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Analysis of the Data Presented by Tide Gauge Stations in Albania

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Abstract
This study focuses on the comprehensive monitoring of tide gauges along the coastal regions of the Republic of Albania, aiming to assess sea level variations and understand the dynamics of the coastal environment. Tide gauges play a crucial role in providing essential data for coastal management, climate change studies, and disaster preparedness. The research involves the deployment and maintenance of tide gauges at strategic locations along the Albanian coastline, coupled with an in-depth analysis of the collected data. The monitoring process includes continuous data acquisition from tide gauges, incorporating advanced sensors and telemetry systems to ensure real-time and accurate measurements. The acquired data are analyzed to identify patterns, trends, and anomalies in sea level variations. Additionally, the study investigates the influence of meteorological and oceanographic factors on tide gauge readings, enhancing the understanding of the complex interactions shaping coastal dynamics. Furthermore, the research explores the implications of observed sea level changes on coastal ecosystems, infrastructure, and community resilience. It provides valuable insights into potential threats such as coastal erosion, saltwater intrusion, and flooding. The findings contribute to the development of effective adaptation and mitigation strategies to address the challenges posed by rising sea levels. The study emphasizes the importance of international collaboration and data-sharing initiatives, as sea level changes are a global concern. By documenting and analyzing tide gauge data in the Republic of Albania, this research not only enhances local coastal management but also contributes to the broader scientific understanding of sea level variations and their implications for coastal regions worldwide. The outcomes of this study serve as a foundation for informed decision-making, sustainable development, and the protection of coastal environments in the face of ongoing environmental changes.
Keywords: Tide gauges; mean sea level; data analysis; accuracy.

1. Introduction

Measuring sea level is one of the main elements that serves to measure the effects of climate change, and it is necessary to analyze past sea level to predict future sea level changes.
However, a qualitative assessment of sea level is difficult to analyze and predict. Many different elements have an impact on sea level, such as temperature changes and the process of melting glaciers.
Local sea level has been measured for hundreds of years to help people understand the sea and to create warning systems to cope with the various damages that can come from the sea.
In fact, the collection of sea level data is carried out by tide gauges, which provide high quality and high accuracy data and have been used in the past to predict future regional and global sea levels.
A tide gauge is a floating system operating in a still well that measures sea level relative to a nearby geodetic reference point (benchmark).
Tide gauges are traditionally used for continuous measurement of sea level at a specific location over a relatively long period of time.
There are three types of tide gauges which are based on pressure, acoustic and radar. There are hundreds of tide stations in the oceans all over the world.
Tide gauges are also placed on the coast and are affected by tides, vertical land movement, weather conditions and shallow water. To find the global sea level by means of tide gauges, a global distribution of them is needed.

2. Time Series Analysis

Time series analysis is used to see trends over time, to equate periodic changes over time, and to predict future valuations.
In this study, time series analysis was used to find trends in tide gauge data in the Republic of Albania.
One of the challenges in determining trends in time series is to determine the time interval that includes enough data to obtain a good linear estimate.
It should be noted that the data transmitted by tide gauges, from the moment of their installation until today, are almost 4-5 years old.
Although the time interval is too short to carry out time series analysis, since for proper analysis a time interval of 30 years is needed, in this paper are the analysis of 2 years of tide gauge data of Durrës, Orikum, Saranda and Shengjin.

2.1. Corrections for mean monthly sea level

The daily transmitted data of tide gauges in Albania for which he is responsible ASIG are used to calculate monthly mean sea level (MMSL).

When calculating MMSL from daily data, if the number of daily data is less than 24 for a month, the value of MMSL is not averaged from these daily data but it is interpolated from a close and calculated value located nearby.

In this way, time series with data gaps are first identified for each mareographic station located in Albania and then their interpolation is performed to correct and fill the series with missing data.

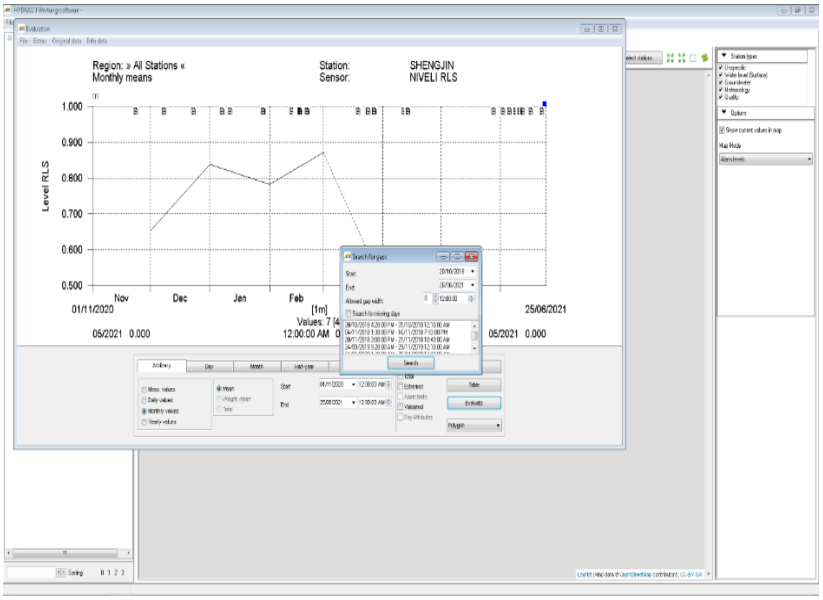

Figure 1. Identification of empty data spaces (Data Gaps) for the mareographic station in Shengjin.

After searching for empty data for each tide gauge, it turned out that only the Shengjin tide gauge lacks data for certain days, the correction of which was carried out through isolines and interpolation.

The interpolation of these values was performed through the Hydras3 program, which is a special program for the processing and manipulation of different values in terms of sea level.

This is used to minimize potential biases arising from the imprecise resolution of biweekly variability associated with anomalies and strong influences that large tides may introduce.

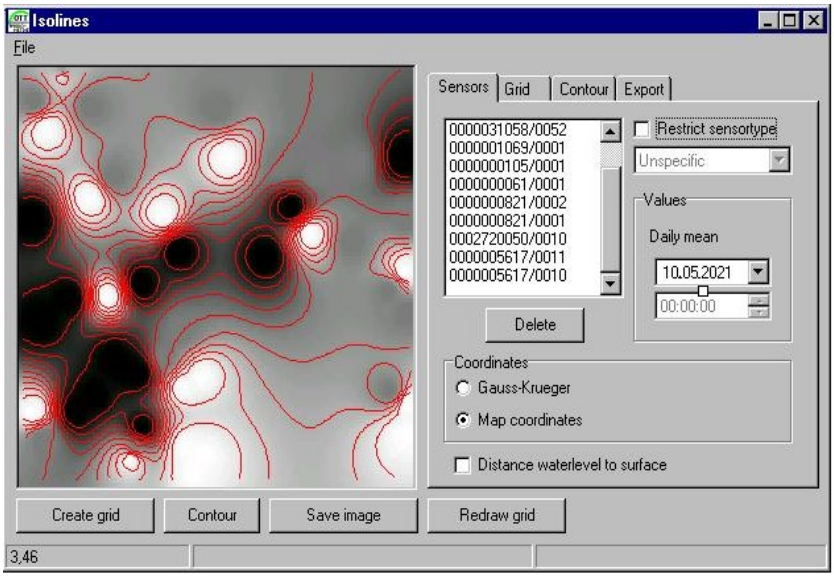

Figure 2. Interpolation of approximate sea level values using the Hydras3 program.

Since the interpolation of the values was done precisely, we can also calculate the atmospheric corrections and other corrections for the data values that we have and will be analyzed.

Using monthly mean sea levels effectively filters out signals with periods shorter than about a week, such as the main diurnal tide and semidiurnal tidal components.
However, longer-period signals (including monthly and semi-annual variations) remain present in the MMSL time series.
Long-period signals can significantly bias long-term trend estimates, especially if the time series is not much longer than the dominant low frequency of the oscillation or if it ends in the middle of a major decadal-vent.

Figure 3. Tide Gauges Network in Albania.

3. Correcting Common Noises

Common noise correction is applied directly to the sea level time series via the Hydras3 program.
This program classifies tide station data according to correlation coefficients by correcting white noise signals or eliminating colored noise signals.
Those stations whose correlation coefficient is greater than 0.6 are categorized into a group.
Thus, the tidal station of Durrës and Shengjin are included in the group where the correlation coefficient is greater than 0.6, while the tidal station of Saranda and Orikum are classified in the other group.
Since the noises are more present in the first group, then the corrections of the data on the sea level of these tide gauges will be greater than the data of other tide gauges.
The remaining series are aggregated within each group to form the regional joint pattern corrections, which are subtracted from the original MMSL series.

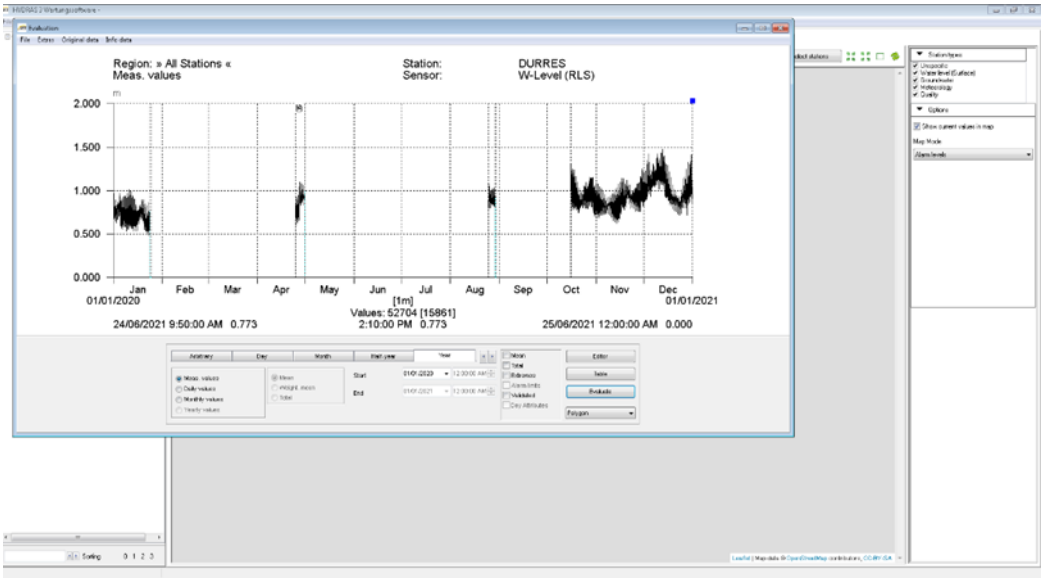

Figure 4. Correction of data noises transmitted by the tide gauge of Durrës.

5. Conclusions

The conclusions for the work done are:

1. First, for the study of the linear trend of the sea level in Albania, at least approximately 19 (18.6) years of sea level data from tide gauges are needed. So, in the future the linear trend of the sea level in our country can be studied for scientific research and can be precisely calculated.
2. Regarding the tide gauges, the criteria for recording their data and monitoring their operation should be followed so that there are no data gaps. In addition, estimating the velocity of vertical land motion by GPS requires that the tide gauge has a continuous GPS station no more than 20 km away.
3. In the Local Datums of tide gauges it is necessary to carry out high precision leveling at defined time intervals according to international standards with in the allowed accuracy.
4. In order to increase the accuracy in determining the mean sea level, it is important to combine the data transmitted by tide stations with the data transmitted by Satellite Altimetry.

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