Publisher: GSA
Journal: GEOL: Geology
Article ID: G30172

# Tsunami geomorphology: erosion and deposition from the 15 November 2006 Kuril Island tsunami

**Breanyn T. MacInnes[1], Joanne Bourgeois[1], Tatiana K. Pinegina[2], and Ekaterina A. Kravchunovskaya[2]**

[1]*Department of Earth and Space Sciences, University of Washington, Seattle, Washington 98195, USA*

[2] *Institute of Volcanology and Seismology, Far Eastern Branch Russian Academy of Sciences, 683006 Petropavlovsk-Kamchatskiy, Russia*

*E-mail macinneb@u.washington.edu

**ABSTRACT**

The 15 November 2006 Kuril earthquake (Mw 8.1–8.4) and tsunami enabled us to collect a compelling data set of coastal geomorphic change in the Kuril Islands from ~3 months before to 9 (and 21) months after the tsunami. Our pre- and post-tsunami surveys of the islands, including four topographic profiles measured in 2006 and reoccupied in 2007, allow us the confidence to attribute many changes to the tsunami, in spite of an absence of eyewitness accounts in the central islands. Areas with low runup, <8 m, experienced limited geomorphic change, primarily confined to the beach or stream channels. Regions with high runup, >15 m, experienced massive erosion that dramatically altered the coastline. Tsunami deposits roughly corresponded with the extent of tsunami runup and inundation. The amount of sediment eroded by the tsunami far outweighed the amount deposited on land in all cases studied. The tsunami was dominantly erosive in the Kuril Islands because the high-relief topography of the coastline accelerated tsunami outflow.

**INTRODUCTION**

To study the full impact of tsunamis on coastal geomorphology, it is essential to understand their role in both addition and removal of coastal sediment. However, most studies of tsunami geology have focused on tsunami deposition rather than erosion (Bourgeois, 2009). Yet on certain coastlines, tsunamis may be important geomorphic agents, causing long-term changes in coastal systems. Pre- and post-tsunami measurements of coastal geomorphology are necessary in order to calculate coastal change and sediment movement during a tsunami— topics of utmost interest to the tsunami community (c.f. Gelfenbaum and Jaffe, 2003; Jaffe and Gelfenbaum, 2007; Huntington et al., 2007) and of broad interest to coastal geomorphologists (Dawson, 1994; Kench et al., 2008).

Tsunami-induced erosional changes of coastlines have been difficult to quantify because pre-event controls are lacking (c.f. Dawson, 1994; Choowong et al., 2007; Umitsu et al., 2007). To date, the only quantified before-and-after studies are beach profiles and atoll-island surveys from the 2004 Indian Ocean tsunami in southwestern India and the Maldives (Kurian et al., 2006; Kench et al., 2006; 2008). Also, Gelfenbaum and Jaffe (2003) estimated depth of erosion by the 1998 Papua New Guinea tsunami from exposed tree roots.

Despite the few quantified studies, many qualitative observations suggest that most tsunami-induced changes in coastal geomorphology are driven by erosion, during either inflow or outflow. Erosional changes to a landscape can be temporary (Kurian et al., 2006), permanent (Andrade, 1992), or continue an ongoing trend (Kench et al., 2006, 2008). Tsunamis remove vegetation and damage man-made structures (Dawson, 1994; Maramai and Tinti, 1997). Tsunami erosion causes beach retreat either as large-scale scour features or as smaller scallops (Dawson, 1994; Gelfenbaum and Jaffe, 2003; Kench et al., 2006; Kurian et al., 2006; Umitsu et al., 2007; Choowong et al., 2007). Tsunamis breach beach berms and other ridges, or erode the surface uniformly (Andrade, 1992; Dawson, 1994; Maramai and Tinti, 1997; Gelfenbaum and Jaffe, 2003; Choowong et al., 2007; Umitsu et al., 2007). They also alter drainage patterns by widening river mouths and creating new drainage networks, especially from topographic lows (Andrade, 1992; Maramai and Tinti, 1997; Umitsu et al., 2007).

From a geologically fortuitous series of field seasons bracketing the 15 November 2006 Kuril Island tsunami, we have been able to quantify tsunami erosion as well as deposition. In four examples of detailed topographic profiles from before and after the tsunami, as well as in numerous post-tsunami study sites, erosion was the primary response of the coastline to the 2006 tsunami in the Kuril Islands. Dominant motion of sediment was offshore, resulting in significant alteration of coastal geomorphology in some areas.

**BACKGROUND**

We surveyed coastlines on the Kuril Islands in summers of 2006-2008, focusing on paleotsunami records and coastal geomorphology as a part of the multi-disciplinary Kuril Biocomplexity Project (KBP). The Kurils are a volcanically active arc with many small islands in the central region (Fig. 1). Accordingly, dominant coastal geomorphologies are rocky cliffs or boulder to gravel beaches, with some sandy embayments.

Between our first and second field seasons, the 15 November 2006 earthquake (Mw 8.1 – 8.4) in the Kuril-Kamchatka subduction zone (Fig. 1) produced a large tsunami (Fujii and Satake, 2008; Ammon et al., 2008). Following the November events, an outer-rise earthquake occurred on 13 January 2007 ($M_w$ 7.9–8.1), adjacent to the 2006 rupture zone (Ammon et al., 2008; Fujii and Satake, 2008), also generating a tsunami. These tsunamis partially refocused our field efforts in 2007 and 2008 to include post-tsunami surveys and detailed examination of tsunami-caused change.

Until our post-tsunami surveys, there were no runup data from the uninhabited central Kuril Islands. However, around the Pacific Rim, tide gauges recorded tsunami amplitudes from the November 2006 event (archived for 113 locations by the National Geophysical Data Center (NGDC) Global Tsunami Database), ranging from <0.1 m (Solomon Islands) to 1.76 m (Crescent City, CA). The ensuing (January 2007) tsunami was on average three times smaller than the 2006 tsunami on tide gauges in the NGDC database.

## METHODS

Our 2006 (pre-tsunami) survey focused on open embayments where paleotsunami records could be preserved, limiting quantified pre- and post-tsunami comparisons to three sandy beach-ridge plains open to the Pacific—Dushnaya Bay on northern Simushir Island, and South Bay and Ainu Bay on Matua Island (Figs. 1, 2). All contain beach ridges greater than 5 m above mean sea level. These sites are vegetated primarily with beach rye (*Elymus arenarius*) and coastal-meadow grasses and flowers. All three sites were trenched by military in WWII, which locally allowed enhancement of tsunami erosion and deposition; for the purpose of this study, we avoided these anthropogenic effects where possible.

Because 10 months (September-June) passed between 2006 and 2007 field observations, we must address the question of whether the 2006 tsunami was the primary agent of observed changes. Other possible agents include the 2007 Kuril tsunami, storms, and seasonal wave regime. Seasonal effects are controlled for by our repeat survey in 2008. Moreover, there was a lack of large regional storms between field seasons (DRText; Figs.

DR2, DR3). We reason that the January 2007 tsunami caused little change because it was much smaller and occurred when the shoreline was frozen (MacInnes et al., 2009).

Post-tsunami survey teams in summers of 2007 and 2008 documented tsunami inundation (local maximum penetration distance), runup (elevation above mean sea level at inundation), erosion, and deposition. We surveyed 9 sites visited in 2006 or earlier, and 18 new sites, measuring in total 192 runup transects along a distance of ~600 km (Fig. 1; Table DR1) We identified tsunami inundation and runup by the farthest inland wrackline of floatable debris. Nearfield measurements of tsunami runup average 10 m and range up to 22 m (Table DR1).

We quantified erosional change on four 2006 topographic profiles (Figs. 1, 3) by re-measuring the profiles using a transit and rod; to relocate we used a combination of landmarks such as trenches and ridge crests, and GPS. On many other profiles, we described and recorded the position of erosional features, measured thicknesses of tsunami deposits, and documented the deposit’s landward-most extent (Table 1). For more on method, see Table DR1 and MacInnes et al. (2009).

## OBSERVATIONS

The 2006 Kuril Island tsunami altered the coastline of the central Kurils in sandy embayments and on boulder beaches. The three sandy embayments focused on in this study—Dushnaya, South and Ainu bays—experienced a range of tsunami size, from low runup (<8 m) to high (>15 m) and exhibited a range of erosional and depositional features.

We observed a greater volume of erosion and deposition where runup was higher (Table 1; Fig. DR4) and fewer erosional features where runup was lower. In Dushnaya Bay, the tsunami was smaller in the center (Fig. 1), with runup of 5–20 m and inundation of 40–

150 m (Table DR1). Central Dushnaya Bay, the location of a before-and-after profile (Fig. 3A), recorded ~6-9 m runup and ~100-150 m inundation, erosion was limited and a sand sheet preserved (Table 1). Runup in South Bay was low (5–8 m), with inundation of ~100–200 m (Table DR1). We found tsunami deposits almost as far as water carried debris, with patches of erosion on vegetated beach ridges (Fig. 3B; Table 1). In Ainu Bay, runup was typically 14–20 m, with inundation up to ~500 m (Table DR1), generating massive erosion, with erosional patches extending farther inland than we found tsunami deposits (Table 1).

## Sediment Removal and Erosional Features

### ***Low Runup***

Erosion in central Dushnaya Bay (Fig. DR1) can be generalized as small-scale retreat of the back-beach scarp (Fig. DR6), surficial sediment removal in areas lacking cohesive soils, and local scour associated with focused water withdrawal, especially into stream channels. At one point, the tsunami breached the seaward beach ridge. Comparison of before and after profiles (Fig. 3A) could not resolve landward retreat of the beach scarp, although nearby we measured up to 3 m of retreat . The only quantifiable change on the profiles was on the unvegetated beach (Fig. 3A), where ~5 $m^3$ (per unit width) of sediment had been removed between 2006 and 2007 (Table 1).

In South Bay, before and after profiles (Figs. 3B, DR10) show a significant difference in the active beach, with ~50 $m^3$ (per unit width) of sediment missing in 2007. In beach-ridge troughs along the profile, our 2006 excavated turf blocks and some flagging tape remained virtually undisturbed in 2007. Small, shallow patches of erosion on high points up to 160 m inland (Table 1) and larger ones elsewhere in South Bay were on seaward sides of beach ridges. Along the shoreline away from the profile, the tsunami removed blocks of turf off the back-beach scarp.

***High Runup***

Much of the erosion in Ainu Bay can be considered persistent geomorphic change (Figs. DR11–14). The tsunami removed ~200 $m^3$ (per unit width) of sediment along the Ainu Bay reoccupied profiles (Fig. 3C,D, Table 1). On both profiles, continuous, deep erosion of vegetation and sediment occurred for ~160 m inland, including landward widening of the beach by up to 55 m (Figs. 2, 3D) via back-beach cliff retreat. The tsunami removed seaward-most beach ridges, reduced others in size, and eroded seaward-facing slopes primarily by stripping young, sandy sediment off the surface (Fig. 3C,D). As a particular example, a continuous scour extending over 100 m laterally formed on a seaward-facing slope of compact soil (at 160 m inland in Figure 3C; Fig. DR13).

Throughout Ainu Bay, smaller-scale but still dramatic erosion included patches of eroded soil and stripped vegetation up to 5 m in diameter. Eroded patches were especially associated with rodent burrow networks and volcanic cinder layers below the sod, both of which facilitated soil stripping. These patches were common at the bases of slopes, some even landward of a recognizable tsunami deposit (Table 1). In areas with sandy soils, gullying and scouring were common where the tsunami was steered by low-lying topography. The tsunami also breached and drained a lake (Fig. 3D, DR14). Most indicators of flow direction, such as plunge pools and gullies, primarily recorded outflow; some, such as a flipped-over sod, recorded inflow.

**Sediment Deposition**

Irrespective of tsunami runup height and inundation distance, there was evidence of deposition on all studied sites (Fig. 3; Table 1). Where sand was available along the shore, the tsunami deposited a landward thinning, continuous sheet of that sand across vegetated surfaces. Sand deposits averaged 2.5 cm thick (20 cm maximum) and were generally thicker in beach-ridge troughs than on crests. Along the sandy beach ridges of Dushnaya, South and Ainu bays, the tsunami added a thin veneer of sediment, ~1-6 $m^3$ per unit width of profile (Table 1). Shorelines along boulder to gravel beaches exhibited patchy tsunami deposits of pebbly gravel, and relocated cobbles and boulders generally <1 m diameter. On most shorelines, the tsunami eroded and deposited blocks of sod, more abundant and larger (up to 3 m diameter) on coarser-grained shorelines.

Sandy tsunami deposits were nearly as extensive as the tsunami (Table 1). The maximum elevation of deposits was on average 90% of runup elevation, and never <71% (a case with limited sand supply). The landward terminus of the deposit averaged 95% of tsunami inundation (as marked by floated debris); the horizontal difference was <10 m in nine cases, and at most 22 m (Table 1).

**Deposition versus Erosion**

Even with ubiquitous deposition, less sediment was deposited than eroded on every profile studied in detail. In the eight cases with measured volumes (per unit width) of both erosion and deposition, the amount of tsunami-transported sand preserved on the coastal plain was usually <10% of that eroded (Table 1); only one of those profiles exhibited focused erosion (Profile 2 in Dushnaya Bay; Figs. DR1, DR9). Even in Dushnaya Bay, where the tsunami was the smallest, erosion the least, and deposition the most extensive, about three times more sediment was removed from the coast then deposited on land.

## DISCUSSION AND CONCLUSIONS

Our survey of tsunami deposits in the Kuril Islands strengthens the argument that on sandy shorelines tsunami-deposit extent can be used as proxy for tsunami runup and inundation (Table 1; Martin et al., 2008), provided the pre-tsunami shoreline position can be reconstructed. Recent post-tsunami studies of low-relief coastlines have shown that tsunami deposits commonly extend to 90% of water runup and inundation limits (Table DR2). On the high-relief coastlines of the Kuril Islands, tsunami deposits are equally representative of onshore tsunami metrics.

The volume of tsunami erosion is related to tsunami runup, distance from shore, and topography; vegetation and local roughness can clearly be factors as well, but in our study they do not measurably vary. That greatest erosion from tsunamis occurs closer to the shore is a common observation of post-tsunami surveys (cf. Gelfenbaum and Jaffe, 2003; Umitsu et al., 2007). Farther from the shore (100s of m in the Ainu Bay case), patches of erosion typically occur where the topography generates local water acceleration, enhancing the erosive capacity of tsunamis.

Some erosional features generated by tsunamis should become preserved geomorphology. In Ainu Bay, the removal of the seaward beach ridges, breaching of a lake and development of inland scours should all be visible for decades or centuries. Indeed, previous (undated) instances of deep coastal erosion and breached lakes can be seen in Ainu Bay stratigraphy (Fig. DR11). Even in cases of relatively low runup, breached beach ridges should remain discontinuous, and we have observed such breaches in older beach ridges in Dushnaya Bay and also along the Pacific coast of Kamchatka.

Our findings agree with previous studies indicating that net direction of tsunami sediment transport is dependent on capacity of the coastline to generate backwash or offshore flow (Umitsu et al., 2007). Tsunamis flowing over low-relief coastlines (Kurian et al., 2006; Gelfenbaum and Jaffe, 2003) generated net onshore transport. On high-relief coastlines such as the Kuril Islands, tsunami backwash can be accelerated to a greater velocity than on low-relief topography, thereby generating net offshore transport. The case where a tsunami completely overtops low-relief islands, as in the 2004 Indian Ocean tsunami washing over the low-relief Maldives, is more complex (Kench et al., 2008).

For the first time, a group of tsunami geologists surveyed a coast both before and after a large tsunami. Our quantitative comparison of erosional and depositional volumes is this case showed that erosion clearly dominated deposition. Nevertheless, geologists interpreting paleotsunamis should be reassured that deposits can be a reliable proxy for tsunami runup and inundation, though the necessary paleogeographic reconstruction remains challenging, especially in light of tsunami erosion. Our data and analyses are also significant for geologists interested in understanding tsunami flow properties, in defining tsunami erosion and deposition patterns (tsunami geomorphology), and in determining coastal geologic histories in tsunami-affected regions. Moreover, while the central Kurils are currently uninhabited, this study may help explain why there are fewer coastal archaeological sites on the Pacific side of the Kurils. It also provides important information about tsunami hazard on high-relief coastlines around the world.

## ACKNOWLEDGMENTS

Funding for fieldwork was provided by the Kuril Biocomplexity Project (NSF grant #0508109, PI- Ben Fitzhugh) and by the Institute of Marine Geology and

Geophysics, FED RAS, Yuzhno-Sahkalinsk, Russia (Director- Boris Levin). For field assistance, we thank Sergei Chirkov, Misty Nikula, Mike Etnier, and Jesse Einhorn. We thank Cecilia Bitz for helping us recover weather data from the region, and we appreciate thorough reviews by Brian McAdoo, Martitia Tuttle and two anonymous reviewers.

**REFERENCES CITED**

Ammon, C.J., Kanamori, H., and Lay, T., 2008, A great earthquake doublet and seismic stress transfer cycle in the central Kuril islands: Nature v. 451, p, 561–566.

Andrade, C., 1992, Tsunami generated forms in the Algarve Barrier Islands: Science of Tsunami Hazards v. 10, p, 21–34.

Apel, E.V., Burgmann, R., Steblov, G., Vasilenko, N., King, R., and Prytkov, A., 2006, Independent active microplate tectonics of northeast Asia from GPS velocities and block modeling: Geophysical Research Letters, v. 33, p. L11303, doi: 10.1029/2006GL026077.

Bourgeois, J., 2009, Geologic effects and records of tsunamis, in The Sea: Volume 15, Tsunamis (eds. Bernard, E.N. and Robinson, A.R.), Harvard University Press, 55–91.

Choowong, M., Murakoshi, N., Hisada, K., Charusiri, P., Daorerk, V., Charoentitirat, T., Chutakositkanon, V., Jankaew, K., and Kanjanapayont, P., 2007, Erosion and Deposition by the 2004 Indian Ocean Tsunami in Phuket and Phang-nga Provinces, Thailand: Journal of Coastal Research v. 23, p, 1270–1276.

Dawson, A.G., 1994, Geomorphological effects of tsunami run-up and backwash: Geomorphology v. 10, p, 83–94.

Fedotov, S.A., Chernyshev, S.D., and Chernysheva, G.V., 1982, The Improved Determination of the Source Boundaries for Earthquakes of $M>7.75$, of the Properties of the Seismic Cycle, and of Long-term Seismic Prediction for the Kurile-Kamchatka Arc: Earthquake Prediction Research, v. 1, p. 153–171.

Fujii, Y., and Satake, K., 2008, Tsunami Sources of the November 2006 and January 2007 Great Kuril Earthquakes: Bulletin of the Seismological Society of America v. 98, p, doi: 10.1785/0120070221.

Gelfenbaum, G., and Jaffe, B., 2003, Erosion and Sedimentation from the 17 July 1998 Papua New Guinea Tsunami: Pure and Applied Geophysics, v. 160, p. 1969–1999, doi: 10.1007/s00024-003-2416-y.

Huntington, K., Bourgeois, J., Gelfenbaum, G., Lynett, P., Jaffe, B., Yeh, H., and Weiss, R., 2007, Sandy signs of a tsunami's onshore depth and speed: Eos, Transactions, American Geophysical Union, v. 88, no. 52, p. 577–578, doi: 10.1029/2007EO520001.

Jaffe, B., and Gelfenbaum, G., 2007, A simple model for calculating tsunami flow speed from tsunami deposits: Sedimentary Geology, v. 200, p. 347–361, doi: 10.1016/j.sedgeo.2007.01.013.

Kench, P.S., McLean, R.F., Brander, R.W., Nichol, S.L., Smithers, S.G., Ford, M.R., Parnell, K.E., and Aslam, M., 2006, Geological effects of tsunami on mid-ocean atoll islands: The Maldives before and after the Sumatran tsunami: Geology, v. 34, p. 177–180, doi: 10.1130/G21907.1.

Kench, P.S., Nichol, S.L., Smithers, S.G., McLean, R.F., and Brander, R.W., 2008, Tsunami as agents of geomorphic change in mid-ocean reef islands: Geomorphology v. 95, p, 361–383.

Kurian, N.P., Pillai, A.P., Rajith, K., Murali Krishnan, B.T., and Kalaiarasan, P., 2006, Inundation characteristics and geomorphological impacts of December 2004 tsunami on Kerala coast: Current Science, v. 90, p. 240–249.

MacInnes, B.T., Pinegina, T.K., Bourgeois, J., Razhegaeva, N.G., Kaistrenko, V.M., and Kravchenovskaya, E.A., 2009, Field survey and geological effects of the 15 November 2006 Kuril tsunami in the middle Kuril Islands: Pure and Applied Geophysics, v. 166,

Maramai., A., and Tinti, S., 1997, The 3 June 1994 Java Tsunami: A Post-Event Survey of the Coastal Effects: Natural Hazards v. 15, p, 31–49.

Martin, M.E., Weiss, R., Bourgeois, J., Pinegina, T.K., Houston, H., and Titov, V.V., 2008, Combining constraints from tsunami modeling and sedimentology to untangle the 1969 Ozernoi and 1971 Kamchatskii tsunamis: Geophysical Research Letters, v. 35, p. L01610, doi: 10.1029/2007GL032349.

Umitsu, M., Tanavud, C., and Patanakanog, B., 2007, Effects of landforms on tsunami flow in the plains of Banda Aceh, Indonesia, and Nam Khem, Thailand: Marine Geology, v. 242, p. 141–153, doi: 10.1016/j.margeo.2006.10.030.

## FIGURE CAPTIONS

Figure 1. **A.** Historical tsunamigenic earthquakes on the Kuril-Kamchatka trench, after Fedotov et al. (1982). The 2007 earthquake was an outer-rise event in the Pacific Plate; all others occurred on the Pacific/Okhostk plate interface. **B.** Tectonic setting of the region, after Apel et al. (2006); velocities on plate boundaries are in mm/yr. Area of **(A)** is shown by a shaded rectangle. **C.** Runup elevation in meters from the 2007 and 2008 post-tsunami surveys (Table DR1) for the shaded area of islands in **(A)**.

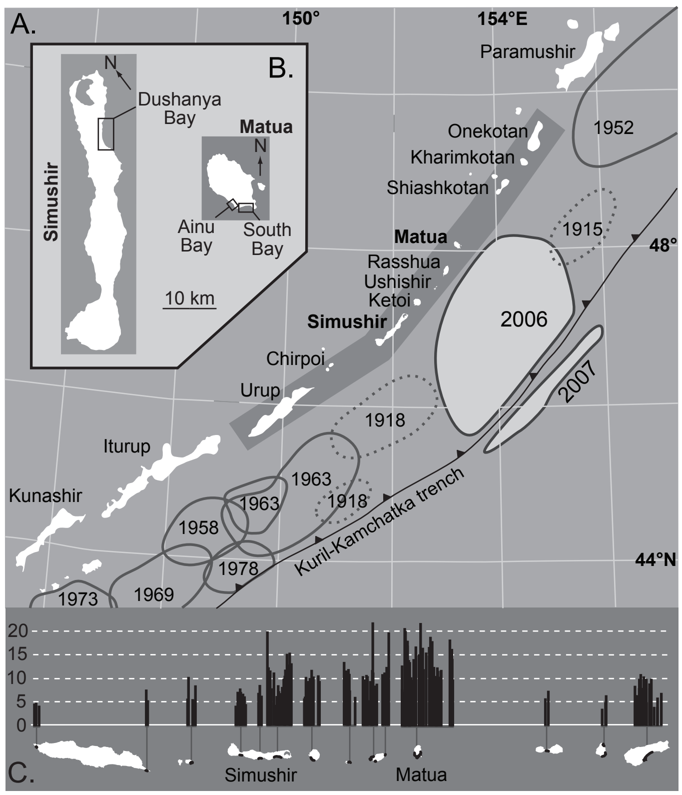
Figure 2. Post-tsunami (2007) view of Ainu Bay, Matua (Fig. 1). Black line marks seaward extent of vegetation in 2006.

Figure 3. Before (2006) and after (2007) topographic profiles from Dushnaya Bay, Simushir Island (**(A)**) and South Matua Island (**(B)**, **(C)**, **(D)**) (locations on Fig. 1, DR1). **(A)** and **(B)** are cases of low runup and **(C)** and **(D)** of high runup. “First vegetation” refers to the seaward limit of vegetation covering the surface; on **(A)** and **(B)**, the location of first vegetation did not significantly change between 2006 and 2007. On **(D)** the lake was present in 2006 but not in 2007; in the area marked “not measured,” seaward-derived sand deposits were mixed with locally eroded cinders and gravel. Additional images: **(A)**: Figures DR5–6. **(B)**: Figure DR10. **(C)**: Figures DR11–13. **(D)**: Figure DR3, DR14.

TABLE 1. CHARACTERISTICS OF THE 15 NOVEMBER 2006 TSUNAMI WAVE, SAND DEPOSITS, AND COASTAL EROSION IN THE CENTRAL KURIL ISLANDS

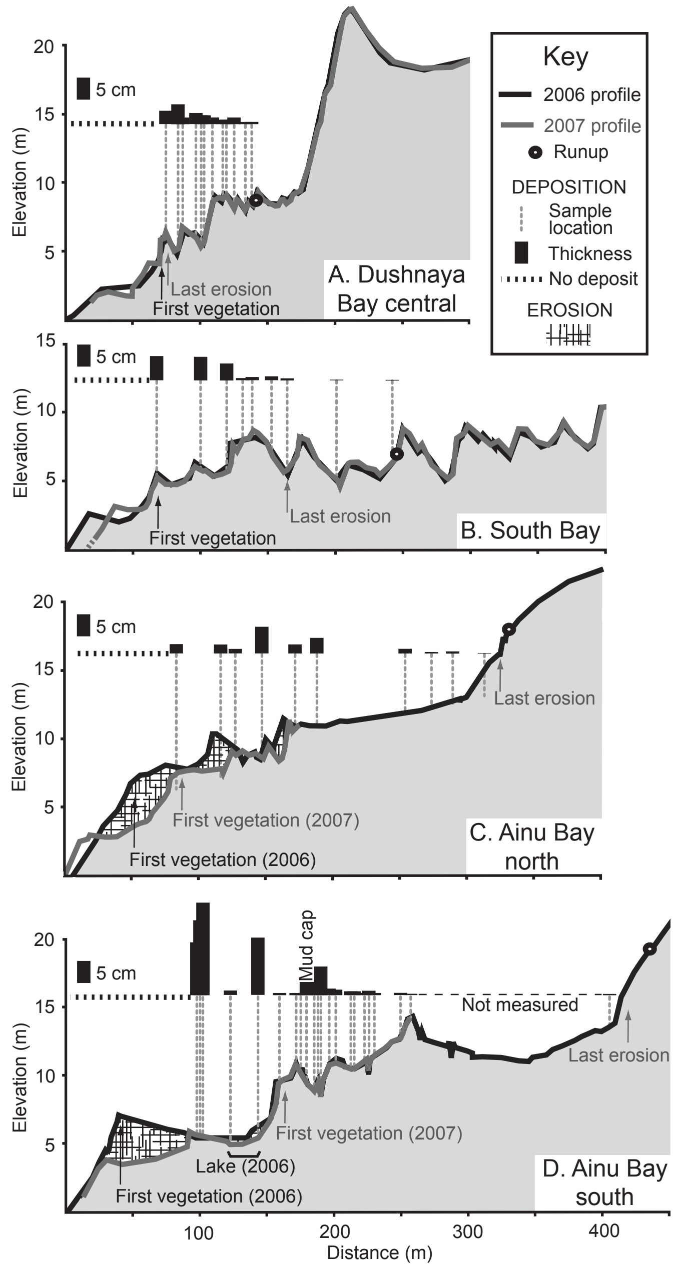
| Topographic profile* | Water limit | | Approximate deposit volume ($m^3$) | Deposit limit | | Approximate erosion volume ($m^3$) | Erosion limit | |
|---|---|---|---|---|---|---|---|---|
| | Runup† (m) | Inundation (m) | | Vertical† (m) | Horizontal (m) | | Vertical† (m) | Horizontal (m) |
| Dushnaya Bay central | 6.7 | 122 | 1.2 | 6.6 | 120 | 5 | 5.1 | 55 |
| South Bay | 5.7 (7.6) | 223 | 3.4 | 5.0 (7.6) | 217 | 50 | 5.3 (7.6) | 160 |
| Ainu Bay north | 17.1 | 327 | 4.8 | 14.8 | 305 | 200 | 16.3 | 310 |
| Ainu Bay south | 18.1 | 432 | 6.3 | 17.4 | 422 | 200 | 17.4 | 422 |
| Dushnaya Bay-2 | 12.4 | 75 | 0.9 | 12.1 | 72 | >50§ | 11.9 | 62 |
| Dushnaya Bay-6 | 4.4 (10.3) | 106 | 1.2 | 4.4 (10.3) | 106 | - | - | - |
| Dushnaya Bay-7 | 6.3 | 139 | 1.7 | 6.3 | 139 | - | 5.9 | 122 |
| Dushnaya Bay-9 | 7.3 (12.6) | 151 | 3.0 | 7.3 (12.6) | 151 | - | - | - |
| Dushnaya Bay-12 | 6.9 | 120 | 0.9 | 5.8 | 112 | - | 3.2 | 59 |
| Dushnaya Bay-109 | 9.1 | 59 | Little sand, 0.4 | 7.5 | 49 | 5§ | 5.6 | 41 |
| Dushnaya Bay-106 | 13.0 | 70 | Local gravel only | - | - | >5§ | 8.2 | 63 |
| Dushnaya Bay-102 | 7.7 | 51 | 1.4 | 6.7 | 46 | >5§ | 5.1 | 37 |
| Sarychevo-125 | 11.8 | 118 | 1.3 | 8.4 | 97 | - | 9.5 | 102 |
| NE Rasshua-201 | 11.4 | 111 | 1.4 | 10.2 | 109 | 5§ | 9.2 | 105 |

*See Figure 1 or Table DR1 for locations.
†(7.6)—Cases with higher topography seaward of runup.
§Minimum estimates because beach change not measurable without pre-tsunami topography.
- —not measured.




MacInnes et al., Figure 1

MacInnes et al., Figure 2




MacInnes et al., Figure 3

**Data Repository**
**for**
# Tsunami geomorphology: erosion and deposition from the 15 November 2006 Kuril Island tsunami

MacInnes, Breanyn T.
Bourgeois, Joanne
Pinegina, Tatiana K.
Kravchunovskaya, Ekaterina A.

## Discussion—Were all observed changes from the 2006 tsunami?

Because 10 months (September-June) passed between field observations, we must address the question of whether the 2006 tsunami was the primary cause of observed changes. Other possible agents acting during these unobserved periods include the 2007 Kuril tsunami, erosion and deposition due to storms, and seasonal beach-profile variations. We reason that 2006 did cause most observed changes, based on the smaller size of the 2007 tsunami, on the fact that the 2007 tsunami occurred when the shoreline was frozen, and on the lack of large regional storms between field seasons.

We reason that the 2007 Kuril tsunami had little impact on the coastline because of its relative size and because of the time of year (MacInnes et al., 2009). Field observations suggest that the 2007 Kuril tsunami had runup of less than 5 m (MacInnes et al., 2009), making its influence on much of the vegetated coastline negligible. Moreover, the average temperature in the central Kurils between the 2006 and 2007 tsunamis was -3 to -6 ºC[1], resulting in a frozen upper beach and coastal plain at the time of the 2007 tsunami, inhibiting marked erosion.

We also reason that all measured change above and most measured change below storm high tide (defined by the presence of dense vegetation and seaweed wracklines) resulted from the 2006 tsunami and not from storms. Storms affecting the coasts of Kurils in 2006, 2007, and 2008 were not abnormally large and therefore likely did not cause measurable changes above storm wracklines observed in 2006 or on the vegetated coastal plain. Wind speed records suggest no unusual storms occurred in the field area between the pre- and post- tsunami surveys (Fig. DR2). Also, in 2007 and 2008 surveys we observed no fresh storm effects beyond the beach on coastlines where the tsunamis also did not surpass the beach.

Below storm high tide, beaches may actively change (c.f. Shepard et al., 1950), and in our study, we did not measure winter-beach profiles, but we argue that the 2006 tsunami is also responsible for most beach-profile changes because the beaches did not recover between 2007 and 2008 (Fig. DR3).

## Post-tsunami survey data—runup and inundation

A compilation of all field measurements of runup and inundation from the 2007 and 2008 (post-tsunami) field seasons is presented in Table DR1. Most measurements made in 2007 were previously reported in MacInnes et al. (2009), but with fewer columns (thus omitting some observations). The data from the 2008 field season are newly reported here.

## Supplemental field observations, data and photographs

[1]Based on four-times daily temperature records; NCEP Reanalysis data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.cdc.noaa.gov/

**Volume of erosion and deposition.** In cases where we could quantify the volume of erosion or deposition along a profile (reported as $m^3$ per unit width), we plotted those estimates relative to runup and to runup times inundation, the latter an approximation of onland tsunami volume (Fig. DR4). We calculated the volume of tsunami erosion along a profile by measuring the area missing in 2007/2008 below profile lines measured in or reconstructed from 2006 (e.g., Figs. 3). We calculated deposit volume along a profile by taking measured thickness of fresh tsunami deposits at survey points (as in Figure 3) and integrating between them to generate the cross-sectional area covered by tsunami deposit along a given profile. We assigned ±10% error to the calculations. There is not a robust correlation of runup to volume of erosion and deposition for runup of less than 13 m (Fig. DR4A); the higher runup in Ainu Bay clearly produced greater geomorphic change. There is a better trend shown by comparing erosion and deposition volumes to runup times inundation (Fig. DR4B), which is a better overall scale of tsunami size. In Fig. DR4B, however, there is an even larger gap between the high numbers of Ainu Bay and the rest of the data.

**Additional illustrations of tsunami effects.** While the Dushnaya Central profile (Fig. 3) on Simushir Island was virtually unchanged across its vegetated surface (Fig. DR5), the tsunami rearranged the beach and locally eroded the beach scarp (Fig. DR6). In northern Dushnaya Bay, runup was higher, with common stripping of turf and soil (Fig. DR7) and deposition of gravel (Fig. DR8). In southern Dushnaya Bay, a very steep, sandy profile exhibited dramatic local erosional scours and enlarged drainage (Fig. DR9). The effects on the shoreline along South Bay, Matua Island (Fig. DR10), were similar to Central Dushnaya Bay, with a greater volume of beach erosion (Figure 3; Table 1). The most dramatic tsunami effects were in Ainu Bay on Matua Island, where stratigraphic analysis suggests tsunamis may have repeatedly produced coastal erosion (Fig. DR11). In the north, young landforms from the beach to 160 m inland were removed or denuded (Fig. DR12) and a long scour developed at the boundary between older and younger landforms (Fig. DR13). In the south, erosion was also severe, especially close to the shoreline (Fig. DR14).

**Discussion**

In order to examine the extent to which tsunami deposits may approximate actual runup and inundation, we compiled our own data (Table 1) with other reported cases and calculated the percent of actual runup and inundation represented by the deposit (Table DR2). We also calculated the total relief (runup/inundation) over the tsunami-affected part of each profile, and the maximum relief on each profile, in order to compare Kurils cases with others where the data are available. Table DR2 shows that Kurils profiles are higher relief than the others.

**Acknowledgements**

The following people contributed to the collection of data that appears in Table DR1: Nadezhda Razhigaeva, Kirill Ganzey, Andrew Ritchie, Sergei Chirkov, Andrei Kharlamov, Douglas Querl, Victor Kaistrenko, Misty Nikula, Mike Etnier, Natalia Slobodina, Dimitri Frolov, Nikolai Vasilenko, Ben Fitzhugh, Boris Levin, Mikhail Nosov, Molly Odell, Erik Gjesfeld, and Elena Sassorova.

**References cited**

Gelfenbaum, G. and Jaffe, B., 2003, Erosion and Sedimentation from the 17 July 1998 Papua New Guinea Tsunami, Pure and Applied Geophysics, v. 160, 1969–1999.

Higman, B., and Bourgeois, J., 2008, Deposits of the 1992 Nicaragua Tsunami, in Shiki, T., Tsuji, Y., Yamazaki, T., and Minoura, K., ed., Tsunamiites: Features and Implications: San Francisco, Elsevier, p. 81–104.

Jaffe, B.E., Borrero, J.C., Prasetya, G.S., Peters, R., McAdoo, B., Gelfenbaum, G., Morton, R., Ruggiero, P., Higman, B., and Dengler, L., 2006, Northwest Sumatra and Offshore Islands Field Survey after the December 2004 Indian Ocean Tsunami: Earthquake Spectra v. 22, p, S105.

MacInnes, B.T., Pinegina, T.K., Bourgeois, J., Razhegaeva, N.G., Kaistrenko, V.M., and Kravchenovskaya, E.A., 2009, Field survey and geological effects of the 15 November 2006 Kuril tsunami in the middle Kuril Islands: Pure and Applied Geophysics, v. 166,

Nanayama, F., 2008, Sedimentary Characteristics and Depositional Processes of Onshore Tsunami Deposits: An Example of Sedimentation Associated with the 12 July 1993 Hokkaido-Nansei-oki Earthquake Tsunami, in Shiki, T., Tsuji, Y., Yamazaki, T., and Minoura, K., ed., Tsunamiites: Features and Implications: San Francisco, Elsevier, p. 63–80.

Shepard, F.P., Macdonald, G.A., and Cox, D.C., 1950, The tsunami of April 1, 1946 (Hawaii): California University, Scripps Institute of Oceanography Bulletin, v. 5, p. 391-528.

Shi, S.Z., Dawson, A.G., and Smith, D.E., 1995, Coastal sedimentation associated with the December 12th, 1992 tsunami in Flores, Indonesia: Pure and Applied Geophysics v. 144, p. 525–536.

Srinivasalu, S., Thangadurai, N., Switzer, A.D., Ram Mohan, V., and Ayyamperumal, T., 2007, Erosion and sedimentation in Kalpakkam (N Tamil Nadu, India) from the 26th December 2004 tsunami: Marine Geology v. 240, p, 65–75.

TABLE DR1: SUMMARY OF CENTRAL KURIL ISLANDS POST-TSUNAMI SURVEY OF RUNUP AND INUNDATION ORDERED BY LATITUDE

| Date | Team* | Location | | | | Method* | Runup (preferred in bold) | | | | | | Higher elevation seaward of inundation (m) | Inundation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Island | Locality name | Latitude of profile* | Longitude of profile* | | Number of runup readings | 2006 runup on profile (m) | 2006 runup avg. near profile (m) | Tide correction (m) | Runup with tide correction (m) | Runup avg. with tide correction (m) | | Measured inundation (m) | GPS calculated inundation (m) |
| 05/07/2007 | VMK | Urup | Os'ma Bay-2 | 45.58223 | 149.45068 | TL | 1 | **4.4** | - | - | - | - | no | 170 | - |
| 05/07/2007 | VMK | Urup | Os'ma Bay-1 | 45.58285 | 149.45138 | TL | 1 | **5.0** | - | - | - | - | no | 48 | - |
| 05/07/2007 | JB | Urup | Os'ma Bay-1-2006 | *45.58300* | *149.45350* | TL | 1 | **4.8** | - | - | - | - | no | 50 | - |
| 21/08/2008 | BTM | Urup | Kostrikum Cape-225 | 46.21145 | 150.54547 | TL | 4 | 7.6 | 7.7 | 0.3 | 7.9 | **8.0** | no | 80 | 79 |
| 21/08/2008 | BTM | Urup | Kostrikum Cape-232 | 46.21520 | 150.54867 | TL | 3 | 5.4 | 5.4 | -0.1 | 5.2 | **5.2** | 5.6 | 61 | 51 |
| 19/08/2008 | JB | Chirpoi | Peschanaya South-V153 | *46.53294* | *150.89059* | HLT | 1 | 5.7 | - | -0.3 | **5.4** | - | no | 70 | - |
| 19/08/2008 | JB | Chirpoi | Peschanaya South-V150 | 46.53397 | 150.89264 | HLT | 2 | 10.4 | 10.3 | 0.0 | 10.5 | **10.4** | no | 91 | 81 |
| 19/08/2008 | BTM | Chirpoi | Peschanaya-221 | 46.53865 | 150.89644 | TL | 1 | 5.6 | - | -0.2 | **5.5** | - | no | 43 | 42 |
| 19/08/2008 | BTM | Chirpoi | Peschanaya-217 | 46.54120 | 150.90598 | TL | 3 | 5.8 | 5.5 | 0.1 | 5.9 | **5.6** | no | 31 | 30 |
| 19/08/2008 | BTM | Chirpoi | Peschanaya-219 | 46.54148 | 150.90152 | TL | 4 | 7.6 | 8.6 | 0.0 | 7.5 | **8.5** | no | 40 | 43 |
| 13/07/2007 | NGR | Simushir | Spaseniya Bay-37 | 46.83173 | 151.87659 | HL | 1 | 4.3 | - | -0.4 | **3.9** | - | 4.4 | 180 | 141 |
| 13/07/2007 | NGR | Simushir | Spaseniya Bay-39 | 46.83411 | 151.87962 | HL | 1 | 2.7 | - | -0.4 | **2.3** | - | 3.9 | 146 | 127 |
| 12/07/2007 | VMK | Simushir | Spaseniya Bay-82 | 46.83668 | 151.88249 | HL | 1 | **7.2** | - | - | - | - | - | 75 | 51 |
| 12/07/2007 | VMK | Simushir | Spaseniya Bay-77b | 46.84178 | 151.89000 | HL | 1 | **5.7** | - | - | - | - | - | 109 | 54 |
| 09/08/2008 | JB | Simushir | Spaseniya Bay-2 | 46.84244 | 151.89121 | HLT | 4 | 7.1 | 7.2 | 0.3 | 7.5 | **7.5** | no | 127 | 118 |
| 13/07/2007 | NGR | Simushir | Spaseniya Bay-36 | 46.84520 | 151.89542 | HL | 1 | 2.2 | - | -0.9 | **1.3** | - | 3.9 | 212 | 172 |
| 09/08/2008 | JB | Simushir | Spaseniya Bay-1 | 46.84772 | 151.89931 | HLT | 5 | 6.7 | 6.8 | 0.2 | 7.0 | **7.0** | 7.1 | 111 | 116 |
| 19/07/2007 | NGR | Simushir | Spaseniya Bay-79 | 46.85087 | 151.90409 | HL | 1 | 6.5 | - | -0.3 | **6.2** | - | no | 80 | 59 |
| 19/07/2007 | NGR | Simushir | Spaseniya Bay-78 | 46.85281 | 151.90750 | HL | 1 | 4.6 | - | -0.2 | **4.4** | - | no | 140 | 115 |
| 18/08/2008 | BTM | Simushir | Opasnaya Bay-215 | 46.94008 | 152.05510 | TL | 2 | 7.2 | 7.0 | -0.3 | 6.9 | **6.7** | no | 79 | 79 |
| 18/08/2008 | BTM | Simushir | Opasnaya Bay-213 | 46.94306 | 152.05847 | TL | 3 | 8.6 | 8.7 | -0.2 | 8.5 | **8.5** | no | 98 | 99 |
| 18/08/2008 | BTM | Simushir | Opasnaya Bay-212 | 46.94655 | 152.06214 | TL | 1 | 6.4 | - | -0.1 | **6.3** | - | 6.7 | 136 | 131 |
| 11/07/2007 | TKP | Simushir | Dushnaya Bay-1 | 47.04313 | 152.15841 | TL | 1 | 19.6 | - | 0.4 | **20.0** | - | no | 83 | 79 |
| 11/07/2007 | TKP | Simushir | Dushnaya Bay-2 | 47.04530 | 152.15915 | TL | 1 | 12.2 | - | 0.2 | **12.4** | - | 12.7 | 75 | 92 |
| 10/07/2007 | VMK | Simushir | Dushnaya Bay-57 | *47.04684* | *152.15963* | HL | 1 | **9.3** | - | - | - | - | - | 136 | 115 |
| 10/07/2007 | VMK | Simushir | Dushnaya Bay-54 | *47.04769* | *152.16070* | HL | 1 | **11.7** | - | - | - | - | - | 44 | - |
| 11/07/2007 | TKP | Simushir | Dushnaya Bay-3 | 47.04942 | 152.16235 | TL | 1 | 7.9 | - | 0.0 | **7.9** | - | no | 123 | 135 |
| 12/07/2007 | TKP | Simushir | Dushnaya Bay-5 | 47.05409 | 152.16471 | TL | 1 | 11.0 | - | 0.3 | **11.3** | - | no | 132 | 128 |
| 12/07/2007 | TKP | Simushir | Dushnaya Bay-6 | 47.05628 | 152.16650 | TL | 1 | 4.2 | - | 0.2 | **4.4** | - | 10.1 | 106 | 98 |
| 12/07/2007 | TKP | Simushir | Dushnaya Bay-7 | 47.05807 | 152.16878 | TL | 1 | 6.3 | - | 0.0 | **6.3** | - | 7.1 | 139 | 139 |
| 13/07/2007 | TKP | Simushir | Dushnaya Bay-8 | 47.05979 | 152.17162 | TL | 1 | 7.9 | - | 0.7 | **8.6** | - | 11.4 | 118 | 120 |
| 13/07/2007 | TKP | Simushir | Dushnaya Bay-9 | 47.06094 | 152.17313 | TL | 1 | 6.7 | - | 0.6 | **7.3** | - | 12.0 | 151 | 154 |
| 10/07/2007 | JB | Simushir | Dushnaya Bay-2-2006 (Dushnaya central) | 47.06201 | 152.17549 | TL | 1 | 6.7 | - | 0.0 | **6.7** | - | 7.7 | 122 | 125 |
| 14/07/2007 | TKP | Simushir | Dushnaya Bay-12 | 47.06393 | 152.17726 | TL | 1 | 6.6 | - | 0.3 | **6.9** | - | no | 120 | 115 |
| 14/07/2007 | TKP | Simushir | Dushnaya Bay-11 | 47.06582 | 152.17981 | TL | 1 | 7.7 | - | 0.5 | **8.2** | - | 8.4 | 115 | 109 |
| 14/07/2007 | TKP | Simushir | Dushnaya Bay-10 | 47.06772 | 152.18230 | TL | 1 | 9.3 | - | 0.6 | **9.9** | - | no | 133 | 121 |
| 13/07/2007 | JB | Simushir | Dushnaya Bay-110 | 47.06960 | 152.18429 | TL | 11 | 10.0 | 8.8 | 0.0 | 10.0 | **8.8** | no | 114 | 107 |
| 14/07/2007 | JB | Simushir | Dushnaya Bay-1-2006 | 47.06971 | 152.18614 | TL | 8 | 9.8 | 10.0 | 0.6 | 10.4 | **10.6** | no | 100 | 102 |
| 13/07/2007 | JB | Simushir | Dushnaya Bay-109 | 47.07039 | 152.18792 | TL | 10 | 8.8 | 9.0 | 0.1 | 8.9 | **9.1** | no | 59 | 56 |
| 09/07/2007 | VMK | Simushir | Dushnaya Bay-24 | *47.07085* | *152.18777* | HL | 1 | **8.7** | - | - | - | - | - | 77 | - |
| 13/07/2007 | JB | Simushir | Dushnaya Bay-108 | 47.07124 | 152.19088 | TL | 9 | 11.7 | 11.6 | 0.3 | 12.0 | **11.9** | no | 61 | 57 |
| 13/07/2007 | JB | Simushir | Dushnaya Bay-107 | 47.07312 | 152.19315 | TL | 12 | 17.9 | 14.8 | 0.5 | 18.4 | **15.3** | no | 85 | 74 |

| Date | Team* | Location | | | | Method* | Runup (preferred in bold) | | | | | | Higher elevation seaward of inundation (m) | Inundation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Island | Locality name | Latitude of profile* | Longitude of profile* | | Number of runup readings | 2006 runup on profile (m) | 2006 runup avg. near profile (m) | Tide correction (m) | Runup with tide correction (m) | Runup avg. with tide correction (m) | | Measured inundation (m) | GPS calculated inundation (m) |
| 12/07/2007 | JB | Simushir | Dushnaya Bay-106 | 47.07537 | 152.19476 | TL | 10 | 11.5 | 13.1 | -0.1 | 11.4 | **13.0** | no | 70 | 66 |
| 12/07/2007 | JB | Simushir | Dushnaya Bay-105 | 47.07754 | 152.19528 | TL | 10 | 14.9 | 15.1 | 0.4 | 15.3 | **15.5** | no | 93 | 102 |
| 11/07/2007 | JB | Simushir | Dushnaya Bay-104 | 47.07809 | 152.19888 | TL | 7 | 13.3 | 13.2 | -0.2 | 13.1 | **13.0** | no | 52 | 52 |
| 11/07/2007 | JB | Simushir | Dushnaya Bay-103 | 47.07818 | 152.20214 | TL | 10 | 10.4 | 10.9 | -0.1 | 10.3 | **10.8** | no | 49 | 46 |
| 11/07/2007 | JB | Simushir | Dushnaya Bay-102 | 47.07835 | 152.20566 | TL | 8 | 7.5 | 7.7 | 0.0 | 7.5 | **7.7** | no | 51 | 50 |
| 11/07/2007 | JB | Simushir | Dushnaya Bay-101 | 47.07880 | 152.20884 | TL | 5 | 8.5 | 8.5 | 0.3 | 8.8 | **8.8** | no | 44 | 39 |
| 11/07/2007 | JB | Simushir | Dushnaya Bay-100 | 47.07971 | 152.21016 | TL,HLT | 1 | 12.9 | - | 0.4 | **13.3** | - | no | 68 | - |
| 08/07/2007 | JB | Ketoi | Yuzhni Bay-3 | 47.29640 | 152.49141 | HLT | 9 | 6.8 | 6.5 | 0.0 | 6.8 | **6.5** | no | 44 | 27 |
| 08/07/2007 | VMK | Ketoi | Yuzhni Bay-10c | 47.29659 | 152.49009 | HL | 1 | 6.7 | - | 0.0 | **6.7** | - | no | 79 | 38 |
| 08/07/2007 | VMK | Ketoi | Yuzhni Bay-13 | *47.29774* | *152.48760* | HL | 1 | 9.2 | - | 0.0 | **9.2** | - | no | 67 | 43 |
| 10/08/2008 | JB | Ketoi | SE coast-V111 | 47.29801 | 152.50985 | HL | 1 | 10.8 | - | 0.4 | **11.2** | - | no | 44 | 46 |
| 08/07/2007 | JB | Ketoi | Yuzhni Bay-2 | 47.29807 | 152.48616 | HLT | 9 | 7.3 | 7.4 | 0.0 | 7.3 | **7.4** | no | 58 | 54 |
| 10/08/2008 | JB | Ketoi | SE coast-V109 | 47.29816 | 152.50784 | HL | 1 | 10.1 | - | 0.1 | **10.2** | - | no | 80 | 49 |
| 08/07/2007 | JB | Ketoi | Yuzhni Bay-1c | 47.29834 | 152.48416 | HLT | 16 | 7.5 | 6.7 | 0.0 | 7.5 | **6.7** | no | 55 | 51 |
| 10/08/2008 | JB | Ketoi | SE coast-V114 | 47.29867 | 152.51329 | HL | 1 | 9.6 | - | 0.5 | **10.1** | - | no | 47 | 42 |
| 08/07/2007 | JB | Ketoi | Yuzhni Bay-1b | 47.29868 | 152.48257 | HL | 9 | 7.1 | 6.9 | 0.0 | 7.1 | **6.9** | no | - | 75 |
| 10/08/2008 | JB | Ketoi | SE coast-V116 | 47.29893 | 152.51373 | HL | 1 | 10.0 | - | 0.5 | **10.5** | - | no | 30 | 28 |
| 08/07/2007 | JB | Ketoi | Yuzhni Bay-1a | 47.29924 | 152.48283 | HLT | 7 | 6.6 | 6.5 | 0.0 | 6.6 | **6.5** | no | 52 | 39 |
| 11/07/2007 | VMK | Ketoi | Yuzhni Bay-73 | 47.29960 | 152.47238 | HL | 1 | 6.8 | - | 0.0 | **6.8** | - | - | 37 | 23 |
| 11/07/2007 | VMK | Ketoi | Yuzhni Bay-10b | 47.29966 | 152.47368 | HL | 1 | 6.2 | - | 0.0 | **6.2** | - | - | 37 | - |
| 11/07/2007 | VMK | Ketoi | Yuzhni Bay-71 | *47.29966* | *152.47368* | HL | 1 | 6.2 | - | 0.0 | **6.2** | - | - | 37 | - |
| 11/07/2007 | VMK | Ketoi | Yuzhni Bay-69 | 47.29968 | 152.47460 | HL | 1 | 7.9 | - | 0.0 | **7.9** | - | - | 54 | 35 |
| 11/08/2008 | JB | Ketoi | SE coast-V121 | 47.29972 | 152.51536 | HL | 1 | 8.6 | - | 0.0 | **8.6** | - | no | 26 | 27 |
| 08/07/2007 | VMK | Ketoi | Yuzhni Bay-3b | 47.29979 | 152.48218 | HL | 1 | 10.6 | - | 0.0 | **10.6** | - | no | 63 | 47 |
| 11/07/2007 | VMK | Ketoi | Yuzhni Bay-62 | 47.30022 | 152.47934 | HL | 1 | 6.0 | - | 0.0 | **6.0** | - | - | 37 | 18 |
| 11/07/2007 | VMK | Ketoi | Yuzhni Bay-67 | 47.30025 | 152.47754 | HL | 1 | 9.7 | - | 0.0 | **9.7** | - | - | 34 | - |
| 11/07/2007 | VMK | Ketoi | Yuzhni Bay-64 | 47.30033 | 152.47762 | HL | 1 | 10.4 | - | 0.0 | **10.4** | - | - | 42 | 22 |
| 11/07/2007 | VMK | Ketoi | Yuzhni Bay-61 | *47.30043* | *152.48006* | HL | 1 | 6.3 | - | 0.0 | **6.3** | - | - | 52 | - |
| 11/07/2007 | VMK | Ketoi | Yuzhni Bay-59 | 47.30047 | 152.48114 | HL | 1 | 6.8 | - | 0.0 | **6.8** | - | - | 67 | 37 |
| 11/08/2008 | JB | Ketoi | SE coast-V122 | 47.30130 | 152.51790 | HL | 1 | 11.8 | - | 0.1 | **11.9** | - | no | 41 | 45 |
| 11/08/2008 | JB | Ketoi | SE coast-V124 | 47.30271 | 152.52079 | HL | 1 | 11.0 | - | 0.1 | **11.1** | - | no | 55 | 63 |
| 11/08/2008 | JB | Ketoi | SE coast-V126 | 47.30438 | 152.52267 | HL | 1 | 11.2 | - | 0.3 | **11.5** | - | no | 72 | 60 |
| 11/08/2008 | JB | Ketoi | SE coast-V128 | 47.30534 | 152.52402 | HLT | 1 | 10.1 | - | 0.4 | **10.6** | - | no | 80 | 72 |
| 10/08/2007 | TKP | Ushishir | Yankicha-257 | 47.52596 | 152.82620 | TL | 2 | 12.8 | 12.7 | 0.8 | 13.6 | **13.5** | no | 57 | 70 |
| 09/08/2007 | TKP | Ushishir | Ryponkicha-238 | 47.53181 | 152.82719 | TL | 4 | 9.4 | 11.0 | 0.7 | 10.1 | **11.7** | no | 52 | 50 |
| 12/08/2008 | JB | Ushishir | Ryponkicha-V135 | 47.53207 | 152.82801 | HLT | 1 | 9.0 | - | 0.2 | **9.2** | - | no | 47 | - |
| 09/08/2007 | TKP | Ushishir | Ryponkicha-245 | 47.53244 | 152.82906 | TL | 5 | 10.8 | 10.6 | 0.6 | 11.4 | **11.2** | no | 56 | 55 |
| 09/08/2007 | NGR | Ushishir | Ryponkicha-285 | 47.53287 | 152.82868 | HL | 1 | 9.9 | - | 0.2 | **10.1** | - | no | 60 | 48 |
| 09/08/2007 | TKP | Ushishir | Ryponkicha-249 | 47.53324 | 152.83098 | TL | 3 | 11.2 | 10.8 | 0.4 | 11.6 | **11.2** | no | 46 | 42 |
| 09/08/2007 | TKP | Ushishir | Ryponkicha-251 | 47.53508 | 152.83231 | TL | 1 | 11.8 | - | 0.2 | **12.0** | - | no | 45 | 55 |
| 09/08/2007 | TKP | Ushishir | Ryponkicha-253 | 47.53632 | 152.83617 | TL | 5 | 12.2 | 11.1 | -0.1 | 12.1 | **11.0** | no | 50 | 47 |
| 09/08/2007 | TKP | Ushishir | Ryponkicha-255 | 47.53742 | 152.84057 | TL | 3 | 7.4 | 7.7 | -0.3 | 7.1 | **7.4** | no | 25 | 30 |
| 09/08/2007 | NGR | Ushishir | Ryponkicha-180 | 47.54934 | 152.85081 | HL | 1 | 6.5 | - | -0.8 | **5.7** | - | no | 54 | 47 |
| 09/08/2008 | BTM | Rasshua | SE coast-187 | 47.68511 | 152.97311 | TL | 3 | 10.2 | 10.5 | 0.0 | 10.3 | **10.5** | no | 46 | 48 |

| Date | Team* | Location | | | | Method* | Runup (preferred in bold) | | | | | | Higher elevation seaward of inundation (m) | Inundation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Island | Locality name | Latitude of profile* | Longitude of profile* | | Number of runup readings | 2006 runup on profile (m) | 2006 runup avg. near profile (m) | Tide correction (m) | Runup with tide correction (m) | Runup avg. with tide correction (m) | | Measured inundation (m) | GPS calculated inundation (m) |
| 08/08/2008 | BTM | Rasshua | SW coast-177 | 47.68617 | 152.96642 | TL | 1 | 7.1 | - | -0.2 | **6.9** | - | no | 38 | 57 |
| 08/08/2008 | BTM | Rasshua | SW coast-179 | 47.69037 | 152.96786 | TL | 1 | 7.5 | - | 0.1 | **7.6** | - | no | 42 | 41 |
| 09/08/2008 | BTM | Rasshua | SE coast-189 | 47.69040 | 152.97519 | TL | 3 | 9.4 | 9.8 | 0.2 | 9.6 | **10.0** | no | 99 | 93 |
| 09/08/2008 | BTM | Rasshua | SE coast-191 | 47.69449 | 152.97826 | TL | 5 | 10.8 | 10.8 | 0.4 | 11.2 | **11.2** | no | 84 | 75 |
| 08/08/2008 | BTM | Rasshua | SW coast-181 | 47.69501 | 152.96827 | TL | 4 | 6.8 | 7.1 | 0.3 | 7.1 | **7.4** | no | 50 | 52 |
| 09/08/2008 | BTM | Rasshua | SE coast-193 | 47.69648 | 152.98709 | TL | 1 | 10.5 | - | 0.4 | **10.9** | - | no | 57 | 53 |
| 11/08/2007 | NGR | Rasshua | SW coast-198 | 47.69893 | 152.96575 | HL | 1 | 4.7 | - | 0.3 | **5.0** | - | no | 66 | - |
| 11/08/2007 | NGR | Rasshua | SW coast-196 | 47.69963 | 152.96543 | HL | 1 | 3.9 | - | 0.3 | **4.2** | - | no | 64 | - |
| 08/08/2008 | BTM | Rasshua | SW coast-183 | 47.70066 | 152.96200 | TL | 1 | 4.7 | - | 0.3 | **5.0** | - | no | 73 | 74 |
| 11/08/2007 | JB | Rasshua | Landing cove-507 | 47.70630 | 152.96405 | HL | 1 | 9.7 | - | -0.3 | **9.4** | - | no | 56 | 53 |
| 10/08/2008 | BTM | Rasshua | Nepristupnaya Bay-195 | 47.70983 | 153.02418 | TL | 3 | 10.9 | 11.8 | -0.3 | 10.7 | **11.5** | no | 43 | 36 |
| 10/08/2008 | BTM | Rasshua | Nepristupnaya Bay-central | *47.71077* | *153.02597* | A | 1 | 22 | - | 0.1 | **22** | - | no | - | - |
| 10/08/2008 | BTM | Rasshua | Nepristupnaya Bay-north | 47.71166 | 153.02907 | A | 3 | - | 11 | 0.1 | - | **11** | no | - | 50 |
| 15/08/2008 | ACR | Rasshua | IMGG cove-V144 | 47.71964 | 152.97135 | HLT | 1 | 8.7 | - | -0.5 | **8.2** | - | no | 63 | 64 |
| 15/08/2008 | ACR | Rasshua | IMGG cove-V142 | 47.72330 | 152.97303 | HLT | 1 | 9.0 | - | -0.5 | **8.5** | - | no | 33 | 40 |
| 14/08/2008 | BTM | Rasshua | Severniy Cape-205 | 47.79095 | 153.04941 | TL | 4 | 10.9 | 11.0 | -0.4 | 10.5 | **10.6** | no | 51 | 34 |
| 11/08/2008 | BTM | Rasshua | Severniy Cape-201 | 47.79513 | 153.05030 | TL | 2 | 11.2 | 11.3 | 0.1 | 11.3 | **11.4** | no | 111 | 107 |
| 14/08/2008 | BTM | Rasshua | Severniy Cape-209 | 47.80009 | 153.04924 | TL | 3 | 12.3 | 12.5 | -0.1 | 12.2 | **12.4** | no | 75 | 78 |
| 11/08/2008 | BTM | Rasshua | Severniy Cape-203 | 47.80408 | 153.04496 | TL | 3 | 19.7 | 19.8 | 0.4 | 20.1 | **20.2** | no | 71 | 57 |
| 06/08/2007 | NGR | Matua | South Bay-153 | 48.03749 | 153.27090 | HL | 1 | 7.8 | - | 0.1 | **7.8** | - | no | 254 | 129 |
| 07/08/2007 | TKP | Matua | South Bay-222 | 48.03976 | 153.23971 | TL | 2 | 6.9 | 7.4 | -0.1 | 6.8 | **7.3** | 7.0 | 174 | 170 |
| 04/08/2007 | NGR | Matua | Ainu Bay-142 | 48.03980 | 153.22876 | HL | 1 | 13.0 | - | -0.1 | **12.9** | - | no | 164 | 128 |
| 07/08/2007 | TKP | Matua | South Bay-224 | 48.04023 | 153.24302 | TL | 1 | 5.8 | - | -0.1 | **5.7** | - | 5.9 | 215 | 219 |
| 06/08/2007 | NGR | Matua | South Bay-152 | 48.04034 | 153.26773 | HL | 1 | 7.8 | - | 0.1 | **7.8** | - | no | 147 | 126 |
| 07/08/2007 | NGR | Matua | Sarychevo-160 | 48.04124 | 153.27865 | HL | 1 | 7.3 | - | 0.0 | **7.3** | - | no | 56 | 55 |
| 07/08/2007 | TKP | Matua | South Bay-228 | 48.04127 | 153.24595 | TL | 1 | 7.3 | - | -0.2 | **7.1** | - | no | 233 | 205 |
| 02/08/2007 | NGR | Matua | Ainu Bay-126 | 48.04154 | 153.22731 | HL | 1 | 21.2 | - | -0.5 | **20.8** | - | no | 436 | 315 |
| 07/08/2007 | NGR | Matua | Sarychevo-161 | 48.04193 | 153.27764 | HL | 1 | 6.1 | - | 0.0 | **6.1** | - | no | 108 | 92 |
| 06/08/2007 | TKP | Matua | South Bay-216 (central) | 48.04199 | 153.24922 | TL | 1 | 5.8 | - | -0.1 | **5.7** | - | 7.6 | 223 | 221 |
| 06/08/2007 | NGR | Matua | South Bay-151 | 48.04202 | 153.26372 | HL | 1 | 7.9 | - | 0.0 | **7.9** | - | 8.1 | 95 | 60 |
| 06/08/2007 | NGR | Matua | South Bay-148 | 48.04234 | 153.25296 | HL | 1 | 4.9 | - | 0.1 | **4.9** | - | 9.9 | 174 | 139 |
| 06/08/2007 | NGR | Matua | South Bay-149 | 48.04244 | 153.25585 | HL | 1 | 6.4 | - | 0.1 | **6.4** | - | 8.2 | 134 | 101 |
| 03/08/2007 | NGR | Matua | Ainu Bay-133 | 48.04266 | 153.22644 | HL | 1 | 20.4 | - | -0.2 | **20.2** | - | no | 503 | 417 |
| 06/08/2007 | NGR | Matua | South Bay-150 | 48.04267 | 153.25930 | HL | 1 | 5.6 | - | 0.0 | **5.7** | - | 6.4 | 176 | 146 |
| 06/08/2007 | BTM | Matua | Ainu Bay-2-2006 (south) | 48.04269 | 153.22650 | TL | 6 | 18.3 | 18.2 | -0.1 | 18.2 | **18.1** | no | 432 | 411 |
| 03/08/2007 | NGR | Matua | Ainu Bay-132 | 48.04284 | 153.22588 | HL | 1 | 18.5 | - | -0.3 | **18.3** | - | no | 398 | 376 |
| 07/08/2007 | NGR | Matua | Sarychevo-162 | 48.04349 | 153.27506 | HL | 1 | 8.0 | - | 0.0 | **8.1** | - | no | 109 | 116 |
| 04/08/2007 | BTM | Matua | Ainu Bay-1-2006 (north) | 48.04412 | 153.22497 | TL | 1 | 17.3 | - | -0.2 | **17.1** | - | no | 327 | 313 |
| 03/08/2007 | NGR | Matua | Ainu Bay-130 | 48.04444 | 153.22463 | HL | 1 | 17.3 | - | -0.1 | **17.1** | - | no | 356 | 315 |
| 07/08/2007 | NGR | Matua | Sarychevo-164 | 48.04504 | 153.27429 | HL | 1 | 8.5 | - | 0.0 | **8.6** | - | no | 124 | 110 |
| 04/08/2007 | NGR | Matua | Ainu Bay-139 | 48.04537 | 153.22430 | HL | 1 | 18.4 | - | -0.2 | **18.1** | - | no | 315 | 288 |
| 05/08/2007 | NGR | Matua | Ainu Bay-143 | 48.04599 | 153.22315 | HL | 1 | 17.2 | - | -0.1 | **17.1** | - | no | 244 | 200 |
| 07/08/2007 | NGR | Matua | Sarychevo-165 | 48.04660 | 153.27397 | HL | 1 | 8.5 | - | 0.1 | **8.6** | - | no | 122 | 101 |
| 04/08/2007 | NGR | Matua | Ainu Bay-144 | 48.04707 | 153.22058 | HL | 1 | 14.2 | - | -0.1 | **14.0** | - | no | 120 | 119 |

| Date | Team* | Location | | | | Method* | Runup (preferred in bold) | | | | | | Higher elevation seaward of inundation (m) | Inundation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Island | Locality name | Latitude of profile* | Longitude of profile* | | Number of runup readings | 2006 runup on profile (m) | 2006 runup avg. near profile (m) | Tide correction (m) | Runup with tide correction (m) | Runup avg. with tide correction (m) | | Measured inundation (m) | GPS calculated inundation (m) |
| 07/08/2007 | NGR | Matua | Sarychevo-166 | 48.04751 | 153.27489 | HL | 1 | 9.5 | - | 0.1 | **9.6** | - | no | 56 | 56 |
| 04/08/2007 | NGR | Matua | Ainu Bay-145 | 48.04786 | 153.21894 | HL | 1 | 13.6 | - | 0.0 | **13.6** | - | no | 121 | 68 |
| 07/08/2007 | NGR | Matua | Sarychevo-167 | 48.04854 | 153.27534 | HL | 1 | 10.3 | - | 0.1 | **10.4** | - | no | 71 | 67 |
| 07/08/2007 | NGR | Matua | Sarychevo-170 | 48.04985 | 153.27407 | HL | 1 | 9.8 | - | 0.1 | **9.9** | - | no | 55 | 48 |
| 03/08/2007 | TKP | Matua | Sarychevo-142 | 48.05172 | 153.27181 | TL | 3 | 13.8 | 14.0 | 0.3 | 14.1 | **14.3** | no | 51 | 54 |
| 03/08/2007 | TKP | Matua | Sarychevo-145 | 48.05310 | 153.26861 | TL | 3 | 11.2 | 11.8 | 0.4 | 11.6 | **12.2** | no | 62 | 55 |
| 03/08/2007 | TKP | Matua | Sarychevo-147 | 48.05498 | 153.26675 | TL | 1 | 16.8 | - | 0.2 | **17.0** | - | no | 49 | 48 |
| 03/08/2007 | TKP | Matua | Sarychevo-149 | 48.05728 | 153.26618 | TL | 1 | 15.4 | - | -0.1 | **15.3** | - | no | 60 | 56 |
| 04/08/2007 | TKP | Matua | Sarychevo-152 | 48.05941 | 153.26706 | TL | 1 | 21.7 | - | 0.2 | **21.9** | - | no | 48 | 41 |
| 04/08/2007 | TKP | Matua | Sarychevo-154 | 48.06177 | 153.26918 | TL | 1 | 16.7 | - | 0.0 | **16.7** | - | no | 46 | 26 |
| 04/08/2007 | TKP | Matua | Sarychevo-157 | 48.06401 | 153.26918 | TL | 3 | 12.0 | 12.3 | -0.2 | 11.8 | **12.1** | no | 69 | 79 |
| 03/08/2007 | BTM | Matua | Sarychevo-86 | 48.06642 | 153.26921 | TL,HLT | 3 | - | 15.5 | 0.2 | 15.7 | **15.7** | no | 56 | 52 |
| 03/08/2007 | BTM | Matua | Sarychevo-83 | 48.06911 | 153.26872 | TL | 4 | 16.9 | 16.7 | 0.1 | 17.0 | **16.8** | no | 38 | 35 |
| 03/08/2007 | BTM | Matua | Sarychevo-79 | 48.07098 | 153.26668 | TL | 4 | 19.6 | 18.8 | 0.2 | 19.8 | **19.0** | no | 50 | 45 |
| 08/08/2007 | JB | Matua | Toporkov-231 | 48.07213 | 153.28239 | HLT | 2 | 9.4 | 9.4 | -0.1 | 9.3 | **9.3** | no | 40 | 40 |
| 08/08/2007 | JB | Matua | Toporkov-234 | 48.07238 | 153.28224 | HLT | 1 | >8.1 | - | -0.1 | **>8.0** | - | no | 37 | 42 |
| 03/08/2007 | BTM | Matua | Sarychevo-73 | 48.07340 | 153.26681 | TL | 1 | 17.7 | - | 0.4 | **18.1** | - | no | 93 | 106 |
| 08/08/2007 | JB | Matua | Toporkov-230 | 48.07375 | 153.28205 | HLT | 2 | 10.0 | 9.8 | 0.1 | 10.1 | **9.9** | no | 42 | 27 |
| 03/08/2007 | BTM | Matua | Sarychevo-69 | 48.07510 | 153.26518 | TL | 1 | 12.4 | - | 0.2 | **12.6** | - | no | 59 | 94 |
| 08/08/2007 | JB | Matua | Toporkov-235 | 48.07510 | 153.28164 | HLT | 1 | 11.4 | - | -0.1 | **11.3** | - | no | 28 | 26 |
| 08/08/2007 | JB | Matua | Toporkov-237 | 48.07637 | 153.28168 | HLT | 4 | 10.5 | 10.2 | -0.2 | 10.3 | **10.0** | no | 41 | - |
| 02/08/2007 | BTM | Matua | Sarychevo-136 | 48.07707 | 153.26329 | TL | 4 | 10.6 | 10.7 | 0.0 | 10.6 | **10.7** | no | 36 | 34 |
| 02/08/2007 | BTM | Matua | Sarychevo-133 | 48.07906 | 153.26357 | TL | 1 | 12.3 | - | 0.2 | **12.5** | - | no | 38 | 44 |
| 02/08/2007 | BTM | Matua | Sarychevo-129 | 48.08123 | 153.26444 | TL | 3 | 10.2 | 10.3 | 0.3 | 10.5 | **10.6** | no | 54 | 42 |
| 02/08/2007 | BTM | Matua | Sarychevo-125 | 48.08323 | 153.26612 | TL | 4 | 11.3 | 11.3 | 0.5 | 11.8 | **11.8** | no | 118 | 103 |
| 02/08/2007 | BTM | Matua | Sarychevo-120 | 48.08416 | 153.26740 | TL | 6 | 12.6 | 11.5 | 0.5 | 13.1 | **12.0** | no | 70 | 68 |
| 05/08/2008 | BTM | Matua | NE Bay-5 | 48.09483 | 153.24565 | A | 1 | 18.5 | - | -0.1 | **18** | - | no | - | 56 |
| 05/08/2008 | BTM | Matua | NE Bay-4 | 48.09620 | 153.24276 | A | 2 | - | 16 | -0.1 | - | **16** | no | - | 43 |
| 05/08/2008 | BTM | Matua | NE Bay-3 | 48.09751 | 153.24232 | HL | 3 | - | 14 | -0.1 | - | **14** | no | - | 36 |
| 05/08/2008 | BTM | Matua | NE Bay-2 | 48.09776 | 153.24250 | A | 3 | - | 13 | -0.1 | - | **13** | no | - | 47 |
| 05/08/2008 | BTM | Matua | NE Bay-1 | 48.09836 | 153.24240 | A | 1 | 10 | - | -0.1 | **10** | - | no | - | 43 |
| 22/07/2008 | BTM | Shiashkotan | Voskhodnaya Bay | *48.78556* | *154.08406* | A | 20 | - | 6 | -0.3 | - | **5.5** | no | - | 60 |
| 22/07/2008 | JB | Shiashkotan | Voskhodnaya Bay-1 | *48.78817* | *154.08586* | TL | 1 | 7.4 | - | -0.3 | **7.1** | - | no | 56 | - |
| 23/07/2008 | BTM | Kharimkotan | 1933 Landslide | *49.12374* | *154.60002* | A | 7 | - | 4 | -0.2 | - | **3** | 7.3 | - | 400 |
| 31/07/2008 | BTM | Kharimkotan | Severgina Bay-south | 49.16001 | 154.49450 | A | 3 | - | 5 | -0.1 | - | **5** | no | - | 556 |
| 31/07/2008 | BTM | Kharimkotan | Severgina Bay-north | 49.16329 | 154.48074 | A | 2 | - | 7 | -0.5 | - | **6** | no | - | 66 |
| 27/07/2008 | BTM | Onekotan | Mussel Bay-south | 49.38688 | 154.82825 | A | 4 | - | 5 | 0.0 | - | **5** | no | - | 36 |
| 27/07/2008 | BTM | Onekotan | Mussel Bay-central-A | 49.38814 | 154.82450 | A | 3 | - | 5 | -0.4 | - | **4** | no | - | 127 |
| 27/07/2008 | BTM | Onekotan | Mussel Bay-central-B | 49.38814 | 154.82450 | A | 1 | 8.5 | - | -0.4 | **8** | - | no | - | 41 |
| 27/07/2008 | BTM | Onekotan | Mussel Bay-north-A | 49.38891 | 154.82392 | A | 1 | 4 | - | -0.2 | **4** | - | no | - | 180 |
| 27/07/2008 | BTM | Onekotan | Mussel Bay-north-B | 49.38891 | 154.82392 | A | 3 | - | 7 | -0.2 | - | **6** | no | - | 123 |
| 26/07/2008 | BTM | Onekotan | Cape Lissii Bay-south | 49.39499 | 154.82517 | A | 2 | - | 7 | 0.1 | - | **7** | no | - | 38 |
| 26/07/2008 | BTM | Onekotan | Cape Lissii Bay-central-A | 49.39749 | 154.82366 | A | 1 | 4.5 | - | 0.1 | **5** | - | no | - | 125 |
| 26/07/2008 | BTM | Onekotan | Cape Lissii Bay-central-B | 49.39749 | 154.82366 | A | 3 | 6 | - | 0.1 | **6** | - | no | - | 63 |

| Date | Team* | Location | | | | Method§ | Runup (preferred in bold) | | | | | | Higher elevation seaward of inundation (m) | Inundation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Island | Locality name | Latitude of profile† | Longitude of profile† | | Number of runup readings | 2006 runup on profile (m) | 2006 runup avg. near profile (m) | Tide correction (m) | Runup with tide correction (m) | Runup avg. with tide correction (m) | | Measured inundation (m) | GPS calculated inundation (m) |
| 28/07/2008 | BTM | Onekotan | Cape Lissii Bay-north | 49.40006 | 154.82539 | A | 1 | 8 | - | 0.4 | **8** | - | no | - | 27 |
| 30/07/2008 | BTM | Onekotan | Cape Lisii-lighthouse | 49.40051 | 154.82888 | A | 3 | - | 7 | -0.3 | - | **7** | no | - | 38 |
| 28/07/2008 | BTM | Onekotan | Blakiston Bay-8 | 49.40144 | 154.81968 | A | 1 | 10 | - | 0.4 | **10** | - | no | - | 39 |
| 29/07/2008 | BTM | Onekotan | Blakiston Bay-9-A | 49.40588 | 154.81512 | A | 1 | 5 | - | 0.4 | **5** | - | no | - | 158 |
| 29/07/2008 | BTM | Onekotan | Blakiston Bay-9-B | 49.40588 | 154.81512 | A | 2 | - | 10 | 0.4 | - | **10** | no | - | 89 |
| 29/07/2008 | BTM | Onekotan | Blakiston Bay-9-C | 49.40588 | 154.81512 | HLT | 1 | 8.0 | - | 0.5 | **8.5** | - | no | 83 | 89 |
| 28/07/2008 | BTM | Onekotan | Blakiston Bay-7-A | 49.41474 | 154.81187 | A | 2 | - | 5 | 0.4 | - | **5** | no | - | 223 |
| 28/07/2008 | BTM | Onekotan | Blakiston Bay-7-B | 49.41474 | 154.81187 | A | 2 | - | 11 | 0.4 | - | **11** | no | - | 114 |
| 28/07/2008 | BTM | Onekotan | Blakiston Bay-6-A | 49.42438 | 154.81009 | A | 1 | 5 | - | 0.4 | **5** | - | no | - | 200 |
| 28/07/2008 | BTM | Onekotan | Blakiston Bay-6-B | 49.42438 | 154.81009 | A | 2 | - | 10 | 0.4 | - | **10** | no | - | 99 |
| 28/07/2008 | BTM | Onekotan | Blakiston Bay-5-A | 49.43465 | 154.80873 | A | 4 | - | 8 | 0.3 | - | **8** | no | - | 159 |
| 28/07/2008 | BTM | Onekotan | Blakiston Bay-5-B | 49.43465 | 154.80873 | A | 1 | 11 | - | 0.3 | **11** | - | no | - | 57 |
| 28/07/2008 | BTM | Onekotan | Blakiston Bay-4-A | 49.44043 | 154.80874 | A | 4 | - | 5 | -0.2 | - | **5** | no | - | 430 |
| 28/07/2008 | BTM | Onekotan | Blakiston Bay-4-B | 49.44043 | 154.80874 | A | 1 | 10 | - | -0.2 | **10** | - | no | - | 105 |
| 25/07/2008 | BTM | Onekotan | Blakiston Bay-3 | 49.45092 | 154.80956 | A | 4 | - | 4 | -0.1 | - | **4** | no | - | 311 |
| 25/07/2008 | BTM | Onekotan | Blakiston Bay-2-A | 49.46020 | 154.81065 | A | 1 | 4 | - | 0.0 | **4** | - | no | - | 162 |
| 25/07/2008 | BTM | Onekotan | Blakiston Bay-2-B | 49.46020 | 154.81065 | A | 1 | 6 | - | 0.0 | **6** | - | no | - | 77 |
| 25/07/2008 | BTM | Onekotan | Blakiston Bay-1 | 49.47269 | 154.81434 | A | 1 | 7 | - | 0.0 | **7** | - | no | - | 103 |

* Initials of team leaders: NGR (Nadezhda Razhigaeva), VMK (Viktor Kaistrenko), JB (Joanne Bourgeois), TKP (Tatiana Pinegina), BTM (Breanyn MacInnes)

† Lat/Long at sea level unless italic

§ Method: TL (transit level and rod), HLT (hand level, rod and tape), HL (hand level, rod for elevation and distance), A (altimeter (+/- 1 m error) and GPS)

- = unknown, not measured, or not applicable

TABLE DR2. DATA FROM SURVEYS RELATING TSUNAMI SEDIMENT DISTRIBUTION TO TSUNAMI RUNUP AND ELEVATION

| Ref | Tsunami | Name of profile or transect | Water inundation (m) | Water runup (m) | Sediment inundation (m) | Sediment runup (m) | % Sed inundation | % Sed runup* | Total relief • (m/m) | Max relief (m/m) | Max elevation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1998 PNG | Waipo | 320 | 1.25 | 280 | 1.5 | 88 | 120 | 0.004 | 0.150 | 3.2 |
| 1 | 1998 PNG | Arop | 720 | 1.5 | 680 | 2 | 94 | 133 | 0.002 | 0.010 | 2.5 |
| 1 | 1998 PNG | Otto | 160 | -0.2 | 130 | 0.25 | 81 | 125 | -0.001 | 0.150 | 0.75 |
| 1 | 1998 PNG | Sissano | 575 | 1 | 575 | 1 | 100 | 100 | 0.002 | 0.027 | 3.1 |
| 2 | 2004 Indian Oc. | Jantang 3 | 665 | 19.7 | 628 | 4 | 94 | 20 | 0.030 | 0.432 | 19.7 |
| 3 | 1993 Hokkaido | Miyano, Taisei A | 445 | 4.75 | 370 | 4 | 83 | 84 | 0.011 | 0.050 | 4.75 |
| 3 | 1993 Hokkaido | Miyano, Taisei B | 460 | 5 | 420 | 4.5 | 91 | 90 | 0.011 | 0.050 | 5 |
| 5 | 1992 Nicaragua | Salina | 425 | 2.2 | 425 | 2.2 | 100 | 100 | 0.005 | 0.110 | 2.75 |
| 5 | 1992 Nicaragua | Yellow house | 380 | 2.5 | 320 | 2.4 | 84 | 96 | 0.007 | 0.067 | 3 |
| 5 | 1992 Nicaragua | Mangrove | 300 | 1.8 | 230 | 1.75 | 77 | 97 | 0.006 | 0.081 | 3.25 |
| 5 | 1992 Nicaragua | Beach rock | 362 | 2.2 | 300 | 2.15 | 83 | 98 | 0.006 | 0.107 | 3.5 |
| 4 | 2004 Indian Oc. | Thiruvidandai | 330 | 6 | 300 | 4 | 91 | 67 | 0.0182 | 0.0917 | 6 |
| 4 | 2004 Indian Oc. | Vadanemmeli | 220 | 3.75 | 220 | 3.75 | 100 | 100 | 0.0170 | 0.0170 | 3.75 |
| 4 | 2004 Indian Oc. | Kalpakkam | 445 | 4 | 445 | 4 | 100 | 100 | 0.0090 | 0.0250 | 4 |
| 4 | 2004 Indian Oc. | Mamallapuram• | 650 | 4.3 | 620 | 5 | 95 | 116 | 0.0066 | 0.0800 | 5 |
| 4 | 2004 Indian Oc. | Kadalore | 70 | 4.2 | 70 | 4.2 | 100 | 100 | 0.0600 | 0.1500 | 4.2 |
| 6 | 1992 Flores Is. | Lato# | 140 | 3.5 | 75 | 1.75 | 54 | 50 | 0.0250 | 0.1000 | 3.5 |
| *7* | *2006 Kuril Is.* | *Dushnaya 2006-2* | *122* | *6.7* | *120* | *6.6* | *98* | *99* | *0.0549* | *1.50* | *6.7* |
| *7* | *2006 Kuril Is.* | *Dushnaya Bay 2* | *75* | *12.4* | *72* | *12.1* | *96* | *98* | *0.1653* | *4.84* | *12.4* |
| *7* | *2006 Kuril Is.* | *South Bay-211* | *223* | *5.7* | *217* | *5* | *97* | *88* | *0.0256* | *1.29* | *7.6* |
| *7* | *2006 Kuril Is.* | *Ainu Bay 2006-1* | *327* | *17.1* | *305* | *14.8* | *93* | *87* | *0.0523* | *1.04* | *17.1* |
| *7* | *2006 Kuril Is.* | *Ainu Bay 2006-2* | *432* | *18.1* | *422* | *17.3* | *98* | *96* | *0.0419* | *0.81* | *18.1* |
| *7* | *2006 Kuril Is.* | *Dushnaya Bay-102* | *51* | *7.7* | *46* | *6.7* | *90* | *87* | *0.1510* | *5.49* | *7.7* |

| Ref | Tsunami | Name of profile or transect | Water inundation (m) | Water runup (m) | Sediment inundation (m) | Sediment runup (m) | % Sed inundation | % Sed runup* | Total relief • (m/m) | Max relief (m/m) | Max elevation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *7* | *2006 Kuril Is.* | *Dushnaya Bay-6* | *106* | *4.4* | *106* | *4.4* | *100* | *100* | *0.0415* | *0.66* | *10.3* |
| *7* | *2006 Kuril Is.* | *Dushnaya Bay-109* | *59* | *9.1* | *49* | *7.5* | *83* | *82* | *0.1542* | *2.48* | *9.1* |
| *7* | *2006 Kuril Is.* | *Dushnaya Bay-12* | *120* | *6.9* | *112* | *5.8* | *93* | *84* | *0.0575* | *0.64* | *6.9* |
| *7* | *2006 Kuril Is.* | *Dushnaya Bay-7* | *139* | *6.3* | *139* | *6.3* | *100* | *100* | *0.0453* | *1.87* | *6.3* |
| *7* | *2006 Kuril Is.* | *Dushnaya Bay-9* | *151* | *7.3* | *151* | *7.3* | *100* | *100* | *0.0483* | *1.05* | *12.6* |
| *7* | *2006 Kuril Is.* | *Sarychevo-125* | *118* | *11.8* | *97* | *8.4* | *82* | *71* | *0.1000* | *1.01* | *11.8* |
| *7* | *2006 Kuril Is.* | *NE Rasshua-201* | *111* | *11.4* | *109* | *10.2* | *98* | *89* | *0.1023* | *0.52* | *11.4* |
| 2 | 2004 Indian Oc. | Jantang, L1-2 | 517.5 | 14.9 | 512.5 | --** | 99 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Lhok Kruet 1 | 376.4 | 12.6 | 275.1 | -- | 73 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Lhok Kruet L1-4 | 414.8 | 17.4 | 334.1 | -- | 81 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Lhok Leupung | 903.3 | 12.2 | 856 | -- | 95 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Kuala Meurisi | 1820 | 12.9 | 1803.3 | -- | 99 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Langi Island | 524.4 | -- | 492.6 | -- | 94 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Langi field | 441.4 | 3 | 234.9 | -- | 53 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Langi village | 294.2 | 10.9 | 276.8 | -- | 94 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Langi 102 | 334.7 | 7.3 | 330.8 | -- | 99 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Busung 2 | 82 | 3.1 | 67.9 | -- | 83 | -- | -- | -- | -- |
| 2 | 2004 Indian Oc. | Busung 1 | 130 | 4.1 | 109.3 | -- | 84 | -- | -- | -- | -- |

*Numbers >100% are cases where slope goes down at end

• "total relief" = runup/inundation

• Disagreement between text and figure; profile plot may be in error

# Fringing reef

**Not reported

References: 1. Gelfenbaum and Jaffe, 2003; 2. Jaffe et al., 2006; 3. Nanayama et al., 2003; 4. Srinivasalu et al., 2007; 5. J. Bourgeois, unpublished field notes, see also Higman and Bourgeois, 2008; 6. Shi et al., 1996; *7. This study*

Table DR2 Page 2

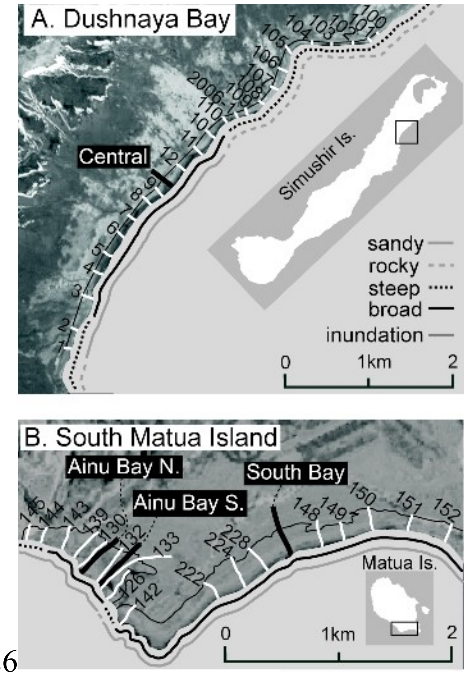



Figure DR1. Location of topographic profiles and mapped inundation limits in Dushnaya Bay, Simushir, and Ainu and South bays, Matua Island. Profiles measured both in 2006 and 2007 are named. **A**. Digital Globe image. **B.** ASTER image.

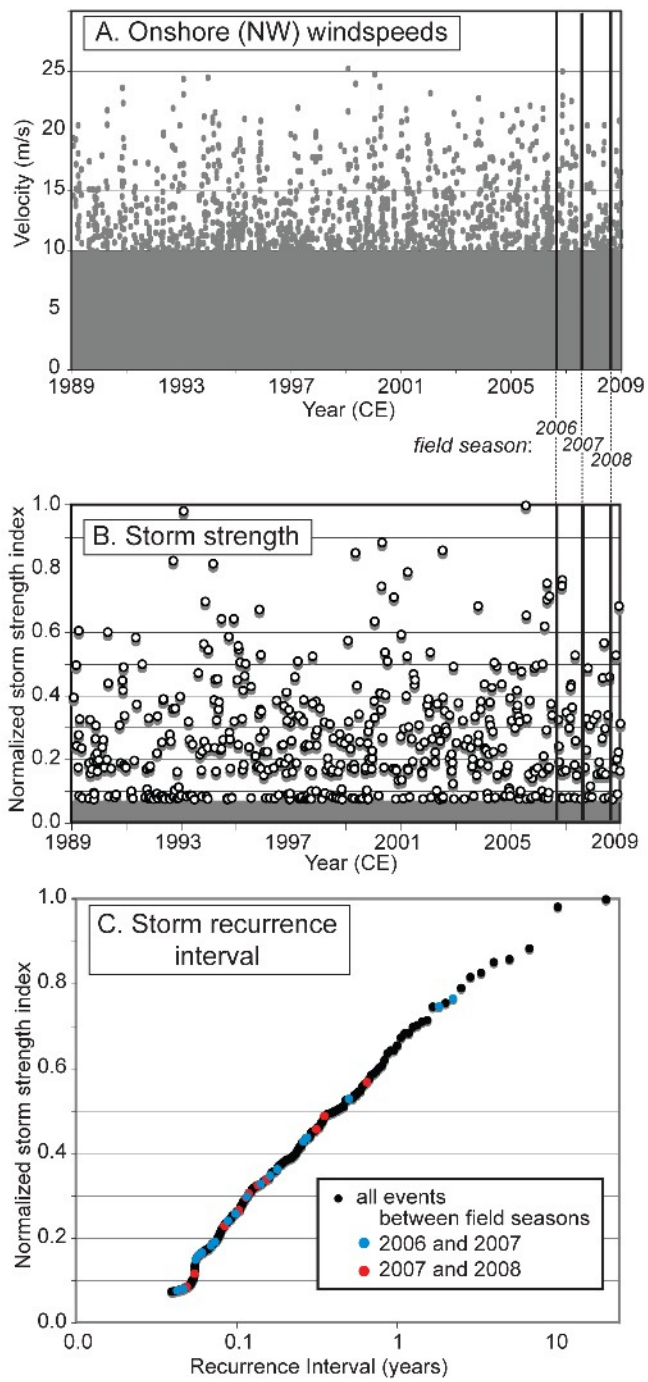



Figure DR2: **A**. Calculated wind speed >10 m/s in the onshore (NW) direction in the central Kuril Islands from Jan 1989-Dec 2008. Data are averaged over 2.5° latitude and longitude centered on 45° N, 150° E and 47.5° N, 152.5° E, derived from 4-times-daily surface winds from NCEP Reanalysis data provided by NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, http://www.cdc.noaa.gov/. The three vertical lines represent the three summer field seasons of KBP. **B**. Same data as in **A** normalized to a comparative index of storm strength to account for storm duration. Wind speeds (in m/s) are multiplied by the length (in days) of sustained >10 m/s wind speeds. Two large events (index = 0.75) occurred in early November 2006 (6-7 Nov and 11-12 Nov), but nothing as large since then. **C**. Recurrence interval for all events with >10 m/s onshore wind speeds between January 1989 and December 2008. The two largest events between field seasons have recurrences of 1.8 and 2.2 years and occurred in 2006 before the tsunami.

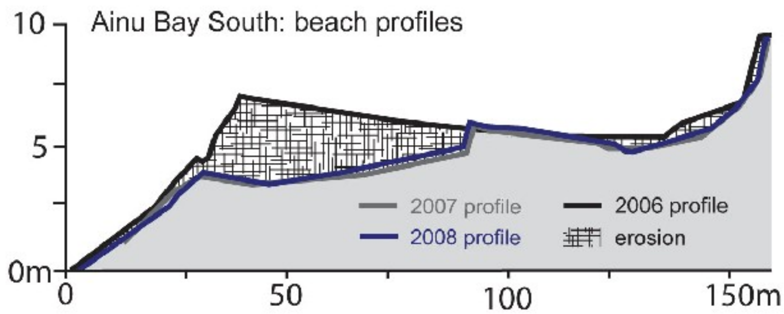



Figure DR3: Topography of the beach on the Ainu Bay south profile from surveys in 2006, 2007, and 2008. That the 2007 and 2008 profiles remain nearly identical (within measurement error) suggests that the large difference from 2006 to 2007/8 is due to tsunami erosion removing sediment entirely from the littoral zone.

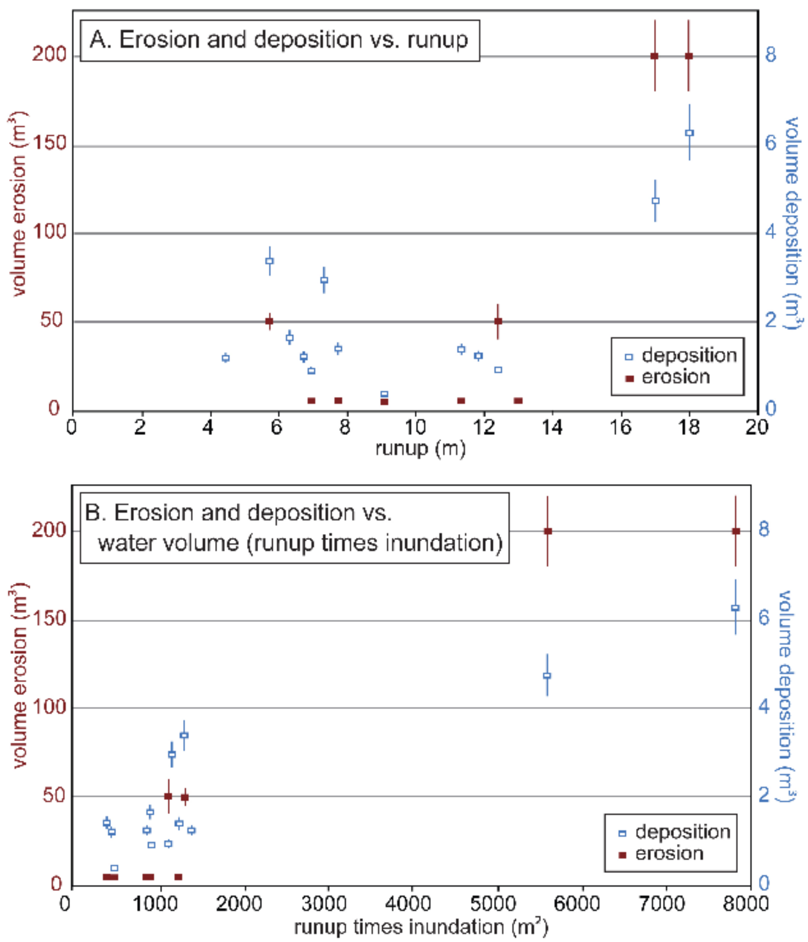



Figure DR4. Calculated and estimated volumes of tsunami erosion and deposition plotted against **A**-runup and **B**-runup times inundation. Plotted data are given in Table 1.

Figure DR5. Stitched panorama centered on Dushnaya Bay Central profile (located in Figure 2, illustrated in Figure 3). Photographer Bourgeois is on high ridge at the back of the profile; the three people are landward of 2006 runup and inundation; some tsunami transported wood is visible near right edge, center. Person in center background is along the profile track. No significant erosion occurred on this profile landward of the backbeach scarp; see Figure DR6. A thin sand layer extended almost to the limit of runup and inundation (Fig. 3; Table 1).


Figure DR6: Before (summer 2006) and after (summer 2007) photoset- Central Dushnaya Bay, near Profile 10 (see Figure 2). A red circle identifies approximately the same point in each photo. The 2007 photo shows evidence of some backbeach cliff retreat—hanging and fallen fresh turf. Also, between photos, the beach has been rearranged so that the backbeach valley has been filled in (as in Dushnaya Central profile, Figure 3). 2006 photo: Dena Berkey; 2007 photo: MacInnes.

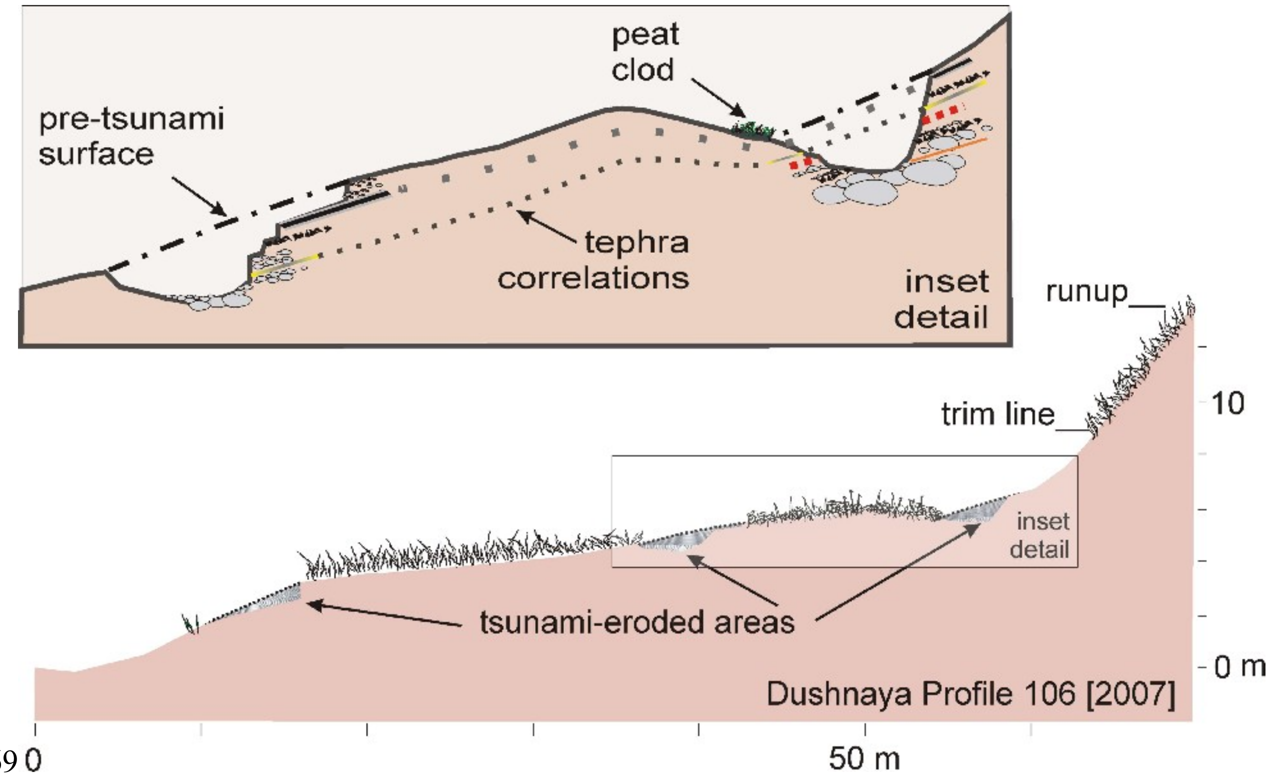



Figure DR7. A steep, well-vegetated profile measured in 2007 from northern Dushnaya Bay, Simushir (2:1 vertical exaggeration). The former surface was inferred from the current surface and the location of soil stripping; also, in erosion zones, remaining root rhizomes often indicated original soil elevation. The soil was cohesive and eroded mainly through block removal, preferentially along certain tephra layers – cinders in particular (see inset). Tephra correlations also show that the surface is progressively younger toward the sea, indicating net progradation since about 2000 – 3000 years ago (from preliminary radiocarbon dates in peat). Photos in Figure DR8 were taken near this profile.


Figure DR8. Before (summer 2006) and after (summer 2007) photoset from northern Dushnaya Bay near profile 106 (between 105 and 106; see Figure 2 for location; see Figure DR6 for a profile near this spot). Our team in 2006 chose a convenient but foolish spot for one overnight. 2006 photo: Beth Martin; 2007 photo: MacInnes.

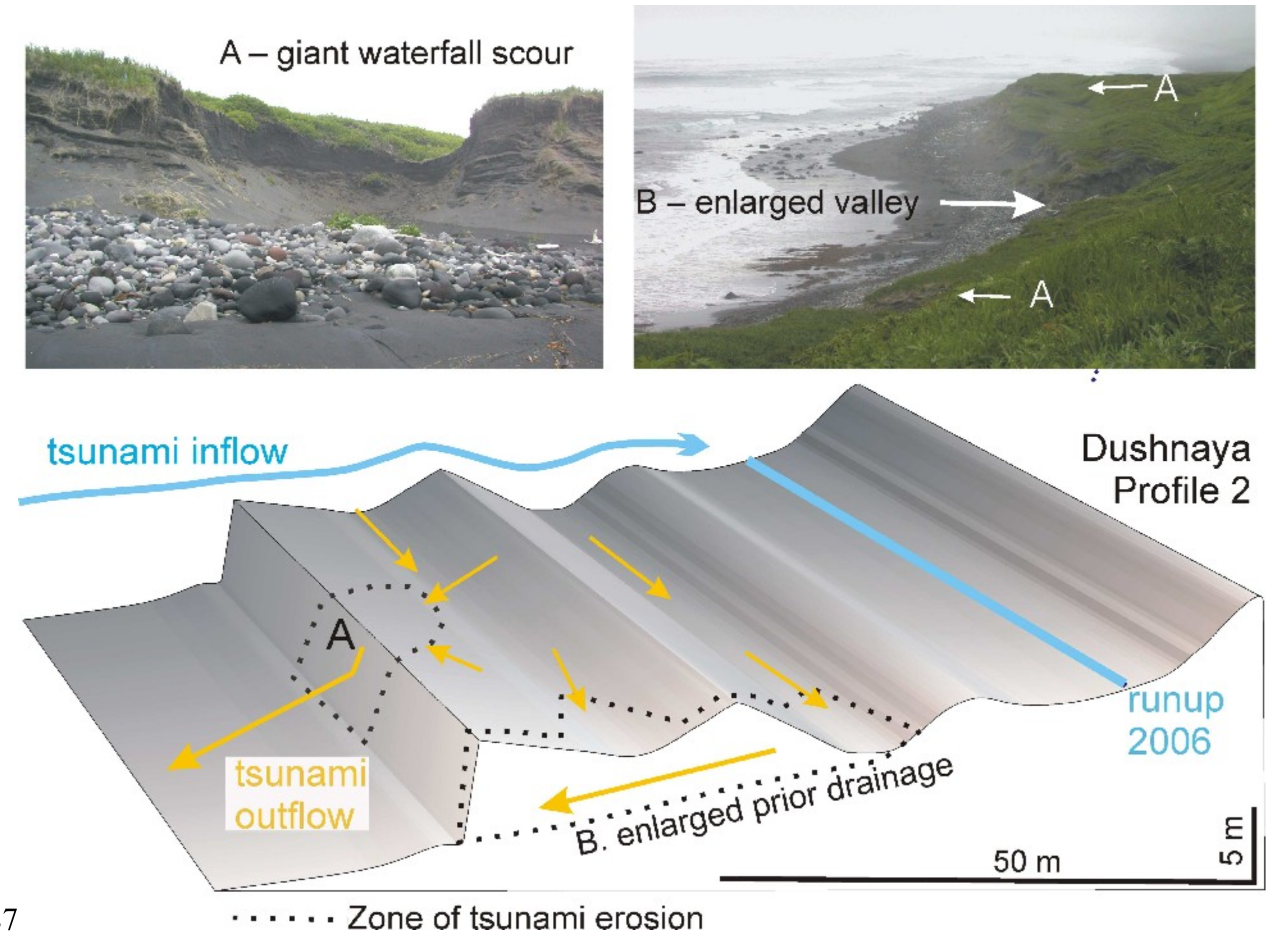



Figure DR9. A steep, short, sandy profile from southern Dushnaya Bay measured in 2007, extruded to show schematically the 3-D tsunami effects. This profile is located on Figure 2, with some data given in Table 1 (runup 12.4 m). Recreated tsunami inflow shown in blue, outflow in orange. Near this profile, the outgoing tsunami removed sand during outflow over the back-beach scarp, creating at least two giant scour/waterfalls about 7 m high. The left picture views one of the scours from the beach, the right picture shows the location of the two scours from the ridge behind and above the scours. In the middle of the right picture is an enlarged prior drainage valley. The outgoing (and possibly also incoming) tsunami enlarged steep stream valleys already cut through the beach ridges. Both photos: Pinegina; right photo is reversed to look similar to profile perspective.


Figure DR10. Before (summer 2006) and after (summer 2007) photoset – South Bay profile on Matua (see Figure 2 for location; Fig 3 for profile). The approximate location of the profile is shown by a red line; a red circle identifies approximately the same point in each photo. Trenches and other excavations from WWII can be seen on both photos, especially well on 2007. On the 2007 (after) photo, the tsunami inundation is visible as gray lines of driftwood, near the top of the picture. The (unseen) unvegetated beach was rearranged between 2006 and 2007 (see Fig. 3), but other erosion was not dramatic. A thin sheet of tsunami sand was deposited almost to the limit of runup and inundation. Both photos: Pinegina.

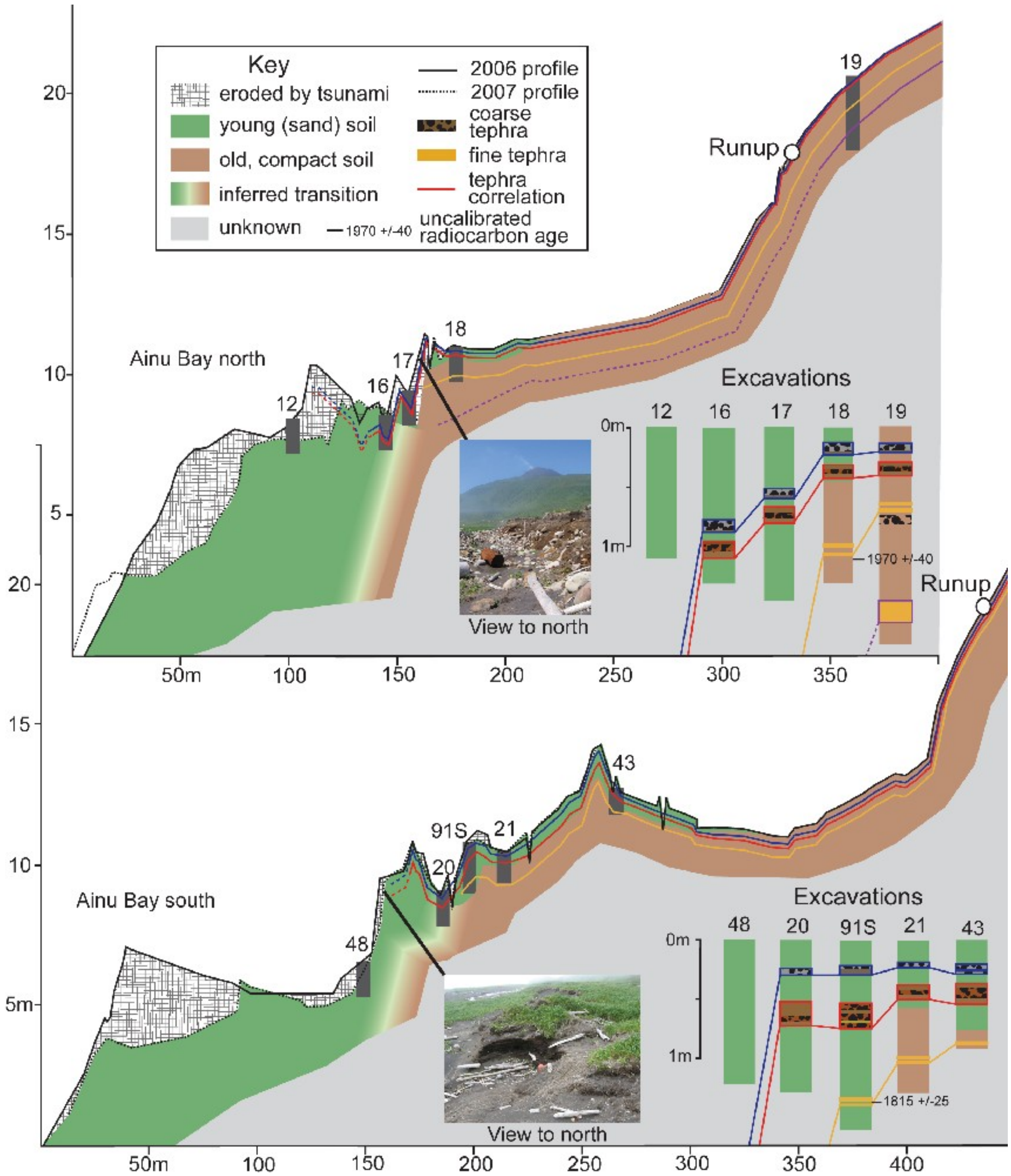



Figure DR11: Profiles and stratigraphy from Ainu Bay, Matua (Figures 2 and 3). The transition between older, well-developed soil (brown) and young sandy stratigraphy (green) is interpreted from excavations and post-tsunami exposures. **Top**. Ainu Bay north--the 2006 tsunami removed a sizable amount of the sandy proximal coastline (Figure DR12). The sharp vertical contact (or paleo-scarp) juxtaposing young sandy soil and older compact soil between excavations 17 and 18 indicates that either large-volume erosional events on the scale of the 2006 tsunami have occurred in Ainu Bay in the past, or that the bay has transitioned from eroding to prograding in the recent past. The scarp (inset) is also detailed in Fig. DR 12. **Bottom**. Ainu Bay south profile (Figure DR14) and stratigraphy are similar, though 91S is thickened by eolian sand. A distinct difference in landscape age between excavations 20 and 21 can be seen in tephra stratigraphy, and 21 is a tundra soil, while 20 is a grassy sandy soil. Inset: scarp with gulley-like scour. Both photo insets: MacInnes.


Figure DR12. Before (summer 2006) and after (summer 2007) photoset – Ainu Bay North profile on Matua (see Figure 2 for location; Fig 3 for profile; also see Figure DR11, DR13). The approximate location of the profile is shown by a red line, and a red circle identifies approximately the same point in each photo. The after perspective is hard to match because of the severe erosion, lowering the surface on which the group camped for two nights in 2006. Both photos: Misty Nikula.

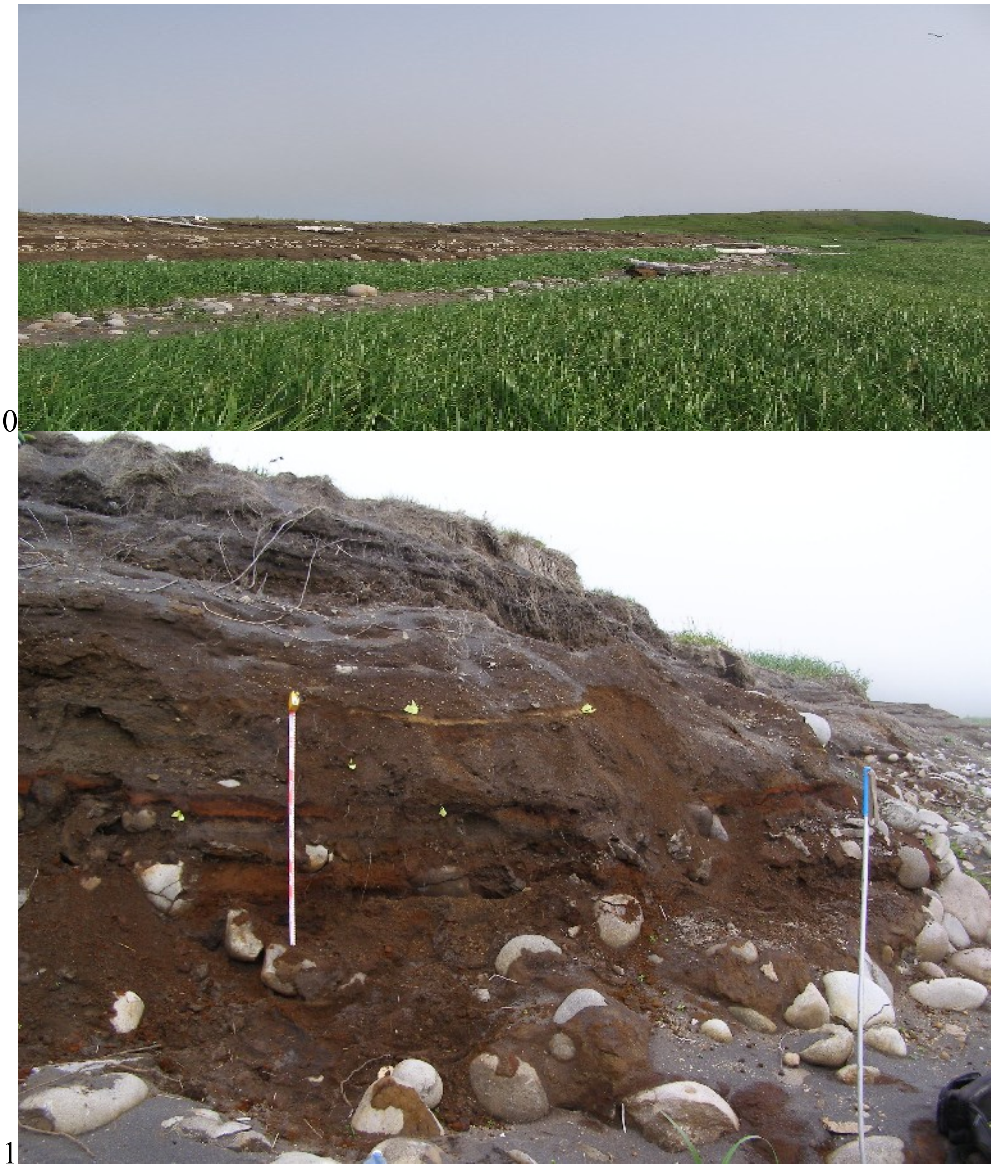


Figure DR13. **Top**: View in 2007 of 100-m-long, tsunami-generated scarp crossed by Ainu Bay North profile (Figs. 3, DR11). Line of bouldery sand in the foreground is another surface stripped of turf by the tsunami. **Bottom**: Close-up of the eroded scarp, with exposed soils and tephra. Tape on outcrop is extended to 100 cm. A light-colored tan tephra in the middle of the scarp (marked at either end by yellow flagging tape) is about 2000 years old.

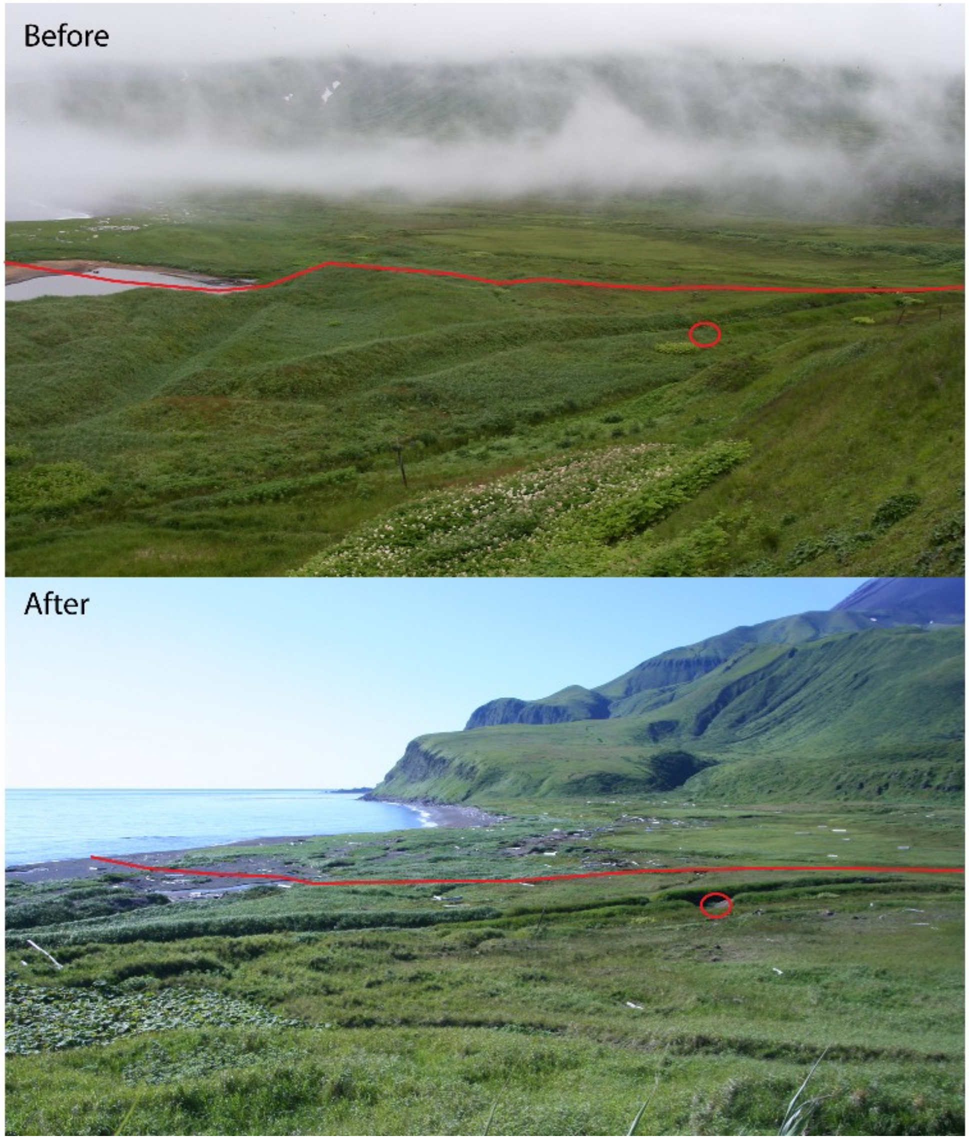



Figure DR14. Before (summer 2006) and after (summer 2007) photoset – Ainu Bay South profile on Matua (see Figure 2 for location; Fig 3 for profile; also see Figure DR11). The approximate location of the profile is shown by a red line, and a red circle identifies approximately the same point in each photo. The beach and proximal vegetated region suffered severe erosion, and the lake was breached, drained and filled with sand. Both photos: Misty Nikula