Report Submission to

Seaside School District (OR)
By

THE VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY

Site specific simulation for Seaside, OR

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SUMMARY OF WORK

We study the effects of bottom friction on the tsunami waves near the site of a local school in Seaside School District (OR). The difference in the resulted inundation extents is an important consideration in their decision for selecting a new location for the school. In a previous study based on conservative estimates using zero bottom friction, the school is inside the inundation zone of the largest Cascadia Subduction Zone (CSZ) tsunamis. We show that with realistic, non-zero bottom friction based on land use types in the region, the school is ~40m outside the inundation zone.

Method

At the request of Seaside School District (OR), VIMS PI repeated the simulations on the impact of XXL1 CSZ tsunami event on the existing tsunami grid for the region (Clatsop grid B; Fig. 1), constructed during the NTHMP mapping project, but with realistic bottom roughness in the project area based on the values published by US Army Corp of Engineers (USACE 2008; Bunya et al. 2009).
The tsunami simulations are carried out using a NTHMP certified tsunami hazard model, SCHISM (Semi-implicit Cross-scale Hydroscience Integrated System Model; schism.wiki), which was also used in the previous mapping projects for the Oregon coastal community. The model is well validated and has been widely applied to field cases (Zhang et al. 2011; NHTMP 2012; Horrillo et al. 2014). The model can be configured in 2D and 3D mode, and here we use the 2D mode as consistent with the previous projects.
The bottom friction is specified as Manning's *n*, which is known to be a function of the land types (USACE 2008). Fig. 2 shows the land use types in the study area, extracted from USGS NLCD 2011 Land Cover (2011 Edition, amended 2014), National Geospatial Data Asset (NGDA) Land Use and Land Cover. The city of Seaside mostly consists of developed space, surrounded by meadows, evergreen forest and woodland. From this information the Manning's *n* is then estimated from the published values in Bunya et al. (2009), and is shown in Fig. 3. The friction generally increases landward, thus helping to dissipate the tsunami wave energy.

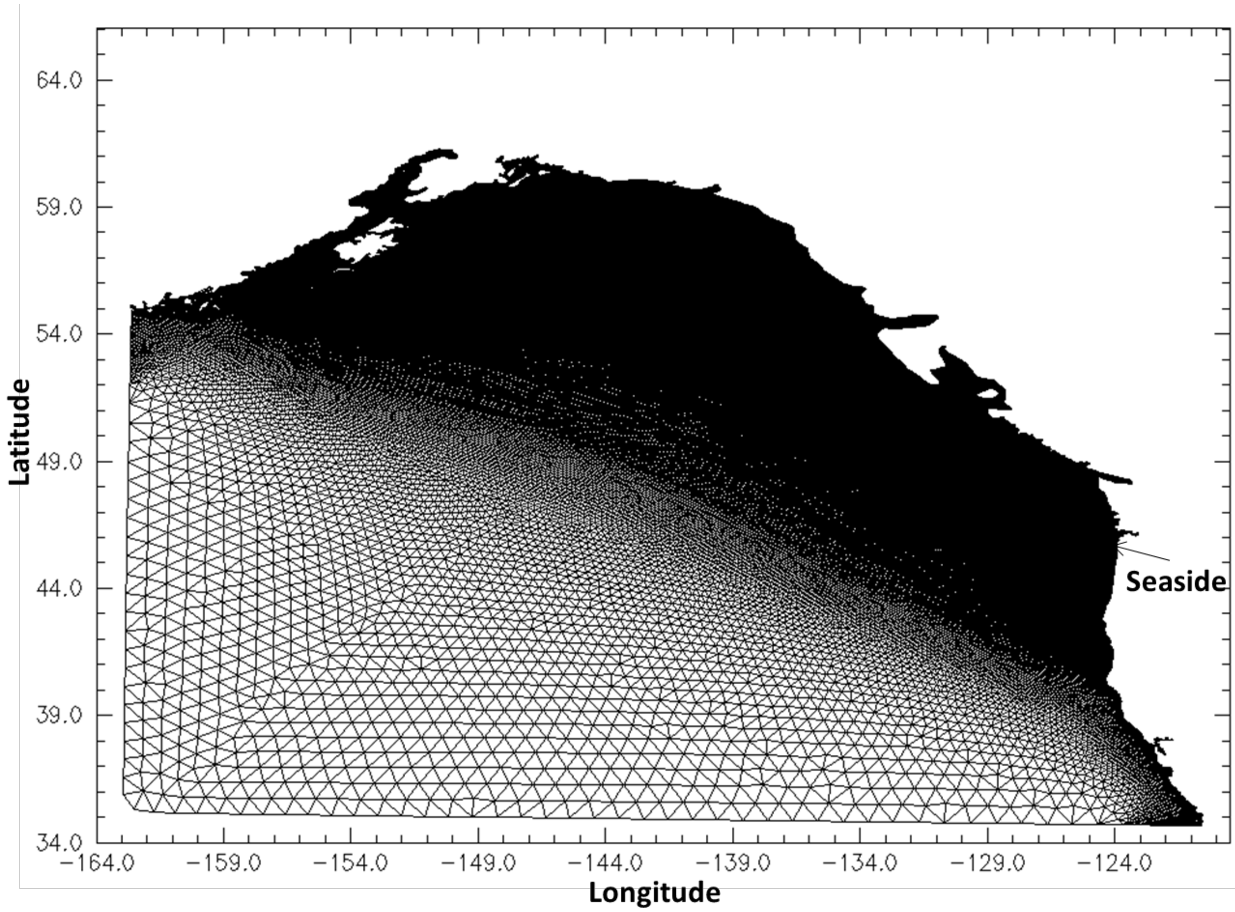
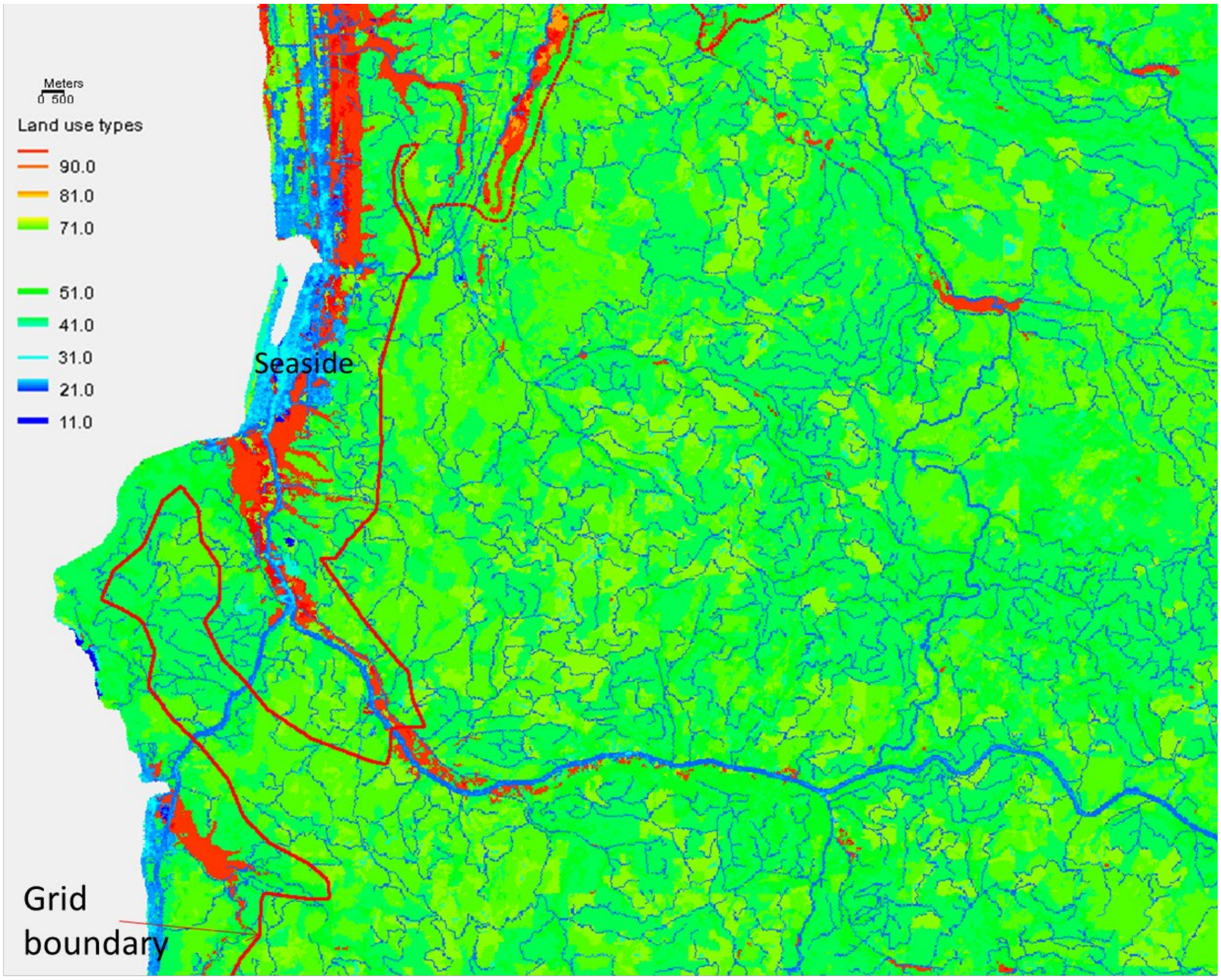


Fig. 1: computational grid for the tsunami simulation, with high resolution for Clatsop County, OR.


Meters
0 500
Land use types
90.0
81.0
71.0
51.0
41.0
31.0
21.0
11.0
Seaside
Grid
boundary

11: 'Open Water‘
12:'Perennial Ice/Snow‘
21:'Developed, Open Space',
22: 'Developed, Low Intensity‘
23: 'Developed, Medium Intensity‘
24: 'Developed, high intensity'
31: 'Barren Land (Rock/Sand/Clay)’
41: 'Deciduous Forest‘
42: 'Evergreen Forest'
43: 'Mixed Forest‘
51: 'Dwarf Scrub‘
52: 'Shrub',
71: 'Grassland/Herbaceous‘
72: 'Sedge/Herbaceous ‘
73: 'Lichens',
74: 'Moss - Alaska‘
81: 'Pasture/Hay‘
82: 'Cultivated Crops',
90: 'Woody Wetlands‘
95: 'Emergent Herbaceous Wetlands'

Fig. 2: land use types near the study site.

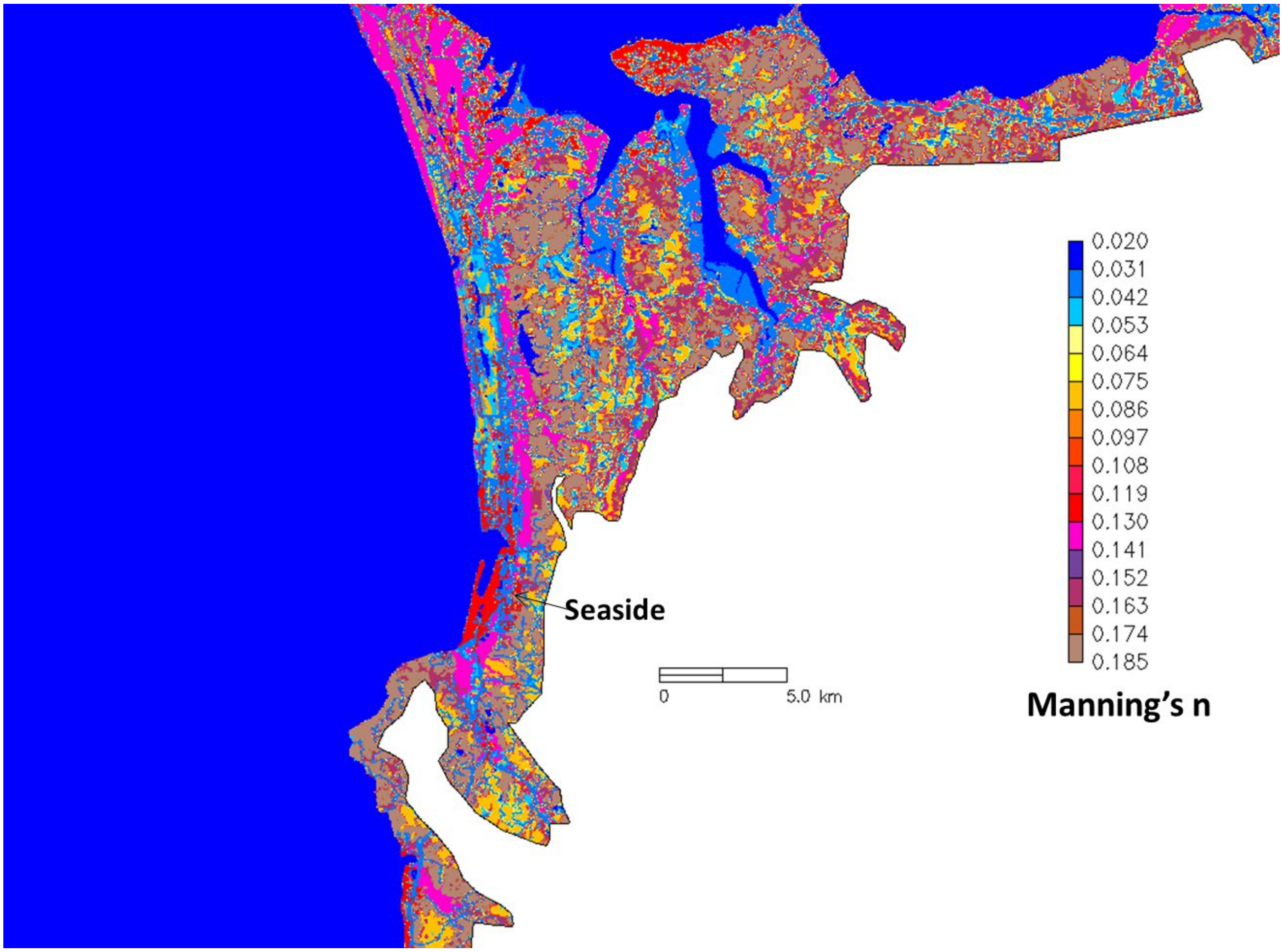


Fig. 3: Manning's *n* in the study area.

Results

Fig. 4 shows the comparison of maximum inundation lines from the largest CSZ event (XXL1), using zero and realistic non-zero bottom friction. With zero friction the school is ~50 m inside the inundation zone. The energy of the tsunami waves is sufficiently damped with realistic friction values that the school is ~40m outside the newly updated inundation zone (acid green line in Fig. 4). The maximum velocity is also reduced near the study site (Fig. 5).

The information on the tsunami flooding depths and current speeds can be used by the school district to aid their decision on whether and where to relocate the school.

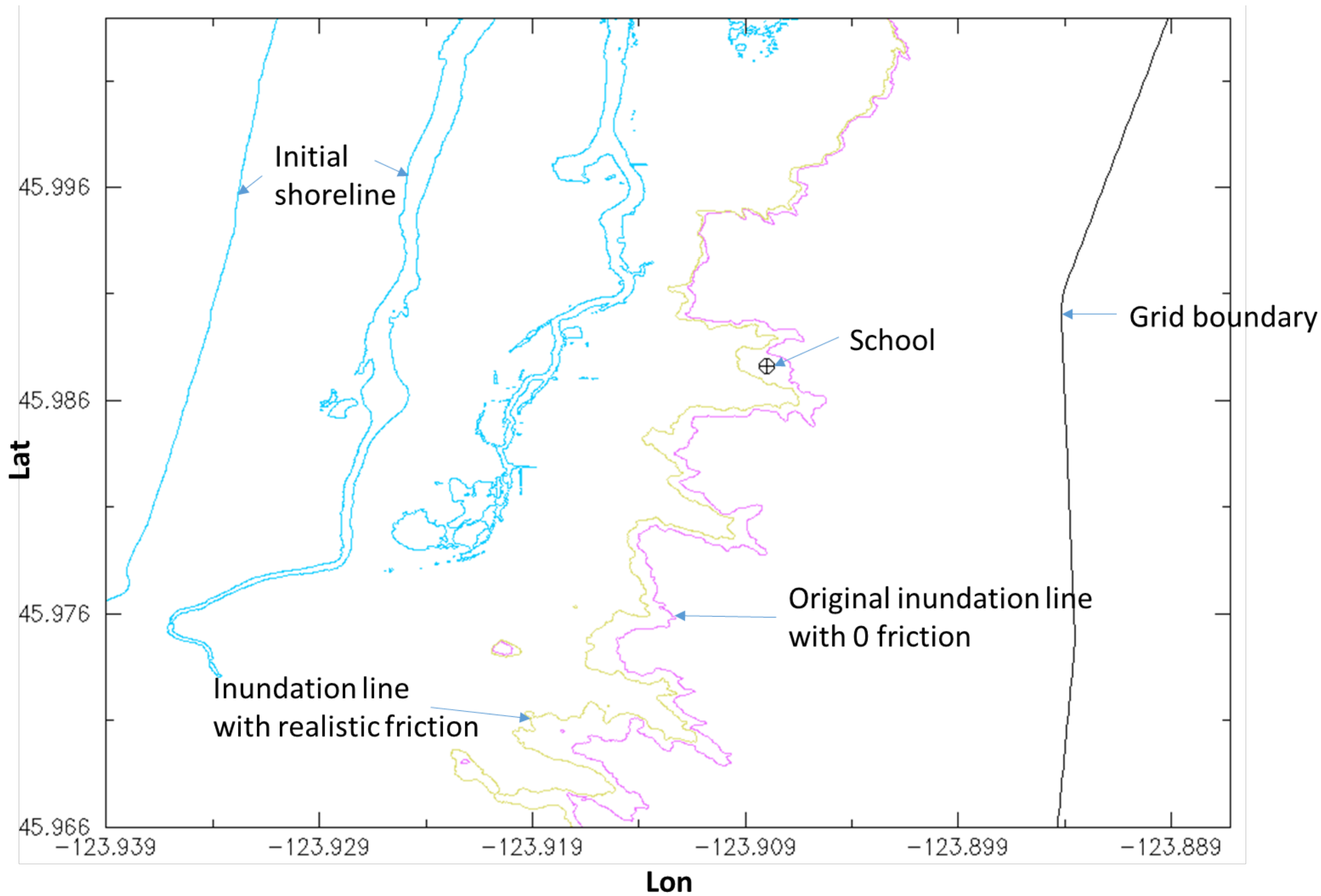
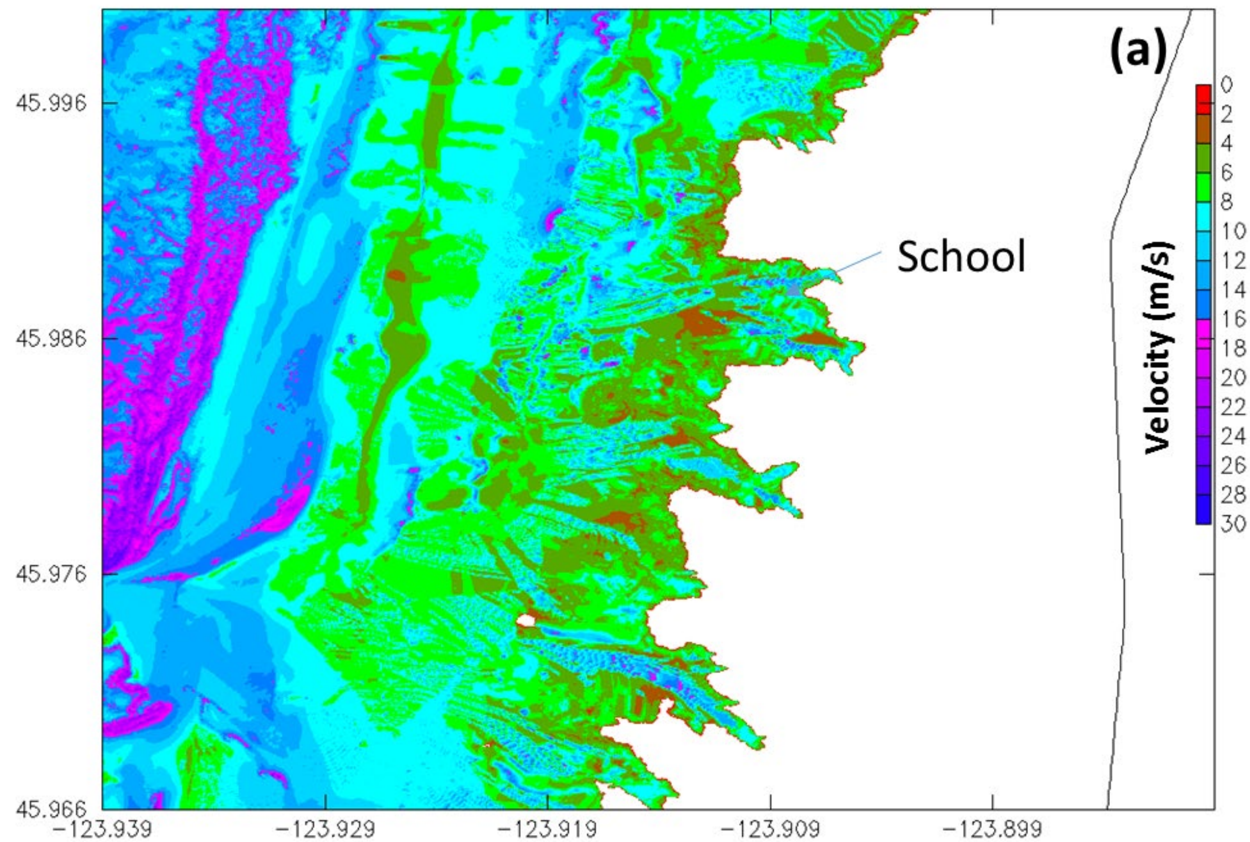


Fig. 4: comparison of XXL1 maximum inundation extents from zero (pink line) and realistic bottom friction (acid green line). The grid boundary and initial shoreline (after the earthquake) are also shown for easy reference.


(a)
School
Velocity (m/s)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
45.996
45.986
45.976
45.966
−123.939
−123.929
−123.919
−123.909
−123.899

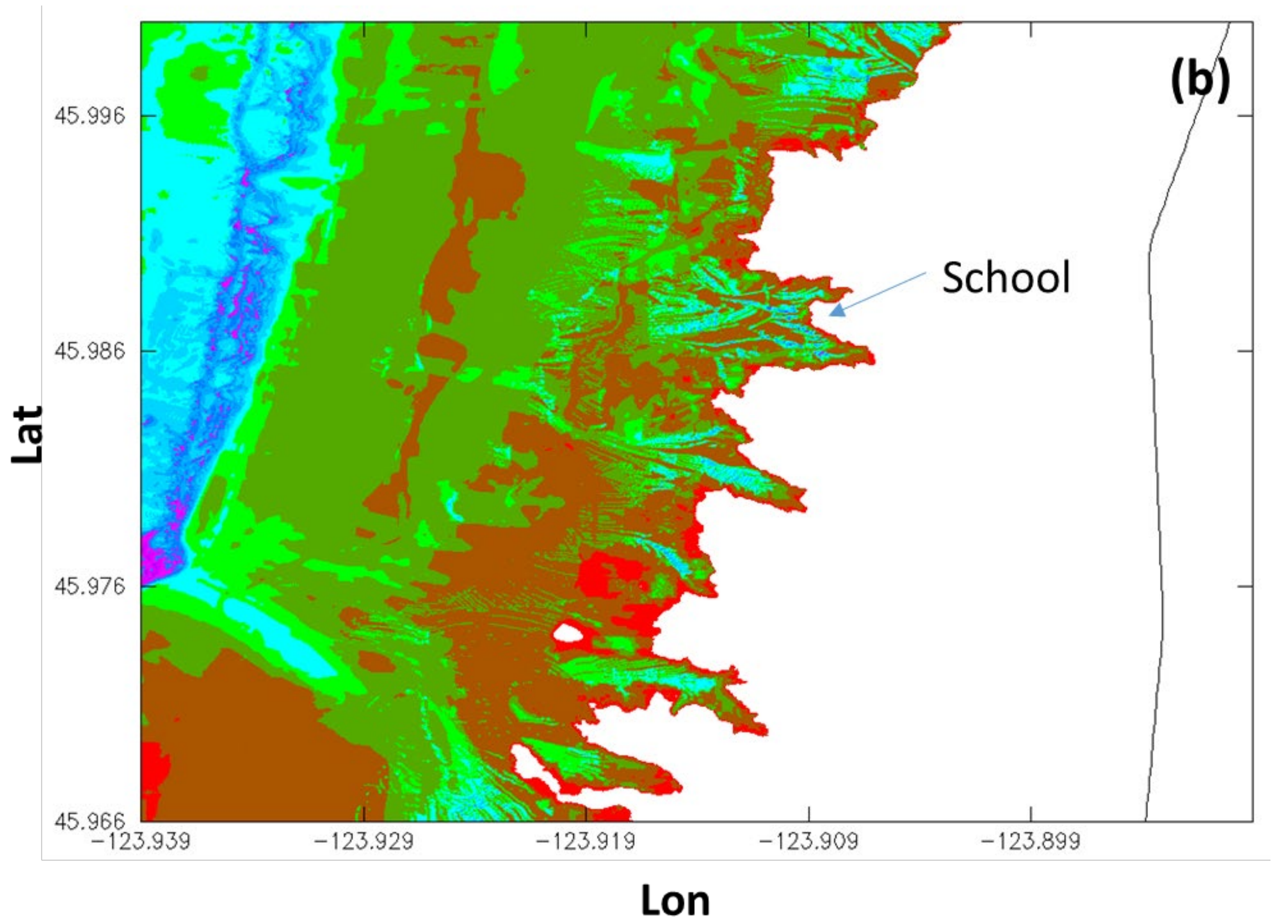


Fig. 5: maximum tsunami velocity with (a) zero friction and (b) realistic bottom friction.

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References

Bunya, S. et al. (2009) High-Resolution Coupled Riverine Flow, Tide, Wind, Wind Wave, and Storm Surge Model for Southern Louisiana and Mississippi. Part I: Model Development and Validation, Monthly Weather Review, 138, 345-377.

Horrillo,H., Grilli, S.T., Nicolsky, D., Roeber, V. and Zhang, Y. (2014) Performance Benchmarking Tsunami Models for NTHMP's Inundation Mapping Activities, Pure and Applied Geophysics, DOI 10.1007/s00024-014-0891-y.

NTHMP (2012) Proceedings and results of the 2011 NTHMP (National Tsunami Hazard Mitigation Program) model benchmarking workshop. Boulder: US Depart. of Commerce/NOAA/NTHMP, NOAA Special Report 436p.

USACE (2008) HEC-RAS River Analysis System, Hydraulic Reference Manual, version 4.0, March 2008, US Army Corps of Engineers.

Zhang, Y., Witter, R.W. and Priest, G.P. (2011) Tsunami-Tide Interaction in 1964 Prince William Sound Tsunami, Ocean Modelling, 40, 246-259.