昭和三陸津波（1933年３月３日、日本）

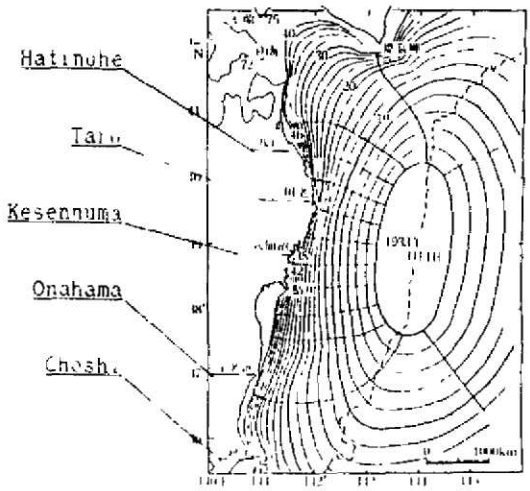
１．津波と被害概要

日本時間の２時31分に三陸はるか沖の北緯39°14′、東経144°31 を震央とするマグニチュード8.1の地震が発生した。地震に先だって、約１ヵ月前からの井戸内水位の低下があり、また、２日前に海水位の低下があった。陸上で感じられた地震動そのものは、気象庁震度５で、壁の亀裂、石垣の破損があった程度であった。地震発生後30分から１時間後に大津波が三陸及び北海道南を襲い始めた。津波の高さは、岩手県田老町田老で10.1m、田野畑村明戸で16.9m、三陸町綾里で23.0mに達した。津波による死者、行方不明は田老で住民の42％に当たる763名、三陸町吉浜で982名、日本全体では3,064名に達した。また、負傷者は1,092名、流失家屋4,034、全壊家屋1,817、浸水家屋4,018に達した。さらに津波襲来中に釜石市で火災が発生し、216戸の焼失家屋を出した。津波は、ハワイ島コナでも３mに達し、小被害を出した。

三陸海岸は、1896年６月15日にも1933年を上回る規模の津波に襲われており、この時は22,066名もの死者が出た。1933年津波の際には、37年前に起きた1896年津波を経験した人々が多数生存していたため、海岸沿いの集落の各地で消防士などの自発的な判断により、高地への住民避難活動がなされ、犠牲者を減らすことが出来た。

２．災害後の対策

1933年の津波後、海岸堤防の新設、かさ上げが行われたほか、漁業施設と住居家屋の分離、あるいは集落全体の高地への移転が多く実施された。近年、岩手県釜石湾、大船渡湾、宮城県女川町などでは、この津波の大きさを設計基準に採用し、湾口に津波防波堤が建設された。また、この津波の最大被災地の一つとなった綾里などでは、居住地域を守るため、津波警報が出たとき短時間に締め切ることの出来る閘門が、川の河口部に設置された。



Epicentre and Wave-spread of the Showa Sanriku Tsunami (Watanabe, 'The Full List of Tsunami Damaged in Japan")

SHOWA SANRIKU EARTHQUAKE TSUNAMI (3 March 1933／Japan)

1 The Tsunami and Resulting Damage

At 02:31 on 3 March (Japan Standard Time), an earthquake with a magnitude of 8.1 occurred off the Sanriku Coast (latitude 39.14°N, longitude 144.31°E), northeast Honshu, Japan From about one month before the main shock, the level of the sea bottom had dropped. Two days before the earthquake, the sea level had lowered. Although intensity grade 5 on the JMA scale was measured along the Sanriku Coast, at the time of the main shock, only stone walls were slightly damaged About 30 to 60 minutes later, a huge tsunami hit the Sanriku coastal region as well as the southern part of Hokkaido. The height of the tsunami was 10.1m in Taro Town, 16.9m in Akedo in Tanohata village, and 23.0m in Ryori in Sanriku Town. The death toll in Taro was 763, which was 42 per cent of the total population In Yoshihama, near Ryori, 982 persons were killed. In the whole country, including Ryukyu, 3,064 persons were killed. 1,092 persons were injured, 4,034 houses were swept away, 1,817 houses were entirely destroyed, and 4,018 houses were inundated Moreover, in Kamaishi City, a fire broke out and burnt 216 houses. The tsunami also hit Hawaii island In Kona, the water level rose to 3m above sea level, but the damage was rather small

Sanriku Coast had been hit by Meiji Sanriku Tsunami on 15 June 1896 The height of the 1896 tsunami somewhat exceeded that of the 1933 tsunami. The number of the victims of the 1896 Tsunami was 22,066 persons. The number of the victims was less in the 1933 tsunami because many people in several villages remembered the 1896 tsunami and quickly took the initiative to evacuate

2. Measures taken after the Tsunami

After the 1933 Showa Sanriku Tsunami, a breakwater and embankments were constructed or raised in many places. In many towns and villages plans to separate residential areas from fishery facilities and to remove the whole residential area to higher places were implemented. In recent years, massive breakwaters were constructed at the mouth of the harbours at Kamaishi, Ofunato and Onagawa, taking into account the height of the 1933 tsunami. In Ryori Village, which suffered the heaviest damage from the 1933 tsunami, a lock gate system, which can be closed within a few minutes of a tsunami warning, was constructed.

A Devastated Port of Ryori in Sanriku Town (Fumio Yamasita "Modern Records of Tsunami in Japan" Seiji-sya, 1984, pp 238)

チリ地震津波（1960年５月22日、チリ）

１．津波と被害概要

チリ時間14時11分、チリ南部ヴァルディビア付近（南緯41.0°、西経73.5°）の沖に、マグニチュード8 5の地震が発生した。正味のエネルギー量に基づくモーメントマグニチュードMwは9.5で、1989年初めの時点では今世紀最大のものであった。この地震に伴い、大津波が発生し、チリの海岸のみならず、ハワイ及び太平洋を取り巻く沿岸各国に被害をもたらした。チリのモチャ島では20～25mという最高の津波が記録され、メウイムでは8.5～15m、コラルでは8 5～10m、タルカウアノでは３mであった。チリでの被害は、死者909名、行方不明834名、重傷235名、軽傷432名であった。津波は、本震発生の約16時間後、ハワイ諸島を襲い、ハワイ島のヒロで10.5mの波高となった。その結果、ハワイでは死者61名、負傷者282名、被害建物537棟に達した。さらに、本震発生の23時間後、津波は日本の三陸海岸に達し、24時間後には紀伊半島から九州の海岸の達した。これらの海岸では３～５mの津波高が記録された。沖縄を含む日本全体での被害は、死者122名、行方不明20名、負傷者873名、全壊家屋1,590棟、半壊家屋2,258棟であった。このほか、北千島のパラムノル島で７mの津波高が記録された。また、この津波によりフィリピンでは、死者19名、行方不明13名が出た。中米、北米、ニュージーランド、オーストラリアでは、津波の高さ、被害ともさほどではなく、被害は、ハワイ、日本列島に集中している。これは、津波のエネルギーが一般に海岸線に垂直方向に多く放出されるという法則があり、ハワイと日本列島はチリの海岸線の垂線の延長線上付近に位置していることによる。

２．災害後の対策

この津波を教訓として、ハワイのヒロでは将来の津波に備えるため、低地を緑地帯として居住家屋は建てさせない、海岸線に沿って樹木を密に植える等の都市計画が実施された。日本では遠地津波の警報体制が整備され、ハワイ、ソ連のハバロフスクとの間での情報交換が行われるようになった。

Wretched sight of Ofunato, Iwate Pref ("Report on the Chilean Tsunami of May 24, 1960, as observed along the coast of Japan", Committee for Field Investigation of the Chilean Tsunami of 1968 1961, pp 397)

CHILEAN EARTHQUAKE AND TSUNAMI (22 May 1960／Chile)

1. The Tsunami and Resulting Damage

A gigantic earthquake with magnitude of 8.5 occurred near Valdivia (latitude 41 0°S, longitude 73.5°W) at 14·11 (local time) on 22 May 1960. The moment magnitude Mw, the value of which is calculated by total radiated net energy, is estimated at 9 5, which is the biggest recorded in the 20th century, up to the beginning of 1989 After the earthquake, a huge tsunami hit not only the coast near the epicentre but also Hawaii and the coast of almost all the countries in the Pacific Rim region. The maximum height of the tsunami was 20-25m in Mocha, Chile The heights of tsunami in Mehuim, Corral, and Talcahuano were 8.5-15, 8.5-10, and 3 0m, respectively. In Chile, 909 persons were killed, 834 persons were missing, 235 persons were seriously injured, and 432 persons were slightly injured. Sixteen hours after the main shock, the tsunami reached Hawaii, and inundation to a height of 10.5m was recorded at Hilo. In Hawaii, 61 persons were killed, 282 persons were injured, and 537 houses were damaged. About 23 hours after the main shock, a tsunami began to effect Sanriku Coast, the north-east coast of Honshu, Japan. Twenty-four hours later, it reached the coast of the Ki Peninsula in Kyushu The average height of the tsunami on the coast of Japan was 3 to 5m In Japan, including Okinawa 122 persons were killed, 20 persons were missing, 873 persons were injured, 1,590 houses were entirely destroyed, and 2,258 houses were partially damaged A tsunami of 7m was reported at Paramushir in the Kuril islands. In the Philippines, 19 persons were killed, and 13 persons were missing. The coasts of Central America, North America, New Zealand, and Australia, however received only slight damage. Damage seems to have been concentrated in Hawaii and Japan. It was theoretically proved that most of the energy of the tsunami would radiate from the source vertically toward the coastline. Hawaii and, approximately, Japan were located in a perpendicular line from the coastline of Chile.

2 Measures taken after the Tsunami

After the Chilean Tsunami, at Hilo a city plan was formulated. Construction of houses was prohibited on lower ground, trees and palms were planted densely along the coastline, and a green belt was preserved along the shore. In Japan, an early warning system for tsunamis was set up and an information exchange among Hawaii, Tokyo and Khabarovsk in U S.S R was inaugurated

The remains of the Hilo Boys Club, left, with the Hilo Theatre in the background ("The Big Wave", The Hilo Tribune-Heral Ltd., 1960)

ミンダナオ地震津波（1976年8月17日、フィリピン）

1．津波と被害概要

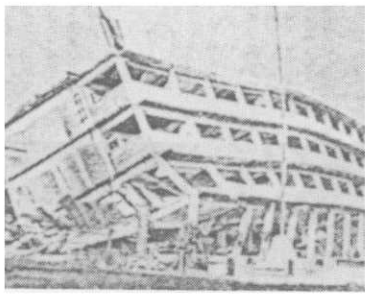
フィリピン時間の午前0時11分、ミンダナオ島南西部モロ湾南東部の北緯6.3°、東経124.0°を震央とするマグニチュード7.8の地震が発生した。モロ湾に面したコタバト市では、道路に幅30cmの亀裂ができ、リオグランテ川に架かる2つの橋が壊れたため、幹線国道が不通になった。ハーバーディアン大学の4階建ての鉄筋校舎が壊れたほか、サンタンホテル、グランドホテル、フランセル劇場など7つのビルが一瞬のうちに崩壊した。商店街の民家の大部分は、半壊状態になった。パガディアン、サンボアンガでも地震動による被害が出た。

しかし、被害は地震動そのものによるよりも、地震発生後しばらくして押し寄せてきた津波によるものの方が大きかった。コタバトでは、津波高さは7mを越え、パガディアンで4.3m、ボンゴ島ラタイェンで4.3mとされているが、モロ湾の沿岸には、10mを越えたところがあったと報道されている。そのため、津波による死者数は、非常に大きいものとなった。コタバト市で約500人の死者が出たのを始め、パガディアン市では180人、サンボアンガ市では130人の死者がでた。死者総数は、5,000人とも8,000人とも言われている。住宅を失った人は28,700人を数え、フィリピンでの史上最大の自然災害となった。

本震発生から約12時間後の17日12時19分に、マグニチュード7.1の強い余震（北緯7.2°、東経122.9°）が発生し、これによる被害もかなり出た。

2．復旧

本震発生後直ちに、ミンナダオ島、スル島、タウイタウイ島、バシラン島の被災地域に大統領命令による非常事態宣言が発令され、食糧・医薬品等のの輸送が開始された。また、ミンダナオ島軍最高指令官の命令による救援復旧活動がなされた。



A Collapsed 4-Story Building of Harbordian University (From 1976's Asahi Shinbun)

MINDANAO EARTHQUAKE AND TSUNAMI (17 August 1976／Philippines)

1 The Tsunami and Resulting Damage

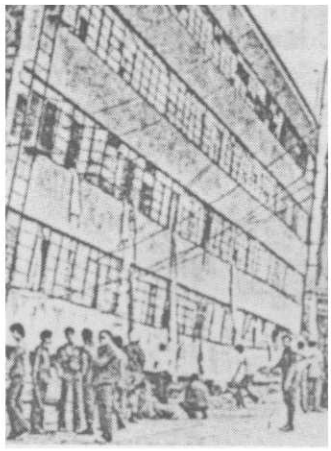
A big earthquake with a magnitude of 7.8 occurred in the southeast part of Moro Gulf (latitude 6.3°N, longitude 124.0°E) In Cotabato city, on the eastern shore of the Moro Gulf, the road was fissured for 30cm. Two bridges on the Rio-Grande river collapsed, and the highways to Davao and General Santos were intercepted. Four-story buildings of Harbordian University, and seven buildings including the Sultan Hotel, the Grand Hotel, and the Francer Theatre were destroyed in an instant Most of the houses in the shopping area were partially damaged.

However, it was not the earthquake but the tsunami which caused the severest damage. The sea water rose to 7m above sea level in Cotabato. The height of tsunami was 4.3m in Pagadian as well as in Latayen on Bongo Island. Along the coast of Moro Gulf, the height of the tsunami was reported to have been over 10m in some places The death toll, therefore, was heavy: 180 in Pagadian and 130 in Zamboanga. The death toll in the whole country ranged from 5,000 to 8,000 The number of people who lost their homes was 28,700. This was the severest natural disaster ever recorded in the history of the Philippines.

At 12 19, on the 17th, about 12 hours after the main shock, a strong aftershock with a magnitude of 7.1 occurred (latitude 7.2°N, longitude 122.9°E) and caused additional damage.

2. Recovery

Just after the main shock, the President declared a state of emergency in the disaster-hit areas of Mindanao, Sulu, Tawitawi, and Basilan Island. Transport of food and medicines was immediately organized to the affected area Moreover, the Chief Commander of the Mindanao Island sent troops to carry out relief and reconstruction activities



A Collapsed Building in Cotabato City (From 1976's Mainichi Shinbun)