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The tsunami urgent computing service in the ARISTOTLE comsortium

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A successful implementation of the numerical model Tsunami-HySEA is currently working at the maximum Technology Readiness Level, TRL 9, in the ARISTOTLE tsunami service (TS). This service relies essentially on an urgent computing service where the stakeholder partner, that in this case is the European Emergency Response Coordination Centre (ERCC), requires the TS to better manage a tsunami emergency situation.

In the Aristotle case, urgent computing (UC) capabilities in the tsunami natural hazard frame- work are strengthening the monitoring and analysis functions of the ERCC and its Situational Awareness Sector (SAS) by helping to design the multi-hazard advice service at global level and on a 24/7 operational basis. In this context, the ARISTOTLE-eENHSP project (All Risk Integrated System TOwards Trans-boundary hoListic Early-warning - enhanced European Natural Hazards Scientific Partnership) has been designed to offer a flexible and scalable system that can provide new hazard-related services to the ERCC.

The ARISTOTLE tsunami service is integrated in the SPADA (Scientific Products Archiving and Document Assembly) IT platform that gathers the scientific, exposure and preliminary impact information which are used by the multi-hazard operational board to assemble the reports. This platform relies on existing and newly developed web services.

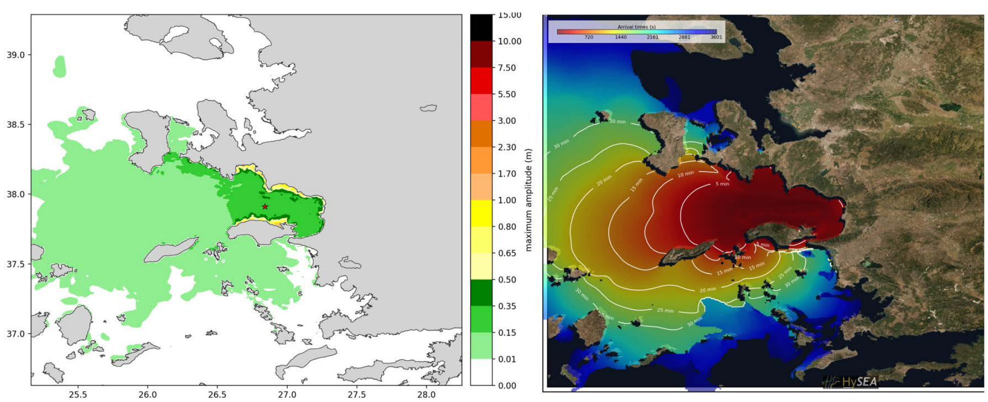

Figure 1: Izmir (Turkey) 2020 tsunami. Left: max. wave amplitude. Right: arrival times.

The system outputs are delivered to the ERCC in a multihazard report providing expert analysis made by an expert panel in the different involved hazards. In our case, the tsunami service outputs are relevant in the sense that they have to be easily readable by the end-users. These aspects have been agreed with all the consortium components related with the TS. For instance, an enhanced semaphore colorbar has been designed where each semaphore color: green, yellow, orange and red has been subdivided into three sub colors. The output is clear even for end-users with basic information (see Fig. 1). The arrival times figure output has also been improved with the addition of a jet colormap that completes the information given by the isochrons.

In the ARISTOTLE Tsunami Service the workflow (see Fig. 2) consists on four steps:

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- The system is triggered by an end-user who is on duty in the service. In this step a message passing system (RabbitMQ) is used between the SPADA system and the supercomputing services.
- Using the earthquake parameters that can be provided by different seismic monitoring sources, the scenario parameterization is defined in the preprocessing step. Depending on the earthquake epicenter location the system is able to automatically select an optimal computational grid size and refinement level depending on the seismological parameters. For example, if the epicenter is located in the Mediterranean Sea, the system automatically performs 8 hours of wallclock simulation in a 2 arc-min resolution grid, then detects the limits where the tsunami waves have arrived and later performs a second simulation in a new domain with more resolution (30 arc-sec).
- The corresponding simulation is sent to the supercomputation resources (in this case located at the University of Málaga).
- Depending on the event magnitude, the computation time can last from a few seconds to the order of minutes. The current outputs of the tsunami service system are: maximum wave height in the considered domain, wave arrival time and maximum wave height along coast locations.

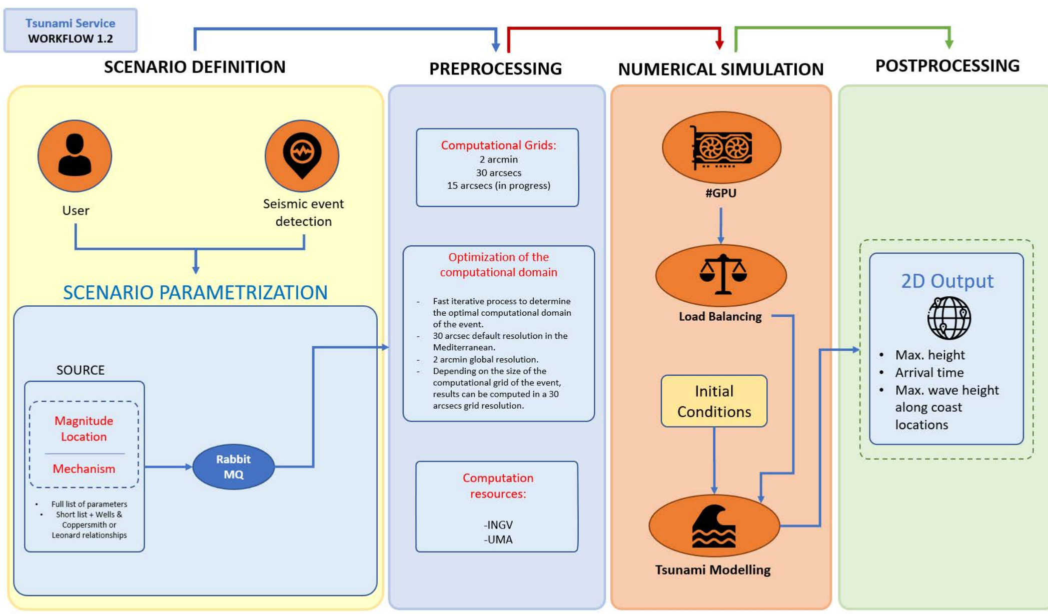

Figure 2: Scheme of the tsunami service workflow implementation in the ARISTOTLE.

This workflow is scalable depending on different aspects, like the computation resources or the Digital Terrain Models (DTM) available. As consequence, the numerical computation output could be improved in different ways: for instance by improving the grid resolution (even using nested meshes in specific areas of interest), or even providing not only one scenario output but considering an ensemble of cases that could deliver even a Probabilistic Tsunami Forecast (PTF).

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