

Reply to Reviewers Comment: Reviewer 1

Comments on 'Extension of high temporal resolution sea level time series at Socoa (Saint Jean-de-Luz, France) back to 1875' by Khan et al. (ESSD)

Text colour codes: Review (black), Reply (blue)

Note my small change to the title.

I did not expect to be asked to re-review this as I think I mentioned first time that it would be acceptable if the text was cleaned up and the points I had raised attended to. It is an interesting piece of data archaeology and reflects a lot of work by the lead author.

So I read it through again. It is again an acceptable draft in substance but the English text is still not very good in many places (trivial things like singular/plural). Anyhow, I have edited the pdf with sticky notes which I have sent to the lead author and one of the co-authors so I hope they will be attended to in the final version.

Also I noticed there were some things that I pointed out first time that had not been done. A small example is that Figure 2a is not referred to in the text.

I looked only at the paper itself and not the supplementary material.

Reply: Thank you for your re-review of the paper.

Title is revised to "Extension of a high temporal resolution sea level time series at Socoa (Saint Jean-de-Luz, France) back to 1875" as suggested.

We accept our failure to minimize the number of small English related errors and typos, and express our gratitude for pointing these things out.

Although in the previous iteration we have systematically checked if all the figures are referenced, Figure 2a slipped through - we apologize. This has now been checked again and all the labelled subplots are now referenced in the manuscript.

We have considered the suggestion provided in the pdf. The changes made in the revised version are listed below. Character L was prefixed to indicates the line number in the original manuscript, "..." was used to indicate truncated segments.

L10: "float gauge" is revised to "float gauges".

L12: "station-year" is revised to "station-years". We have also reorganized the line to read as follows -

"Using this large set of rescued documents the Socoa time series has been extended back to 1875, with more than 58 station-years of additional data.

L22: "They have a crucial contribution to our..." is revised to "They have a crucial role in our..."

L29: "...applied to different part..." is revised to "...applied to different parts...".

L31: "...high water level..." is revised to "...high water levels...".

L43: The sentence is now revised to "Alongside the mean sea level, tide has also been found to manifests long-term evolution and high-frequency (typically hourly or less) data are needed to investigate such changes (Woodworth, 2010b, Haigh et al. 2020)."

L46: "Taking advantage of the archaeology of such high-frequency..." is revised to "Taking advantage of the archaeology of the availability of such high-frequency..."

L51: "These contemporary results..." is revised to "These recent results..."

L52: "...studying the evolution of tide." is revised to "...the evolution of the tide."

L67: "...high-resolution dataset..." is revised to "...high-resolution datasets...", and "...has been instrumental for the current..." to "...have been important for the current global...".

L68: "Such a dataset..." is revised to "Such datasets...".

L89: "...(containing data and metadata) are discussed..." is revised to "...(containing data and metadata) is discussed...".

L104: "...transferred to the Socoa in ..." is revised to "...transferred to Socoa...".

L106: "Until then, the..." is revised to "Up until then, the...".

L113: "In the currently available archives, e.g., Shom, or Permanent Service for Mean Sea Level (PSMSL, Holgate et al. 2013), there are data available during the World War II (WWII) period – from November 1942 to May 1944." is revised to "In the currently available archives, e.g., Shom, or Permanent Service for Mean Sea Level (PSMSL, Holgate et al. 2013), there are data available for the World War II (WWII) period from November 1942 to May 1944."

L114: "While 44 charts were found in the Shom archive at Brest covering this period, the, rescued metadata do not report any tide gauge operating at Socoa." is revised to "In fact, 44 charts were found in the Shom archive at Brest covering this period, but the rescued metadata information (discussed in Section 2.5) does not include mention of any tide gauge operating at Socoa."

L115: "After inspection, we found a different paper size of these charts compared to Chazallon or Brillie, which indicates that it was a different tide gauge." is revised to "After inspection, we found that these charts had a different paper size compared to those of the Chazallon or Brillie eras, which indicates that it was a different type of tide gauge."

L117: "Local historians confirm that it was indeed another tide gauge, installed by the Germans, on the other side of the Socoa bay." is revised to "Local historians confirm that there was indeed another tide gauge, installed by the Germans, on the other side of the Socoa bay."

L119: "No record was found between this German tide gauge (1944) and the Brillie tide gauge (1950)." is removed as it does not contribute any additional information.

L123: "...for Chazallon gauge" is revised to "...for the Chazallon gauge".

L127: "...this tide gauge, except the..." is revised to "...this tide gauge, except knowing the...".

After revising the line for clarity, the new sentence reads as -

"Surprisingly, no documentation was found in the catalogued archives regarding the installation and operation of this tide gauge, except knowing the physical existence of the tide gauge itself till 2004."

We have stated in L127 that the tide gauge itself existed until 2004, but the data stopped in 2001. To be consistent, we have updated the caption to Figure 2. "(d) A photograph of the Brillie type tide gauge operated till 2001..." is revised to "(d) A photograph of the Brillie type tide gauge that was installed until 2004..."

L132: "...each chart is found to contain..." is revised to "...each chart was found to contain..."

L145: "...Sea Level Monitoring Facility..." is revised to "...Sea Level Station Monitoring Facility..."

Figure 2: Figure 2a is not currently referenced in the text. To incorporate it into the text, we have revised L88-L91 as follows -

"The new sea level time series extended in this work is shown in Figure 2a with existing data in grey and the new data in black. To describe the development of this new time series, the history of the Socoa tide gauge is first presented through various instrumentation periods in Section 2. A summary of the rescued documents (containing data and metadata) is also presented alongside. The rescue process and the analysis of the time series are described in Section 3, which is followed by the quality control and the data quality assessment in Section 4. In Section 5, we present a trend analysis. The data availability is detailed in Section 6 with concluding remarks in Section 7."

Please also note that the color scheme in Figure 2a is revised to a colorblind-friendly scheme.

L159: "A chronology of the available measurement period, instruments, recording medium, time system during recording, time sampling before and after digitization and the source archive is summarised in Table 1." is revised to "A chronology of the available measurement periods, instruments, recording mediums, time systems during recording, time sampling before and after digitization and source archives is summarised in Table 1."

L166: Caption to Table 1 is revised to "Overview of the instrumentation periods, original data storage mediums, sampling period of the source and digitized data, and time system of the source observations."

The periods presented in the first column of Table 1 is reformatted to yyyy-mm-dd format.

L68: The line is revised to "During the rescue process, administrative documents were found in the archives in which the Socoa tide gauge was mentioned. These documents include tide gauge journals for the Chazallon period containing logs of tide gauge operations, the correspondence with the ministry (ministry of public works, and ministry of marine and

colonies), the engineering and hydrographic survey reports, the quotes for works, drawings etc."

L173: "...(see Data availability)" is revised to "...(see Section 6 Data availability)".

L176: "...1875-1920 period exists in..." is revised to "...1875 to 1920 period exist in...".

L187: "During digitization, the time data..." is revised to "During digitization, the time values...".

L188: "...from 1894 to 1920 it was recorded..." is revised to "...from 1894 to 1920 they were recorded...".

L208: "...applied before passing it through..." is revised to "...applied before passing them through...".

L211: "...very faint, either fully or partially. Further..." is revised to "...very faint, either fully or partially, we applied image processing to enhance the contrast to process them using NUNIEAU (Supplementary Figure S4)".

We have also revised L213 for clarity from "We have applied NUNIEAU on these charts to extract the water level at a chosen 5-minute interval." to "From the charts, the water levels were extracted at a chosen 5-minute interval."

L231: We have added a line to further elaborate on the use of Apparent Solar Time (AST) in the early days of Chazallon tide gauge. The revised segment reads as follows -

"...are in local AST. As noted by Wöppelmann et al. (2014), AST was used in the earlier days of the Chazallon tide gauge era despite the MST being the legal time in France since the early 18th century. Afterwards..."

L235: "with, t is the..." is revised to "where, t is the...".

L236: "...is fitted..." is revised to "...is specified...".

L265: "...are referenced at different height..." is revised to "...are referenced to different heights...".

L282: "...ZH was estimated 18 cm..." is revised to "...ZH was estimated as being 18 cm...".

L283: "...the connection with the sea..." is revised to "...connection to the sea...".

L288: "...primary benchmark is located..." is revised to "...primary benchmark was located...".

L308: "...as follow:" is revised to "...as follows:".

We have additionally revised the first line of Section 4.1 - "The flag value is defined as a 4-bit number where 1 means the correction is applied and 0 means no correction is applied. Each bit from left to right corresponds to the following:" which now reads as "The flag value is defined as a 4-bit number where 1 means the flag is on and 0 means off. Each bit from left to right corresponds to the following:"

L315: "...following section..." is revised to "...following sections...".

L233: "...was applied..." is revised to "...were applied...".

L331: "...typically in the order..." is revised to "...typically of the order...".

L340: "(See also Data availability)" is revised to "(See also Section 6 Data availability)".

L371: To incorporate the suggestion from both of the reviewers, we have revised the line as following -

"Figure 5 shows the M2 amplitude and Greenwich phase lag with the error bars representing the 95% confidence interval."

The caption of Figure 5 is also revised to "M2 amplitude (top) and Greenwich phase lag (bottom) calculated for one-year segments using tidal harmonic analysis. The dotted lines correspond to the amplitude and phase lag computed for the whole time series. Error bars are 95% confidence intervals."

L385: "These amounts to about 29 percent of the total recovered hourly data flagged as impacted by siltation." is revised to "In total, about 29% of the total recovered hourly data are flagged as impacted by siltation."

L390: "...under current condition..." is revised to "...under current conditions...".

L391: "For Socoa tide gauge,..." is revised to "For the Socoa tide gauge,...".

L400: "Brest tide gauge..." is revised to "The Brest tide gauge...".

L405: "...computing the monthly for Socoa..." is revised to "...computing the monthly means for Socoa..."

L407: "...using daily average." is revised to "...using daily averages."

L411: "...removed from Socoa..." is revised to "...removed from the Socoa..."

L420-421: "...to Brest. Hence, producing..." is revised to "...to Brest, hence, producing..."

L425: "...computed yearly mean using..." is revised to "...computed yearly means using..."

L426: "...the trends estimate and ..." is revised to "...the trends and ..."

L428: "To compare with previously..." is revised to "To compare with the previously..."

L430: "...under common period with an asterisk (*)." is revised to "...under the corresponding period with two asterisks (**)". We have also revised "...the trend estimate is very close for..." to "the trend estimate is very similar for..."

L435: "...the estimated trend..." is revised to "...the estimated trends..."

L436: "...during Brillie era..." is revised to "...during the Brillie era..."

L436: "Similar magnitude..." is revised to "A similar magnitude..."

L438: "During Chazallon..." is revised to "During the Chazallon..."

L439: "...the factors that contributes..." is revised to "...the factors that contribute...".

L452: "Javrejeva et al. (2008) shows..." is revised to "Javrejeva et al. (2008) show...".

L470: "The dataset starts from..." is revised to "The dataset starts at...".

L483: "...metadata analysis and..." is revised to "...metadata analysis, and...".

L488: "The amount of data where time..." is revised to "The amount of data when time...".

L505: "...computational environment, and notebook as..." is revised to "...computational notebooks as...".

L515: "...but many remains undigitized..." is revised to "...but many remain undigitized...".

Reply to Reviewers Comment: Reviewer 2

Comments on 'Extension of high temporal resolution sea level time series at Socoa (Saint Jean-de-Luz, France) back to 1875' by Khan et al. (ESSD)

Text colour codes: Review (black), Reply (blue)

The paper has been largely improved and is really clearer now. The new organization improves the readability. The Data Availability section is more detailed. The Conclusions section highlights the main findings and give some recommendations. We just have some very minor comments listed below.

- line 38: "a sea level trend of 0.8 ± 0.2 mm/year" over which period?

Reply: We have revised the line by adding the period. We have also updated the line to better reflect the findings by the cited paper.

"Similarly, Hunter et al. (2003) recovered and analysed intermittent sea level records made in Port Arthur, Tasmania (southern Australia) reporting an average sea level trend of 0.8 ± 0.2 mm/year relative to land and 1.0 ± 0.3 mm/year considering vertical land motion over 1841 to 2002."

- line 43: "tide has also been through changes – which requires..." the second part of the sentence is not very clear, maybe it could be reformulated "and high-frequency data (typically hourly or less) are needed to investigate such changes."

Reply: We have revised the line following your suggestions. The new sentence reads as follows -

"Alongside the mean sea level, tide has also been found to manifests long-term evolution and high-frequency (typically hourly or less) data are needed to investigate such changes (Woodworth, 2010b, Haigh et al. 2020)."

- line 45: "to appear" instead of "appearing"

Reply: Corrected to "to appear". The corresponding sentence now reads as follows -

"During the first half of the 19th century automatic mechanical tide gauges started to appear, paving the way for systematic continuous measurements of water levels at high frequency (Wöppelmann et al 2006b)."

- line 67: Haigh et al. 2022? (rather than 2020?)

Reply: Thank you for noticing, it is indeed supposed to be Haigh et al. 2022, referring to the latest GESLA version. The citation is now corrected.

- line 70: modelling of "surges" (rather than "surge")

- line 70: stations "have time series shorter than 50 years" (rather than "have a time series less than 50-year long")

Reply: Thank you for the suggested changes, they are now incorporated in the revised manuscript. The lines read as follows -

"Such a dataset also allowed global and regional analysis of tide (Piccioni et al. 2019), the non-linearity of tide-surge interaction (Arns et al. 2020), as well as data driven modelling of surges (Tadesse et al. 2020). Yet, most of the stations in GESLA have time series shorter than 50-year long."

- line 88: long sentence that could be split in two sentences. "...various instrumentation periods. Then, a summary..."

Reply: This paragraph has been revised in response to a review suggestion. The revised paragraph now reads as follows -

"The new sea level time series extended in this work is shown in Figure 2a with existing data in grey and the new data in black. To describe the development of this new time series, the history of the Socoa tide gauge is first presented through various instrumentation periods in Section 2. A summary of the rescued documents (containing data and metadata) is also presented alongside. The rescue process and the analysis of the time series are described in Section 3, which is followed by the quality control and the data quality assessment in Section 4. In Section 5, we present a trend analysis. The data availability is detailed in Section 6 with concluding remarks in Section 7."

Please note that the color scheme in Figure 2a is revised to a colorblind-friendly scheme.

We have also revised the last line of the introduction to Section 2. The revised lines reads as

"In the following sub-sections, we provide descriptions of each instrumentation period, along with detailed information about the cataloged documents."

- line 111: "Brest (France)"

Reply: "(France)" is now added at the end of the line.

- line 112: "1942 to 1944" without parentheses (as for 2.1 and 2.3 titles)

Reply: The title is now revised by removing the parentheses. The new title reads as - "2.2 Temporary tide gauge during World War II period: 1942 to 1944".

For 2.1, we have revised "1875-1920" to "1875 to 1920". The title text for 2.3 remains the same.

- line 155: Pouvreau (2008)? rather than Pouvreau et al. (2008)?

Reply: Thank you for noticing this typo. It is indeed Pouvreau (2008), instead of Pouvreau et al. (2008). We have revised the reference.

- line 235: "with, t the time" instead of "with, t is the time"

Reply: We have revised it as "where t is the time"

- line 236: “we” instead of “We”

Reply: Thank you. We have fixed this typo in the revised version.

- line 239: “This amounts to 404 seconds to be added to the MST recorded in Socoa to get the time in UTC.” the sentence is not very clear, it could be reformulated, for example “This leads to add 404 seconds to the...”

Reply: To clarify the sentence, we have revised two sentences into one. The revised sentence now reads as -

"To convert from MST to UTC, 404 seconds was added, which corresponds to a correction of 4 minutes per degree of longitude difference between Socoa and Greenwich (zero-longitude)."

- line 287: “zéro de l’échelle” with accents in French?

Reply: The typo is fixed now. The corresponds segment now reads as -

"... “the zero of the tide pole” (le zéro de l'échelle)..."

- line 300: the data “were flagged” rather than “was flagged”

Reply: This is now corrected and reads as "... data were flagged."

- line 317: several methods “were applied” instead of “was applied”

Reply: This is now corrected and reads as "Several basic quality control methods based on visual inspection were applied ...".

- line 333: “When the time-shift is different” rather than “Where”?

Reply: This is now corrected and reads as "When the time shift is different ...".

- line 365: “After restarting the operation of the tide gauge in 1950, the stilling well exhibited ‘again (?)’ siltation and blockage related problems”

Reply: Following your suggestion, we have revised the sentence as following -

"After restarting the operation of the tide gauge in 1950, the stilling well exhibited again the siltation and blockage related problems (Robertou 1963)."

- line 372: for this paragraph starting from “Figure 5 shows...”, a short sentence of introduction would be welcome, for example “To investigate siltation problems, we computed changes in M2 tide. Figure 5 shows...” (another option is to start the paragraph with line 379, “As noted in the literature...”)

- line 386: 29 % (instead of 29 percent, as % is used in the whole manuscript)

Reply: Following these two suggestions, we have revised corresponding paragraphs as follows -

"One of the main known issues for the Socoa tide gauge is the siltation of the stilling well (Roubertou 1963, Poirier et al. 2017). The geometry of the stilling well is shown in Figure 4a. The stilling well (Figure 4b) is connected through a pipe of 8cm diameter. The first major siltation problem with the data recording was noticed within the first few years of operation. Notably, the accumulation of silt inside the stilling well restricted the movement of the float (previous subsection) and impacted the recording of the low water levels (less than 70cm). Significant maintenance work was undertaken during 1883-1884 to improve the connectivity of the stilling well to the ocean by creating a duct (Figure 4a,d). The entrance shown in Figure 4c,d was apparently open and accessible through a wooden door. At some (unknown) point, the entrance was partially closed, and the connectivity with the stilling well was severed. After restarting the operation of the tide gauge in 1950, the stilling well exhibited again the siltation and blockage related problems (Robertou 1963).

"As noted in the literature (e.g., Pugh and Woodworth 2014), malfunctioning of the instrument can be detected by examining the tidal constituents. More specifically, blockage related to siltation can be detected as a simultaneous amplitude attenuation and phase delay (e.g., Wöppelmann et al. 2014). Here we computed the changes in M2 tide, from a running tidal harmonic analysis with yearly segments from 1875 to 2020 using Utide (python) version 0.2.6 (Codiga 2011, <https://github.com/wesleybowman/UTide>). Figure 5 shows the M2 amplitude and phase lag with the error bars representing the 95% confidence interval. The most apparent impact of siltation on tide can be observed during 1956-1963 in Figure 5, which is supported by the report of hydrographic surveys carried out at that time (Robertou 1963). Another simultaneous amplitude attenuation and phase delay can also be spotted around the end of the 1990s (1997-2000).

"We have flagged (fourth bit set to 1) the data that are deemed to be impacted by the siltation problem. Based on the above-mentioned harmonic analysis, the data from 1955 to 1963, and 1998-1999 period are flagged. We also added the siltation flag to the data from 1875-11-12 to 1883-08-31 based on the metadata. In total, about 29% of the total recovered hourly data are flagged as impacted by siltation."

- line 393: open-air radar "tide gauge"

Reply: Thank you for the suggestion. The sentence is revised to "For Socoa tide gauge, which is currently equipped with a guided wave radar, we recommend a transition from the installation on the stilling well to an installation mounted on the quay of the dike with an unguided open-air radar tide gauge."