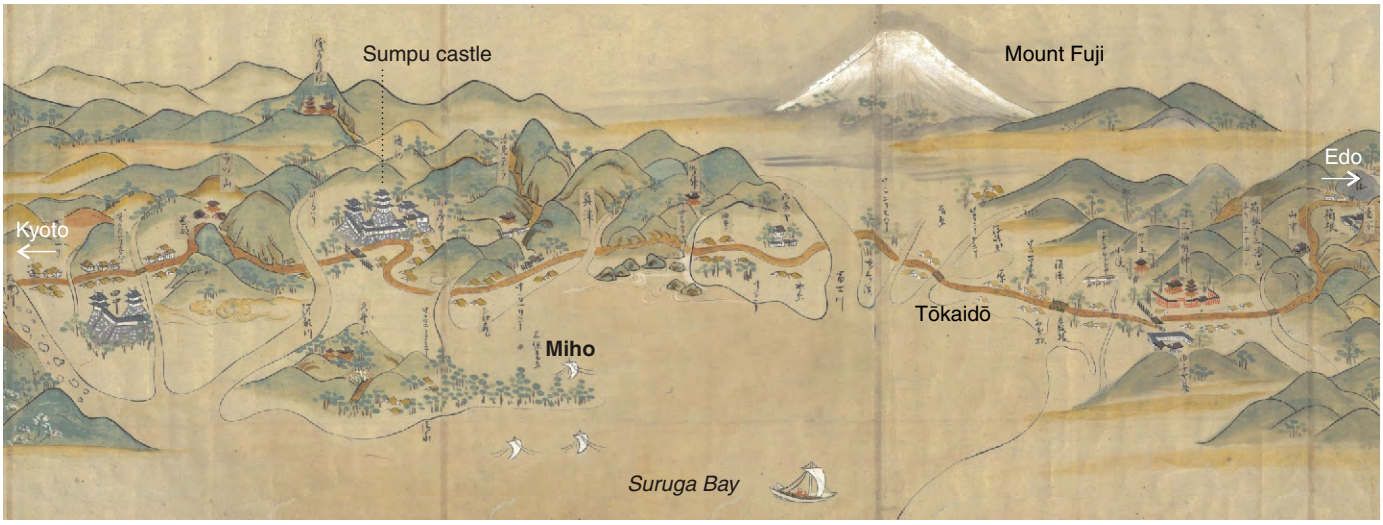
Miho 三保



← West and southwest

1687

Sumpu castle (p. 41)

Village (each oval)

Miho (right)

Shipping route (p. 33)

Miho-mura
Miho village

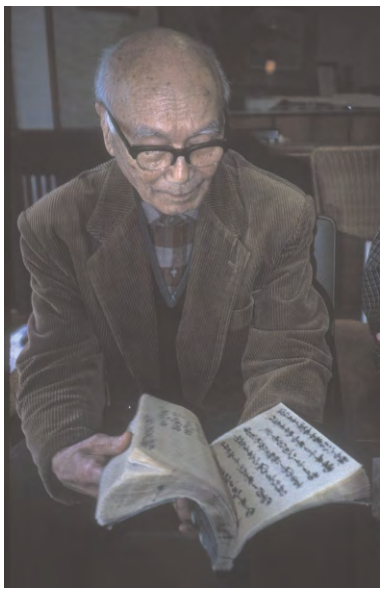
Pines

1702

Miho myōjin
Miho shrine

Boundary between two of the seven counties in Suruga province (p. 31)

Miho village, on a sheltered shore of a pine-covered sand spit, was home to some 300 peasants in 1700. To their headman, the tsunami of that year resembled a series of brief high tides. He noted that the waves lacked a parent earthquake felt in Miho or nearby. His inquisitive eyewitness account survives in "Miho-mura yōji oboe," a selection of headmen's records probably compiled in the early 19th century. At right, the document and its possessor in 1999, hotel owner Endō Kunio.



THE OBLIQUE VIEW at top comes from "Tōkaidō narabini saigoku dōchū ezu," a picture map dated Jōkyō 4 (1687). The full map unfolds to a length of 8.7 meters. In the reduced image above, which represents one-tenth of that span, Miho's pine-covered spit commands a view of Mount Fuji. Not far from the village, the Tōkaidō—the famed Eastern Sea Road between Edo and Kyoto (p. 30-31; Naito and Hozumi, 2003, p. 32-33)—winds past Sumpu castle, where a diarist for Tokugawa Ieyasu wrote "tsunami" in its modern characters (p. 41). Courtesy of East Asian Library, University of California, Berkeley.

THE PLAN VIEWS are details from a map of Suruga province, "Suruga no kuni," dated Genroku 15 (1702). The entire map spans 4.5 m by 3.9 m; the detail at left, 70 cm by 35 cm. The closeup at right shows Miho shrine labeled *myōjin*, illuminating god. From the collection of Ashida Koreto (1877-1960); map 54-35 of Ashida Bunko Hensan I'inkai (2004, p. 226). Courtesy of the library of Meiji University, Tokyo.

"MIHO-MURA YŌJI OBOE" Endō Kunio, 85 years old in 1999, inherited "Oboe" from his grandfather. Endō Shōji edited a pair of volumes on "Oboe" that reproduce all its cursive entries, print them in old characters, transcribe these into modern characters, and place the accounts in historical context (Endō and Nagasawa, 1989; Endō and others, 1990). An "Oboe" entry from Hōei 3 (1706) gives the village's population as 328 and its number of houses as 54.

Main points

While waves held the rice boat off Nakaminato (p. 73), the sea at Miho rose and fell repeatedly, like a swift series of tides (p. 78-80).

Wary of flooding, Miho's headman advised villagers to flee (p. 46; 79, columns 6-7).

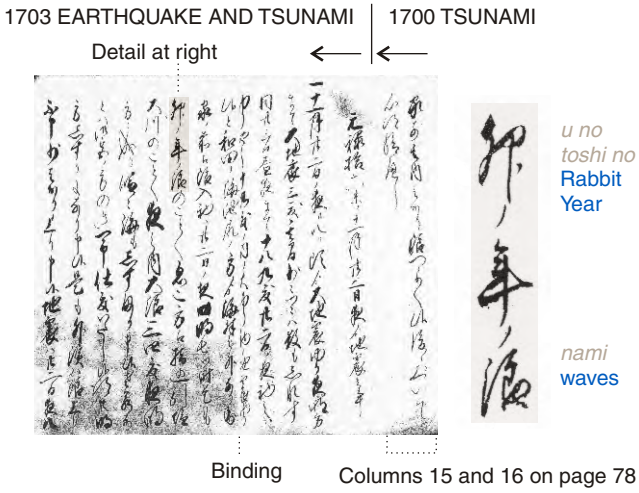
The lack of an associated earthquake puzzled the headman, who expected that an earthquake would precede a tsunami (p. 40; 54; 78, columns 12-14).

Like the 1960 tsunami, the 1700 tsunami at Miho was probably under 2 m in height and caused less flooding than did a storm of its era. The largest wave of the 1960 tsunami at Miho probably rode a higher tide than did the 1700 tsunami (p. 82-83).

Documents

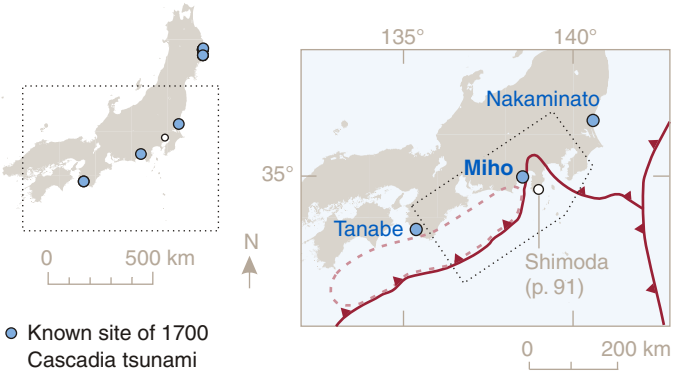
Compiled in the 19th century from records of the village's headmen, "Miho-mura yōji oboe" contains 71 entries on a wide range of topics. Three-quarters of these date from 1694 to 1730.

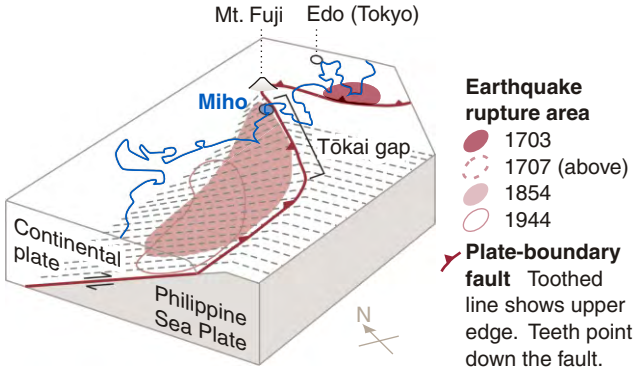
The 1700 tsunami appears twice in "Oboe"—as the main event in the account on the next two pages, and as a flashback in the entry below, which begins with an earthquake that devastated Edo in December 1703. The tsunami from this earthquake reminded the headman of Rabbit Year waves—doubtless those of Genroku 12 (p. 42). In both cases, the likely writer was either Gorōemon or Chūemon, the village's headmen in 1698.



"MIHO-MURA YŌJI OBOE" also recounts: **1697**, Fire destroys 23 homes—40 percent of the village's houses—when wind fans flames from the home of Zen'emon. Later, villagers dry a big catch of sardines and the shogunate orders a new map of the area (probably the 1702 map, opposite). **1698**, Gorōemon and Chūemon, as *shōya* (headmen) of Miho, sign a land survey that assesses Miho's cropland at 54.2 koku (expected yield: 9,756 liters of rice, or its equivalent). **1699**, Destructive typhoon (p. 83). **1713**, Villagers build a salt-water fish pond in front of the headman's house. They capture a wild pig after it attacks children. **1715**, Inflation raises the price of rice; villagers die of malnutrition. **1719**, The shogunate, through a merchant in Edo, orders fresh fish from Miho for a 500-person delegation from Korea. **1722**, A wet summer hurts salt production. **1729**, An elephant passes through a nearby village while on its way to Edo. Seven years old, it has a height of 6 *shaku* 5 *sun* (2 m) and a length of 1 *jō* (3 m). Its tail extends 3 shaku 3 sun (1 m), its tusks 1 shaku 3 sun (0.4 m). Its ears are shaped like ginko leaves, its eyes like leaves of bamboo. Its daily diet includes 100 tangerines, 6 *sho* (11 liters, or 3 gallons) of cooked rice, and 9 sho of sake.

PLATE-BOUNDARY EARTHQUAKES



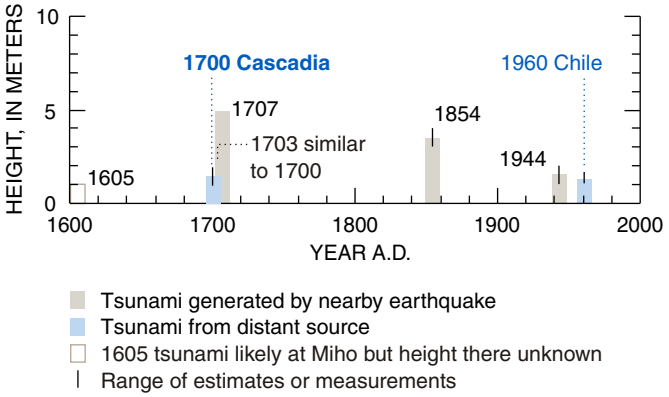


Tectonic setting and local tsunamis

Barely ten kilometers of continental crust separates Miho from the giant fault on which the Philippine Sea tectonic plate descends. Beneath Miho, this fault ruptured during an earthquake in 1854, and perhaps in 1707, but not in 1944. Efforts to predict earthquakes in Japan focus largely on the patch that failed to break in 1944—the Tōkai gap.

The earthquakes of 1707 and 1854 produced tsunamis as much as 5 m high in Miho. Lesser tsunamis in Miho resulted from nearby earthquakes in 1605, 1703, and 1944.

NOTABLE TSUNAMIS IN MIHO SINCE 1600



ON HISTORICAL EARTHQUAKES near Miho and forecasts for the Tokai gap, see Ishibashi (1981). We traced the block diagram from his page 312.

THE TSUNAMI HEIGHTS are from Watanabe (1998, p. 71, 80, 93, and 133) for 1605 and 1707, and from Hatori (1976, p. 24) for 1854 and 1944.

Account in “Miho-mura yōji oboe” 『三保村用事覚』の記述

THE MIHO HEADMAN describes the 1700 tsunami as having entered "something like a very high tide" (column 2). There were seven such waves between dawn and late morning (4). Each wave rose gradually and went out "with the speed of a big river" (3). The flooded area included a bayside grove of pines (maps, p. 76, 82).

Puzzled by the waves, the headman took the precaution of sending elders and children to the high ground of Miho

Formal language—*sōraeba* (8, 12), *sōrae* (9, 13), *sōrō* (9, 10, 14, 15).

Sound change at word juncture—*suezue* for *suhe suhe* (11).

Modern Japanese kana include diacritics (*dakuten*) that alter consonants, as in changing こ *ko* into ご *go*. Like some of his contemporaries, the “Oboe” writer did not use dakuten. His kana can be read, out of context, as *Eko* (instead of *Ego* in 2), *nato* (instead of *nado* in 2, 10, 12), and *shisumari* (instead of *shizmari* in 12).

The “Oboe” writer used simple phonetic script (*kana*) instead of complex ideograms (*kanji*) for *nado* (2, 10-11, 12, 13), *hodo* (4, 6), *kainaku nari* (5), *narenu* in *kikinarenu* (6) and in *minarenu* (9), *naru* (6), *shizumari* (8), *odoroki* (10), *suezue* and *kangae* (11), *tame* and *sei* (12), *yota* (12-13), *bakari*, *tsuyoku*, and *oite* (15). The “Oboe” script thus looks simpler than the kanji-rich columns of the other orphan-tsunami accounts (p. 34-35).

shrine (columns 6-7). The waves also perplexed elders the headman consulted (8-9). Though the headman had heard that an earthquake usually precedes a tsunami, these waves followed no earthquake felt in Miho or nearby (12-14).

Among surviving accounts of the 1700 tsunami, this one stands out as the testimony of an involved eyewitness who pondered a phenomenon beyond his life experience.

COLUMN 1

11, *kangae*—Written *kangahe.*

12-13, *mottomo...mono to mōshi sōrae*—Further, it is said that if an earthquake happens, a tsunami follows.

12-13, *yotanami*—Literally, wild waves.

14, *goza naku sōrō*—Written *naku goza sōrō.*

14, *soto hama*—The beach facing the open sea.

7, *nigashi*—I advised them to escape.

7, *kiotsuke*—Romanized transliteration contains the object marker *wo*, pronounced *o.*

9. *yue*—Literally, reason.

9-10, *mura jū*—All people in the village.

10, *suzunami*—A now-unknown term that may have meant "quiet waves"

← NOTES. Columns 1-2, *lenomae*, *Wada*, and *Ego*—Place names in Miho (map, p. 82).

1 and 14, *e*—Pronounced and written *e.* Signifies "to" as does *e* in 7, where written *he* へ.

3 and 7, *wa*—Topic marker written *ha* ハ.

6, *rōnyaku*—The elderly and children.

7, *o-miya*—Miho shrine (maps, p. 76, 82).

Tidal waves 津波の挙動

A tsunami that resembles a tide may sweep away buildings.

TIDE-LIKE WAVES
OF 1700 TSUNAMI

michishio
high tide

nado no yōni
or
something
like

sashikomi
entered

p. 79, column 2

HOKUSAI'S WAVE
MISUSED AS A TSUNAMI ICON

January 18, 1996

1997

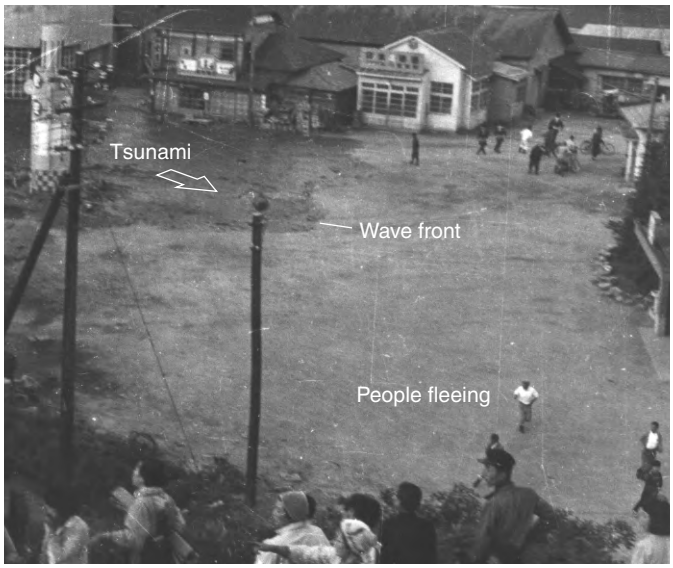
Internationalized, 2003 (p. 46)

A TOWERING, BREAKING WAVE dominates one of Hokusai's "Thirty-six views of Mount Fuji." Though an exaggerated wind wave, it has become an icon of tsunamis. Reproduced on the cover of a leading scientific journal, it represents a report on the 1700 tsunami in Japan. Adapted on a Japanese postage stamp, it commemorates diplomatic relations with a country known in Japan for its 1960 tsunami (below and opposite; see also p. 55). Simplified on American roadsides, it identifies tsunami-evacuation routes (p. 46).

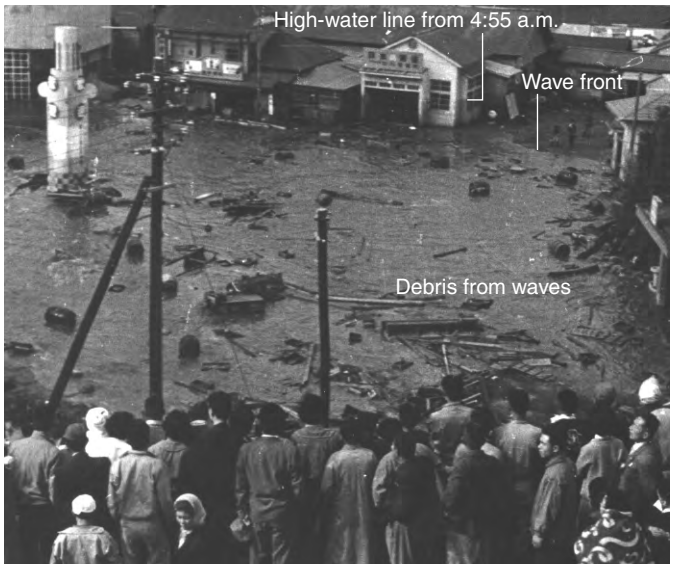
The tide-like flows described by the Miho headman (quote, left) more nearly resemble a real tsunami. Tens of kilometers crest to crest, tsunami waves typically come ashore as relentlessly rising surges, like the ones captured in horrific videos from South and Southeast Asia in 2004.

The headman's words bring to mind the 1960 Chile tsunami in Japan. It entered Onagawa as waves that neither towered nor broke (below). At Ōfunato (opposite) its swift currents drove boats ashore (p. 55) while sweeping buildings off their foundations (opposite). Near Tsugaruishi and Tanabe it resembled a river in flood (photos, p. 51, 85). Such flooding probably explains the how the orphan tsunami of 1700 destroyed houses beside Miyako Bay (losses quoted, p. 48, 56).

1960 TSUNAMI AT ONAGAWA: FIRST LARGE WAVE...

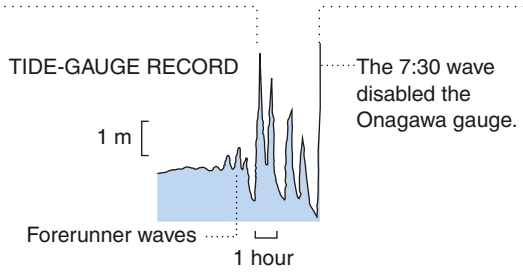


...AND A LATER WAVE



4:40 a.m.
May 24

7:30 a.m.



"THE INAPPROPRIATE ICON" is the late Doak Cox's epithet for tsunami symbols that contain or mimic Hokusai's wave. Towering breakers rarely signal a tsunami's arrival (Lander and others, 1993, p. 2; Cox, 2001). The *Nature* cover spotlights the orphan-tsunami report by Satake and others (1996). For footage of the 2004 Indian Ocean tsunami, see http://www.waveofdestruction.org/videos/.

ONAGAWA PHOTOS, attributed to M. Kondō, are from a notebook stored at the Earthquake Research Institute, University of Tokyo. An alert fireman, noting water-level changes from forerunner waves, warned residents to go to high ground before 4:40 a.m. Everyone survived (Atwater and others, 1999, p. 8).

AFTER THE 1960 TSUNAMI AT ŌFUNATO

Courtesy of Ōfunato city. Additional view, p. 133

Selective history

THE DEVASTATION ABOVE, from the 1960 tsunami, contributed to 52 deaths in Ōfunato. The 1700 tsunami surely came ashore here as well; the two tsunamis attained similar size elsewhere in Japan (p. 48). However, the orphan tsunami of 1700 is unknown from Ōfunato, probably because of accidents of human history:

- Ōfunato belonged to a domain, Sendai-han, that kept fewer administrative records than did Morioka-han.
- Magistrates reported the 1700 tsunami incompletely even in Morioka-han. They documented its effects close to their district offices in Miyako and Ōtsuchi but neglected the damage or flooding 7 km to the south at Tsugaruishi (compare p. 38-39 with p. 52).
- The district office for Ōfunato, at Imaizumi, was 10 km away on a different bay.
- Ōfunato had less at risk in 1700. The area probably had little more than one-tenth its 1960 population. Few houses stood in 1700 on land the 1960 tsunami would rake.

ŌFUNATO also lacks records of the 1611 tsunami, which crested over 5 m high between Miyako and Sendai (p. 41). The village area had 1,217 residents in 1641 (Ōfunato Shishi Henshu I'inkai, 1978, appendix, p. 378), versus 11,200 in 1960. An 1822 map shows paddies and salt ponds on low ground but houses solely on uplands (Kin'no, 1981, p. 22-23).

Tsunami size 津波の高さ

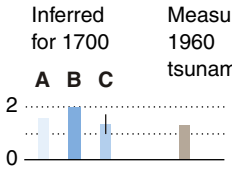
At Miho, the far-traveled tsunamis of 1700 and 1960 were similarly small.

NO REPORTED DAMAGE resulted from the 1700 tsunami at Miho. To enter the pine grove, the tsunami probably rose a meter or two above ambient tide, which likely stood near mean sea level as the water repeatedly rose and fell (graphed tide curve, opposite). The 1960 tsunami similarly amounted to little at Miho, even though its largest wave coincided with a tide several tenths of a meter higher.

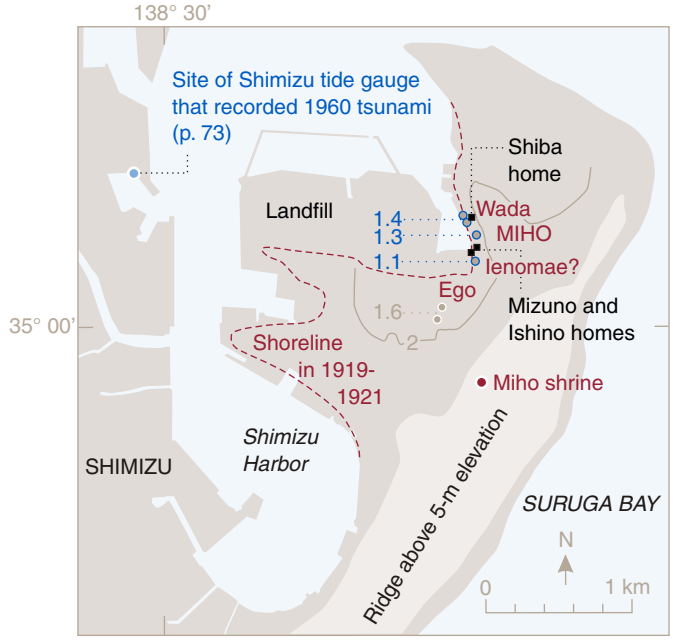
EVIDENCE FOR 1700
IN "MIHO-MURA YŌJI OBOE"

matsu no uchi
within pine groves
[at Ego]

TSUNAMI HEIGHT,
IN METERS AT BAY SHORE

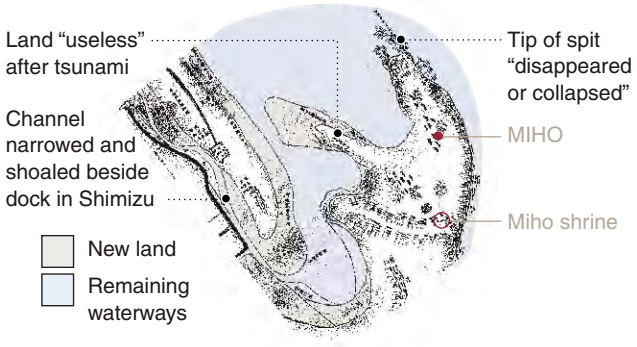


MODERN LANDSCAPE



2 — Elevation, in meters above TP on map dated 1988
1.6 ○ — Contour and point probably above 1960 tsunami
1.3 ○ — Point probably below level of 1960 tsunami
Ego - - - • **Historical feature** Ienomae located approximately

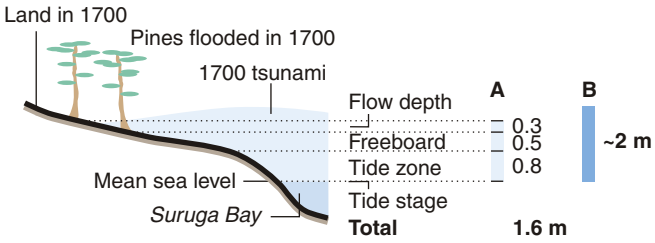
EFFECTS OF 1854 EARTHQUAKE AS RECALLED IN 1893



UPPER MAP Base traced from Kokudo Chiri'in (Geographical Survey Institute) Okitsu, Shimizu, and Shizuoka 1:25,000 quadrangles, 1996-1998. Earlier shoreline, plotted only near Miho, mapped by Rikuchi Sokuryōbu at 1:50,000, 1919-1921. Elevations from 1988 Shimizu city planning map. Tide-gauge location from Teramoto and others (1961, p. 324); Wada, Ienomae, and Ego locations from Endō and Nagasawa (1989, map 2).

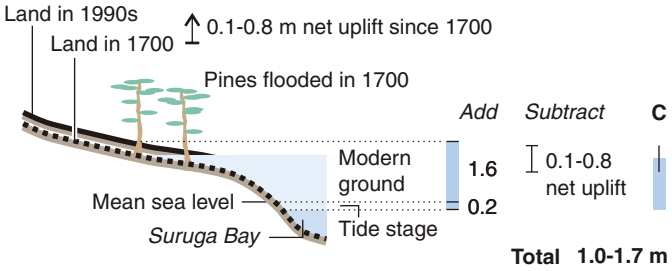
1700 tsunami at Ego

A and **B** Height inferred with simplest assumptions



ASSUMPTIONS
Inland change in tsunami height None (**A**). Inland descent (**B**), by analogy with the 1960 tsunami at Ōtsuchi and Shinjō (p. 65, 89).
Flow depth In pines, 0.3 m (**A**) or 0.5 m (**B**).
Freeboard Storm-wave swash excluded pines from land less than 0.5 m above highest astronomical tides.
Tide zone Highest astronomical tides 0.8 m above mean sea level.
Tide stage At 1700 mean sea level during tsunami (facing page).

C Height depends greatly on net uplift since 1700



ASSUMPTIONS
Inland change in tsunami height None.
Tide stage 0.2 m below 1700 mean sea level (facing page).
Modern ground The area of the flooded pines is now about 1.6 m above TP (map, upper left).
Net uplift 0.1-0.8 m since 1700: coseismic uplift 0.0-0.7 m in 1707 and 1.4 m in 1854; interseismic subsidence 4.8 mm/yr (250-year extrapolation of Shimizu trend, p. 65).

LOWER MAP at left originated in 1893 with officials of Shizuoka prefecture, the modern regional jurisdiction to which Miho belongs (Hatori, 1976). The validity of height **C**, from Tsuji and others (1998), depends partly on the shoreline changes reconstructed on this map. Those changes demonstrate uplift at Shimizu but not necessarily at Miho. Ishibashi (1984, p. 107) estimated that the 1854 earthquake elevated Shimizu by about 3 m. Before the earthquake, ships of 1,000-koku (180,000 liter) capacity would pull into the dock. Afterward, the channel became too narrow and shallow for such use (Hatori, 1976).

Comparisons with storms

At Miho, the 1700 and 1960 tsunamis crested below storm surges of their eras. The 1700 tsunami caused less flooding or damage in Miho than did a typhoon in 1699. Similarly, the 1960 tsunami failed to enter houses that were flooded during a storm in 1974.

In September 1699, a typhoon advanced from Kyushu to northern Honshu. In Miho it caused greater flooding and damage than did the orphan tsunami four months later. The storm surge drove villagers through waist-deep water to Miho shrine. Two persons had to be rescued from the sea; another was reported missing. On returning to their houses, villagers found high-water marks 1-2 *shaku* (0.3-0.6 m) above floor level. Three homes lost everything but their support posts. Also damaged were rice paddies, some destroyed "forever" (*eiare*). One seventy-year-old farmer, Jōzō, said he had seen his Miho paddy flooded thirteen times in 41 years. Only one or two of those floods damaged his standing crop of rice as much as did the 1699 typhoon.

Likewise for elders in modern Miho, the flooding of record accompanied a storm, not a tsunami. A storm surge on July 7, 1974 flooded the bayside homes of the Mizuno and Ishino families, in the approximate area of the neighborhood called Ienomae in 1700 (index map, opposite). Interviewed in 1999, elders of the two families recalled no other flooding of these homes, even though they lived there in 1960. The 1960 tsunami also failed to flood the home of Shiba Tsune, in nearby Wada. In her account, the water went no farther than the bayshore road in front of her house.

Adjustments for tides

When the 1700 tsunami was first noticed in Japan, the astronomical tide stood near mean sea level (left graphs below). The tsunami's midnight arrival at Kuwagasaki and Ōtsuchi coincided with a falling tide a few tenths of a meter below mean sea level. Dawn flooding at Miho and Tanabe occurred on the rising side of that low tide. Only later waves arrived with the tide above mean sea level.

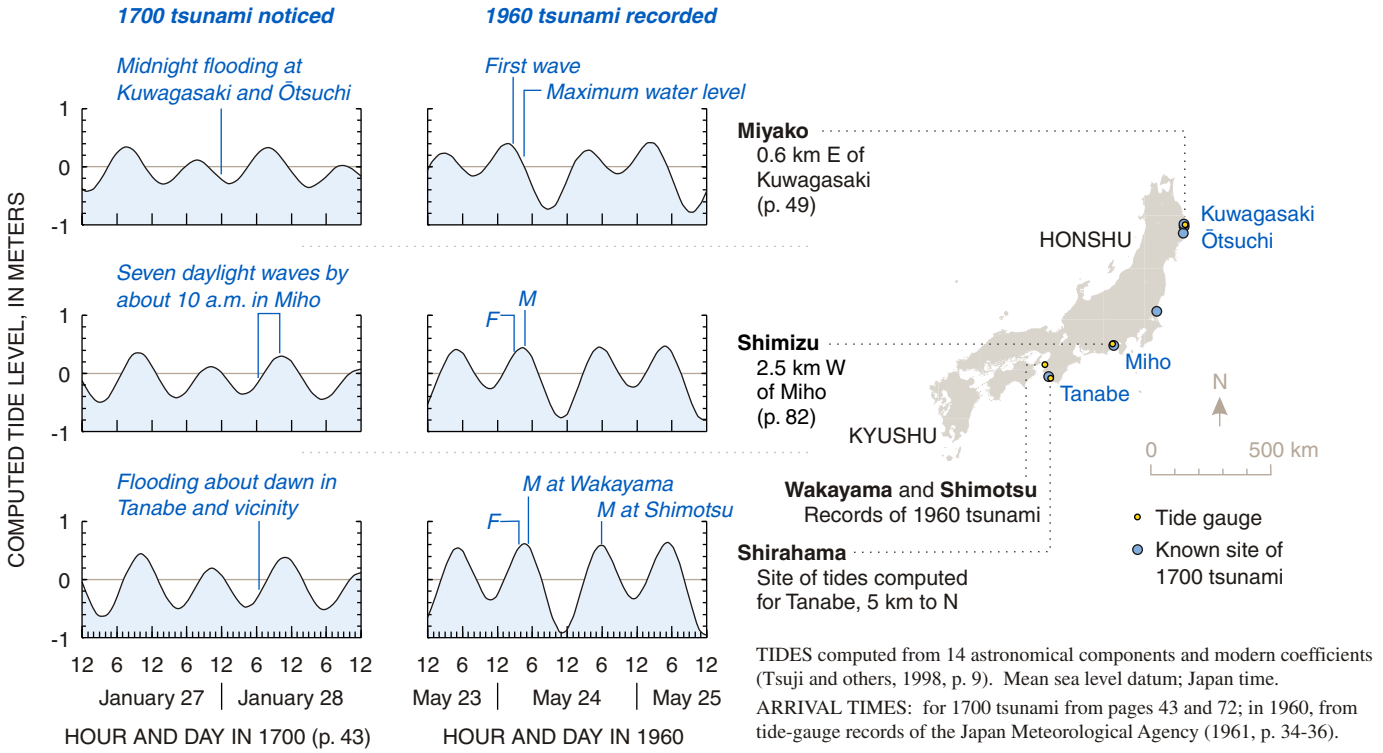
In contrast, the 1960 tsunami crested during high tide (right graphs). Its largest wave nearly coincided with the peak of high tide at Miho and Tanabe. Near Miho at the Shimizu gage, the tide stood about 0.3 m above mean sea level. Because the 1960 tsunami at Miho did not exceed 1.6 m above mean sea level, it crested no more than 1.3 m above ambient tide.

TIDES The 1700 tsunami is unlikely to have piggybacked on a storm surge during its first 12 hours in Japan (p. 72). The tsunami coincided with neap tides—astronomical tides of smaller than average range (Mofjeld and others, 1997). The Pacific coast of Honshu has two daily high tides and two daily lows (Maritime Safety Agency, 1998). The mean tide range is 1-2 m. An individual tide sweeps southward, reaching Tanabe nearly 3 hours after leaving Kuwagaski.

HEIGHT OF 1960 TSUNAMI IN MIHO In the record of the Shimizu tide gauge (p. 73), the first large wave of the 1960 tsunami crested 1.3 m above TP (The Committee for Field Investigation of the Chilean Tsunami of 1960, 1961, p. 194, 371). The Mizuno and Ishino homes occupy low ground near intersections 1.1-1.3 m above TP, while the Shiba home is founded a few tenths of a meter above a road 1.4 m above TP (map, opposite). TP (Tokyo Peil) is a datum near mean sea level.

TYPHOON OF SEPTEMBER 1699 An anthology like those by earthquake historians (p. 62) identifies more than ten historical accounts of this storm (Arakawa and others, 1961). Japan's typhoon season runs from June to November and peaks in September. Storm surges account for much of the damage they cause (Arakawa and Taga, 1969, p. 129).

COMPUTED TIDE CURVES COMPARED WITH OBSERVED TIMES OF THE 1700 AND 1960 TSUNAMIS



TIDES computed from 14 astronomical components and modern coefficients (Tsuji and others, 1998, p. 9). Mean sea level datum; Japan time.

ARRIVAL TIMES: for 1700 tsunami from pages 43 and 72; in 1960, from tide-gauge records of the Japan Meteorological Agency (1961, p. 34-36).