On a tax map probably made in 1730, Ötsuchi’s houses line a road between bayside paddies and the district magistrates’ office. To the southwest, smoke rises from kilns.

The kilns may mark the area of salt evaporators reportedly damaged by the 1700 tsunami. Notes below kilns identify recipients of rice-tax revenues.

Ötsuchi magistrates stationed here, in a government office building (o-yakuya 郷役屋), sent a report on the 1700 tsunami to Morioka castle. A later Ötsuchi magistrate prepared a summary from which a Japanese earthquake historian would learn of the 1700 tsunami by 1943 (p. 62).

Ötsuchi’s main street probably escaped flooding by the 1700 tsunami and also by the 1960 tsunami. Lining the street were neighborhoods named for their market days. The 1677 tsunami, of nearby source, entered 20 houses in the eighth-day neighborhood, Yökamachi.

Other tsunamis

- 1600
- 1700
- 1751
- 1856
- 1896
- 1933
- 1960
- 1968

THE PICTURE MAP, conserved at Morioka-shi Chuo Kōminkan (p. 44), is probably tied to tax records from about 1730, according to Koushi Hiroaki, the Kōminkan documents librarian (interviewed 1999). Text beside kilns describes division of 74 koku (about 13,000 liters) of rice among Morioka-han (21 koku) and three samurai (17, 6, and 29 koku). In the fourth-day neighborhood (四日町 Yokkamachi), market days ended in four (4th day, 14th day, 24th day); likewise in the eighth-day neighborhood (八日町 Yökamachi), markets were open on the 8th, 18th, and 28th.

Main points
The sea invaded Ötsuchi the same date and hour as it did 30 km to the north, in Kuwagasaki (p. 43, 72). The flooding damaged paddies, two houses, and two salt-evaporation kilns (p. 60). This damage, though small, was reported to Edo, perhaps to help justify financial relief from the Tokugawa shogunate (p. 61). An earthquake historian included this flooding in an earthquake catalog issued in 1943 (p. 62).
The flooding in 1700 probably stopped short of Ötsuchi’s main Edo-period street. The 1751 Chile tsunami reportedly crossed this street, but the 1960 Chile tsunami did not (p. 64). Because of puzzling regional subsidence, places covered by the 1700 tsunami in Ötsuchi may now stand a meter lower, relative to the sea, than they did in 1700 (p. 65).

Setting
Nestled between hills and bayside paddies, Edo-period Ötsuchi stretched along a road between two river mouths. Houses flanked both sides of the street. In a side valley stood the office of a magistrate, or magistrates, who administered the Ötsuchi district of Morioka-han.

Documents
Morioka-han “Zassho” provides the main account of the 1700 tsunami in Ötsuchi. Like the entry about the tsunami in Kuwagasaki (p. 36), it is based on a report from coastal magistrates (p. 44). The report from Ötsuchi probably reached Morioka castle the day after the report on Kuwagasaki arrived from Miyako (p. 60). The 1700 tsunami killed no person or horse in Ötsuchi, according to “Ötsuchi kokon daidenki,” a chronological record of the Ötsuchi magistrates’ office. A secondary source, “Daidenki” contains material from 1596 to 1796 that was compiled and edited in Ötsuchi by Ogawa Magobei Yoshiyasu (1735-1820). The oldest surviving version was copied from Ogawa’s compilation. The compiler or the copyist wrote the 1700 tsunami’s month and hour but neglected its day. Before earthquake historians found the “Zassho” account, this omission in “Daidenki” obscured the link between the 1700 tsunami in Ötsuchi and the flooding of similar character in Tanabe (p. 62).

Other tsunamis
Tsunamis generated off northeast Honshu devastated Ötsuchi in 1611, 1896, and 1933. Deaths from the 1611 waves totaled about 800 in Ötsuchi and vicinity. In the town of Ötsuchi alone, the 1896 and 1933 tsunamis took 600 and 61 lives, respectively. An inscription on the back of a memorial stone, above, further states that the town lost more than 600 houses to each of these latter tsunamis.

Lesser near-source tsunamis reached heights of several meters in Ötsuchi in 1677, 1793, 1856, and 1968. The 1677 tsunami covered the floor in 20 of 60 houses in the Yökamachi neighborhood along the town’s main street.

Among tsunamis of remote origin, 1751 Chile may have reached the farthest into Ötsuchi. It entered both the Yokkamachi and Yökamachi neighborhoods, flooding a dozen houses. The 1960 Chile tsunami approached 4 m in height along the bayshore south of town. Its crest descended onshore to the tsunami’s limit near the 2 m topographic contour, seaward of the main Edo-period street (p. 64-65).

NOTABLE TSUNAMIS IN ÖTSUCHI SINCE 1600

TSUNAMI MEMORIAL mapped on page 65.
HIGH WATER came to the small port of Ötsuchi at a time equivalent to midnight (column 1; clock, p. 43). Damaged were rice paddies and vegetable fields seaward of Ötsuchi’s main street (2). In addition, the Ötsuchi magistrate’s office learned of damage to two houses and two salt kilns (2-3). All this news was forwarded to Edo (4).

3, migi—Mentioned in a previous column, at right. 4, Edo e möshiage sōrō—Officials in Morioka forwarded the news to the domain’s officials in Edo. See facing page.

4, e—Pronounced and written as e, signifies “to.”

Sound change at word juncture—dōkō for tōkō (1), dōri for tōri (2), gama for kama (3).

NOTES. Columns 1 and 3-4, Minami Hei—Mutsu province (labeled, p. 32), contained 54 counties, or gun (Suruga province contained seven, p. 31). Morioka-han administered Hei-gun as two districts, Miyako-dōri in the north and Ötsuchi-dōri in the south (map, p. 44).

1, ura—Small port; unlike Miyako, lacks shipping route on shogunal map from 1702 (red line, p. 33).

1, ōshio—Parsed on page 40.

2, machiya—Probably refers to the neighborhoods yōka-machi and yokka-machi (p. 58).
SEVERAL REPORTS of the 1700 tsunami make their immediate purpose clear. Magistrates justify an allocation of rice and a request for wood in Kuwagasaki. Other magistrates certify the sinking of 28 tons of rice off Nakaminato. A headman wonders about stealth waves in Miho. A mayor in Tanabe expresses concern about the flooding of a nearby storehouse that belongs to a branch of Japan’s ruling Tokugawa family.

Left unstated, in column 4 at left, is why samurai in Morioka castle forwarded to Edo—the shogun’s bustling capital—details on small losses from a natural disturbance to a remote shore. We speculate that officials of Morioka-han kept track of natural disasters in hopes of financial relief from the Tokugawa shogunate.

Morioka-han spent heavily to comply with Tokugawa edicts. Through most of the Edo period, the shogunate required daimyo—some 260 land barons, including the distant Nambu governor of Morioka-han—to reside alternate years in Edo. This required residence consumed over half the tax income of Morioka-han. The Nambu governor would journey between Morioka and Edo, 546 km by road, with a showy entourage of some 250 persons and 100 horses. While in Edo, he would reside in a mansion near the shogun’s castle (map, lower right).

The shogunate allowed Morioka-han to cancel this journey after poor harvests in 1695. Reportedly starving that year were 34,000 people—ten percent of the domain’s population. The domain’s next famine, in progress at the time of the 1700 tsunami, resulted from frost and rain during the 1699 growing season. The domain’s records state that 27,186 people suffered from hunger that year. Such circumstances may have spurred domain officials to document natural disasters as minor as the 1700 tsunami in Ōtsuchi.

THE NUMBER OF DAIMYO DOMAINS, or han, stood at 241 in 1668 and reached 262 by 1720 (Bolitho, 1991, p. 201). Each han had an expected annual production worth at least 10,000 koku of rice (on koka and hyō, see page 71).

IN MORIOKA-HAN, according to figures for internal use (naidaka; Tsukahira, 1966, p. 82), the expected yield was 241,922 koku (Mori, 1963, p. 921) on the basis of surveys in 1666-1683 (Kambun 6 to Ten’na 3). For the required residence in Edo (sankin kōtai), the governor’s entourage journeyed 139 ri between Morioka and Edo (Hosoi, 1988, p. 79). The domain’s yearly costs of sankin kōtai in the 17th century have been estimated conservatively as 46,500 ryō (Hanley and Yamamura, 1977, p. 130-131). To help cover these expenses, Morioka-han levied special taxes on its samurai (1.5 ryō per 100 koku of stipend) and on its commoners (total yearly revenues about 8,300 ryō).

THE 34,000 REPORTEDLY STARVING after the 1695 harvest compares with 334,887, the commoner population recorded by Morioka-han for 1695 (Mori, 1963, p. 642). Mori (1972 p. 125) associates the poor harvest in 1695 with this famine and with the cancellation of sankin kōtai. He lists a shortfall of 100,000 hyō in 1695 and 77,320 hyō in 1699. At 0.4 koku per hyō, the shortfall in 1699 amounts to nearly 31,000 koku, or about one-eighth the domain’s naidaka. The Tokugawa shogunate (the bakufu) commonly helped daimyo domains after disasters: “By far the most common type of assistance took the form of loans [that were] reserved for the emergencies of which Tokugawa Japan seemed to produce an inordinate number. [When]ever a crop was ruined, a castle damaged, or an Edo mansion destroyed, the bakufu could be relied on for aid” (Bolitho, 1991, p. 202).

LANDHOLDINGS IN 1664 from Totman (1967, map 4). The Ainu, native people, held most of Ezo (now Hokkaido) until 1800 (Walker, 2001).

ON EDO population, mansions, and maps see Naitō and Hozumi (1982; 2003, p. 104, 108, 117, 178). The main mansion (kami-yashiki) of Morioka-han stood on a five-acre estate—a parcel of 6013 tsuibo (Mori, 1963, p. 360), or two hectares. The lower map is a detail from “Eiri Edo öezu” (p. 106), courtesy of East Asian Library, University of California, Berkeley.

The orphan tsunami—Ōtsuchi
**Collected writings 史料集**

Modern recognition of the 1700 tsunami in Japan began with a teacher’s mimeographed anthology of historical earthquakes.

MUSHA KINKICHI (1891-1962), an educator and geographer, collected accounts of historical earthquakes on behalf of the Earthquake Research Institute in Tokyo. He began this work in 1928 and continued it into the 1940s.

Because his mandate included events possibly related to earthquakes, Musha noted reports of high water at Ōtsuchi and Tanabe from the year 1700. Musha summarized them side-by-side in a collection brought out first as a wartime mimeograph and printed later as one of the green hardbound volumes at right.


The Musha and “Shinshū shiryö” anthologies together identify 45,698 Japanese earthquakes from the years A.D. 416 to 1872. Most date from the Edo period (1603-1867), when record-keeping first flourished outside the nation’s capitals (graphs, facing page). Coincidence with the Edo period thus helped the 1700 tsunami enter written history.

**MODERN DISCOVERY OF THE ORPHAN TSUNAMI OF 1700**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1983-2004</td>
<td>Tsugarushi</td>
<td>A regional historian transcribes the Mori-ke “Nikki kakitome cho” account in 1983. The transcription is quoted ten years later in “Shinshū Nihon jishin shiryö.” In 2004, earthquake historians view the 18th-century source and confirm a copyist’s error (p. 50-53).</td>
</tr>
<tr>
<td>1983-2004</td>
<td>Ōtsuchi</td>
<td>Musha Kinkichi, in his anthology from 1943, cites “Ōtsuchi kokon daidenkki,” which omits the day of the flooding (above). This missing detail survives in Morioka-han “Zassho” (p. 60), as quoted in “Shinshū Nihon jishin shiryö” in 1993.</td>
</tr>
<tr>
<td>1982-1998</td>
<td>Miho</td>
<td>“Miho-mura yōji oboe” contains an entry on the earthquake and tsunami of 1703 alludes to the 1700 tsunami as “Rabbit Year waves” (p. 76-77). This flashback, collected by Tsuji in 1982, appears in a 1989 volume of “Shinshū Nihon jishin shiryō.” Ueda, in 1998, notices that the preceding entry in “Miho-mura yōji oboe” describes the 1700 waves in detail (p. 78-79).</td>
</tr>
<tr>
<td>1943-1993</td>
<td>Tanabe</td>
<td>Musha’s 1943 anthology summarizes the account in “Tanabe-machi daichō” (above; full text on our page 86). In 1981, a parallel account from “Mandaiki” (p. 84) appears in an earthquake anthology. The 1993 volume of “Shinshū Nihon jishin shiryō” also contains the “Mandaiki” version.</td>
</tr>
</tbody>
</table>

DURING THE FIREBOMBING of Tokyo in 1945, the manuscript for Musha’s 1949 volume awaited war’s end in a galvanized box 3 m underground. Musha worked for the military geology branch of the U.S. occupation forces from 1949 to 1960. His collection of earthquake accounts built on previous work, much of it by Tayama Minoru, who issued a two-volume anthology in 1904 (Usami, 1979a, b). USAMI (1996) summarizes descriptions of more than 300 earthquakes that struck Japan between 416 and 1872. A parallel summary for tsunamis was compiled by Watanabe (1998). Tsuji and others (1998, p. 2-4) trace the origins of accounts of the 1700 tsunami.

A PREFECTURAL FISHERIES ASSOCIATION published the Nakaminato account in a volume edited by Ouchi (1943).

THE COLUMNS OF JAPANESE TEXT above are excerpted from Mombushō Shinsai Yōbō Hyōgikai (1943, p. 25; see also our page 112). The photo of Musha Kinkichi, undated, was provided by his family through Matsu’ura Ritsuko.
JAPANESE EARTHQUAKES A.D. 600-1872, IDENTIFIED IN OLD DOCUMENTS

Emperor in Nara

Shogun in Kamakura

Kyoto

A.D. 1700

Edo

Emperor in Kyoto

Kamakura

Edo

Yearly number of earthquakes

Nara (mainly in 700s)

or Kyoto (after 794)

“Genji monogatari”

≥ 100

≥ 100

≥ 100

≥ 100

Elsewhere in Japan

A.D. 600

800

1000

1200

1400

1600

1800

Data from Ueda and Usami (1990). The tallies include aftershocks.

Genroku

THE CULTURAL PEAK of the Edo period is known as Genroku 元禄, the era name for 1688-1704 (p. 42). The Genroku society that kept prodigious records also produced literary innovations, popular titles, and scholarly tomes.

Genroku innovations include haiku—poems of seventeen syllables in three unrhymed lines. These were refined and popularized by Matsuo Bashō (1644-1694). In a posthumous collection he tells how to focus verse so brief: “You should put into words the light in which you see something before it vanishes from your mind.”

Bashō’s contemporary, Ihara Saikaku (1642-1693), introduced realistic description of the lives of urban merchants and samurai. His novels and collections of short stories include “The life of an amorous man” (1682), “Five amorous women” (1686), “The great mirror of love between men” (1687), “The Japanese family storehouse” (1688), and “Reckonings that carry men through the world” (1692).

The playwright Chikamatsu Monzaemon (1653-1725) popularized puppet theater and wrote dance dramas (kabuki) as well. Some of his works treat turmoil in the houses of land barons; others, beginning in 1703, tell of lovers driven to suicide by social obligation and financial difficulty.

Genroku publishers issued thousands of commercial books. A book-dealers’ catalog from 1696, in 674 pages, listed 7,800 titles. The books in print included how-to manuals for home use by the young. “Onna chōhōki” (1692) instructed young women; “Otoko chōhōki” (1693), for young men, provided lessons on calligraphy, Chinese and Japanese poetry, tea ceremony, and letter writing.

“Shōbai ōrai” (“Merchants’ manual,” ca. 1694) exhorted merchants’ children to practice writing and arithmetic “from infancy.” “Nōgō zensho” (“Encyclopedia of farming,” 1697) advised peasants to “lay up stores of money and grain” as precautions against “the very great risk of dying of starvation in bad years.”


The shogun throughout the Genroku era, Tokugawa Tsunayoshi (1646-1709), was more scholar than soldier. He is said to have lectured on the “Yiching,” an ancient Chinese book of wisdom and divination, no fewer than 240 times between 1693 and 1700.

“Honchō tsugan” (“General history of our State”), completed by 1680, filled 310 volumes. Attributed to the founder of a competing historical project, “Daitenhō shi” (“The history of greater Japan”): “In writing one must be true to fact, and the facts must be presented as exhaustively as possible. An excess of detail is preferable to excessive brevity.”


The orphan tsunami—Ōtsuchi

63
**Tsunami size 津波の高さ**

The 1700 tsunami crested several meters high at the edge of Ōtsuchi Bay.

### 1700 tsunami

#### EVIDENCE, HEIGHTS A AND B

- ryōshi no fishermen's place
- tokoro place
- ni-ken two houses
- shiogama salt kilns
- ni-kō two sets
- hason damaged

**INFERRED HEIGHT OF TSUNAMI AT BAY SHORE, IN METERS**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### EVIDENCE, HEIGHTS B AND C

- machiya commercial district
- uradōri back street,
- tahata paddies and fields
- sōsu were damaged

### ASSUMPTIONS

- **Flow depth** 0.5 m where fishermen's sheds damaged.
- **Freeboard** To have floors above swash during storms—and perhaps with the 1677 tsunami in recent memory—villagers sited these sheds at least 0.5 m above high astronomical tides.
- **Tide zone** Highest astronomical tide in 1700 was 0.7 m above mean sea level, by analogy with modern tides at Kamaishi.
- **Tide stage** 0.2 m above mean sea level; computed for midnight arrival of high water (p. 83).

### C Modern land level, adjusted for tectonic subsidence since 1700

- **Land in 1700, at inland limit of tsunami**
- **Benchmark at Town Hall** (top map on facing page)
- **Subsidence** 1.5 m since 1700 (extrapolated tide-gauge trend, right).
- **Modern ground** Maximum height of 1700 tsunami approximated by benchmark 1.6 m above TP.
- **Tide stage** 0.2 m below 1700 mean sea level (p. 83).

Both estimates are based on the following:

**Inferred with 1960 analogy** The 1700 and 1960 tsunamis both went about the same distance inland. Thus, the 1700 tsunami probably reached heights at the shore similar to those of the 1960 tsunami, in the range 3.6–4.0 m (top map, opposite).

**Inferred from subsidence** Paddies overtopped by the 1700 tsunami, now at least 1.2 m above mean sea level (brown points on map), may have stood 1.5 m higher in 1700 because of chronic subsidence (estimated in C, below).

**TRENCH JAPAN**

The 1700 tsunami crested lower in Ōtsuchi than did the 1677 and 1751 tsunamis, for these flooded houses along the town’s main street (p. 59). Unlike estimate B, the published height for the 1677 tsunami in Ōtsuchi (2.8 m) lacks correction for an onshore decrease in tsunami height; and unlike estimate C, it neglects land subsidence since 1677.

Land-level changes since 1700

THE DESCENDING PACIFIC PLATE dragged land downward along the Japan Trench through the last half of the 20th century. If such subsidence persisted through the last 300 years, northern sites flooded by the 1700 tsunami stood 1.0-1.5 m higher than now—as assumed in the C estimates on pages 48, 57, and 64. The assumption is doubtful because (1) 20th-century sea-level rise explains part of the apparent subsidence, (2) stability prevailed at Ayukawa early in the 20th century, and (3) long-term uplift has raised the region’s coast in the past 125,000 years.

The coast farther south has a history of cyclic land-level changes related to historical subduction earthquakes on the Nankai Trough (p. 91).

TIDE-GAUGED TRENDS, LAND LEVEL RELATIVE TO THE SEA

<table>
<thead>
<tr>
<th>Year</th>
<th>Miyako</th>
<th>Kamaishi</th>
<th>Ofunato</th>
<th>Shimizu</th>
<th>Wakayama</th>
<th>Shirahama</th>
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</thead>
<tbody>
<tr>
<td>1900</td>
<td>3.3</td>
<td>5.0</td>
<td>4.8</td>
<td>4.0</td>
<td>-0.8</td>
<td>-1.0</td>
</tr>
<tr>
<td>1950</td>
<td>3.0</td>
<td>4.5</td>
<td>4.2</td>
<td>4.0</td>
<td>-0.5</td>
<td>-0.5</td>
</tr>
</tbody>
</table>

The orphan tsunami—Ötsuchi