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Spectral analysis of tide-gauge records in the Gulf of Corinth, Greece, and implications for tsunami detection

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The Gulf of Corinth is known to be prone to tsunamis due to the concurrent mechanisms related to the strong tectonic activity and to the large sediment discharge on the steep slopes of the basin. Recent high-resolution bathymetric surveys have shown that submarine failures, potentially tsunamigenic, are probably more frequent than previously thought. In view of the implementation of a Tsunami Warning System in the Gulf, it is of relevance to know which kind of signature tsunamis of seismic origin or related to mass failures can leave on tide gauge records and how this can be discriminated from the usual background sea-level fluctuations. The aim of this work is to assess the main features of the background signals in the Gulf of Corinth in the frequency window that is typical of tsunamis and then to focus on the implications for the identification of tsunami signals.

In this work use has been made of records of tide gauges that were installed by IPGP in one permanent and four temporary sites of the Gulf in the framework of the European project 3HAZ-Corinth. The sites are located in the port of Galaxidi, in the north coast of the Gulf, and in the area of the Trizonia island in front of the city of Aigion. The data analysed are an 8 month long time-series recorded by the tide gauge placed in the harbour of Trizonia island and short records from the other sites. For all time series, periodograms on records with astronomical tide removed were calculated for time windows of about 90 minutes, with 15 min time shift. Periodograms tend to be quite stable, showing the persistence of spectral frequencies that are characteristic for each site even under quite different meteorological conditions. These frequencies are likely to be related with the free oscillations (eigenmodes or seiches) of the man-made (harbour) or the natural sub-basins affecting the place where the instruments were

installed.

The stability of the periodogram over time is a quite relevant property and is probably due to the small loss of energy of the sea level oscillations in a basin that is almost closed. The spectral stability implies that short observational intervals (a few days long) are sufficient to evaluate the background signal in any site.

The second part of the work consisted in the computation of synthetic tsunami wave spectra for the sites where tide gauges were installed. Simulations of earthquake tsunamis and of a landslide tsunami were used for this purpose. The scenarios elaborated comprise typical submarine faults, such as the one responsible for the Ms=6.2 15 June 1995 Aigion earthquake and tsunami, and typical submarine slides. Spectra of tsunamis due to earthquakes and landslides differ substantially each other, but what matters most is that they differ remarkably also from the background spectra. This implies that tsunamis carry a characteristic signature that spectral analysis can identify. This property has many applications also related to the Tsunami Warning System. In the project 3Haz-Corinth it can be exploited to analyse the available tide-gauge records (several years of data) to look for undetected small tsunami events caused by submarine landslides or earthquakes. While the occurrence of a tsunamigenic earthquake is expected to be confirmed by the seismic records, the methodology presented here could be a precious tool to detect (usually small) submarine landslides.