An Approach of Coastal Areas Flood Dynamics Using GIS Techniques

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Abstract

The exceptional conditions of the coast for the development of multiple human activities have led to a continuous migration of inhabitants, industries and services to the coastal areas. The reasons for such migration have evolved over time, being historically the commerce, the port activity and the agricultural settlements in the fertile deltas and alluvial plains the causes of such migration, while at present it is are tourism associated with leisure and the enjoyment of the coastline.

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Keywords: Flood Dynamics, Coastal areas

Introduction

Flood Dynamics have been an emerging research area where large number of researchers participate their roles[1-6]. The exceptional conditions of the coast for the development of multiple human activities have led to a continuous migration of inhabitants, industries and services to the coastal areas[7].

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are tourism associated with leisure and the enjoyment of the coastline.

According to the Intergovernmental Panel on Climate Change (IPCC), about 50% of the world's population lives in the coastal zone.

In Europe alone, more than 70 million inhabitants reside in coastal municipalities, with the

total value of property located within 500 meters of the European coastline, including homes, land

agricultural and industrial facilities, close to one billion euros.

All these inhabitants and material goods are threatened by coastal flooding due to the dynamics Marine. According to IPCC predictions, the risk of flooding

increases every year for urban, tourist and industrial infrastructure, farmland, recreational areas and habitats[8].

natural. Said Intergovernmental Panel estimates that the annual number of victims due to coastal flooding will reach

158,000 in 2020 and that more than half of the wetlands will disappear as a result of said flood.

The economic cost of the mitigation actions of the

The effects of coastal flooding, closely related to coastal erosion, are increasing. I agree with you

It is important to point out that this cost only reflects the investments carried out to protect assets exposed to an imminent risk, but not the costs induced in human activities. According to previous IPCC studies, these expenses have an annual average of about 5,400 million euros.

Sea level oscillations

The sea level undergoes continuous variations in response to different atmospheric, marine, tectonic and planetary, being usual to classify these oscillations by the timescale of the oscillation. Apart from tsunamis, the subject of a specific article in this edition of the magazine, the most relevant oscillations in terms of coastal flooding are: waves, infragravitational waves, meteorological tide, astronomical tide and variation of long-term sea level.

The swell is, without a doubt, the oscillation of the sea more commonly known and also the most relevant in terms of coastal erosion and coastal flooding. The waves, generated by the action of the wind on the surface of the sea, is an oscillation of the sea level with periods between 3 and 30 seconds whose magnitude, in a return period of 50 years, exceeds nine meters of significant wave height on the Spanish Atlantic coasts and six meters on the Mediterranean coasts.

Figure 1 shows an example of the effects of the wave storms in port infrastructures. The figure shows the fishing- sports port of Llançá (Gerona), the which was subjected to an East-Northern storm in October 1997.

As a result of the Eurosion project, in 2001 the funds dedicated toThe virulence of the storm

astal protection in Europe amounted to

3.2 billion euros, 30% more than in 1986. It is im

(significant wave height of 5.4 m at the Rosas buoy) wascan be seen in photograph A, where the overshoot of thewave above the port shoulder affecting the fish market.

On the other hand, as can be seen in

photograph B, the Gola beach was completely flooded by the sheet of Water. In this particular case, the superelevation due to the meteorological tide was not of great importance, the flooding being due almost exclusively to the magnitude of the waves (the superelevation due to the meteorological tide was less than 10 cm).

Infragravity waves are oscillations of the level of the sea with periods between 50 and 500 seconds. The origin of this oscillation is the modulation of the wind swell in packets of large waves small waves produced by the propagation of same on the continental shelf. This train modulation of incident waves causes disturbances in the balance of dynamic forces of the water mass, generating variations in the sea level that tend to balance the system. These oscillations, known as infragravity waves or long waves associated with wave groups, have a magnitude of centimeters or a few decimeters in deep water but, like tsunamis, they are amplified as they they reach the coast. This type of oscillation shows its relevance at the ports, where it can be coupled with the eigenmodes of oscillation of the docks giving rise to port resonance phenomena, and on the beaches, where the breaking of the waves it releases the long waves trapped in the groups and the gentle slope of the beach slope amplifies their magnitude, reaching over a meter in storm conditions.

The meteorological tide [6, 9]is an oscillation of the sea level due to the joint action of atmospheric pressure and wind drag, and its period can be from several minutes to days. The low atmospheric pressures associated with the passage of storms generate a rise in sea level associated with their barometric depression. The large extra-tropical storms that affect the Spanish coast generate, habitually, overelevations of the order of 30-40 centimeters and can even generate overelevations of the order of the subway. The wind, due to its ability to drag water, is another factor that can give rise to the over-elevation of the level of the sea on the coast. For the action of the wind to generate a significant sea level rise, it is necessary that the magnitude of the wind is significant, above 20 m/s, and, fundamentally, that certain conditions of geometry of the coast and shallow draft. In some places of world, either because of the magnitude of the storms (hurricanes) or due to the geometric characteristics of the coast (the Netherlands, Venice...), the effects of the meteorological tide can reach to be, combined with the presence of waves, devastating.

In Spain, and particularly in the Mediterranean, major meteorological tidal events occur, with the consequent coastal flooding.

This is the case of the well-known storm of November 2001 that affected the Catalan, Balearic and Valencian coasts mainly. In November 2001 on Chilches beach (Caste llón). As can be seen in said figure, the average flood level (swell + meteorological tide) is around 0.5 to 1m. However, throughout the day of November 11, the arrival of the storm took place (with heights of significant hello propagated to pie de playa of between 3 and 4 m and a meteorological tidal surge of 1 m). The level of flooding in the simulation carried out reached 4.5m An image of what happened on Lloret beach during the same storm can be seen in figure 3.

In view of these results, it is concluded that the phenomenon of coastal flooding is a phenomenon in which it is necessary to take into account not only the waves and the meteorological tide independently, but also to model the correlation between both.

The astronomical tide is an oscillation of the sea level of a deterministic nature whose oscillation period varies between 12 hours and 19 years. The magnitude of it along the Spanish coast is highly variable, with a maximum of tidal race in Santander, where the five meters, and a minimum in Gerona, where they barely reach 40 centimeters in equinoctial spring tides.

Contrary to what it might seem, the astronomical tide plays a role of "lamination" of the extraordinary events of coastal flooding, since the coincidence of an extreme meteorological wave and tide event coinciding with an equinoctial spring tide has a period of major occurrence. Typically, such extreme events occur with mean tides and, therefore, the effects of meteorological elevation are attenuated.

Flood level regime

From all of the above it follows that coastal flooding is a random phenomenon resulting from the combination of different processes of marine dynamics. In a simplified way the coastal flooding phenomenon can be represented by according to the scheme in figure 4. At a given instant, a point on the coastline is characterized by a tide level

The mean wind and meteorological tide regime shows a negative trend (reduction), but on a very small scale. It is important to highlight the great statistical significance provided by the negative trend results of meteorological tide in the Mediterranean, the Balearic Islands and the north west coast of Galicia, despite their very small variations.

Gulf of Cadiz

The Gulf of Cadiz shows a very clear negative trend in wave energy for all wave variables studied, which confirms the trend towards a milder maritime climate.

Canary Islands

A clear North-South zonation is detected in the trend of change of storms. This fact is explained by the different nature of wave generation in the north (waves generated in the North Atlantic with a generation fetch very extensive), with respect to the south (waves generated in an area closest to the archipelago). The variation results to long-term indicate

(NM) composed of the astronomical tide and the meteorological tide (MA+MM) and a bathymetry. On this level of tide is the wave that, depending on its characteristics and the bathymetry of the beach, spreads towards the coast.

When reaching the coast, the waves break (on the beach, es collera breakwater, promenade...), producing a movement of rise of the water mass along the profile of the coast,

tends to be more eastern.

that there has been an increase in storms in the north and a trend towards energy reduction and clockwise rotation of wave directions in the south.

Effects of long-term trends of the flood level regime

The variations in the wave regime, meteorological tide and mean sea level described in the study carried out by the Spanish Office for Climate Change will lead to significant effects on coastal flooding, both with regard to beaches and structures. port defense. Specific:

Effects on beaches

The most important effects that climate change can assume on the beaches will manifest themselves basically in the variation in the level of flooding and in the retreat, or in its case advance, of the coastline.

In the case of the flood level, this parameter is determined by the joint probability of the tide astronomical, of the meteorological tide, of the in the run-up beach and the rise in mean sea level. of the values obtained for all these variables, an increase is obtained total level of flooding, which is mainly induced by the rise in mean sea level. Nevertheless,

On the Galician coast and in the northern part of the Canary Islands, the increase is greater than in the rest of the coast, since In these areas there is a significant increase in the height of a significant wave with a return period of 50

years. On the other hand, the variation of the meteorological tide Along the entire coastline, it partially counteracts the increase in the flood level produced by variation of the

mean level and significant wave height. As representative data,

nother effect that will take place on the beaches is the retreat of the coastline, which will also bring about an increase in coastal flooding. This setback will be induced by an increase in the mean level, which makes the active profile of the beach

have to climb to reach dynamic equilibrium with this new mid-level condition. For this, it is necessary to cover the sand deficit that occurs in the active profile and this will be done at the expense of the dry beach sand and the berm, producing a setback of the high tide line. The beaches most susceptible to the rise in mean sea level are

those located on the Atlantic coast of the Spanish coast, as well such as those located in the Balearic Islands, obtaining in these setback zones of the order of 16 meters. In the Mediterranean

area, the setback will be less, since the extension of the active profile of the beaches is less.

Another parameter that can contribute to additional beach retreat is variation in flow direction.

energy medium. This recoil is highly dependent of the type of beach considered, as well as the propagation that the waves suffer from indefinite depths to the specific beach. The beaches most susceptible to this type of setback correspond to the north of the Mediterranean, especially those of the Costa Brava, with the effect on the Balearic Islands and also in the south of the Balearic Islands being particularly relevant.

Canary Islands. In these areas the recoil can reach up to 40-50 meters, since the variation of the flow direction average energy sometimes exceeds 8°. In the rest of the coastline, this fact cannot be underestimated either, observing values of the setback of the order of 20 meters.

Conclulsion

With regard to the possible effects on maritime works, the long-term changes due to climate change can suppose important changes in the overflow of the works, both in sloped structures as in vertical structures. Yes, for

For example, consider a vertical impermeable structure without type bootolas, characterized by a one-meter francboard, assuming the climate change scenario estimated in the previous section, it can be verified that the rebase in this

type of structures will undergo significant changes with respect to current values and that these dimensional variations will be more noticeable in the Mediterranean area, especially in the area between Malaga and Algeciras,

where variations of up to 250% can be achieved with

with respect to the current overhangs (in this type of structure).

References:

[1] Y. Liu, E. M. Ozbayoglu, E. R. Upchurch, and S. Baldino, "Computational Fluid Dynamics Simulations of Taylor Bubbles Rising in Vertical and Inclined Concentric Annuli," *Available at SSRN 4135059*.

[2] Y. Liu, T. A. Tong, E. Ozbayoglu, M. Yu, and E. Upchurch, "An improved drift-flux correlation for gas-liquid two-phase flow in horizontal and vertical upward inclined wells," *Journal of Petroleum Science and Engineering,* vol. 195, p. 107881, 2020.

[3] A. Al-Hanbali, B. Alsaaideh, and A. Kondoh, "Using GIS-based weighted linear combination analysis and remote sensing techniques to select optimum solid waste disposal sites within Mafraq City, Jordan," *Journal of geographic information system,* vol. 3, no. 04, p. 267, 2011.

[4] Y. Liu, E. R. Upchurch, and E. M. Ozbayoglu, "Experimental study of single taylor bubble rising in stagnant and downward flowing non-newtonian fluids in inclined pipes," *Energies,* vol. 14, no. 3, p. 578, 2021.

[5] Y. Liu, E. R. Upchurch, and E. M. Ozbayoglu, "Experimental and Theoretical Studies on Taylor Bubbles Rising in Stagnant Non-Newtonian Fluids in Inclined Non-Concentric Annuli," *International Journal of Multiphase Flow,* vol. 147, p. 103912, 2022.

[6] M. P. Vanparia and Y. Ghodasara, "Review Paper On To Study and Enhance Coastal Security System Using GIS/GPS Tool," *International Journal of Computer Applications & Information Technology,* vol. 1, no. II, 2012.

[7] B.-J. Butijn, D. A. Tamburri, and W.-J. v. d. Heuvel, "Blockchains: a systematic multivocal literature review," *ACM Computing Surveys (CSUR),* vol. 53, no. 3, pp. 1-37, 2020.

[8] L. Wenqiang *et al.*, "Wellbore drift flow relation suitable for full flow pattern domain and full dip range," *Petroleum Exploration and Development,* vol. 49, no. 3, pp. 694-706, 2022.

[9] M. Ghose, A. K. Dikshit, and S. Sharma, "A GIS based transportation model for solid waste disposal–A case study on Asansol municipality," *Waste management,* vol. 26, no. 11, pp. 1287-1293, 2006.