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Discussion of Coastal Planning Should Be Based on Proven Sea-Level Data

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Abstract

In each tide gauge where enough information was available to infer a trend decades ago, the addition of new data has not resulted in a generally increased relative rate of rise, but, rather, in small fluctuations both in positive and negative. As the worldwide surveys of the relative sea level rises return numbers that are positive and negative, small on average and about constant, this means the alarming claims of up to 2 metres sea level rise to be added everywhere in the flood maps because of the increasing anthropogenic carbon dioxide emission lacks of a evidence.

Keywords

Sea Levels, Ocean and Coastal Management, Scientific Debate

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1. Introduction

In the case of the paper "COASTAL PLANNING SHOULD BE BASED ON PROVEN SEA-LEVEL DATA" which I published in the journal Ocean and Coastal Management with Professor Clifford Ollier as coauthor [7], Hunter, Woodworth and Willliams submitted a comment. As usual in the peer review, the editor requested a polite reply by me, that he sent to the authors of the comment, together with the request of only remove personal accusations to me and the editorial board. They were not expecting a reply, though this is the method of science, as they decided to withdraw their comments to submit to another coastal journal. This paper gives my further clarifications to prevent misinterpretations of the commented paper, and shows how past reconstruction and present satellite estimations of global mean sea levels (GMSL) fail the evidence at the tide gauges. This makes the predictions of future GMSL driven by the anthropogenic carbon dioxide emission unreliable.

2. Relative Sea Level Rises

As the tide gauges measure the sea levels relative to an instrument that may be subjected to a vertical velocity of subsidence or uplift, what is measured by the tide gauges is the relative rate of rise of the sea levels.

2.1. Worldwide Surveys of Relative Sea Level Rises

The relative sea levels rises and falls have been measured since the 1800s in a few selected locations around the world, covering a very limited portion of the world's coastline. This relative sea level rises and falls are linked to the inland subsidence or uplift, the extra subsidence of the tide gauge, and the alleged contribution of thermal expansion for the warming of the oceans and the mass addition from the melting of ices on land.

The PSMSL surveys as [1] are the best tide gauge information available. These surveys are based on the recorded monthly average mean sea levels (MSL) vs. time

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from individual tide gauges. These surveys include all the world tide gauges featuring long term datum control where at least 70% of annual means are present over a given period. Trends are not calculated for stations which have been marked with a quality control flag. Data marked with a quality control flag are ignored and are treated as missing.

If we consider the latest (23-Feb-2016) relative mean sea level rates of rise (SLR) computed by PSMSL [1], the listed 722 tide gauges have naïve average SLR +1.38 mm/year, but a maximum of +10.25 mm/year and a minimum of -17.63 mm/year. Maximum and minimum number of years to compute a trend are 189 and 21 years.

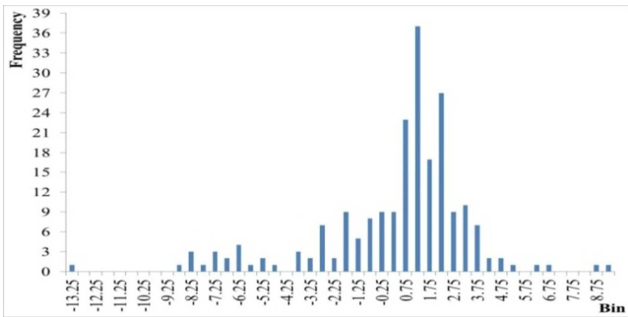
Of the 722 tide gauges of this survey, only 2 of these tide gauges started their recording before the year 1840, and only 72 have their recording started before the year 1900. The most part of these long term tide gauges are located in Northern Europe and the US East Coast. These most reliable, older, 72 tide gauges, have a naïve average SLR of -0.62 mm/year.

If we consider all the tide gauges that started recording before 1934, i.e. those tide gauges with more than 60 years of time span of data (hopefully with only minor gaps and good quality) at the start of the satellite era in 1993, this subset of 158 tide gauges has a naïve average SLR of +0.03 mm/year.

The naïve averages of the two subsets, the one with 72 and the one with 158 tide gauges, do not mean that the sea levels are globally falling of -0.62 mm/year or globally rising of +0.03 mm/year, but simply that picking up tide gauges, of different subsidence, length, long term rise or fall, and quality and gaps in a scattered population mostly covering few areas, there is no way to compute a meaningful GMSL.

If we consider all the tide gauges with at least 60 years of recorded data in 2014, this subset of 212 tide gauges has a naïve average SLR of +0.41 mm/year, maximum +9.41 mm/year, minimum -13.22 mm/year. Figure 1.a is the histogram of this data set. There are 64 tide gauges with negative SLR and 148 tide gauges with positive SLR. The number of tide gauges with a "relative" SLR exceeding the alleged global "absolute" SLR of +3.25 mm/year are 16 of 212. The most common SLR is +1.25 mm/year in 37 tide gauges.

If we consider all the tide gauges with record start not later than the year 1945 and record end not earlier than the year 2000, there are 146 tide gauges that satisfy the above requirement. The histogram of the distribution is proposed in Figure 1.b. For this other subset, the SLR is on average +0.32 mm/year, with a maximum of 6.75 mm/year and a minimum of -17.63 mm/year. 39 tide gauges of 146 have negative SLR. 98 tide gauges of 146 have "relative" SLR positive but smaller than the alleged global "absolute" SLR of +3.25 mm/year. 9 tide gauge of 146 have SLR larger than the +3.25 mm/year. The most common SLR is +1.25 mm/year found in 27 tide gauges.



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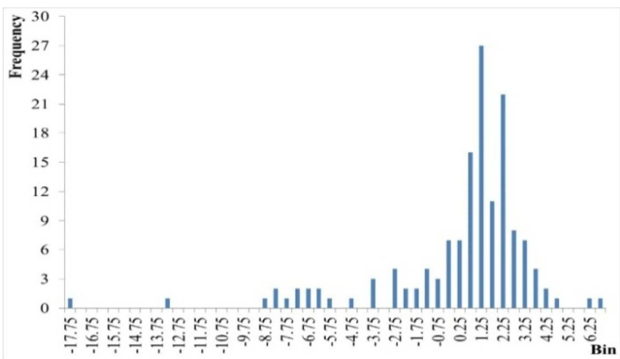


b

Figure 1. Frequency vs. bin of relative rate of rise of sea levels for (a) the 212 tide gauges with at least 60 years of recorded data in 2014 and (b) the 148 wordlwide tide gauges with start date ≤1945 and end date ≥2000.

Quality and length are not an issue for the tide gauges of previous subsets. For this last subset for example, the time span of data is on average 100 years, maximum 208 years, and minimum 58 years. The number of recorded years is on average 98 years, maximum 189 years and minimum 53 years. The completeness is on average 97%, maximum 100% and minimum of 79%.

To be noted, the latest PSMSL table [1] not only differs from previous tables because of the addition of fresh, new data. It also differs for some changes in the population, with some new tide gauges added and some other removed, plus a different computation of the trend versus the past PSMSL surveys.

The method of calculating the relative sea level trends by PSMSL was changed in 2015, and as claimed by PSMSL "*the trends displayed are not directly comparable with any calculated before that date*". As PSMSL writes, "*previously trends were calculated using a simple linear regression. However, this method is unsuitable for calculating uncertainties in trends, as the observations in the series are not totally independent of each other. In order to attempt to account for this autocovariance, trends are now fitted using an Integrated Generalized Gauss Markov stochastic model"*. We haven't checked the accuracy of the novel procedure. We may only comment that if "*the trends displayed are not directly comparable with any calculated before that date*", then we do not have the opportunity to compare the relative SLR of different PSMSL surveys to quickly assess the presence or absence of a sea level acceleration in the stations included in all the surveys. Comparison of apples with apples becomes more and more difficult also in the PSMSL.

We use the term "*naïve*" average as we know very well that the tide gauges are mostly located in North Europe, in areas of well known subsidence and uplift, as well as along the East Coast of the United States that is an area of subsidence. With just a couple of tide gauges covering the southern hemisphere since the 1880s, we leave to others such as [14], the computation of GMSL without having the supporting data.

Regarding the selection of tide gauge records, in our individual analyses we usually consider time span of data, completeness % of the record (i.e. gaps), plus perturbations that may have affected the recording (destruction of the instrument, change of site, improper revised reference). We were only concerned in providing a "*naïve*" average relative sea level rise with what is made available by PSMSL as their "*best shot*" in their surveys [1] not questioning the reliability of their data. We do not compare the naïve average of different subsets of tide gauges collected over different time windows in different locations. We compare only the relative rates of rises computed in exactly the same locations only accounting for freshly measured new data, without any adjustment (or "*administrative correction*") of method or past data.

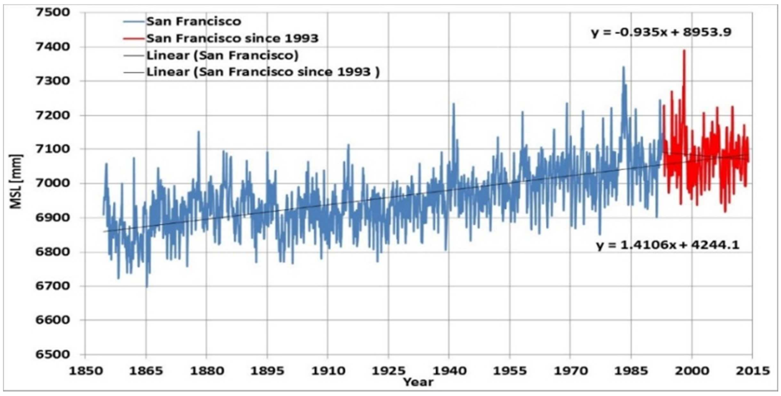
It is not by comparing two different data sets, one with 60 years of recorded data, and one with 80 years of recorded data, that you compute an acceleration. The higher naïve average of shorter records is only due to having recently established tide gauges in areas of more concern i.e. with larger subsidence. To meaningfully compare two naïve averages up to 1993 and up to 2014, you would have only to consider all the tide gauges with starting date prior of 1934 and high quality data collected up to 2014, and then consider as the end dates 1993 in one naïve average, and 2014 in the other.

2.2. Local Sea Level Pattern, Short Records and Multidecadal Oscillations

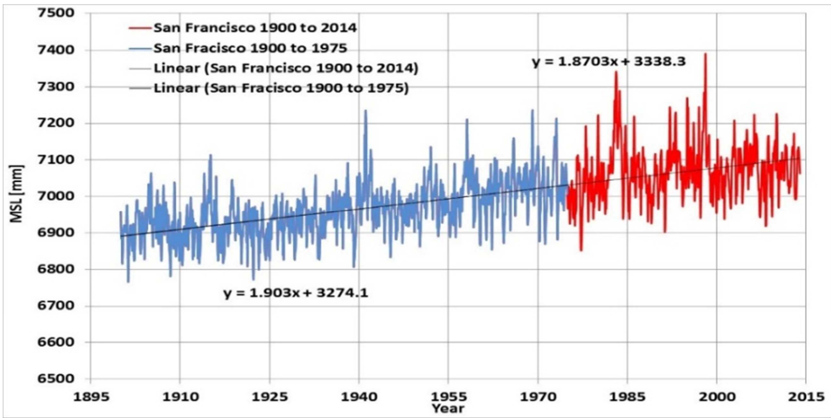
Not all the trends of the PSMSL survey [1] or many other works are meaningful. Without enough data of good quality there is no opportunity to compute a meaningful trend. Records with 15 years of data collected since 1993, that somebody may state "*which we consider a reasonable requirement in order to derive a reasonably accurate trend in this short period*", are actually insignificant. Because of the well known multi-decadal oscillations, minimum of 60-70 years of continuous data collected without major perturbations to the instrument are required to infer reliable trends [2-7].

Figure 2 shows the MSL measured in San Francisco and Seattle. The 2014 sea levels are lower than at the end of the 1990s. However, it is not correct to claim that the sea levels in San Francisco have been reducing since 1993 at a rate of -0.94 mm/year, or at a rate -0.63 mm/year in Seattle, as we could have wrongly inferred if the measurements would have started only in 1993. Rather, the sea levels have been mostly oscillating about the longer term trend of +1.41 mm/year in San Fransciso and +1.96 mm/year in Seattle and the 15 years or the 21 years time windows are definitively simply too short to compute any meaningful trend.

If we want to focus only on the data collected after 1900 as now done in the PSMSL online facility [8], in San Francisco the SLR in 1975 was +1.90 mm/year, and it is +1.87 mm/year in 2014. In Seattle, it was +1.92 mm/year in 1975 and it is +1.96 mm/year in 2014. So the values are pretty much the same now and 40 years ago. As acceleration is the time rate of change of the velocity, then we may conclude that between 1975 and 2014 there has been not too much of sea level acceleration in San Francisco or Seattle.


San Francisco
San Francisco since 1993
Linear (San Francisco)
Linear (San Francisco since 1993)
y = -0.935x + 8953.9
y = 1.4106x + 4244.1
MSL [mm]
Year

a


San Francisco 1900 to 2014
San Fracisco 1900 to 1975
Linear (San Francisco 1900 to 2014)
Linear (San Fracisco 1900 to 1975)
y = 1.8703x + 3338.3
y = 1.903x + 3274.1
MSL [mm]
Year

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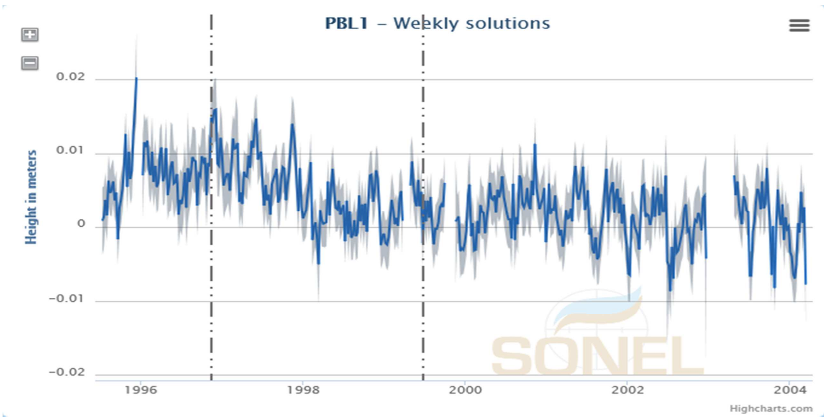
PBL1 – Weekly solutions
Height in meters
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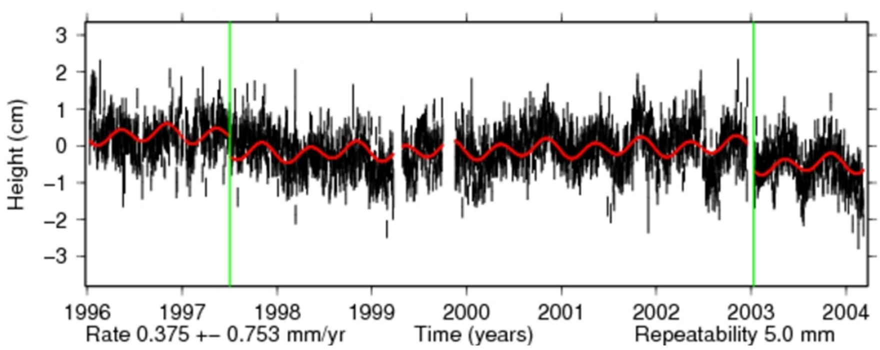
Height (cm)
Rate 0.375 +– 0.753 mm/yr
Time (years)
Repeatability 5.0 mm

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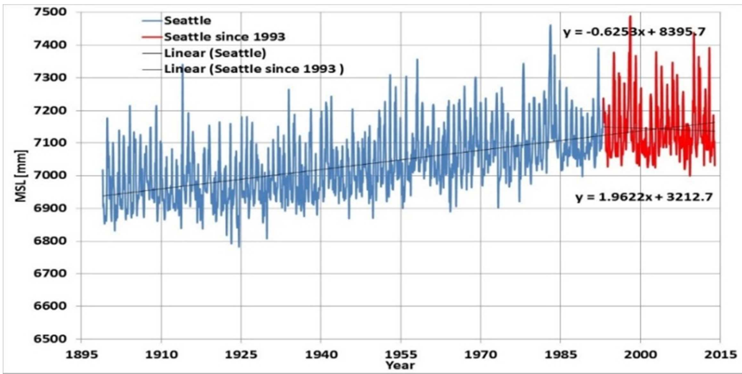

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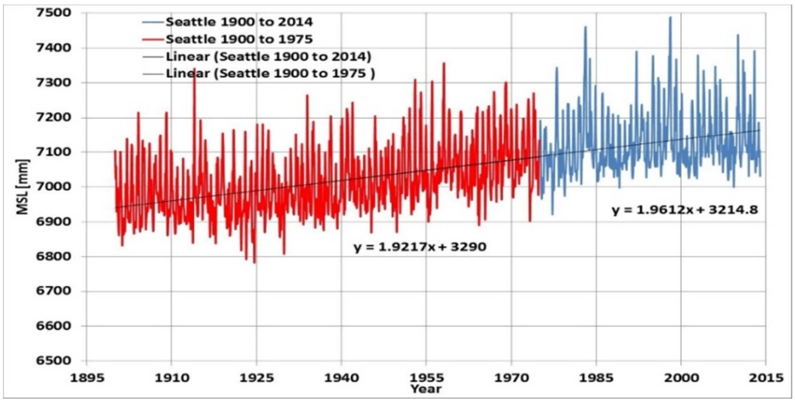

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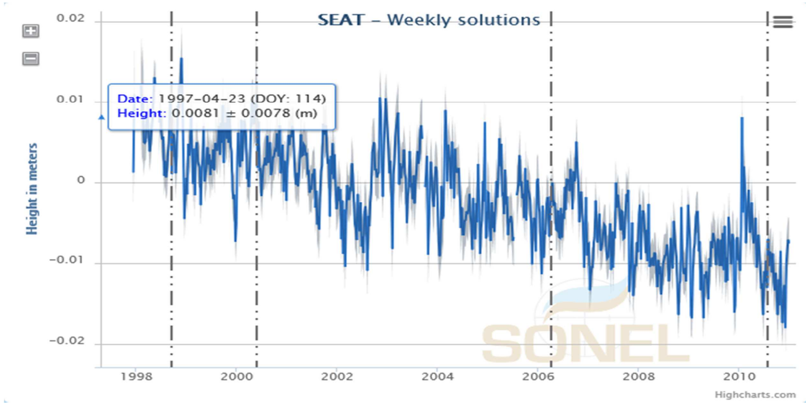

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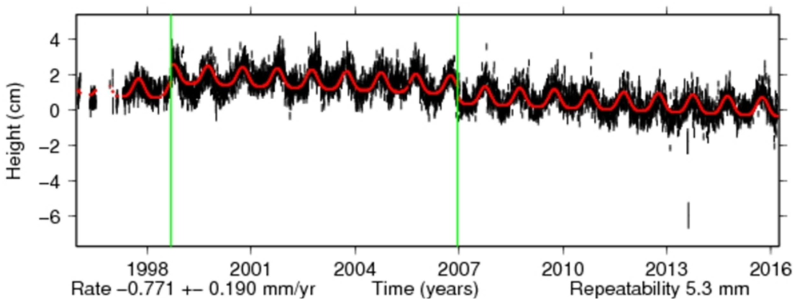

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Figure 2. Relative sea levels in San Francisco (a,b) and Seattle (e,f), data from PSMSL, plus GPS estimate of the land motion nearby the tide gauge location, for San Fracisco (c,d) and Seattle (g,h), images from SONEL and JPL. The position tide gauge vs. GPS dome is unassessed. The GPS computation is still suffering significant inaccuracies, usually much larger than the relative rates of rise of sea levels. The sea levels rise in these locations about the likely rates of fall of the tide gauge, with the alleged sea level rise component from melting of ice and thermal expansion everything but overwhelming.

We consider the MSL measured by a specific tide gauge at a specific time. We then consider in the same locations only the addition of freshly new data.

Finally, if we compute in the same way the SLR as the slope of the linear fitting curve, the changes in this result over the time window will tell us if the sea levels have been accelerating. If the SLR change very little both in positive and negative, then, there is no appreciable acceleration.

Without 60-70 years there is no way to compute a meaningful SLR. Is the SLR in San Francisco or Seattle +1.41 or -0.94 mm/year, or +1.96 or -0.63 mm/year? For us, it is clear it is +1.41 and +1.96 mm/year. By accepting the view that 15 years may be sufficient, -0.94 mm/year and -0.63 mm/year would be the correct answer.

As our comparison suggests "every single tide gauge and the global the naive average show the sea level is stable", similarly to what is shown in San Fransciso or Seattle.

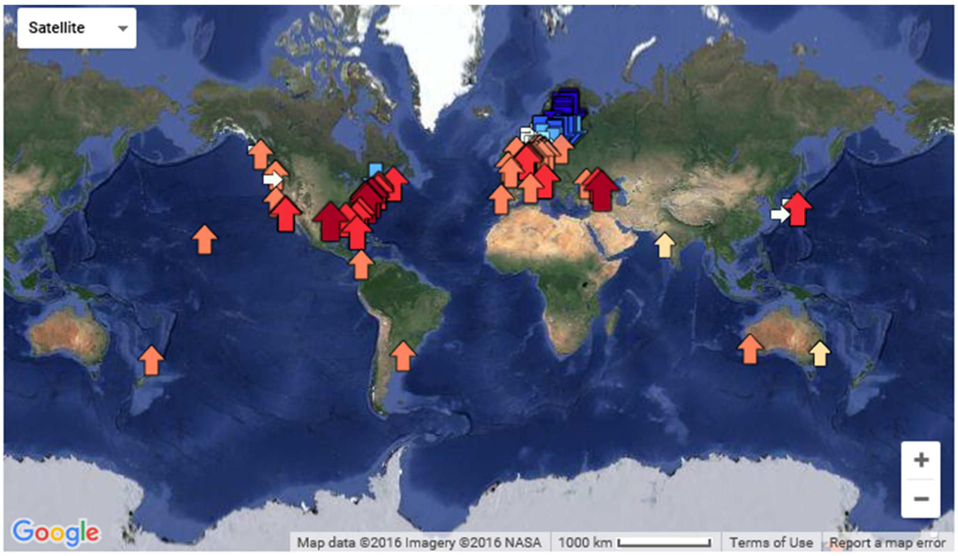
2.3. Quick Assessment of Sea Level Acceleration

To gather further confirmation of the 20th century and early 21st century sea level pattern, we may also use the interactive PSMSL investigator of global mean sea level trends [8]. This exercise tells us more about where the tide gauges are located, and eventually how they change over different time windows.

By using the online facility by PSMSL [8], where the start date cannot be placed earlier than 1900 and the last update is 2014, no matter the few "*administrative corrections*", the maps of relative sea level trends 1900 to 1975 and 1900 to 2014 appear very close to each other as previously shown in [9]. Computed with the same method in the same locations and considering only the addition of new measurements, the sea level rises or falls are pretty much the same.

Figure 3 presents a synthethic view of the SLR of the worldwide tide gauge with at least 70% of unflagged data over the period 1900 to 2014, plus the SLR of the tide gauges of Europe and North America during the period 1945 to 2014 with same percentage of good data. The focus is on Europe and North America because these are the two areas where the most part of the tide gauges are located. The number of tide gauges with a SLR exceeding +4 mm/year are very few and these few are all located in very well-known areas of subsidence. Where it is measured, the sea level rises or falls at about constant rate, without significant positive accelerations in the longer term trends cleared of natural oscillations.

A more accurate assessment may certainly be obtained by the analysis of the individual tide gauges. We already did this for the longest tide gauges, and all had small oscillations cancelling each other out in the naïve average, as it is shown for example in [4-7]. The relative sea levels have been rising or falling in the first part of the 20th century more or less as they did in the second part of the 20th century. So there has been no substantial acceleration and there is no reason to expect rises in the 21st century too far from those experienced in the 20th century.



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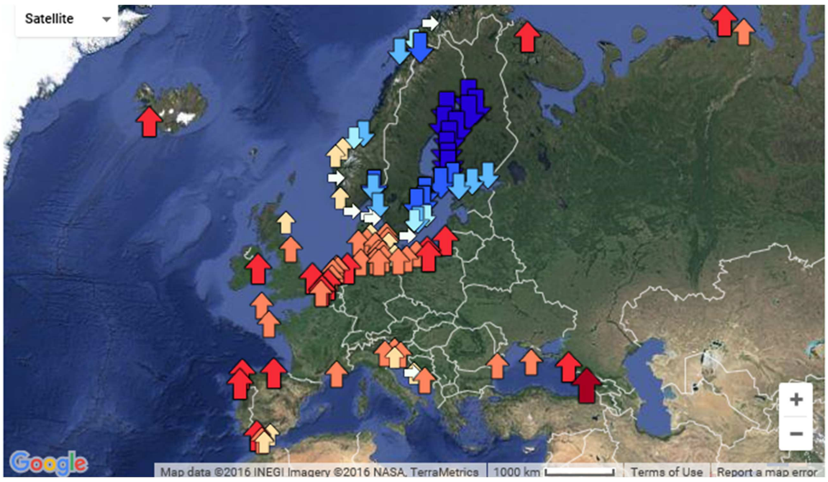

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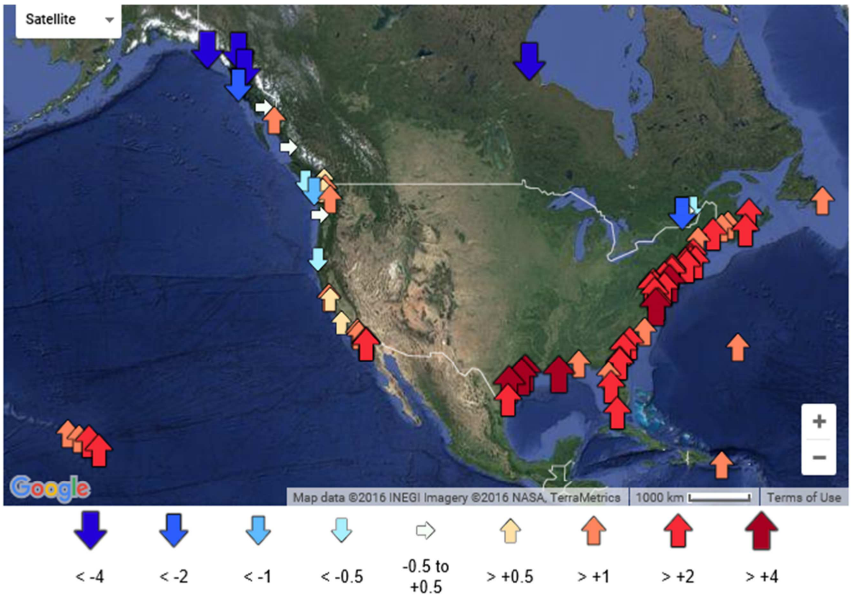

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Figure 3. Relative rates of rise of sea levels all over the world 1900 to 2014 (a), and in Europe and North America over the time window 1945 to 2014 (b,c). Images from [8].

2.4. Reliability of Global Mean Sea Level Reconstructions

This part is crucial to understand the future sea level patterns. The past GMSL is an artefact not supported by measurements. This artefact is used to prove the anthropogenic carbon dioxide emission driving the sea level rise. If the past GMSL is wrong, also the future predictions are wrong.

The locations with more than 60 years of data recorded are not that many worldwide also today, and considering those with suspicious data shift (see Karachi, [15]) or other quality issues, they are even less. There are simply not enough data to compute an accurate GMSL over the 20th century. However, what is available may certainly be used to question popular GMSL reconstructions as [14].

Ref. [14] is producing a continuous accelerating pattern similar to the anthropogenic carbon dioxide emission by nominally stacking tide gauges of different length and different subsidence that on average are acceleration free. This does not make sense.

The theory of the anthropogenic carbon dioxide emission driving temperatures, sea levels, ocean pH and whatever is climate change is built on a very subjective interpretations of scattered data revised to support the theory.

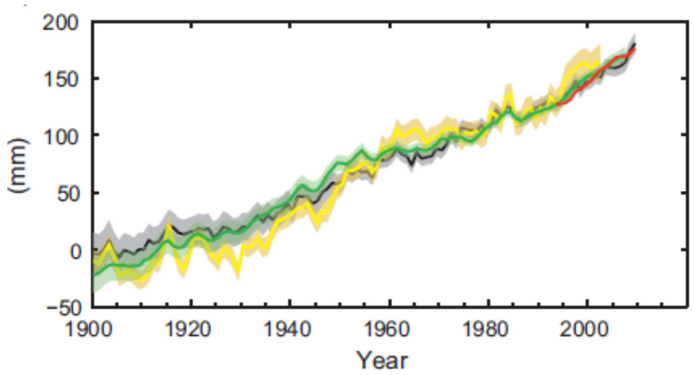
The sea level sensitivity to the anthropogenic carbon dixodie emission is an assumption rather than a result.

The sea level evidence of the IPCC AR5 WG1 [36, 37] is reproduced in Figure 4. It consists of a reconstructed 20th century and a forecasted 21st century GMSL. The forecasts are made dependent on the anthropogenic carbon dioxide emission scenarios through the CMIP5 models.

The figure also proposes the rate of rise of the updated version of the GMSL time series of [14] downloaded from [38]. The GMSL rate of rise is obtained by linearly fitting the reconstructed GMSL with a 20 years' time window.

The graph of past GMSL indicates a sea level rise of about 180 mm over the last 100 years, corresponding to a yearly rate of rise of about +1.8 mm/year. The sea level is also increasingly accelerating over the 100 years. The sea level rise was much smaller than the average in the early 1900s to get about the latest satellite GMSL above +3 mm/year since 1993.

The projected future sea level rise for the 21st century relative to the period 1986-2005 indicates a band in between 260 and 980 mm over about 100 years, for an average yearly rate of rise of about +2.6 to +9.8 mm/year.



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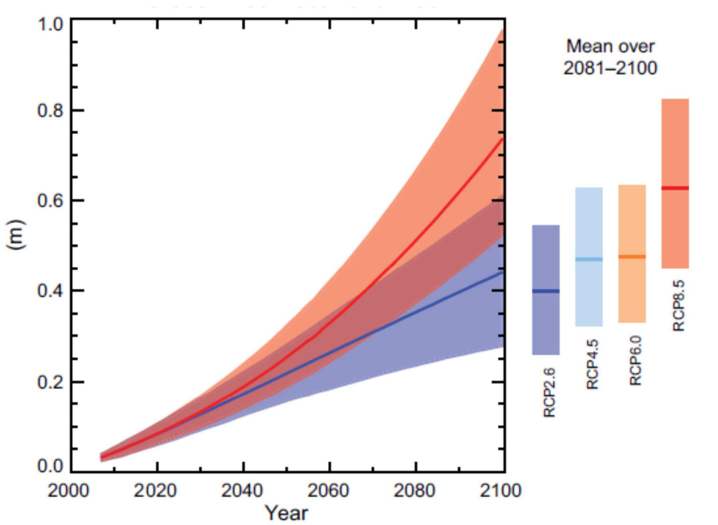

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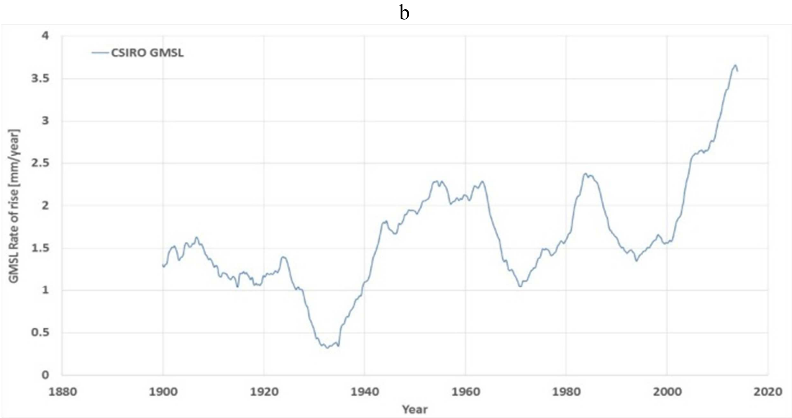

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Figure 4. Past (a) and (b) future global mean sea levels (GMSL) according to the IPCC AR5 WG1 [36]. Images taken from [36]. (c) rate of rise over a time window of 20 years of the reconstructed GMSL of [14, 38]. The GMSL of [14] is included in (a).

Ocean and coastal management bodies are now considering sea level rise forecasts even much worse than the IPCC AR5 WG1 forecast, with for example up to 2 meters sea level rise by 2100 in the United States [39].

Despite these extreme values are suggested by not even peer review works as [40], nevertheless the latest floods maps are obtained by adding 2 meters sea level rise everywhere [41].

The representation of Figure 4 certainly has the consensus of the authors of the IPCC AR5 WG1 Chapter 13. However, this does not mean it is correct.

We have discussed the rate of rise. In very few locations worldwide the rate of rise is about same of the GMSL rate of rise. In the most part of the locations, it is much less, even negative. Then, we have discussed the time rate of change of this rate of rise, i.e. the acceleration. Subsequent surveys of rates of rise return about same rates of rises in the same locations years after year, somewhere larger, somewhere smaller, almost perfectly cancelling each other in their average.

What is different in between the global population of tide gauges and the reconstructed GMSL of [14, 38] is not only the rate of rise and the acceleration, but also the time rate of change of the acceleration. This is evidenced with cubic fittings of the GMSL and of local MSL data.

A parabolic fitting of the GMSL 1900 to 2014 of Figure 4.c returns a trend $y=7.83241E-03x^2 - 2.89565E+01x + 2.66106E+04$ mm, translating in an average GMSL acceleration $d^2y/dx^2=1.57E-02$ mm/years^2. A cubic fitting returns a trend $y = 2.57101E-05x^3 - 1.43111E-01x^2 + 2.66390E+02x - 1.65989E+05$ mm. This translates in a GMSL acceleration $d^2y/dx^2=1.54261E-04x – 2.86222E-01$ mm/year^2. This GMSL acceleration is always positive over the time window and it is increasing year after year. This is not the case in local MSL.

A parabolic fitting of the MSL of Seattle 1900 to 2014 of Figure 2.f returns a trend $y = 2.01942E-03x^2 - 5.94283E+00x + 1.09466E+04$ mm, translating in a much smaller average MSL acceleration $d^2y/dx^2=4.03884E-03$ mm/years^2. A cubic fitting returns a trend $y=-4.43395E-04x^3 + 2.60519E+00x^2 - 5.09949E+03x + 3.33251E+06$ mm. This translates in a MSL acceleration $d^2y/dx^2=-2.66037E-03x + 5.21038E+00$ mm/year^2. This MSL acceleration is decreasing year after year and it is negative since mid-1958.

A parabolic fitting of the MSL of San Francisco 1900 to 2014 of Figure 2.b returns a trend $y = -1.56404E-03x^2 + 7.99190E+00x - 2.65005E+03$ mm translating in a much smaller, negative, average MSL acceleration $d^2y/dx^2=-3.12808E-03$ mm/years^2. A cubic fitting returns a trend $y = -3.30175E-04x^3 + 1.93689E+00x^2 - 3.78492E+03x + 2.47075E+06$ mm. This translates in a MSL acceleration $d^2y/dx^2=-1.98105E-03x+3.87378E+00$ mm/year^2. This MSL acceleration is decreasing year after year and it is negative since mid-1955.

It may be argued different areas may have different trends. The West Coast of the United States is a “*cold spot of decelerations*” if the East Coast is a “*hot spot of accelerations*”.

A parabolic fitting of the MSL of The Battery (NY) 1900 to 2014 returns a trend $y = 3.29276E-03x^2 - 9.83764E+00x + 1.35942E+04$ mm, translating in a still smaller average MSL acceleration $d^2y/dx^2=6.58552E-03$ mm/years^2. A cubic fitting returns a trend $y = 6.25170E-05x^3 - 3.63744E-01x^2 + 7.08332E+02x - 4.54733E+05$ mm. This translates in a MSL acceleration $d^2y/dx^2=3.75102E-04x-7.27488E-01$ mm/year^2. This acceleration is increasing year after year but it is now positive only since 1939.

Therefore, not the rate of rise, neither the acceleration, nor the time rate of change of the acceleration of the reconstructed GMSL are representative of the tide gauge population. Again, as the reconstructed GMSL for the 20th century is an artifact, the forecasted 21st century GMSL is a computation done by using non-validated models that should not be thrusted. The sea levels are rising, but not driven by the anthropogenic carbon dioxide emission. Consideration of 2 meters sea level rise in today’s flood maps as done in [39, 40, 41] is everything but scientific.

3. Absolute Sea Level Rises

As the pattern of sea levels evidenced by the measurements at the tide gauges is not supportive of the global warming narrative, alternative products more or less computationally based have been introduced to negate this evidence.

3.1. Local Vertical Velocity of the Tide Gauge Instrument

As what may produce a flood is the relative rate of rise sea level vs. land, there is no reason with about constant, small, relative rates of rise everywhere in the world where there is a tide gauge of enough quality and length to even think about absolute (geocentric) sea level rises. Nevertheless, for scientific purposes different from ocean and coastal management it has to mention the attempt to correct the local tide gauge result with the velocity of inland GPS domes.

The GPS monitoning is an inaccurate examining of the positioning of few inland domes located nearby few tide gauges. To further boost unreliability, the relative motion tide gauge vs. GPS dome is not assessed.

In the example of Figure 2, the GPS velocity of the dome of Bluff Point (PBL1) nearby the San Francisco tide gauge is -1.12 mm/year from SONEL [11] but it is +0.375 mm/year from JPL [12]. The GPS velocity of the dome of Seattle (SEAT) nearby the Seattle tide gauge is -1.34 mm/year from SONEL [11] but it is -0.77 mm/year from JPL [12]. Differences in between the similarly constrained computations from the same GPS traces of the position of the same inland GPS domes from two communicating organizations, SONEL and JPL, are still far from being consistent, as discrepancies are usually even much larger than those of Seattle and San Francisco. Therefore, there is no reason to believe that these nearby GPS dome vertical velocities accurately represent the true vertical velocities of the tide gauges. The GPS monitoring of few inland domes, and not even the tide gauges, is certainly progressing, but it is still far from being reliable.

From Figure 2 we may conclude that the land nearby both tide gauges, or better both tide gauge instruments, are very likely subject to a subsidence comparable to the relative rates of rise of the sea level.

If the interest is to assess the contribution by mass addition and thermal expansion, there are only minimal opportunities of an extra contribution to sea level rise however practically constant over at least the last 40-50 years.

3.2. Satellite Altimetry (and Peltier's Glacial Isostatic Adjustment)

It is a matter of fact that many recent studies of sea-levels have defocused from the relative sea level rise measured along the coastline, to focus on implausible "*global*" and local "*absolute*" values.

The Peltier's Glacial Isostatic Adjustment (GIA) model is questionably extending globally a local or regional feature, the glaical isostasy [10]. The load of the continental ice caps of the Ice Ages deformed the bedrock and the land rose in postglacial time. Both the Fennoscandian and global sea level data support a regional, not global, compensation.

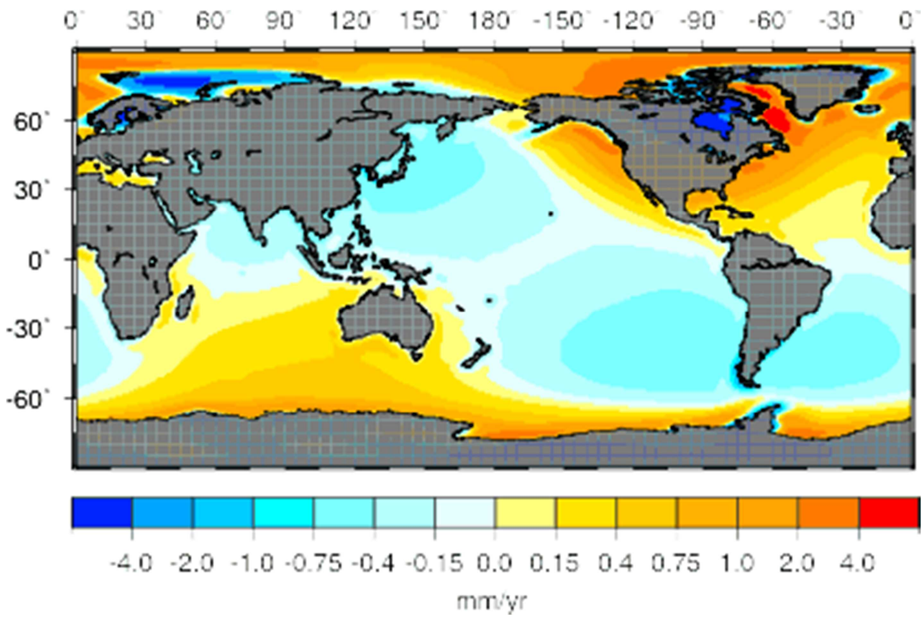
Subtracting the Peltier's GIA corrections from the otherwise almost detrended, mostly noisy satellite altimetry records brings all the different sea level indications, satellite and tide gauges, into harmony of a present minimal mean global sea level rise, that according to [10], may be everything bewteen 0.0 and +1.0 mm/year.

With the addition of the Peltier GIA model corrections, the result of the satellite altimetry is a computation rater than a direct measurement, and we do not certainly need one more flawed computational result.

The Peltier's GIA model is also conflicting with the GPS monitoring of fixed inland domes done by SONEL [11] or JPL [12], that despite still far from being as accurate as the relative rates of rise of the tide gauges, are certainly much better estimation of the land velocities than the Peltier's GIA model [13].

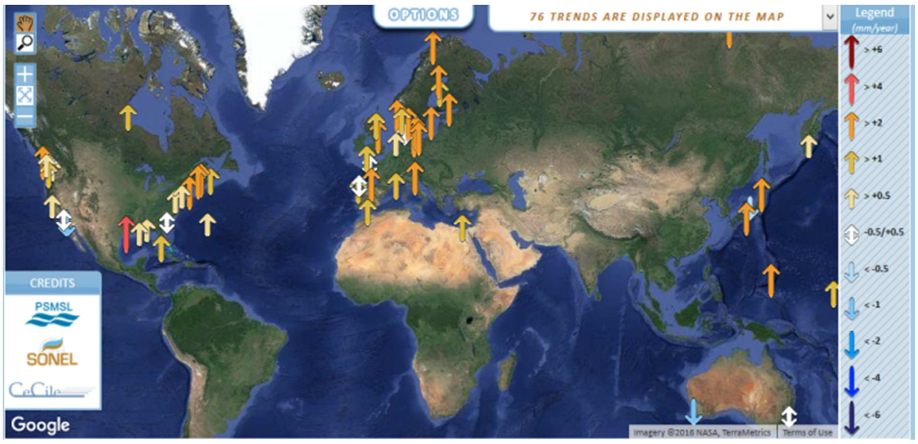
Figure 5 proposes the computed glacial isostatic adjustment (GIA) signal present in tide gauge data of the Peltier model as proposed by PSMSL [16], plus the GPS vertical velocities by SONEL [17]. The absolute and relative sea level velocities computed by SONEL [18] are also provided.

The relative sea level rise are computed over the window 1900 to 2013 where there is a nearby GPS dome of "*robust*" signal (according to SONEL).



a

b



c

d

Figure 5. Peltier Glacial Isostatic Adjustment results as proposed by PSMSL [16] (a). SONEL [17] velocities of inland GPS domes (b). Absoute (c) and relative (d) sea level rises according to SONEL [18], with sea level trends estimated over the period 1934 to 2013. The naïve average absolute sea level rise is obviously larger than the naïve average relative sea level rise. The absolute sea level rises are much larger than the relative in Europe, and much smaller in Australia. The Peltier model is not detailed enough, nor accurate enough, to predict the global mean sea level. It only serves the purpose to globally add almost 3 mm/year of global sea level rise in every geographical area.

According to Peltier, near the loading centers, the relative sea level is falling due to the continued uplift of the crust, while surrounding these loading centers, the crust is subsiding due to the collapse of fore bulge, and thus the relative sea level is increasing. The Peltier model is absolutely not adequate to represent the vertical motion of tide gauges and nearby lands, as the sea level rates of rise and the GPS vertical velocities are strongly variable in the areas where the Peltier's model returns about constant values.

Remarkably in the SONEL result, as the major area of concern of SONEL is Europe, the absolute sea levels are rising in Europe much faster than the relative sea levels at the price of a fall of the absolute sea levels in Australia where conversely the relative sea levels are rising.

No result is shown by SONEL for Alaska where the relative sea levels are sharply falling as the GPS signals are considered "*not robust*" enough by SONEL, while JPL actually produces estimates.

We believe the best estimation of the coastal land subsidence (or uplift) is still the measure at a tide gauge. There is no reason to search for "*absolute*" sea levels when the issues of sea level rise for coastal management are fully covered by a proper assessment of the local relative sea level rise and acceleration in every worldwide location with enough data to assess.

The statement by others "While GMSL measurements are continuously calibrated against a network of tide gauges, it is stated that the GMSL result cannot be used to predict relative sea level changes along the coasts" seems quite odd. The tide gauges "monitoring and consistency check" does not seem to work that well if the global mean sea levels from satellite are rising about the same +3 mm/year close to coastal areas monitored by tide gauges of sharp relative sea level decline over same time window as the US West Coast and Alaska, and close to coastal areas monitored by tide gauges of similarly sharp relative sea level increment over same time window as the West Coast of the United States.

Without "*administrative corrections*", the "*absolute*" altimeter rates of sea level are consistent with tide gauge rates at the coast. Without the arbitrary spreading of the Peltier's Glacial Isostatic Adjustment to the entire world producing generalised rates of rise of about +3.25 mm/year in every geographical area, the raw global relative rate of rise is something in between 0.0 and +1.0 mm/year [10].

We have already mentioned many times the arbitrary corrections of data sets. The temperature data sets hold by NOAA, GISS or BOM, but recently also RSS, for example all have experienced corrections where from one day to the other the past has been revised inevitably in the direction of magnifying the effects of global warming. With the satellite altimeter, there have been already few highly "*suspicious*" rounds of corrections raising reliability issues not certainly *"readily demolished at the time"* but still ongoing. We are concerned to provide the best numbers for coastal management. We do not believe coastal planning should be based on the spreading worldwide of one glacial isostatic model improperly called satellite altimetry global mean sea level.

4. Discussion of Coastal Management Implications

In the United States, the Biggert-Waters Act (HR 4348) had a provision mandating for coastal flood maps to change from being based on the local last 100 years of historic data to have a forecasted global SLR component estimated by climate models added everywhere. The Technical Mapping Advisory Council (TMAC) established by the Biggert-Waters legislation decided what SLR data to use to add to flood maps. In their recommendations [39], they accepted not even peer reviewed NOAA predictions [40] that are much worse than the IPCC AR5 WG1 predictions [36, 37]. This is not the aaplication of the "Best Available Coastal Science".

4.1. Adaptation Strategies Are Only Needed in Few Selected Locations

The relative sea level analysis for velocity and acceleration, in every location worldwide with good data, is ultimately what is needed for coastal management. In absence of acceleration in all the long term tide gauges, if the sea level is locally rising sharply, as for example EUGENE ISLAND, USA, where the relative rate of rise is +10.25 mm/year, there is certainly the need to enforce "*adaptation strategies*". But if the sea level is locally sharply falling, as for example SKAGWAY, USA, where the relative rate of rise is -17.63 mm/year, there is no need of such measures. From Figures 1 and 3 there is a need of adaption measures in very few worldwide locations, where extreme subsidence is the main reason of concern.

4.2. Coastal Management Should Be Based on Proven Data

Coastal management has to be based on accurate relative sea level rates of rises and accelerations in every available worldwide location to determine the better adaption strategy to prevent natural hazards. Planners need the best local information while ensuring the lack of any acceleration worldwide.

When the "*absolute*" modelled information is used to replace the accurate, measured, relative information to suggest construction of sea walls even where there is no need (the vast majority of the world coastline), then it should be stated clearly how inaccurate is this information is.

4.3. Downplaying the Evidence Contrasting the Narrative

The claims that "*computer model projections*" of future sea level are "*flawed*" is not based solely on a report by participants in the questionable *"Nongovernmental International Panel on Climate Change" (Carter et al.,* *2014)"* and a quotation from a paper by the economist R.S. Pindyck. The authors have published more than 100 papers explicitly exposing the inconsistency of models and actual direct measurements, i.e. the failed validation of climate models that unvalid should not be trusted for future predictions, with those listed in [19-29] just to name some. Many others also did, as for example [30-35].

4.4. We Cannot Afford to Enforce Draconian Measures Forgetting Other More Relevant Issues

We completely disagree with the statement "One can think of a GHG abatement policy as a form of insurance: society would be paying for a guarantee that a low-probability catastrophe will not occur (or is less likely)". In the today's world, almost half the population - over three billion people - live on less than $2.50 a day. Resources should be allocated to the solution of real global problems.

5. Conclusions

There are no preconceived errors in our assessment. The worldwide surveys of the relative sea level rises at the tide gauges return numbers that are small and about constant. This means nowhere the sea levels will rise of 1 or 2 metres by 2,100.

While satellite altimetry and GPS monitoring may certainly be interesting in the long run, right now they are not accurate enough to replace the information from the tide gauges or correct this information. The network of world tide gauges is the best source of information we do have to assess the local sea level rise and the global sea level acceleration.

In scientific research, a large data set is preferred to a small one, more accurate results are preferred to less accurate results and models are validated vs. experimental evidence. This should happen also in the science of sea levels.

Even if some may have an interest to believe (and force the others to believe) the opposite, there is no alarming sea level rise driven by the anthropogenic carbon dioxide emission. Coastal management should not be based on extravagant claims having no real supporting evidence.

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