

## Responses to Reviewer Comments

We thank the reviewer for his thoughtful comments and suggestions. We have included almost all of the raised suggestions and below we present a point-by-point response to the comments.

### Report #1

I have revised the paper for the second time, I find it ameliorated with respect to the previous version.

However, I would like to address some more suggestions:

- Inaccuracies are still present in the text, I have tried to identify those but I could miss some. Please look carefully at the text;

-concerning the material and data, one table is missing: you should provide the list of the interface core sites, their lengths and collecting depths, with geographical coordinates. However, three tables are already given, please consider to provide this type of data in the supplementary material

- Check the correspondence between “Results” and “Discussion”. For instance, in the discussion related to the short core, you use element ratios that you have not presented before in the “Results” Other minor details can be found in the annotated manuscript (pdf).

As last point, I would like to rise a major issue: this work can be useful for application in the paleo-flood reconstructions or extreme events records, certainly. However, the discussion is really poor in this respect (lines 18-20, pag. 17). I would expect a larger discussion on the previous work in Tunisian and Mediterranean regions (arid or not), the approach known in this field, the results obtained and found in the previous literature and the contribution of this work for making progress in this field.

Page 3 Line 5

We agree with the reviewer and the sentence “ However, these sedimentary sequences are often continuous nor complete.” is removed

Page 3 Line 7

As suggested, we removed the sentence “an area where significant sedimentary sequences are absent or not continuous in time”

Page 3 Line 8-9

We agree with the reviewer. This sentence is rephrased: “In this study we tried to reveal the importance of lagoonal archives to reconstruct past flood activities under a semi-arid environment in southern part of Tunisia, studying the paleo-floods from high resolution geochemical and sedimentological analyses”

Page 3 Line 11-13

We modify the sentence as proposed:

“The second aim was to reconstruct flood events from the lagoonal archives during the last century”.

Page 3 Line 17

We agree with the reviewer and we take into account his suggestion:

“The Djeffara (Inner domain) and the Dahar (Outer domain)”

Page 3 Line 20

We replace “belonging” by “belongs”.

Page 3 line 21

The term “outcrop” is removed.

Page 3 Line 22

We agree with the reviewer. “Fig. 1B” was added in the paragraph.

Page 4 Line 10

We thank the reviewer for his comment and a sentence was added:

“(under marine isotopic stage 5e: last interglacial)”.

Page 4 Line 14

A box around El Bibane lagoon is added in the Figure 1.

Page 4 Line 18

El Gharbi (western) and Ech Chargui (eastern) were added in the Figure 1.

Page 5 Line 14

Figure.2 is replaced by Fig. 2.

Page 5 Line 23-24

A table was added in the supplementary data as asked.

Page 6 Line 9-10

We agree with the reviewer and a sentence was added:

“S6 represents the surface sediment sample of a lagoon sediment core (BL12-10)”.

Moreover, to reconstruct the recent flood events occurred in the studied area, a short sediment core (BL12-10, 40 cm length; Latitude: 33°14'58.7"; Longitude: 11°10'3.7" Fig.3) was recovered from the El Bibane Lagoon (EBL) by a hand corer 75mm diameter PVC tube.

Page 9 Line 15

The sentence “Surface sediment samples have been collected from three different types of location” is removed.

Page 9 Line 16

We agree with the reviewer and the sentence is added:

“of the surface sediment samples”.

Page 9 Line 17

“depending on the environmental setting” is added in the text as asked

Page 10 Line 3

“fluvial” is removed.

Page 10 Line 6

“even” is removed

Page 10 Line 14

We agree with the reviewer.

“Our” is replaced by “the”

Page 12 line 14

We agree with the reviewer and we take into account his suggestion. A paragraph describing the geochemical results was added:

“Our results display that these three mud layers preserved in the core are also characterized by high Fe/Ca and Ti/Ca elemental ratios (Fig. 12)”.

Page 12 line 18

We thank the reviewer for his remark.

In this study, we undertake the calibration of the sedimentary archive and the hydrological data during the last century. The historical hydrological data begun in the early 1930, that's why we select the sedimentological and the geochemical analysis up to 30cm depth of the core which cover this time period.

The whole BL12-10 core length is 90 cm. Results of this total 90cm length core will be reported in a next paper (Affouri et al., in prep.) discussing the climatic change during the warm periods (Antiquity and Medieval) and the cold periods (LIA) and its impact on the flood variability of the Fessi River.

Page 16 Line 25

The flood events recorded in 1969 and 1979 in the sedimentary archive correspond to 14 and 17 cm core depth. The down core distribution of the  $^{210}\text{Pb}$  does not show a clear split in the profile indicating that no significant erosion happened in the lagoon at the location of the core during the studied period.

Page 17 Line 4-5

We agree with the reviewer and we take into account his suggestion

The term bioturbation is removed. The composition of the sedimentary archive is homogeneous and linked to bottom currents. These sediments are suspended and re-deposited.

The deposits thickness associated with these flood events is low (<5cm).

Page 18-19

We thank the reviewer for his remark and we take into account his suggestion. Text have been changed asked.

“These results indicate that finer material, high content of mud (clay+silt), as well as high ratios of Fe/Ca and Ti/Ca are associated to flood events in the lagoonal sequence. The association of these proxies in the sedimentary sequence of the El Bibane lagoon can therefore be used to reconstruct flood activities in Southeastern Tunisia during the upper Holocene”.

## Responses to Reviewer Comments

We thank the reviewer for his thoughtful comments and suggestions.

### Report #2

1) Additionally, the semi-quantitative Niton XRF data might be not really robust for pure quantitative comparisons. However, the authors must show at least the same XRF proxies for the catchment, PCA and core stratigraphy.

Indeed, the XRF scanner is a semi-quantitative measurement. Geochemical data are expressed in ppm or percentage values. Analytical error on replicate standard are lower than 5% for Ti, Cr, Fe, Zn, Pb, between 5 and 15% for Ca, Mn, As, Rb, Sr, and between 15 and 25% for K and Co. (The technique is described in the chapter materials and methods).

However, variability of Fe/Ca and Ti/Ca ratios in surface sediments and along the lagoonal core are higher than analytical errors indicating that this semi-quantitative approach is sufficient to mark the past floods of the Fessi River.

### Abstract

Page 1 Line 19: It is mention in the abstract that surface samples in the lagoon's catchment trace the origin of lagoon deposits. Do the data really provide this information? High Fe/Ca and Ti/Ca and high clay and silt contents indicate paleofloods in the lagoon but is there a coupling with the surface samples in the catchment?

Our data suggest that the surface samples characteristics of the catchment can be used to identify the origin of the lagoon deposits. The aim of our study is to identify and to calibrate the proxies which can be used to reconstruct the paleofloods archived in the sediments of El Bibane lagoon.

In this context, geochemical data of major and trace elements have been used to display their distribution on the whole studied area, from the upper watershed to the coast. To a first approximation, this approach allowed us to distinguish between the different sources of sediments (Aeolian, marine and fluvial). However, it is difficult to make palaeoenvironmental reconstitutions using only geochemical elements because of the dilution processes which can strongly affect the geochemical profiles. That's why we used elemental ratio to overwhelm the dilution effect. Consequently, elemental ratios such as Fe/Ca and Ti/Ca, (Fig. 11) are proposed in this study to identify the modern sediment sources in the studied area and to reconstruct past changes in the sources of the lagoon sediment. Figure 11 have permitted to identify the different sediment sources.

For instance, it displays that the fluvial end member is characterized  $Fe/Ca > 0.08$  and  $Ti/Ca > 0.02$ . When applying this proxy along the core BL12-10, we can see that the three mud layers which were interpreted as flood events present  $Fe/Ca$  values close to 0.08 and  $Ti/Ca$  close to 0.02 (fig. 12), close to the present day fluvial end member.

Page 2 Lines 1ff The authors mention historical flood events. For me, a historical flood event is a short event that is not comparable with an enhanced annual mean in precipitation. The authors do not show these event data but only annual means in precipitation.

We agree with the reviewer.

The southern of Tunisia suffered a real catastrophic event. The mean annual rainfall is about 200 mm in the southern Tunisia but precipitation is very irregular with episodic catastrophic flooding followed by long periods of drought which may extend over several years (Medhioub et al, 1981). Flood events were linked to heavy precipitation events which were very close in time. For example: the flood of 1969 (24 to 48 hours; Pias, 1970; Kallel.R and Colombani.J, 1972), the flood of 1979 in Medenine (4 days; Bonvallet, 1979), the flood of 1995 in Tataouine (11 to 24 hours; Boujarra and Kttita; 2009, Fehri, 2014) and the flood of 1932 (A heavy rainfall has been recorded in Medenine region; 449 mm during few days; Bonvallet, 1979).

### **Manuscript**

Page 2 Line 13: I am not sure about this statement. There were already a network of gauges and meteorological stations in Mediterranean North Africa during the colonial period. However, the easiest option to support your statement might be significant reference.

We thank the reviewer for his comment. In fact, no reference is available to support our statement, but the official web page of the Tunisian National Institute of Meteorology indicates that the establishment of the first synoptic observation network by FMO (French Meteorological office) was in 1926. For Southern Tunisia, available data start in the early 1930.

Page 3 Line 3ff. The knowledge about centennial-scale Holocene flood phases in Tunisia is by far better than mentioned in the introduction. Please consider Faust et al 2004 QSR, Zielhofer and Faust 2008 QSR and references therein. The approach of cumulative probability plots that is applied in Zielhofer and Faust 2008 does not need continuous archives. Hence, I cannot follow your argumentation at this point.

We thank the reviewer for his remark. We specified in the text that our statement about the poor knowledge of centennial-scale Holocene flood phases concerns only Southern Tunisia.

Page 3 Line 16 to Page 4 line 12. This paragraph is somewhat complicated to read. It might be better to put these statements into a figure or a table.

This paragraph describes the geology setting of the studied area and these statements were placed on the figure (Please see Fig. 1) in order to become easy to reading.

Page 5 Line 15ff You cannot deduce short-term flood events from mean annual data. Maybe, you just exclude the term “flood events” in the manuscript and emphasise peaks in mean annual precipitations.

We agree the reviewer comment. The higher annual data recorded in 1969 was associated with heavy precipitation events which were close in time (September and October).

Page 7 Line 14ff Please mention only parameters that are shown in the result chapter as well.

Granulometry parameters that are not used in this work have been removed from the text, as asked.

#### **Chapter 5.1.1.**

Please do not use references in the result chapter.

All references of the result chapter were removed.

Why do you present the data of the dunes? Do you have dunes in the lagoon record? It might be better to emphasise the S9 and S10 fluvial reference samples.

The dunes represent the main source of aeolian material. We have decided to sample the dunes in the study area in order to characterize the aeolian supply to the lagoon.

Chapters 5.1.2 and 5.1.3 are not convincing to me. Within the lagoon core you point to Fe/Ca and Ti/Ca ratios as proxies for alluvial fills. Please use the same proxies (ratios) for the catchment analysis.

The elemental ratios Fe/Ca and Ti/Ca are also analyzed for both surface samples (Fig. 11) and along the BL12-10 core (Fig. 12).

Chapter 6.2 It would be much better to discuss element ratios than simple elements.

We thank the reviewer for his remark.

In this section we choose to discuss simple elements by statistical analyses (PCA) with the aim to separate simple elements in link with their origin (Marine, fluvial and Aeolian end members). The statistical analysis of the some elemental ratios (Fe/Ca and Ti/Ca) demonstrated that they can be used to identify the principal sediment of the El Bibane lagoon. By so doing, we avoid problems linked to possible dissolutions in the past.

## Responses to Reviewer Comments

We thank the reviewer for his thoughtful comments and suggestions.

### Report #3

The revised manuscript by Affouri and co-authors describes a way to reconstruct past flood events from the El Bibane lagoon from Southeast Tunisia. The sedimentary records from lagoons are definitely an underexplored archive for the reconstruction of flood events and therefore this manuscript could be of wider interest for the paleo-flood community. Affouri et al. applies classical methods like grain size analysis and elemental fingerprinting of different potential source lithologies in order to identify the flood layer deposits in the El Bibane lagoon. Although the conclusions drawn from the analysis are at first sight convincing, I'm puzzled by the fact that the high-energy flood deposits are actually smaller in grain size than the 'normal' sedimentation in this lagoonal setting. Typically, lagoons are associated with low energy depositional areas and therefore I would expect a coarser grain size for the flood deposits compared to the marine/lagoonal sediments. Unfortunately, it is not clear from the manuscript what are the expected depositional processes at the coring site.

Here, the past flood activity was investigated using a multi-proxy approach combining sedimentological and geochemical analysis of surface sediments from the Southeast of Tunisia catchment in order to trace the origin of sediment deposits in the El Bibane lagoon. Three sediment sources were identified: marine, aeolian, and fluvial. The grain size analysis showed that the fluvial source has a bi to multimodal distribution with two or even three modes. In order to obtain the best resolution in the identification of the fluvial source, we choose to use the sediment samples which were collected only along the River Fessi: S9, S10, S12 and S13. These surface sediment samples show a decrease in the mean grain size from the upstream to the downstream of the River Fessi watershed. The decrease in the mean grain size could be explained by a strong change of the topographic slope around Tataouine region. Here, the coarser material is deposited and the finer material is transported away by the river. These finer sediments are deposited in the low plain of the river and in the El Bibane lagoon. Therefore, we suggest that S9 and S10 (collected between Tataouine and the lagoon) characterize the fluvial component in the lagoon. The grain size distribution for S9 is unimodal with a mean grain size around 96  $\mu\text{m}$  indicating moderately sorted muddy sand. The corresponding size range is very coarse silty/very fine sand. Sample S10 is fine silt with trimodal distribution in 7 $\mu\text{m}$ , 26 $\mu\text{m}$  and 73 $\mu\text{m}$ , and poorly sorted mud sediment type. These characteristics will serve to identify the fluvial source into the lagoon.

For this reason, I would suggest to clarify the following three aspects for a convincing flood deposit identification:

#### 1. Definition of the marine end member sediment source

The authors want to define the marine sediment source by sampling beach sands, but I would not call these sediments as the marine source for the lagoon. These are shoreline deposits and should be labeled as such. I would relate the marine sediment source of the lagoon to particles that are produced within the water column (which are rather small in grain size). Is there anything known about this marine sediment source? What about the productivity within the lagoon and the deposition of organic matter?



We agree with the reviewer.

Numerous studies have been carried out on the coastal environments. These environments correspond to the watershed, the lagoonal and the marine area near the sea. Therefore, we preferred to name these samples as marine sediments because they were coherent with other studies dealing with coastal environments such as Raji et al. (2014) and Dezileau et al. (2016). Moreover, we demonstrated clearly in this work that the fine fraction found in the lagoon sediments is associated with periods of higher discharge of Fessi River (flood events).

The productivity within the lagoon has been treated in this study on the distribution of the mollusk species (Affouri et al; in prep) and according the previous studies (Medhioub et al, 1977, Zouali , 1982, Capapé et al, 2004 and Jouili el 2016), the El Bibane lagoon was considered to be among the most biologically diverse and productive ecosystems and a nursery for several species.

The organic matter deposition in the lagoon has not been studied in this work. Therefore Medhioub et al, 1981; show in his study on the El Bibane lagoon, an anomalous repartition of the organic matter in the sediment. This anomalous could be explained by a local mortality of marine organisms related to the junction of the inflow and the more saline and confined waters of the lagoon.

2. How were the lagoonal samples collected? Related to the first aspect above is the question about the definition of the lagoonal sediment. The authors need to explain the method used for collecting the lagoonal sediments (grab sampler, coring,..?) and which sediment depth interval is covered in this surface samples? If only the topmost cm was sampled then this could be related to the marine end member source. In addition, the authors should show the grain size distribution of S6 in Fig. 5 as this surface sample is closest to the coring site and therefore the most relevant one of the 3 lagoonal samples.

The first three centimeters of the core were used to characterize the surface samples (Cf line 9-11, page 6). The studied core BL12-10 was recovered in the southern part of the lagoon, far from the connection with the Sea. Thus it cannot be used to characterize the marine source.

We agree with the reviewer that more surface sediment covering the whole area of the lagoon are needed to better characterize the modern influence of the different sources.

### 3. Shell fragments in the flood deposits

According to the Figures 9 and 11, the finer flood deposits FL1 and FL2 contain shells or maybe shell fragments. How is it possible that a fluvial deposit, which is likely deposited within hours or days can contain – I assume – marine shells? Would this not contradict with the interpretation of fluvial deposit?

Internal circulation within the lagoon can cause a re-suspension of the material. Bioturbation can also play a role which may explain the occurrence of these shells in the flood deposits. In any case, the occurrence of these fragments are negligible in these flood deposits.

Overall:

The manuscript needs major clarification concerning the flood layer recognition. The number of

figures needs to be consolidated and the quality of the figures should partly be improved. Furthermore, the manuscript needs careful evaluation for consistency (see comments below) and some language polishing.

Specific comments and technical corrections (changes are marked within 'apostrophes')

For the entire manuscript: Consistent use of abbreviation throughout the manuscript

Write the name of the study object in capital letters: 'El Bibane Lagoon'. Occasionally it is abbreviated (->EBL), but not consistently. I would advise not to do it. Check throughout the manuscript.

[We thank the reviewer for his remark and we take account his suggestion.](#)

The same is with the term Principal component Analysis (PCA) on Page 9, Line 2, as well as in other locations within the manuscript.

[Done](#)

Page 2, Line 16: ...floods 'in' the future.

[Done](#)

Page 2, Line 22: ... where overwash deposits 'are' preserved within

[Done](#)

Page 3, Line 5: In 'this' study', we tried...

[Done](#)

Page 3, Line 6: ... 'the semi-arid environment of Southern Tunisia' (delete the rest of this sentence)

[Done](#)

Page 3, Line 9: ...lagoonal sequence in Southern Tunisia (delete 'the')

[This sentence is removed](#)

Page 3, Line 13: ..., we 'undertook a' calibration

[Done](#)

Page 3, Line 16: Morphological, (delete the) 'S'outhern Tunisia '-' known as the Tunisian platform '-' includes...

[Done](#)

Page 4, Line 2: The Cretaceous series 'represents' a general 'succession' from neritic,...

Done

Page 4, Line 15: It has 'a maximum water depth of' 6m in the...

Done

Page 5, Line 10: ...30 days/'years (remove space)

Done

Page 5, Line 11: ... October to Mar'ch'...

Page 5, Line 23: I would like to see a table with all the coordinates of the surface samples. This was the case for the original submitted manuscript, but such a table was then removed due to a comment of reviewer 2, although reviewer 2 only requested to move this table to the supplement. This sentence here ("The locations of all...") could then be moved to the description of this table.

[A table of the coordinates of the surface samples is added and moved in the supplementary data](#)

Page 5, Line 24: Sentence: "Sediments were returned to the laboratory for analysis." is not needed.

Done

Page 6, Line 15: ...split, photographed, 'and' logged...

Done

Page 6, Line 17: ....with a 'hand-held' Niton....

Done

Page 6, Line 19: 4'μ'm (micrometer, not millimeter)

Done

Page 7, Line 1: remove space between Beckmann-"Coulter

Done

Page 7, Line 18: ...calculated arithmetically', (delete: and) geometrically (in microns)', and logarithmically....

Done

Page 8, Line 2: 210Pbex: ex should be subscripted through the manuscript; check also the figures.

[We thank the reviewer for his comment.](#)

Page 9, Line 4: remove the word chemical

Done

Page 9, Line 15: ...types of location's'

This sentence "Surface sediment samples have been collected from three different types of location" was removed

Page 9, Line 17: Use the same order to mention the different sources (i.e Aeolian, Marine and Fluvial) here as they are discussed subsequently (Pages 9 and 10)!

Done

Page 9, Line 18 ...encompasses' sediment samples...

Done

Page 10, Lines 5-8: The authors claim that the fluvial sediments have a bi- to multimodal distribution, but the samples S9 and S12 (Fig. 5) are unimodal. It is mentioned further down, but this section needs to be revised!

Done

Page 10, Line 12: transported 'further' by the river.

Done

Page 12, Lines 16-17: Sentence can be removed. Redundant information.

Page 13, Line 12: ..shows 'a maximum' at...

Done

Page 14, Line 7: Rephrase to: 'Furthermore, the lagoon samples showed a higher variability in the grain size due to the presence of shell fragments.'

Done

Page 15, Line 25: Identification of flood 'layers' in the...

Done

Page 17, Line 4: The authors state that the sedimentation rate of these flood events is not high, but by definition these event layers are deposited within hours to days. These event deposits need to have a high sedimentation rate! Clarify.

We agree with the reviewer comment. The deposits thickness associated to these flood events is low important (<5cm).

Fig. 2: Could be combined easily with Fig. 12!

We thank the reviewer for his comment.

Fig. 3: It is confusing that the water bodies are colored blue in the upper figure, whereas the landmass is colored blue in the lower figure. Please correct!

Done

Fig. 4, Line 3: S3 (and not S1) is shown in the figure

Done

Fig. 4, Line 4: According to the image of S17 1cm can NOT be the diameter of the photos!

Done

Fig. 8, Line 5: ...and 'a'eolian sand dune.

Done

Figs. 9 and 12: Combine these to figures as they have a very similar content. Show the grain size data in the full resolution (as in the Fig 9 now). And the blue bars for the flood deposits are not consistent between Fig 9 and Fig. 12. Revise!

We agree with the reviewer. The grain size of the BL12-10 was performed at high resolution each 1 cm but the geochemical analysis were each 2 cm. When we correlated the two proxies we choose to place the grain size results each 2cm which match the geochemical analysis.

Table 3 continued: Check the values for MODE 1; it is highly unlikely that all values are identical for mode 1 (i.e. 106.0)! Please correct!

We thank the reviewer for his remark. Indeed, GRADISTAT program version 4.0 (Blott, 2000) was used for grain size statistical analysis. The following sample statistics are calculated using the Method of Moments in Microsoft Visual Basic programming language: mean, mode(s), sorting (standard deviation), skewness and kurtosis. Grain size parameters are calculated arithmetically, geometrically (in microns) and logarithmically (using the phi scale). The results of the grain statistical analysis (Table 3 continued) were determined automatically using this grain size program. All of the samples, except one, have Mode 1 at 106 $\mu$ m. These samples are different in their Mean values.