Cascadia Subduction Zone Earthquake and Tsunami Modeling in Washington

by

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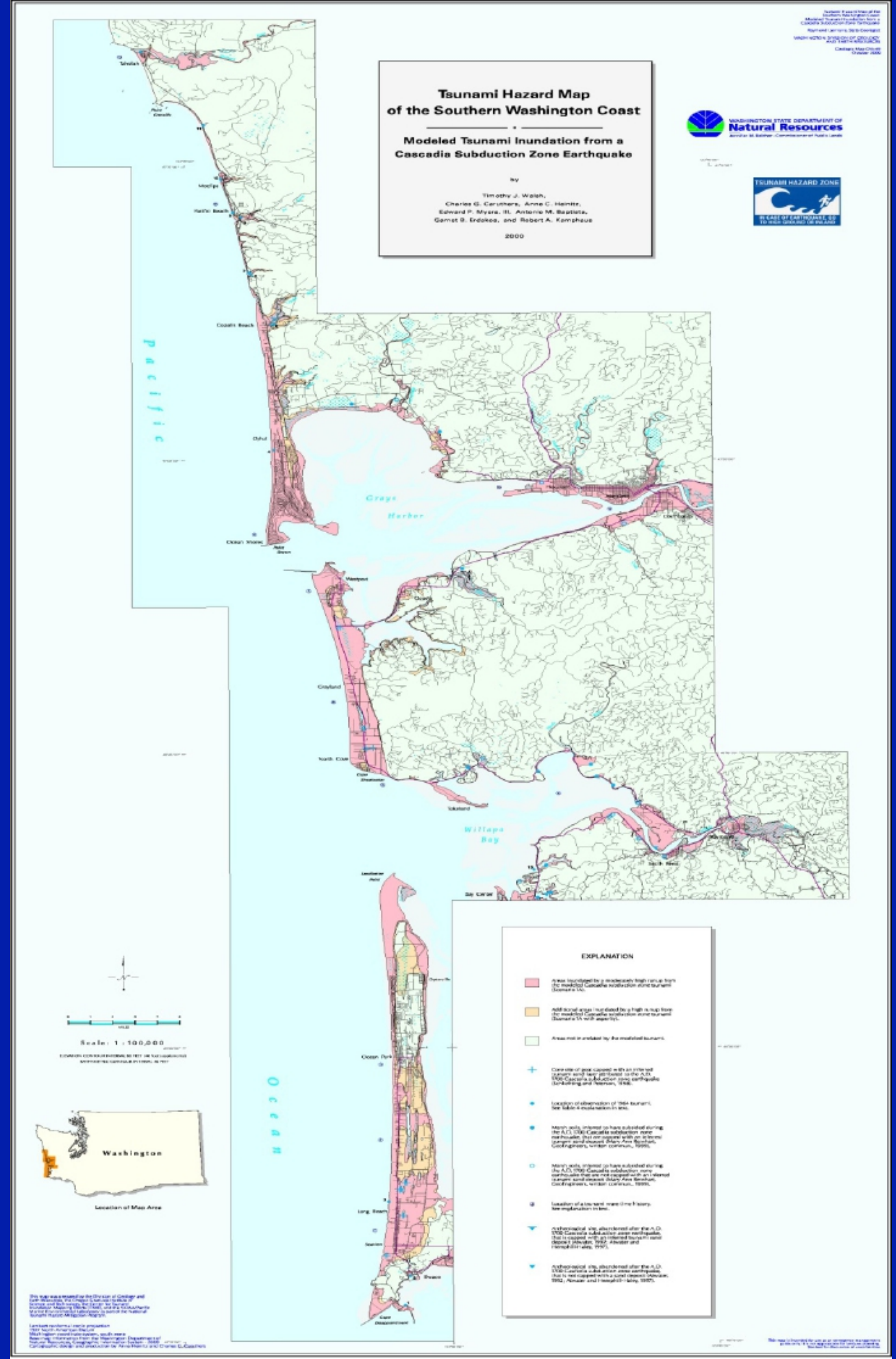
This is the first tsunami hazard map that we developed for the southern Washington coast. The area is within the Columbia River littoral cell and is dominated by accretionary shoreforms marked by low relief. This is where most of the resident population of the outer Washington coast lives and where evacuation is most difficult.



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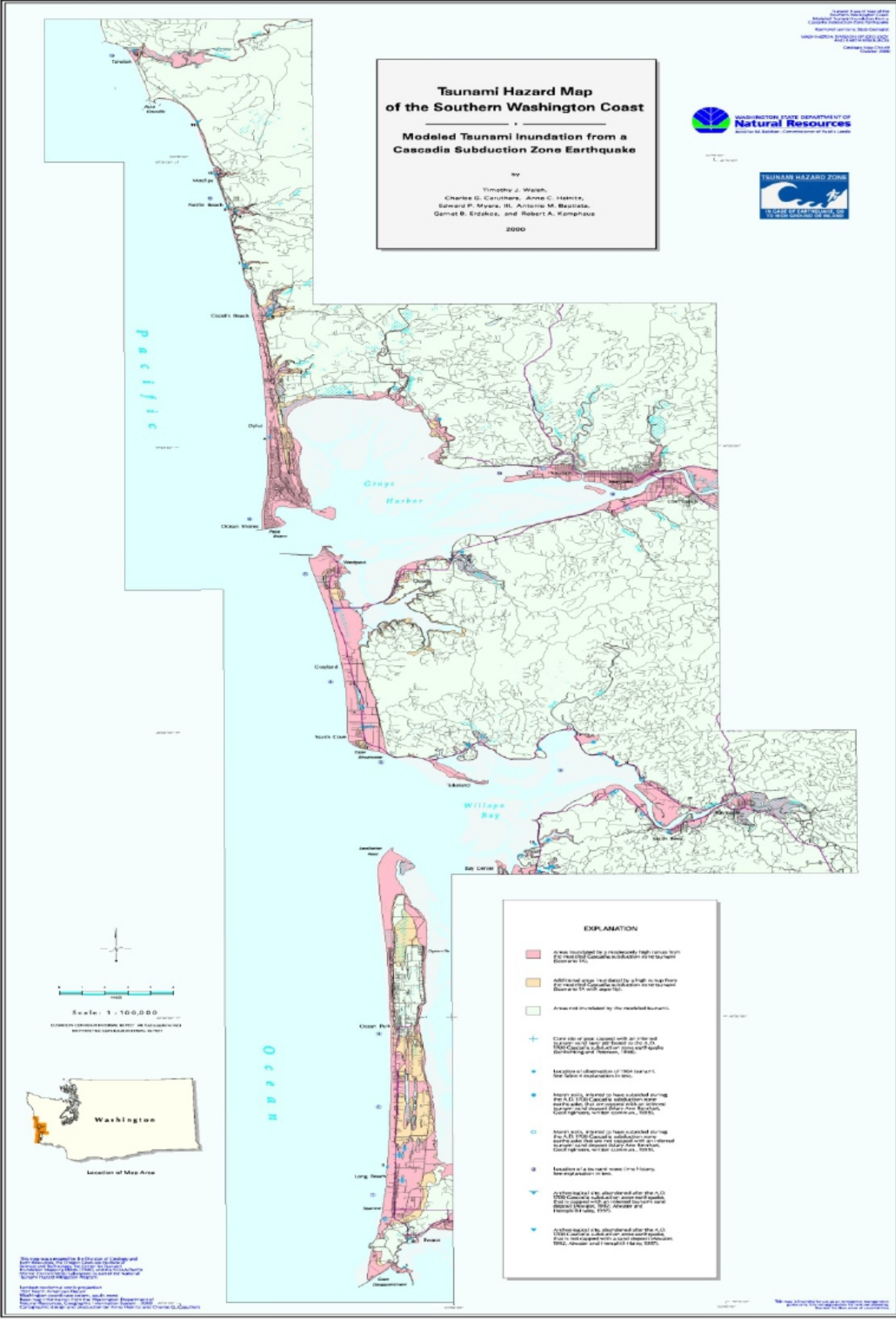

EXPLANATION

- Areas inundated by a moderately high runup from the modeled Cascadia subduction zone tsunami (Scenario 1A).
- Additional areas inundated by a high runup from the modeled Cascadia subduction zone tsunami (Scenario 1A with asperity).
- Areas not inundated by the modeled tsunami.
- Core site of peat capped with an inferred tsunami sand layer attributed to the A.D. 1700 Cascadia subduction zone earthquake (Schlichting and Peterson, 1998).
- Location of observation of 1964 tsunami. See Table 4 explanation in text.
- Marsh soils, inferred to have subsided during the A.D. 1700 Cascadia subduction zone earthquake, that are capped with an inferred tsunami sand deposit (Mary Ann Reinhart, GeoEngineers, written commun., 1999).
- Marsh soils, inferred to have subsided during the A.D. 1700 Cascadia subduction zone earthquake that are not capped with an inferred tsunami sand deposit (Mary Ann Reinhart, GeoEngineers, written commun., 1999).
- ② Location of a tsunami wave time history. See explanation in text.
- Archeological site, abandoned after the A.D. 1700 Cascadia subduction zone earthquake, that is capped with an inferred tsunami sand deposit (Atwater, 1992; Atwater and Hemphill-Haley, 1997).
- Archeological site, abandoned after the A.D. 1700 Cascadia subduction zone earthquake, that is not capped with a sand deposit (Atwater, 1992; Atwater and Hemphill-Haley, 1997).

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SJDF propagation (0:30)

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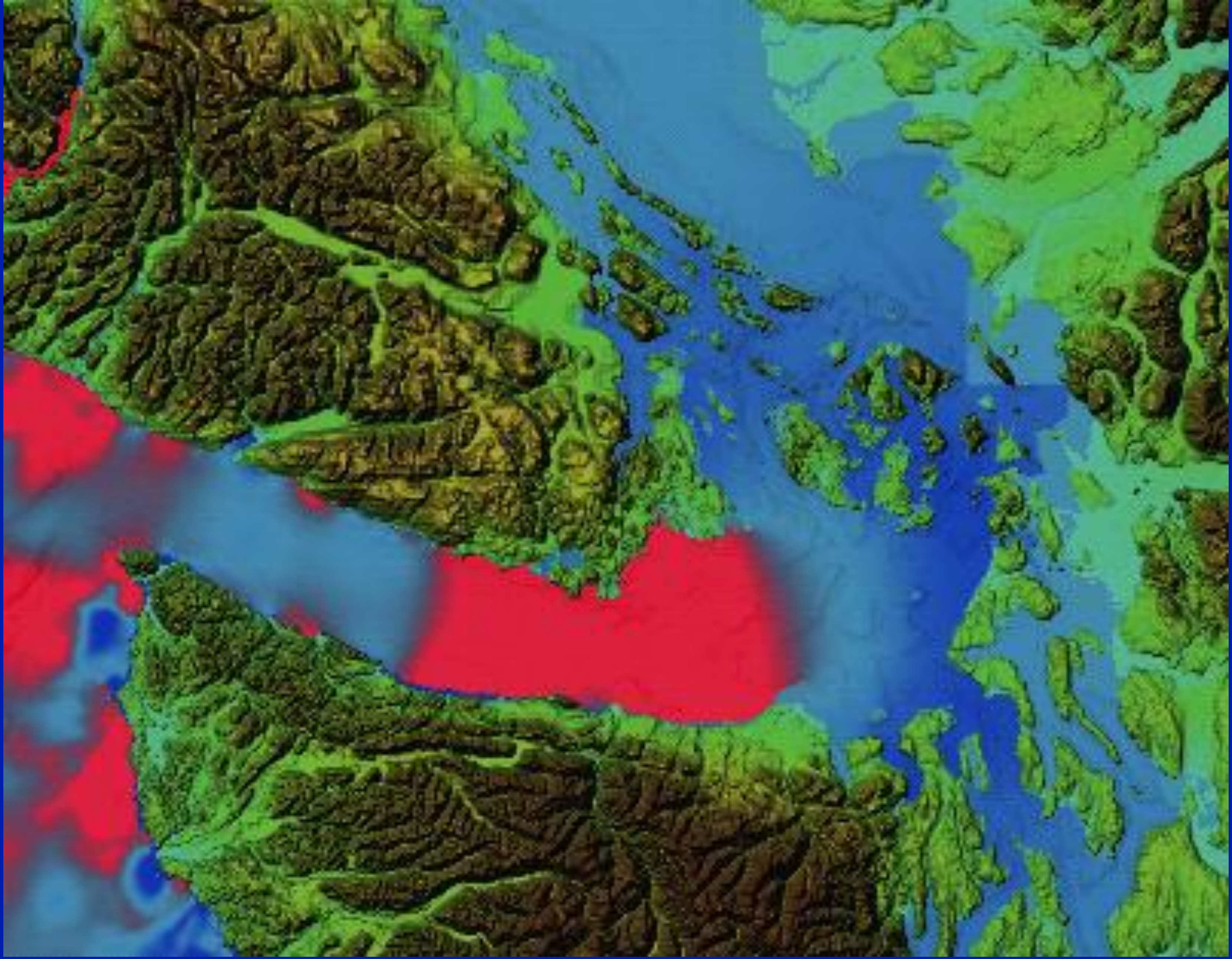
SJDF propagation (1:00)



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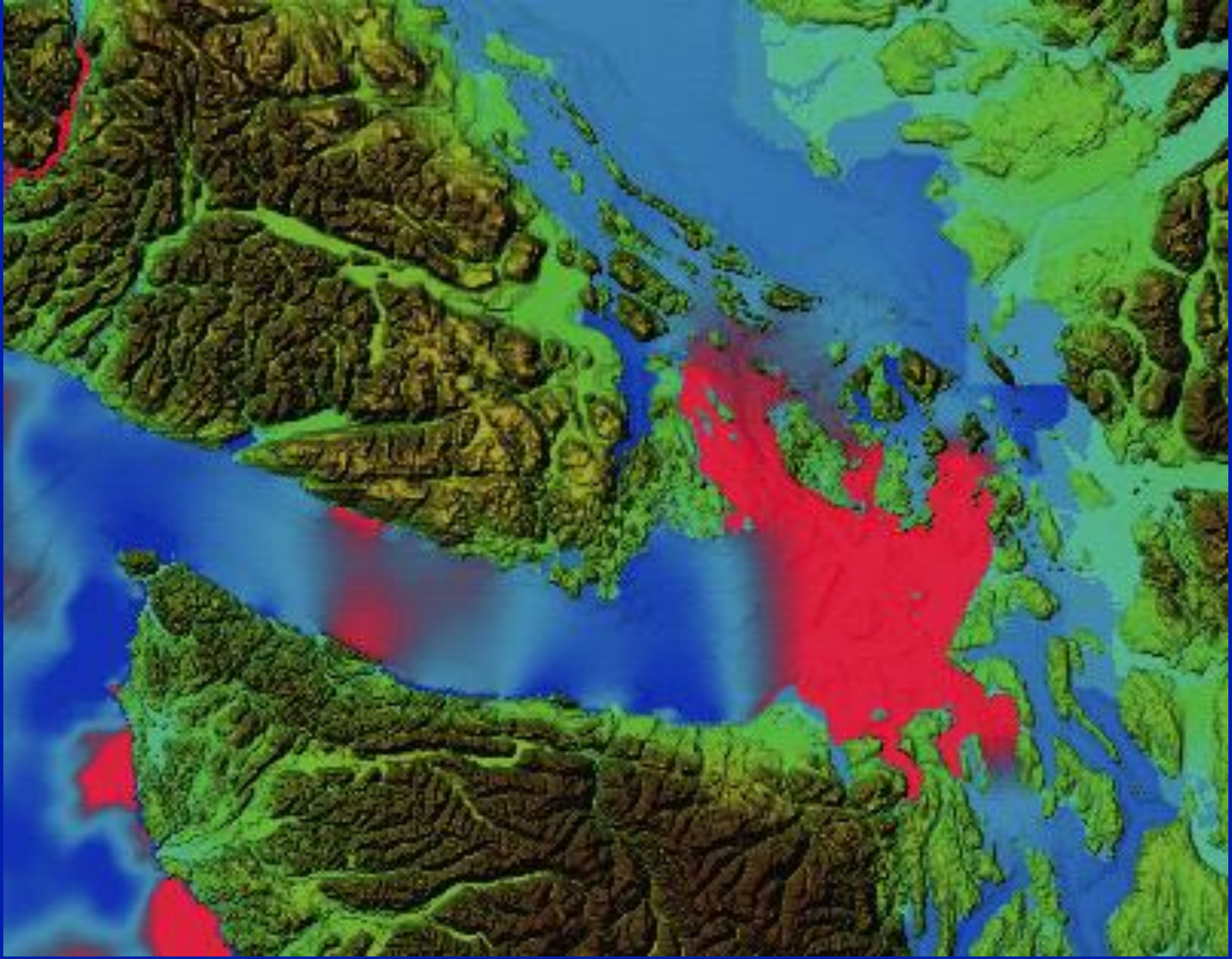

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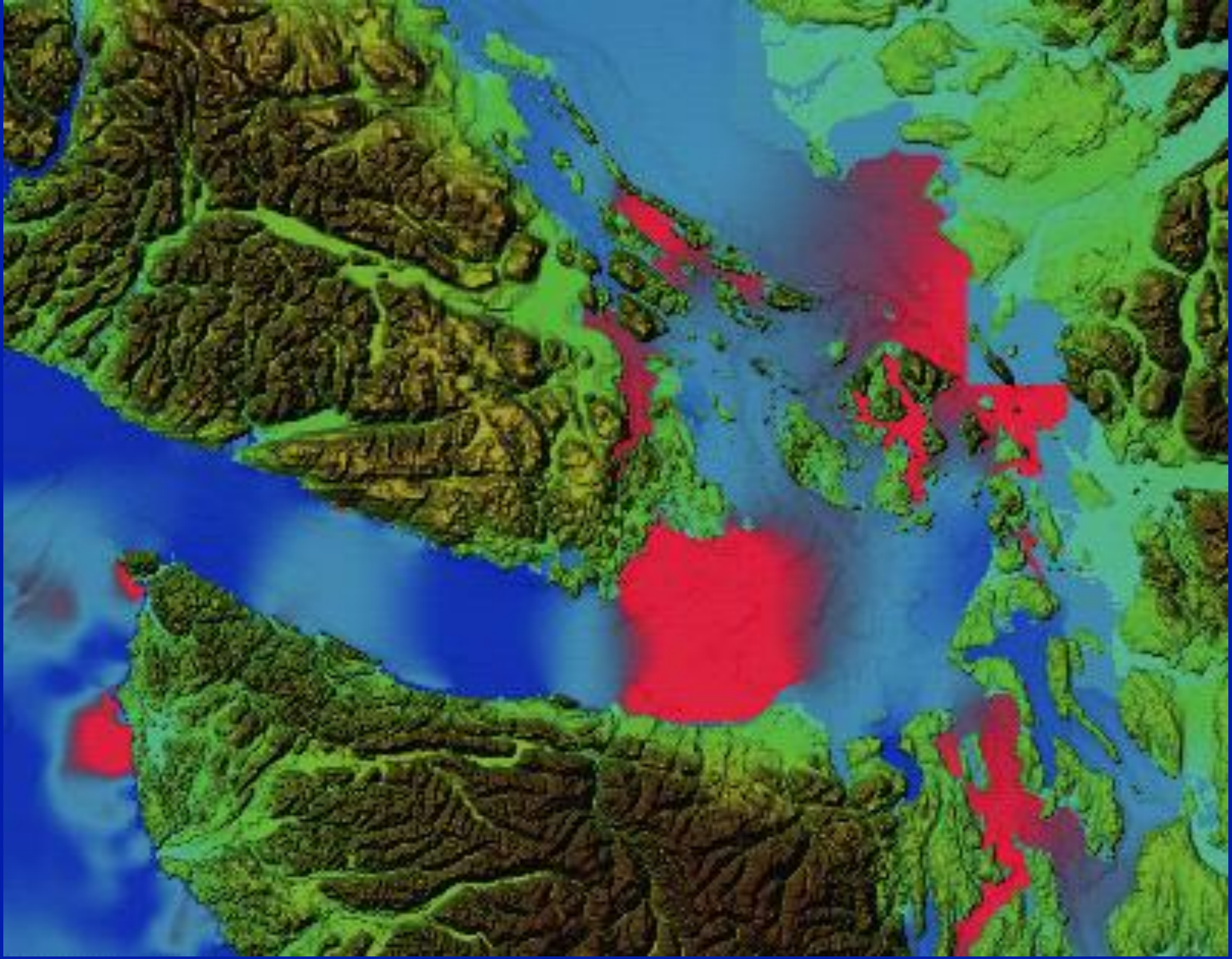

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SJDF propagation (2:30)

SJDF propagation (3:00)

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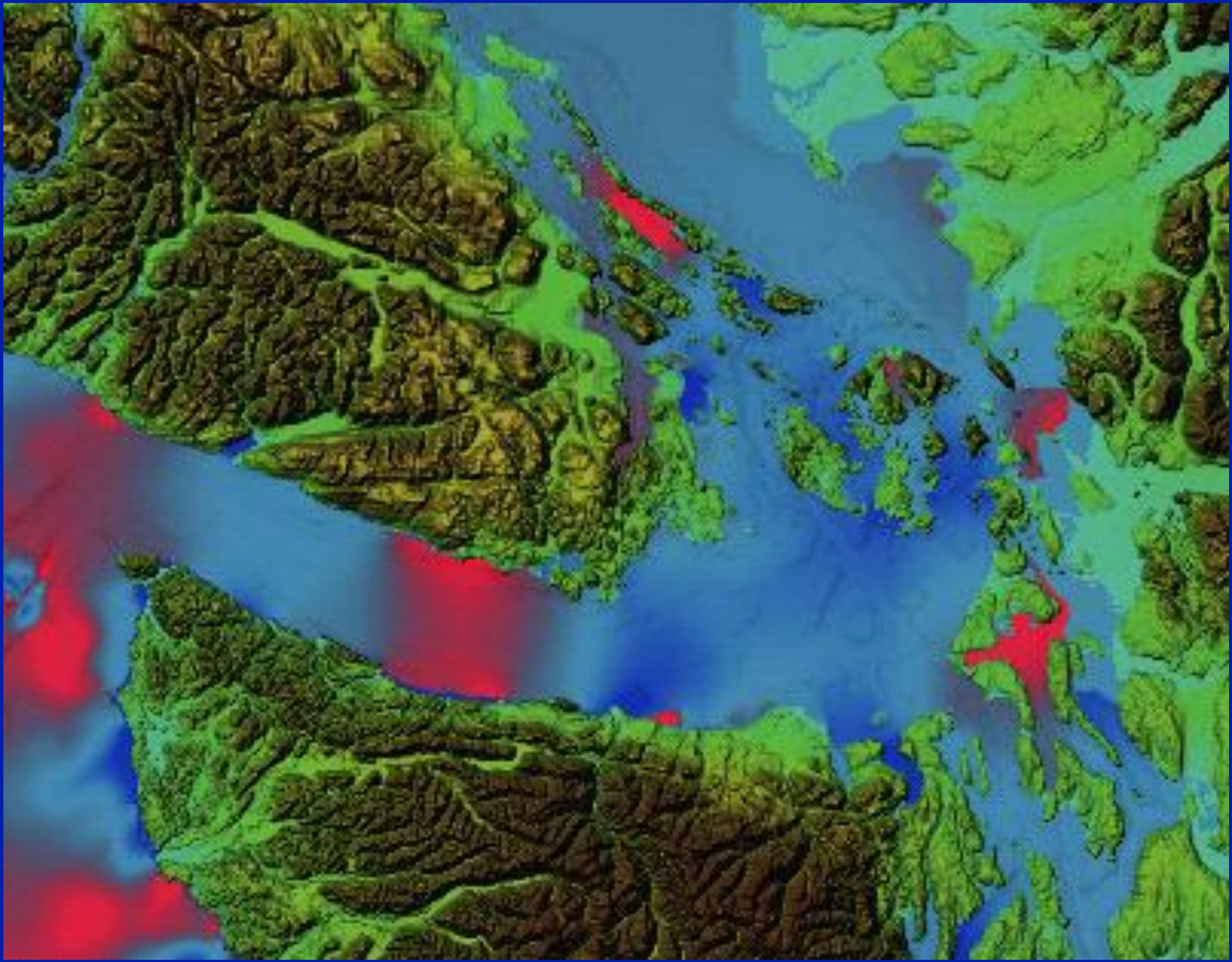

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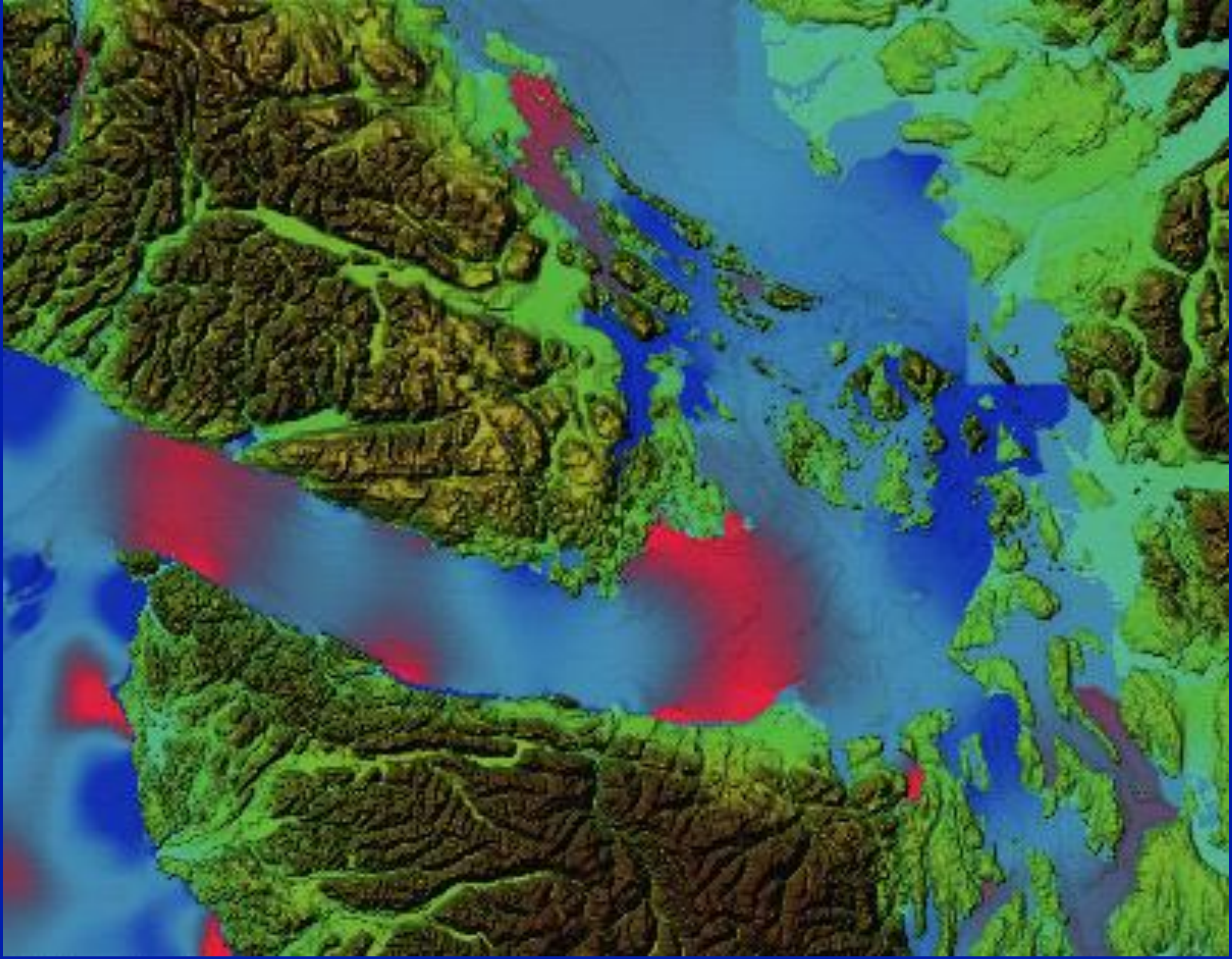
SJDF propagation (3:30)



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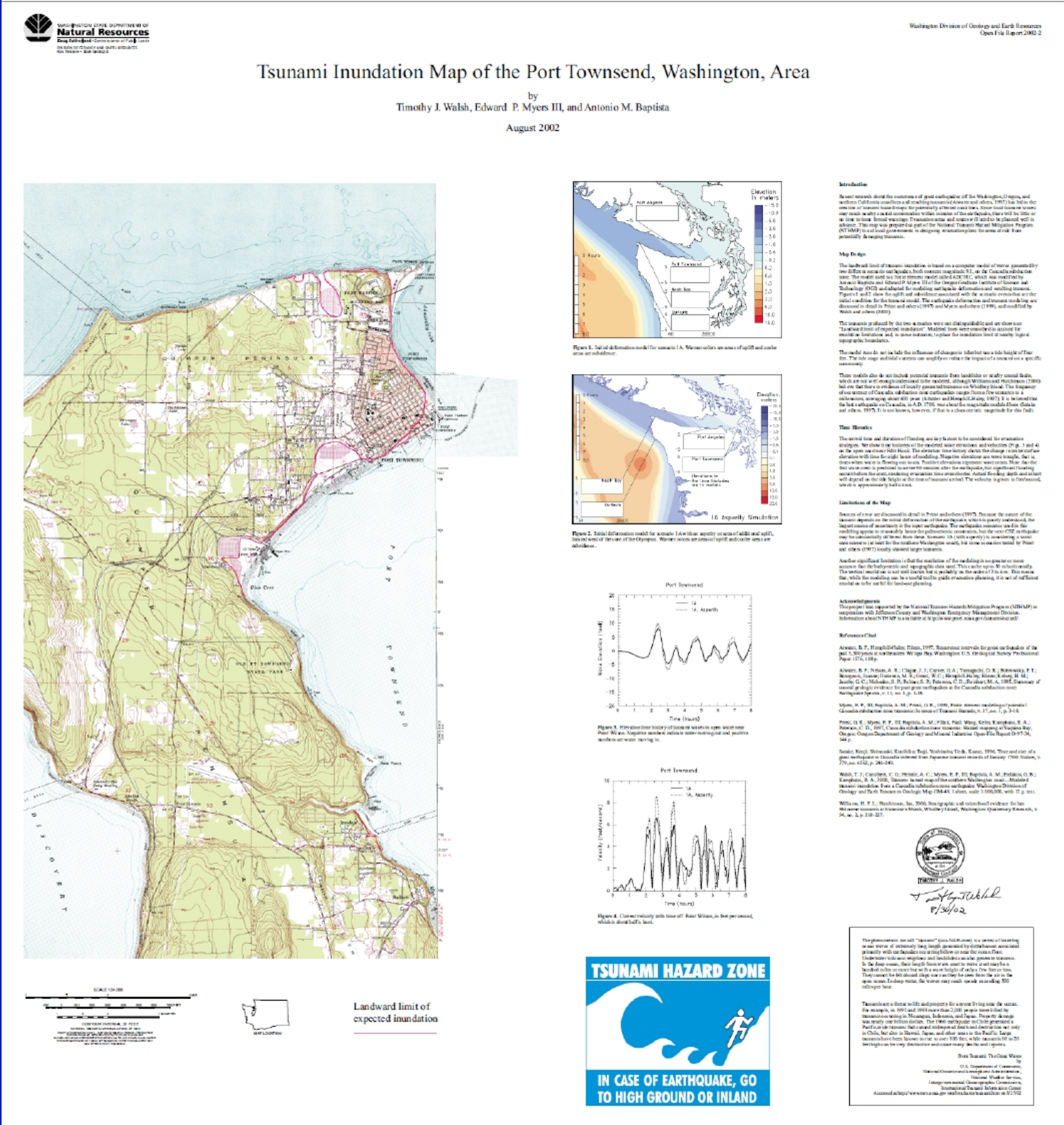
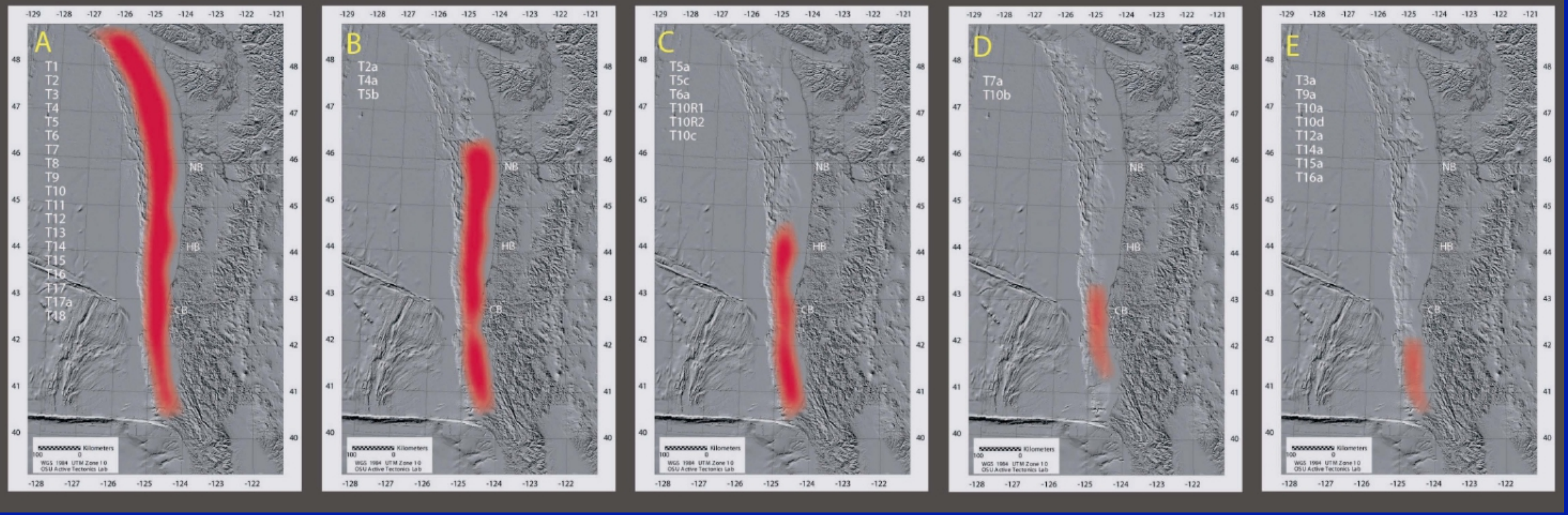
SJDF propagation (4:00)

We made a number of these hazard maps, including this one of the Port Townsend area





This led them to conclude that 21 turbidites were simultaneously triggered along the entire Cascadia margin, while another 20 or so had shorter spans. This, Adams earlier work, and Atwater's work all led to the conclusion that the full length of Cascadia ruptured, on average, with a 550 yr recurrence interval. Goldfinger et al. further proposed that smaller ruptures occurred between the larger ones and were confined to the south.

From Chris Goldfinger
and others

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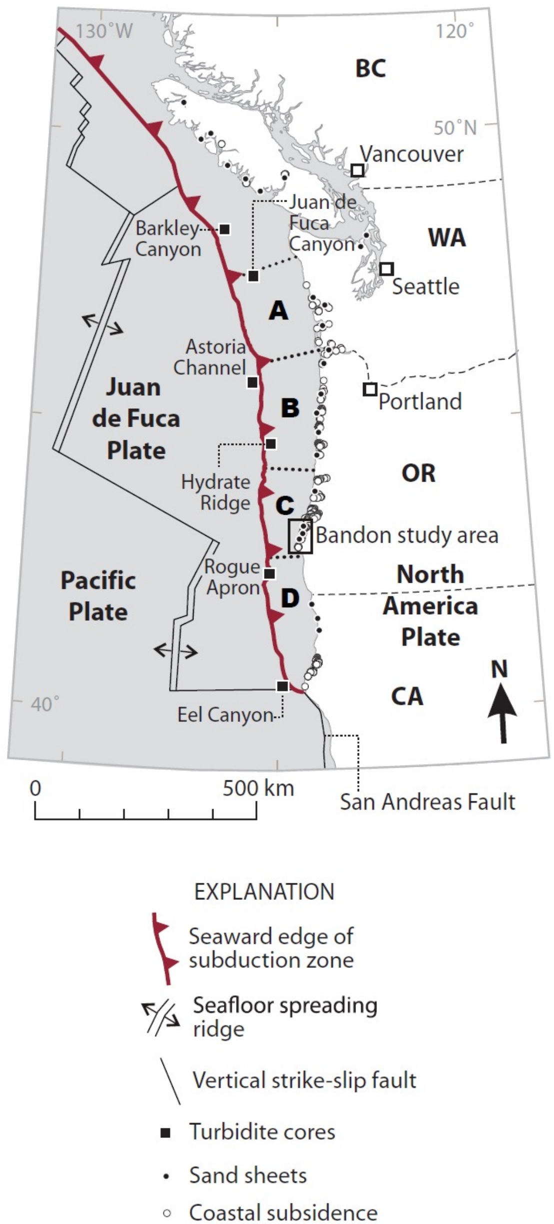
Witter and others combined data from Goldfinger, from Bandon, and Bradley Lake to infer that some tsunamis over the last 10,000 years had been larger than the one in AD 1700. They constructed hypothetical earthquake scenarios simulated tsunamis, then compared them to these data.



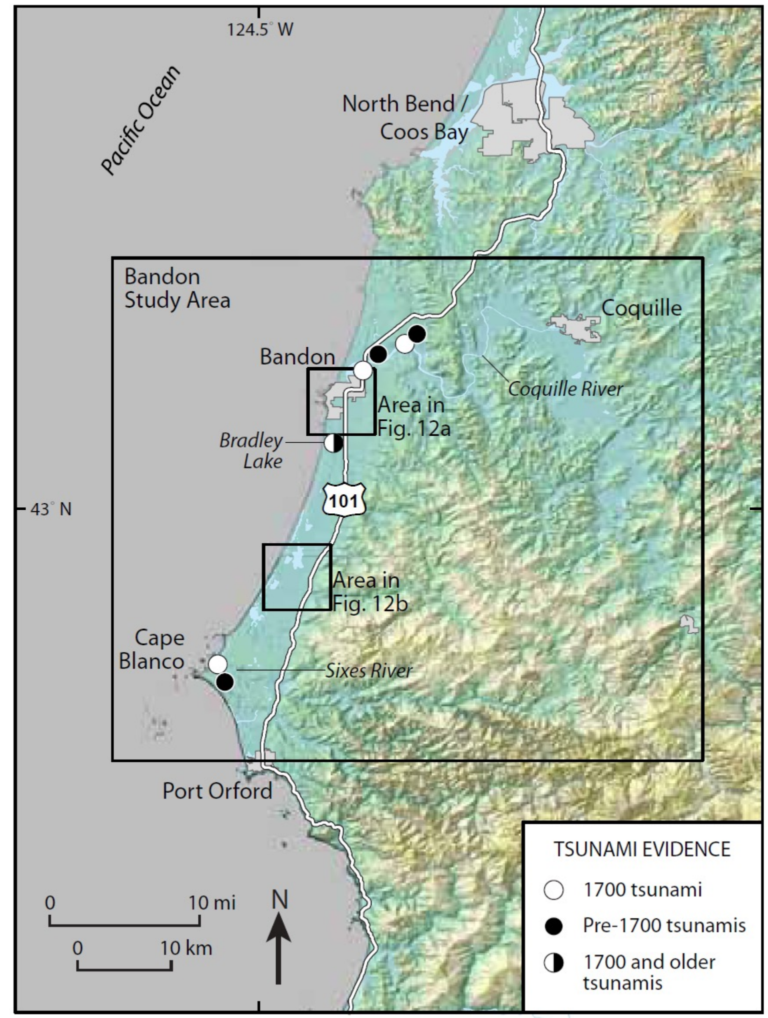


Figure 2. Relief map of the Bandon, Oregon, project area showing locations of human population centers and major coastal rivers. Sites of deposits left by the AD 1700 tsunami are shown by white circles; sites of older Cascadia tsunami deposits are shown as black circles; sites preserving both types of evidence are shown by circles half white and half black.

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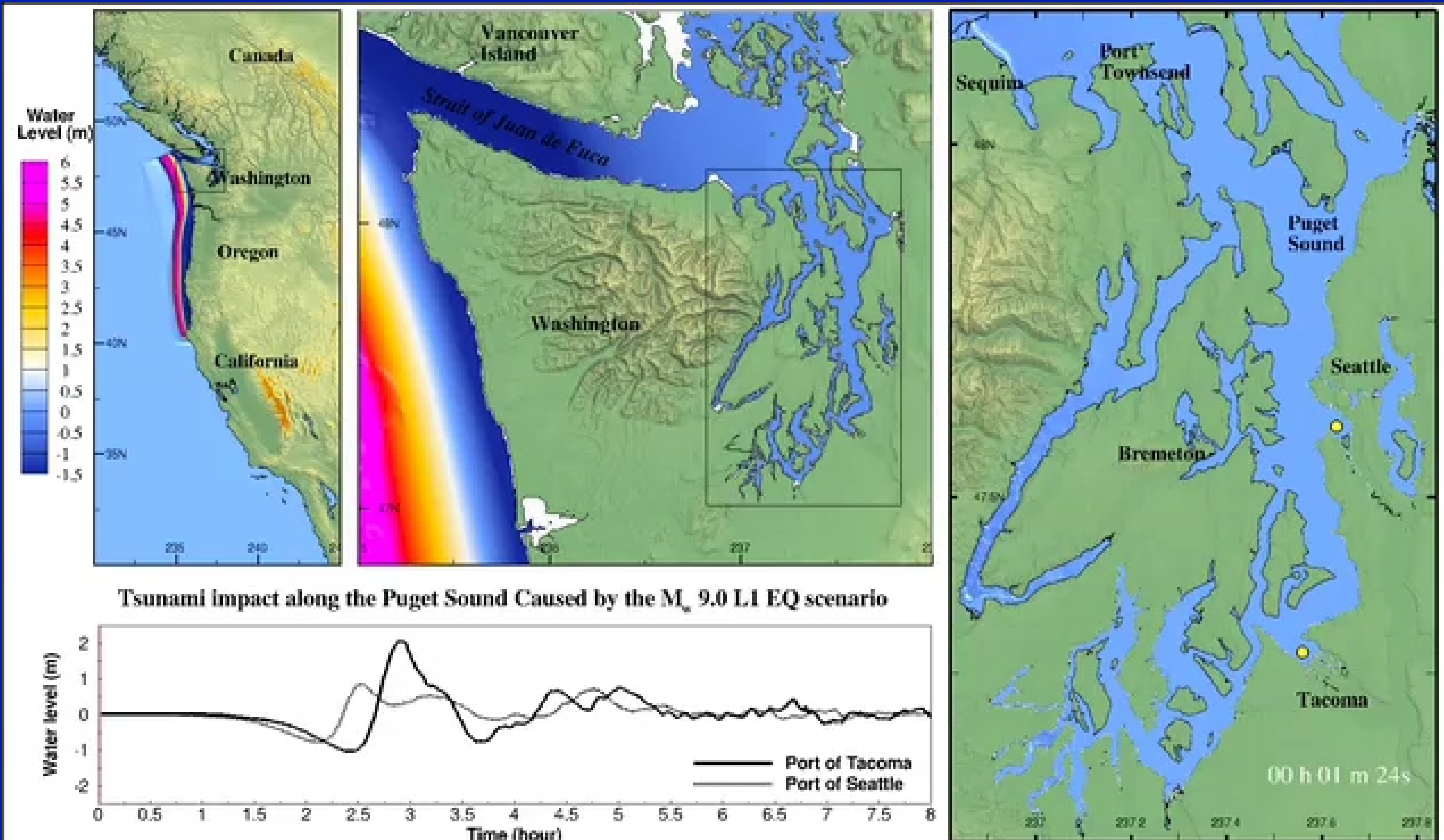
Table 3. Cascadia earthquake source parameters used to define 15 rupture scenarios. Logic tree branch weights shown in parentheses. Total scenario weight listed in right column.

Earthquake Size	Interevent Time (yrs)	Fault Geometry	Slip Range (m)		M_w	Scenario Name	Total Weight
			Maximum	Average			
Extra Extra Large (0.025)	1,200	Splay fault (0.8)	36–44	18–22	~9.1	**XXL 1**	0.02
		Shallow buried rupture (0.1)	36–44	18–22	~9.2	**XXL 2**	0.0025
		Deep buried rupture (0.1)	36–44	18–22	~9.1	**XXL 3**	0.0025
Extra Large (0.025)	1,050–1,200	Splay fault (0.8)	35–44	17–22	~9.1	**XL 1**	0.02
		Shallow buried rupture (0.1)	35–44	17–22	~9.2	**XL 2**	0.0025
		Deep buried rupture (0.1)	35–44	17–22	~9.1	**XL 3**	0.0025
Large (0.16)	650–800	Splay fault (0.8)	22–30	11–15	~9.0	**L 1**	0.128
		Shallow buried rupture (0.1)	22–30	11–15	~9.1	**L 2**	0.016
		Deep buried rupture (0.1)	22–30	11–15	~9.0	**L 3**	0.016
Medium (0.53)	425–525	Splay fault (0.6)	14–19	7–9	~8.9	**M 1**	0.318*
		Shallow buried rupture (0.2)	14–19	7–9	~9.0	**M 2**	0.106
		Deep buried rupture (0.2)	14–19	7–9	~8.9	**M 3**	0.106
Small (0.26)	275–300	Splay fault (0.4)	9–11	4–5	~8.7	**SM 1**	0.104
		Shallow buried rupture (0.3)	9–11	4–5	~8.8	**SM 2**	0.078
		Deep buried rupture (0.3)	9–11	4–5	~8.7	**SM 3**	0.078

*Scenario M1 carries the highest weight and represents the "most likely" event in our analysis.

The initial condition in the model is the L1 Scenario (Fig. 2) (Witter and others, 2011) which is a splay fault model in which some slip is partitioned into a thrust fault in the accretionary wedge that is subparallel to and with the same sense of movement as the plate interface, resulting in a broader uplift than a simple fault rupture. The land surface at Port Townsend is modeled to subside during ground shaking only minimally or not at all



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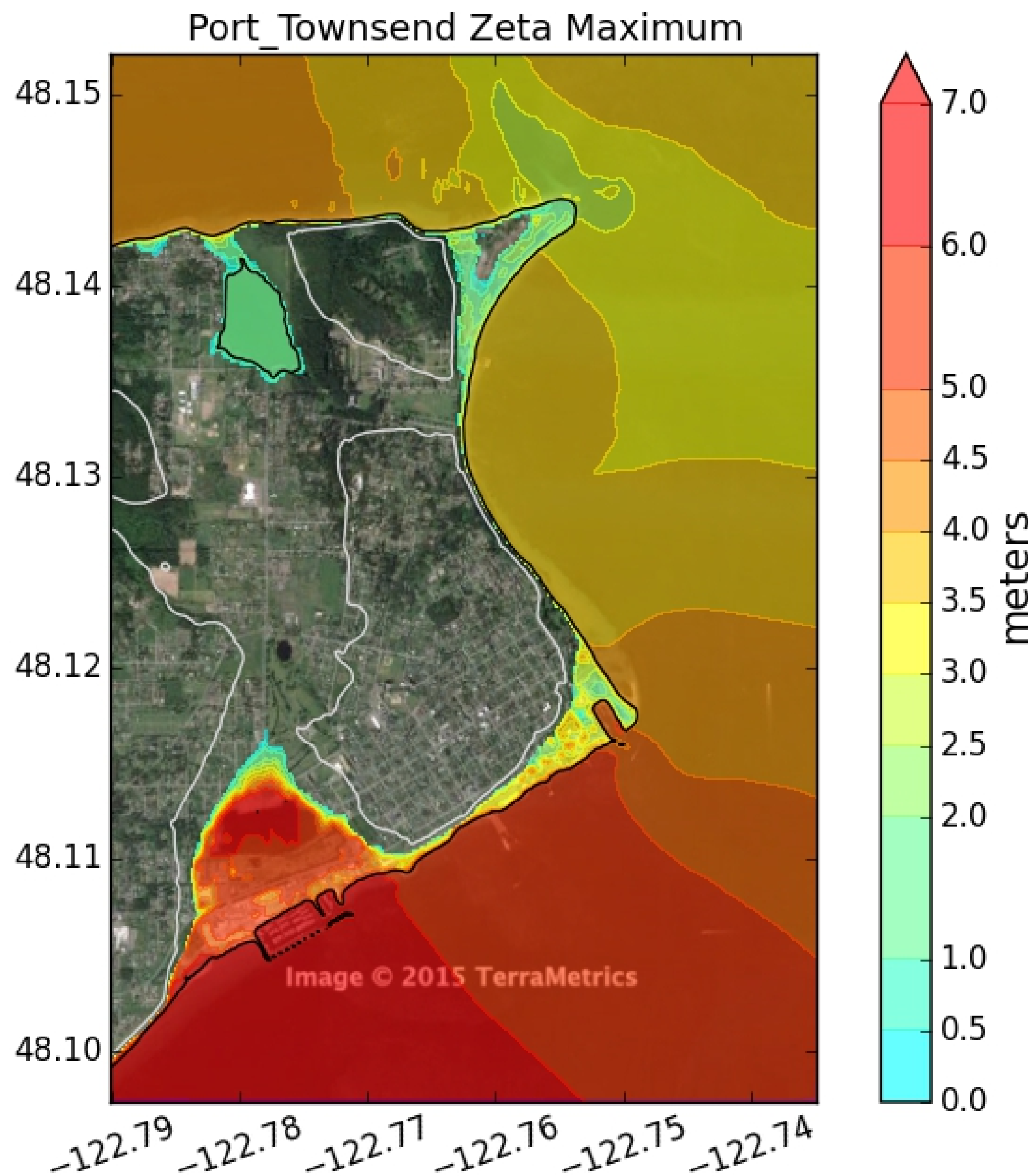

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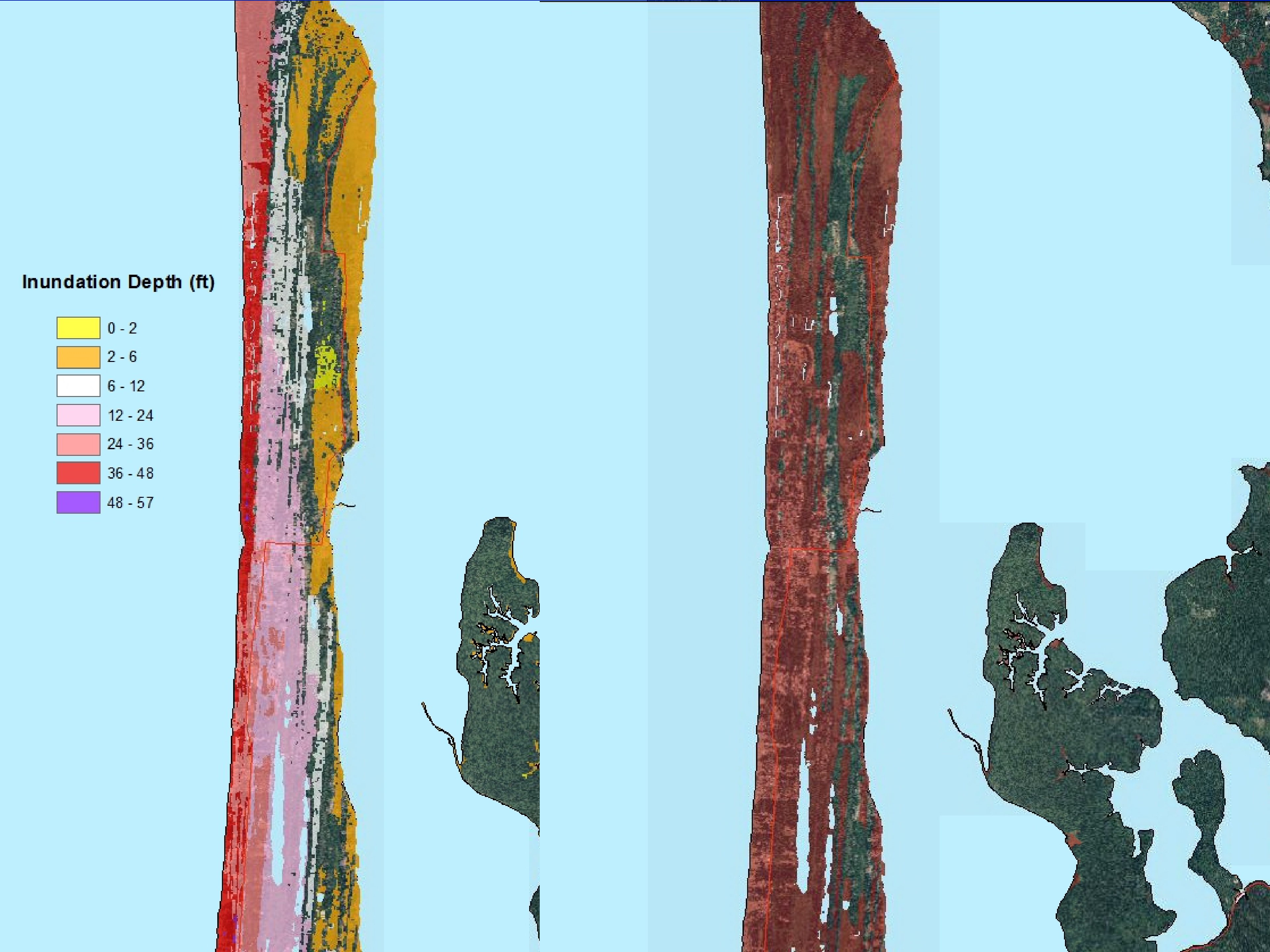
Inundation Depth (ft)
0 - 2
2 - 6
6 - 12
12 - 24
24 - 36
36 - 48
48 - 57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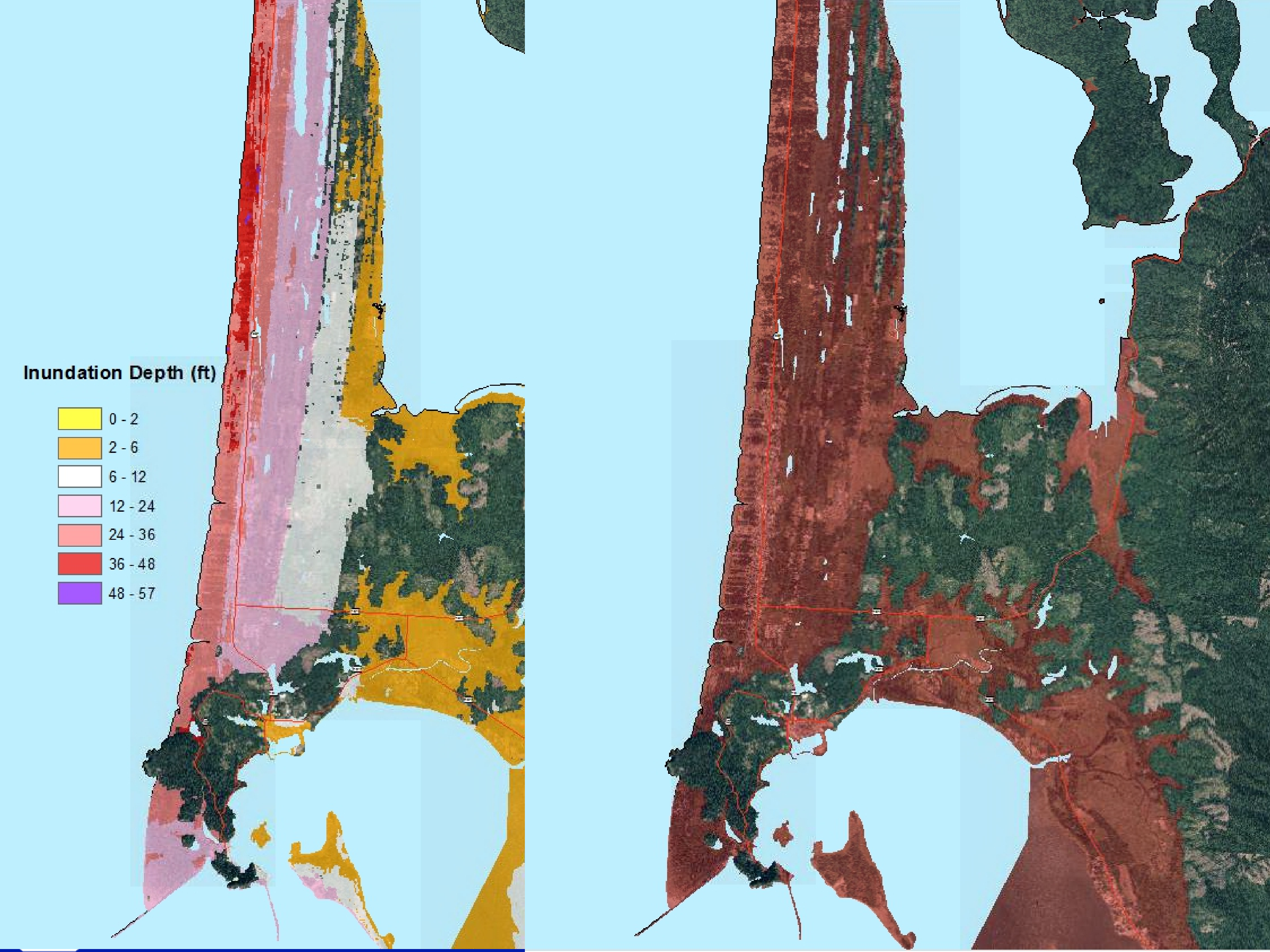
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