid transport and landfalls, 1999
7. Alain RECKING, Equations and concepts for calculating solid transport in rivers, 2020
8. M. Bouvard, Diversion works and solid transport, 1983
9. Maurice Pardé , On the mechanism of sediment transport carried out by rivers and on the correlative alterations of river beds, 2018
10. BET Report: Studies and Measures the 5 Domains, study for the realization of a cartography and a geographical information system on the major risks in Morocco, Mission 1, identification of the risks, Version 1.0. September-2008
11. BET Report: Jebha Port Servicing Study, September 2016;
12. M. E. SAIDI, L. DAOUDI, M. E. H. ARESMOUK, F. FNIGUIRE & S. BOUKRIM (2010) The floods of the Ourika wadi (High Atlas, Morocco): Extreme events in a semi-arid mountain context. Comunicações Geológicas, Lisbon, t. 97, p. 113-128
13. A. El Mimouni, L. Daoudi, M. E. Saidi & A. Baiddah (2010) Hydrological and dynamic behavior of a watershed in a semi-arid environment: Example of the Ksob watershed (Western High Atlas, Morocco). Revista Cuaternario y Geomorphology, 24 (1-2), 99-112, Madrid
14. Benoît Camenen, Irstea Lyon, Bedload measurement methods: Which tools at the scale of a structure? Oct., 2014, Limoges
15. Abdellah LAOUINA, can we mitigate water risks in the piemonts atlasics? International symposium on natural risks and land use planning. Oujda 9 and 10 November 2018.
16. Abdelaziz Rhazi, Dr. Ali Essahlaoui, PES , Abdellah El Hmaidi, PES, Abdelhadi El Ouali, PES, Study of Vulnerability to Flood Risks In the City of Meknes. Contribution Of Sigs, Mnt And Empirical Models, 2017
17. Hydrological Sciences Journal, Aicha El Mahi, Mohamed Meddi & Jean Paul Bravard Water Science and Technology Laboratory, Faculty of Science and Technology, Mascara University, El Mamounia Road, Mascara, Algeria National School of Hydraulics of Blida, Algeria Lumière Lyon 2 University, Lyon, France; Analysis of suspended solid transport in the watershed of Oued El Hammam (Northern Algeria), Oct, 2012

18. Ashour ABOUESSA, characteristic sedimentary structures of a fluvial-Tidal transitional zone (Dur At Talah Sequence, Upper Eocene, Libya), 13th French Congress of Sedimentology, Dijon, – Book of abstracts, 2011
19. ZORKANI Mohammed, Department of Hydraulics, River thrusting and artificial canals & slope stability, 2020
20. A. El Mimouni, L. Daoudi, M. E. Saidi & A. Baiddah, hydrological and dynamic behavior of a watershed in a semi-arid environment: example of the ksob Watershed (western high atlas, Morocco), 2010
21. Fares KESSASRA, Modeling in Hydrology and Hydrogeology, March 4, 2017
22. Driss Elhafid, National Association of Moroccan Geographers, Erosion, development and hydrological risk in the catchment basin of the Sidi Yahya wadi, Oujda, Morocco, 2011-2012
23. Shirazy, A., Shirazi, A., & Nazerian, H. (2021). Application of Remote Sensing in Earth Sciences–A Review. International Journal of Science and Engineering Applications, 10(5), 45-51.