Towards near-realtime computation of tsunami inundation as part of the LEXIS project

Natalja Rakowsky[1], Sven Harig[1], Alexey Androsov[1], Thierry Goubier[2], Hannah Neuwirth[1,3], Lucas Kersten[1,4]

[1] Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

[2] CEA List, DSCIN/LCYL, Gif sur Yvette Cedex, France

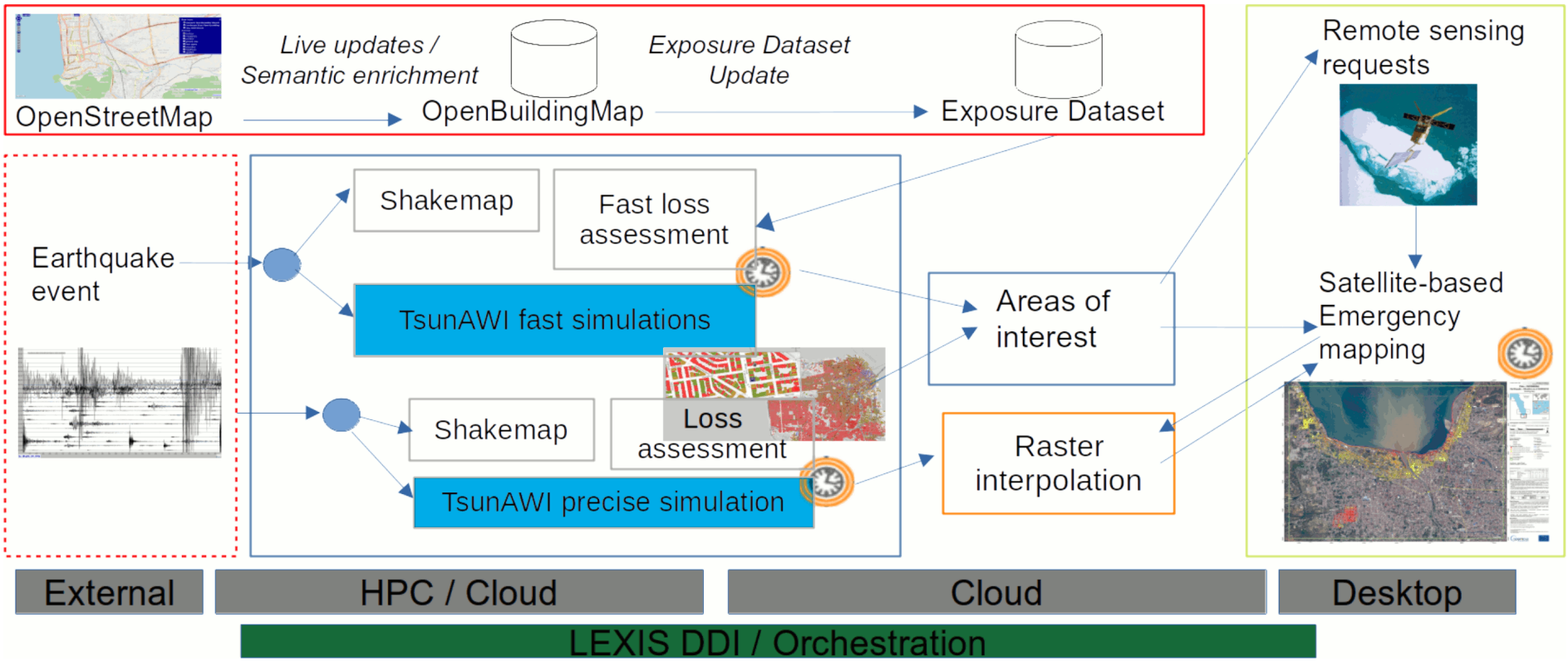
[3] University of Münster, Germany [4] University of Göttingen, Germany

EGU General Assembly 2020, 4-8 May 2020, online

LEXIS builds an advanced engineering platform at the confluence of HPC, Cloud and Big Data. LEXIS develops infrastructure to enable workflows and demonstrates its abilities through three large-scale socio-economic pilots

- aeronautics
- weather & climate
- catastrophe alert systems: earthquake & tsunami

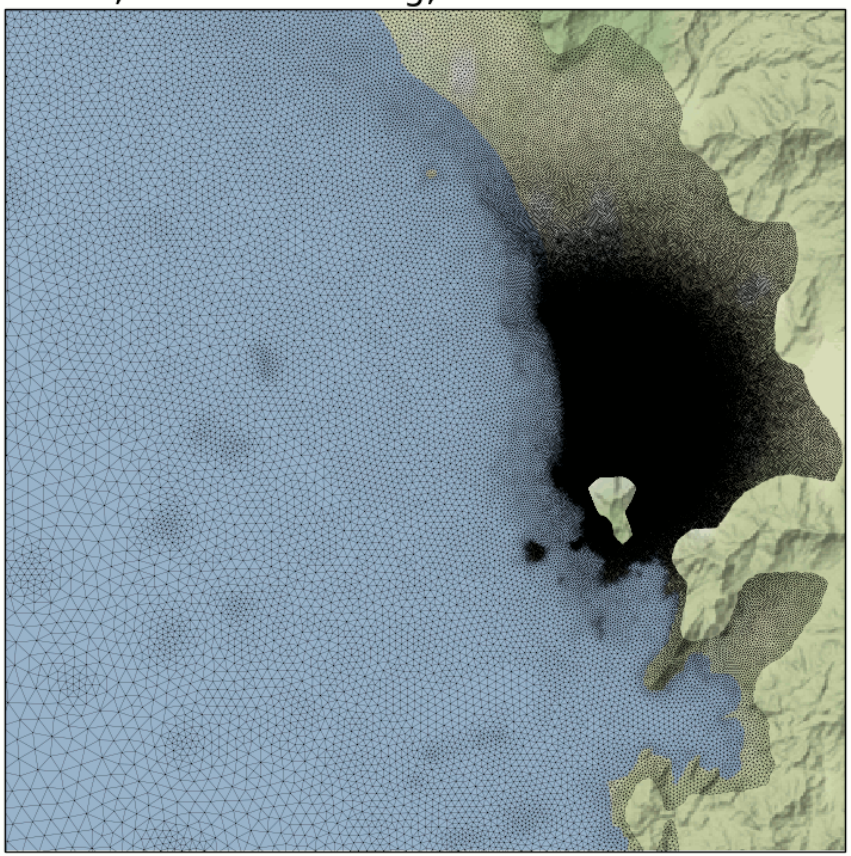
The LEXIS work flow of the earthquake and tsunami pilot with the tsunami inundation simulation.



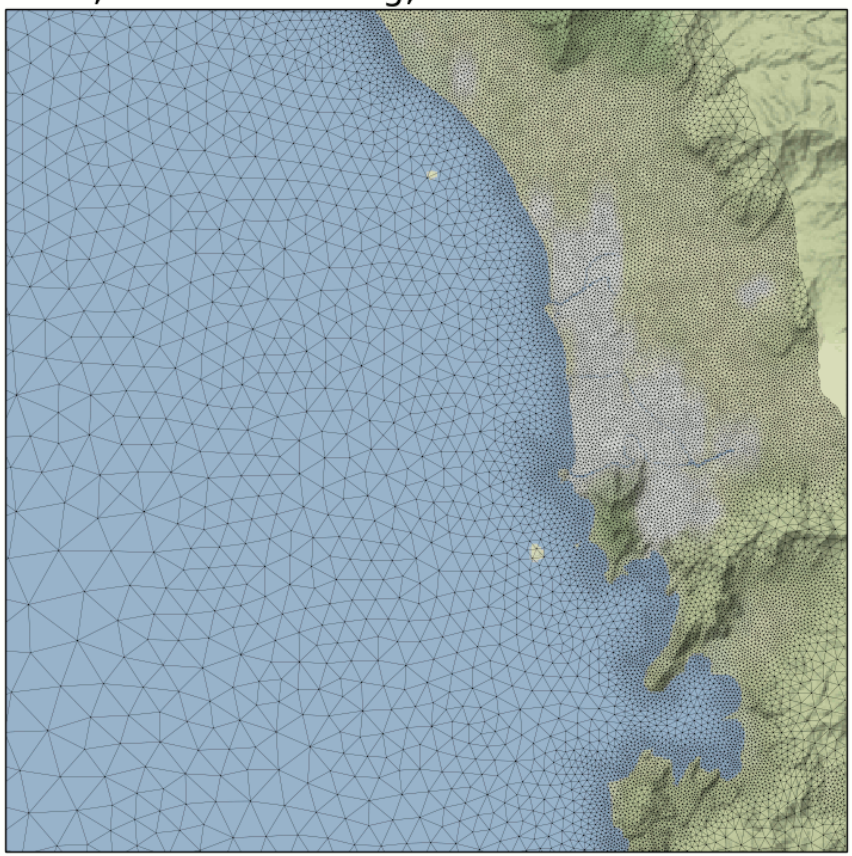
High quality tsunami simulation with inundation is compute intensive. The resolution on land should be 20m (Griffin et al. 2015*).

But how coarse can the mesh be for a reasonable estimate?

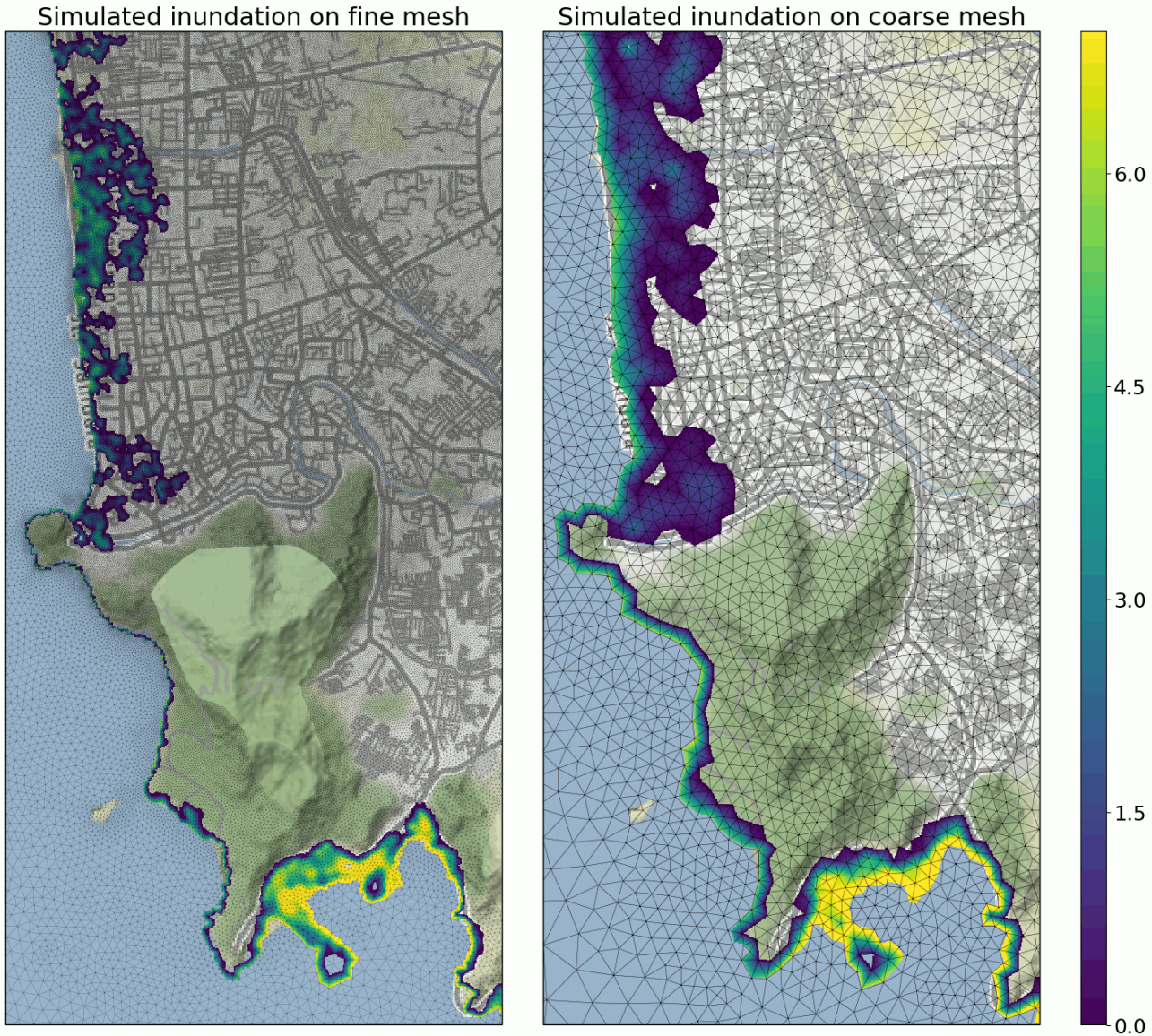
Grid, zoom to Padang, 20m-5km resolution



Grid, zoom to Padang, 200m-15km resolution



*doi:10.3389/feart.2015.00032



Testing with different resolutions:
200m is a good choice for a first estimate of the inundation.

Left: Simulated inundation [m] of a tsunami caused by a hypothetical earthquake, Mw=8.8, west off Padang, Sumatra, Indonesia.

Improvements performed in LEXIS

- Adapt TsunAWI to the workflow: read quakeML, write raster data or netcdf with the mesh reduced to the inundated area for fast interpolation.
- Profiling. Major bottlenecks: memory bandwidth and NUMA effects vs. load inbalance in TsunAWI's OpenMP.
- Test different mesh resortings. Forsyth's algorithm outperforms the current space filling curve by approx. 10%.
- Planned: Set up automated workflow to tune time step and to remove mesh vertices on land that are not reached by any strong tsunami.
- Planned: Reduce floating point precision double $\rightarrow$ single where possible.

		Detailed mesh	Coarse mesh
Resolution	in Padang in the ocean	20m 5,000m	200m 15,000m
Number of mesh vertices		1,242,653	231,586
Timestep		0.15s	1.5s
Compute time for a 2h simul.	salomon.it4i.cz, 24 threads, 2x Intel Xeon E5-2680v3	20:40min	20s
	ollie.awi.de, 36 threads, 2x Intel Xeon E5-2697v4	15:45min	15s
	lise.hlrn.de, 192 threads w. hyperthreading, 2x Intel Xeon Platinum 9242	5:04min	5s

Conclusion

With software optimization, modern hardware, and careful model setup, real-time computation of tsunami inundation becomes feasible.

LEXIS gives us the chance to focus on the technical aspects.

Thanks to all partners in LEXIS!

https://lexis-project.eu

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement 825532