From the sea to the clouds: TsuDAT, a community-based tsunami simulation application hosted in the cloud

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ABSTRACT

TsuDAT, the Tsunami Data Access and Simulation Tool, is a novel new approach to tsunami inundation simulations that farms out computationally intensive tsunami simulations to a computing cloud. TsuDAT consists of a web-based mapping application where users can explore their offshore tsunami hazard and easily build detailed tsunami inundation simulations, and a backend that employs an open-source hydrodynamic modelling application run on virtual machines in the cloud. This approach allows non-modellers, such as emergency managers, planning officials and land-use planners, to create detailed tsunami inundation hazard maps and assess the tsunami risk for coastal communities. The benefit of this approach is that users do not require specialist software or high performance computing resources to be installed locally. In addition the scalability of cloud computing offers increased supply of computational resources as demand increases. TsuDAT aims to transfer the capability of computational tsunami simulations from handful of experts to a much wider community of modelers located in the state and territory governments around Australia.

INTRODUCTION

During the devastating 26 December 2004 Indian Ocean Tsunami, the threat that tsunami pose to coastal nations was highlighted in dramatic and horrifying fashion. Since 2005, Geoscience Australia has been working closely with emergency managers around Australia to assist them understand and manage their tsunami risk. Fundamental to managing tsunami risk is information on the tsunami hazard, impact and risk. This information can range from broad regional hazard assessments to detailed impact assessments at the community level.

To develop a detailed plan for tsunami preparation and response, disaster managers require tsunami impact assessments for a number of communities. This involves creating detailed tsunami inundation simulations for a particular community. Over the past six years, over twenty communities around Australia have had detailed tsunami risk assessments conducted by Geoscience Australia.

However, the methodology applied around the country does not sustainably allow the Australian states and territories to manage their own tsunami risk. To enhance the capacity of the states and territories to independently conduct detailed tsunami inundation assessments within their own timeframes and specifications, Geoscience Australia has developed TsuDAT.

ARCHITECTURE

TsuDAT consists of two components, a graphical user interface (GUI) where the user develops their tsunami simulation and a backend where the tsunami simulations are farmed out to virtual machines in the cloud.
The TsuDAT GUI is built on the open source GeoNode spatial data management architeture. This provides all the map sharing, user data management, and map visualization functionality needed for TsuDAT in line with Open Geospatial Consortium standards. The backend of TsuDAT consists of a hydrodynamic modelling software package called ANUGA which is run on virtual machines hosted in a computing cloud. ANUGA was developed by the Australian National University and Geoscience Australia and is Free and Open Source Software (FOSS).

TsuDAT is hosted in a technical computing cloud at the National Compuational Infrastructure (NCI) at the Australian National University running the open source OpenStack cloud interface. When a user creates and submits a tsunami simulation in the TsuDAT interface the input data and parameters are bundled and transferred from the web-server to the computing cloud at the NCI. For each simulation request, a new virtual machine (VM) is initiated that is used for the tsunami simulation (Figure 1). When the simulation is finished the results are transferred back to the web-server database and the VM is terminated. The benefits of this are two-fold. First, it means that the users are not required to install any specialist software on their local machines or have the need to have high performance computing facilities. Second, the computing resources are scalable so that as demand increases, there is still a large pool of virtual machines available for simulations.

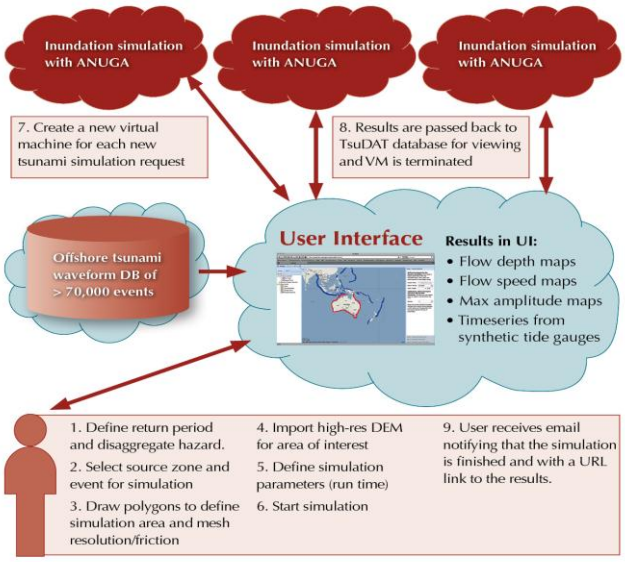

Figure 1:The TsuDAT architecture and workflow

WORKFLOW

The basic workflow for TsuDAT is described in Figure 1 and is outlined in the following steps:

1. Choose an offshore location, usually directly offshore the community of interest,
2. Define a return period of interest,
3. Disaggregate the hazard to identify which source zones are most likely to generate a tsunami affecting the community,
4. Choose a tsunami event to be modelled,
5. Draw or upload a polygon to define the simulation area and areas of interest,
6. Upload high-resolution elevation data to be used in the simulation,
7. Define tide height and end time for the simulation,
8. Define what results are needed from the simulation (e.g. flow depth, tsunami amplitude, tsunami flow speed),
9. Submit simulation request. The simulation may take a few days to run.
10. Receive email notifying the simulation has finished with a URL link to the simulation results
11. Visualise, analyse and share results in a map interface.

CONCLUSION

TsuDAT aims to increase the capability of state and territory governments in Australia to conduct detailed tsunami inundation simulations that will underpin their tsunami risk mitigation activities. This is possible by combining a novel user-friendly web-browser based mapping application with the flexible and scalable computing environment offered by cloud computing. The TsuDAT system architecture can be expanded for other computationally intensive modeling processes, particularly those that involve spatial data.

REFERENCES

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