Wave characteristics on the Pacific coast of Costa Rica for energy production

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INTRODUCTION

Costa Rica has a great potential for the production of electricity from waves, especially in the Pacific coast [2]. Currently, 99% of the country's electric energy is produced by renewable sources such as hydropower, wind and geothermal; the extractable energy potential from waves in the Pacific coast equals the combined energy of all these sources [3].

The iMARES group of the University of Costa Rica has carried out a continuous measurement of the Pacific waves of Costa Rica, from which wave characteristics have been determined and how these can influence the production of electrical energy.

The arriving waves at the Pacific Coast of Costa Rica are originated mainly in the east side zone of New Zealand and they travel more than 10000 km through the Pacific Ocean basin to the Central American coast.

Due to this long voyage, swell takes the following characteristics:

1. Long period waves

In this transoceanic voyage of more than 10000 km, waves suffer a transfer of energy from their original frequencies to lower ones, increasing the range of frequencies in which a specific storm is distributed. Figure 1 shows the peak period from 2005 to 2018 with a mean value around 15s. During storm condition, a Tp of 20s is easily reached.

2. All year "homogeneous" and no extreme waves

Wave height is very homogenous, varying from 1 m in low energy season to 2 m in the high energy as shown in Figure 2. This can be very convenient for the design of energy harvesting equipment for continuous energy production. Also, there are only few events that exceed the threshold of 3 m and just one over 4 m, so is easy to prevent equipment destruction.

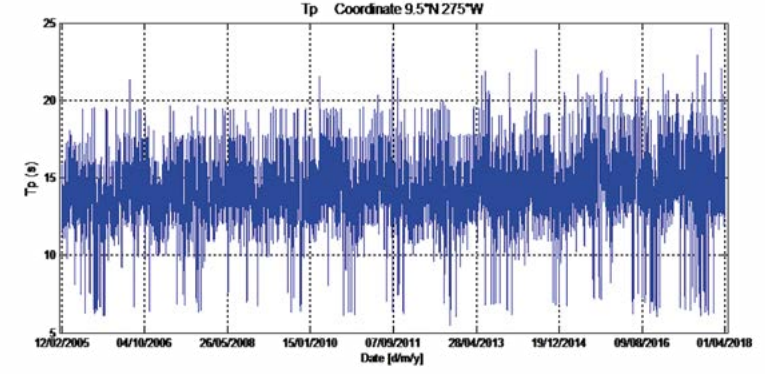

Figure 1. Wave spectra peak period in the Pacific coast of Costa Rica

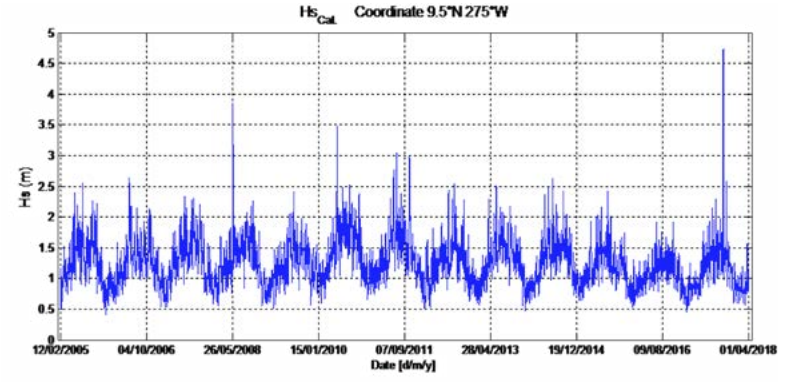

Figure 2. Significant wave in the Pacific coast of Costa Rica

3. Multipeak wave spectra

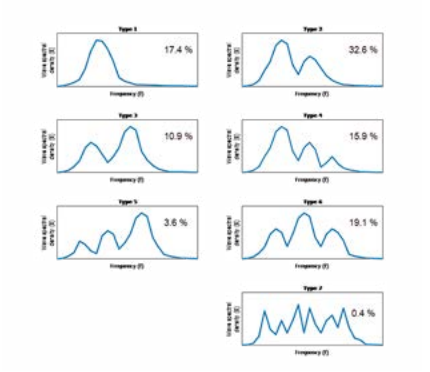

Figure 3. Energy spectra diagrams with their percentage of occurrence [4]

Wave spectra arriving at the coast of Costa Rica have shape distributions as presented in Figure 3. The standard unimodal spectrum shape is present only 17,4% of the time and it was characterized by a JONSWAP spectrum by Lopez [5]. For types 2 (32.6%) and 3 (10.9%), Corrales [4] used a combination of two JONSWAPs.

The effects of multi peak spectra swells over structures and power production equipment must be investigated and taken into account during design.

4. Five to ten days of high predicted waves

Since waves travel several days, we can predict the incident energy with high precision. This is because the swell was already produced, and current propagation software is very accurate. The black isolines in Figure 4 represent the wave travel time to the Pacific coast of Costa Rica.

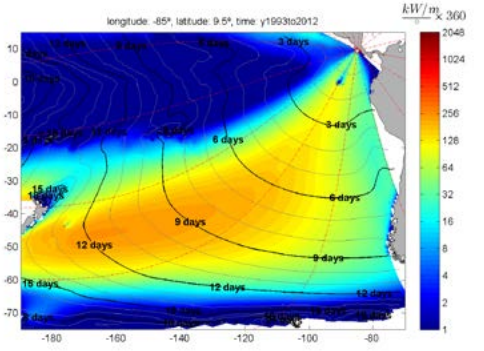

Figure 4 Average energy flow on the Pacific coast of Costa Rica from 1993 to 2012 [1]

5. Diffraction or “shadow” zone of the Galapagos Islands

As most of the energy that arrives at the Pacific coast of Central America is produced near New Zealand, Costa Rica is just in the diffraction or “shadow” zone of the Galapagos Islands. This phenomenon causes the available energy to be less, although it also protects against greater storms.

In addition to this, global wave propagation models such as the NOAAs Wavewatch III [6] are not so accurate in these areas.

CONCLUSIONS

The wave energy potential in the Pacific coast of Costa Rica is very important, nevertheless, the adaptation of technology to the particular swell conditions must be done carefully.

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Technical Note.