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Factor Analysis of Water-related Disasters in Sri Lanka

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by

Junichi YOSHITANI
Norimichi TAKEMOTO
Tarek MERABTENE

The International Centre for Water Hazard and Risk Managemant

Synopsis:

Vulnerability to disaster differs considerably depending on natural exposure to hazards and social conditions of countries affected. Therefore, it is important to take practical disaster mitigating measures which meet the local vulnerability conditions of the region. Designating Sri Lanka as a research zone, this research aims to propose measures for strengthening the disaster mitigating system tailored to the region starting from identifying the characteristics of the disaster risk threatening the country. To this end, we identified the country's natural and social characteristics first, and then analyzed the risk challenges and their background as the cause to create and expand the water-related disasters. Furthermore, we also analyzed the system of the socio-economic structure, the evacuation behavior of the affected people and related experience to disasters.

Key Words: water-ralated disaster, risk management, case study, disaster prevention plan

List of Abbreviations

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nation
CNO	Center for National Operations
CRED	Centre for Research on the Epidemiology of Disasters
DDMA	District Disaster Management Authority
Div DMA	Division Disaster Management Authority
DS	Division Secretary
EM-DAT	Emergency Disasters Data Base
FTA	Free Trade Agreement
GA	Government Agent
GRP	Gin Ganga Regulation Project
IMF	International Monetary Fund
IOC	Intergovernmental Oceanographic Commission
IOTWS	Indian Ocean Tsunami Warning and Mitigation System
IPKF	India Peace Keeping Force
ISDR	International Strategy for Disaster Reduction
JST	Japan Standard Time
JVP	Janatha Vimukthi Peramuna (People's Liberation Front)
LHMP	Landslide Hazard Mapping Programme
LTTE	The Liberation Tigers of Tamil Eelam
MAIMD	Ministry of Agriculture, Irrigation and Mahaweli Development
MDMHR	Ministry of Disaster Management and Human Rights
MDRS	Ministry of Disaster Relief Services
MWESW	Ministry of Women Empowerment and Social Welfare
NBRO	National Building Research Organization
NCDM	National Council for Disaster Management
NDMC	National Disaster Management Center
PA	People's Alliance
PRSP	Poverty Reduction Strategy Paper
PTWC	Pacific Tsunami Warning Center
SLFP	Sri Lanka Freedom Party

TAFLOL	Task Force for Logistics and Law and Order
TAFREN	The Task Force to Rebuilding Nation
TAFRER	Task Force for Rescue and Relief
UNCHS	United Nations Centre for Human Settlements (Habitat)
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNP	United National Party
UPFA	United People's Freedom Alliance
USGS	United States Geological Survey
UTC	Coordinated Universal Time
WMO	World Meteorological Organization

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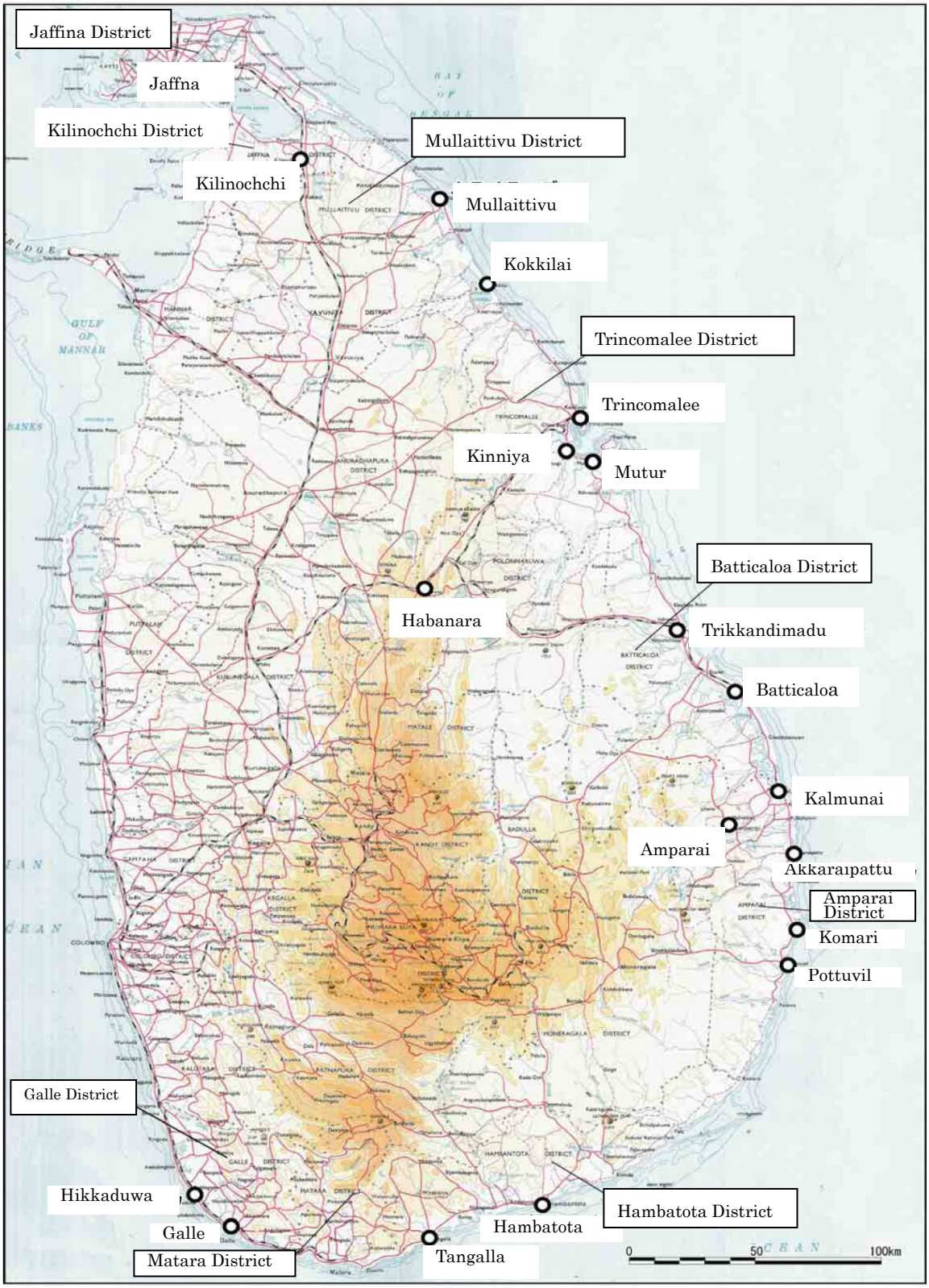


Source: S Preliminary Report on Sri Lanka's Urgent Indian Ocean Tsunami Disaster Recovery and Rehabilitation Program (S09)

General View of Sri Lanka

1. General Information

1.1 Social Economy [S01], [S16], [S18]

Ever since it gained independence from the British Empire in 1948, Sri Lanka has been a democratic country where people have the right to vote for their leaders in democratic elections. The current population is about 20 million, in which the Sinhalese make up more than 70% (72.9%), forming the largest ethnic group in the nation. This is followed by the Tamils who live in the northeastern area (18%), the Sri Lankan Moors (8%), constituting the minority groups. Both Sinhalese and Tamil are Sri Lanka's national languages, while English is used as the link language. Buddhism is the major religion, with 70% of the population as followers, followed by Hinduism (10%), Islam (8.5%) and Christianity (11.3%). Otherwise, Sri Lanka also boasts a high adult literacy rate (92.3%) due to its particular educational system established while under the British rule whereby tuition is free up to university (See note). Furthermore, other features include high life expectancy and a low infant mortality rate.

Note: The total span of schooling spreads over a period of 13 years. Tuition is free up to university level. However, there are private schools that do charge tuition.

Sri Lanka's Major Indicators

Major indicators	Content
Total land area	65,610km^2
Date of independence	February 4, 1948 (making Sri Lanka a dominion)
Total population (2005)	About 19,670,000 (excluding some areas)
Population density	314 per km^2
Life expectancy (2006)	73.4 yrs old (men: 70.8 yrs old; women 76.1 yrs old)
Gross domestic product (GDP) (2005)	US$ 23,540,000,000 (nominal GDP, market price)
GDP per capita (2005)	US$ 1,197 (nominal GDP, market price)
Export (2005)	US$ 6,351,040,000
Import (2005)	US$ 8,869,420,000
Infant mortality rate (2006)	14.0/1,000 (estimate by US CIA)
Birth rate (2006)	15.5/1,000 (estimate by US CIA)
Literacy rate (2003)	92.3% (men: 94.8%, women: 90.0%)

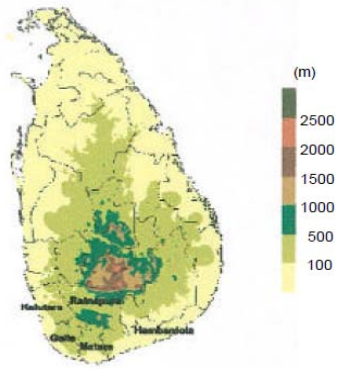
In order to rebuild economic confidence that has fallen since 1983, Sri Lanka has been, under an accord with the International Monetary Fund (IMF), implementing structural adjustment policies since 1988 including cutting back government spending, privatizing public companies and easing regulations such as foreign exchange control. The negative growth the country experienced in 2001 turned positive at the beginning of 2002 and achieved dynamic growth later that same year. This was mainly due to the fact that the environment of the domestic economy improved with the development of the peace process, as well as other factors including monetary policies such as the suppression of policy rates, efforts to improve finances, development of structural reforms, and changes in the international environment such as the recovery of the global economy.

Despite the negative factors in recent years such as a deterioration of public security, natural disasters including tsunamis, and soaring international oil prices, the country has been maintaining an overall growth rate of about 5 - 6% due to the steady performance of the service industry.

1.2 Natural Conditions (S01), (S03), (S19)

Sri Lanka is an island located about 29km south of India, between latitude 5°55' and 9°50' and longitude 79°42' and 81°53'. It is surrounded by either the Indian Ocean or Bay of Bengal and has a coastline of 1,340km. Its total land area is 65,610km2, which is slightly larger than Kyushu, and is 432km long and 224km wide.

The northern half of the land is mostly flat, the southern half is a mountainous area with lush vegetation, and in the south-central part of the island stands Pidurutalagala, the highest point in Sri Lanka, rising 2,524m in the highlands along with other mountains exceeding 2,000m (See Fig. 1).

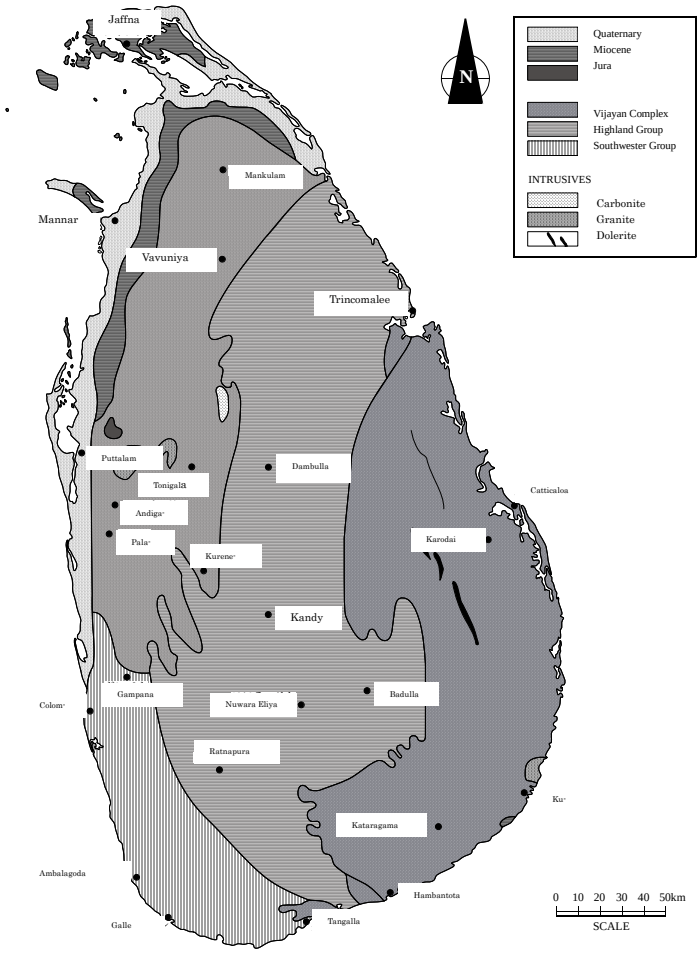


Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 1 Topographical map

From areas surrounding Kandy and Nuwara Eliya are rivers flowing toward the north, south, east, and west. Among them the Mahaweli River is the longest at 335km. Its catchment spans 10,448km2, and it feeds 1,003 tanks. Agricultural land consists of about 15% of the entire land and the rest is mostly mountainous and densely-wooded areas.
Most of the less-than-30m-above-sea-level coast consists of sandy beaches indented by coastal lagoons. In some areas of the island's most northern district of Jaffna, limestone beds are exposed to the waves as low-lying cliffs. In the northeast and south coastline, rocky cliffs, bays and offshore islands can be found. These conditions have created one of the world's best natural harbors at Trincomalee on the northeast coast and at Galle on the southwestern coast.

Fig. 2 shows Sri Lanka's geological conditions. Most of the island is underlain by metamorphic rocks and granites (hereinafter called "ancient rocks") which constitute the original rocks accumulated during the Precambrian age (over 600 million years ago). These rocks form the south Indian shield, one of the oldest crusts on earth, which has undergone metamorphism during either the middle Precambrian age (1,300 million - 1,500 million years ago) or the early Paleozoic age (450 million - 550 million years ago). These ancient rocks are divided into three major units: the Vijayan Complex, the Highland Group and the Southwestern Group, which are composed of metamorphic rocks originating from various types of accumulated rocks, in other words various types of gneiss, granite, charnockite and granulite. The accumulated rocks of the Jurassic period of the Mesozoic era are distributed as small crustal blocks in the faults of the western Vijayan Complex. In addition, Miocene fast limestone (Jaffna limestone) is found along the northwestern coastline, on the northern Jaffna peninsula and western islands. The sediments of the fourth period of the Cenozoic era covered the above-mentioned ancient rocks and accumulated rocks, forming a relatively good aquifer.



Source: 2002 Report on the Aid Policy Research (Democratic Socialist Republic of Sri Lanka) (S19)

Fig. 2. Geographical Map

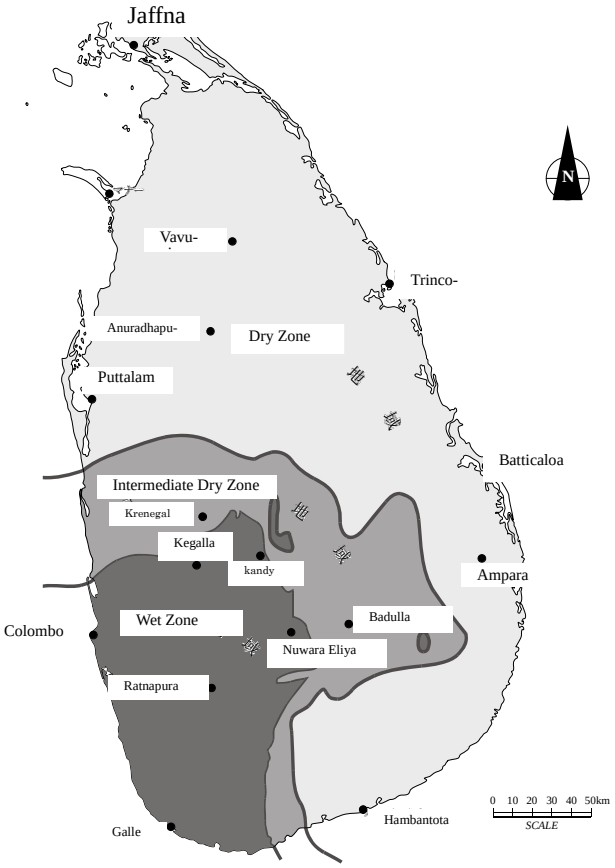
2. Regional and Local Features

(1) Meteorological Features (S03), (S19)

1) Climate・Climatic Division

The entire island of Sri Lanka has a tropical climate, and the average yearly temperature of the capital region of Colombo is 27ºC. Colombo is hottest around April - May, and the period between November and February is relatively comfortable. Sri Lanka's climate conditions are briefly divided into three zones. The northern half, the southeast, and east coast of the island comprise the dry zone. The southwest area, including the central highlands comprise the wet zone, receiving ample rainfall. The areas between these two are referred to as the intermediate zone.

Fig. 3 shows the climatic division of Sri Lanka.



Source: 2002 Report on the Aid Policy Research (Democratic Socialist Republic of Sri Lanka) (S19)

Fig. 3. Climatic Division

Sri Lanka is greatly affected meteorologically by the monsoons that hit the country twice a year. It is subject to two monsoons: the southwest monsoon or Yala season from May to September and the northeast monsoon or Maha season from December to the following February. Due to these monsoons, the meteorological conditions are categorized into 4 periods as shown in the following Table 1.

Table 1. Climatic Divisions and their Characteristics

Division	Period	Characteristics
Inter-Monsoon Season (March April)	March - April	During this period, the equatorial trough moves from the island's south to north. Due to the resulting humid air from the southwest thus brings frequent showers and thunderstorms mainly in the southwest regions.
Southwest Monsoon Season (Yala)	May - September	During this season, the equatorial trough shifts northward, as a result of which the humid monsoon from the Indian Ocean penetrates the island from the southeast. The monsoon then hits the central highlands, bringing an average of 1,000 to 3,500mm of rainfall in the southwest area of the island. During this period, 3,000 to 4,000mm of rainfalls in Sri Lanka's central highlands.
Inter-Monsoon Season (October - November)	October - November	During this season the equatorial trough moves from the center of the island toward the south, causing a tropical storm or cyclone that brings rain across the entire island.
Northeast Monsoon Season (Maha)	December - following February	During this period, because the equatorial trough has shifted southward, the monsoon from the northeast hits the east side of the island and brings rain in that area.

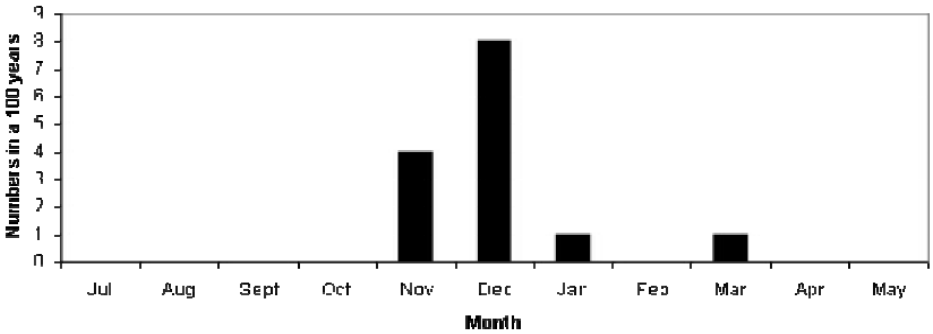
Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

2) Frequency of Cyclones

Located between latitude 5°55' and 9°50' and longitude 79°42' and 81°53', Sri Lanka is affected by cyclones formed in the Bay of Bengal. As shown in Fig. 2, cyclones are not that frequent, with less than 20 of them recorded during a period of 100 years, most of which are concentrated between November and December.

However, past records show that Sri Lanka suffered severe damage in the east, north and northern central areas. The most recent cyclones that hit the island were in 1921, 1931, 1964, 1978, 1993, 1994, 1997 and 1998.

Meanwhile, as will be mentioned later in 4.1, a cyclone unusually formed and stalled in the Bay of Bengal in May 2003, which caused torrential rainfall in Sri Lanka.



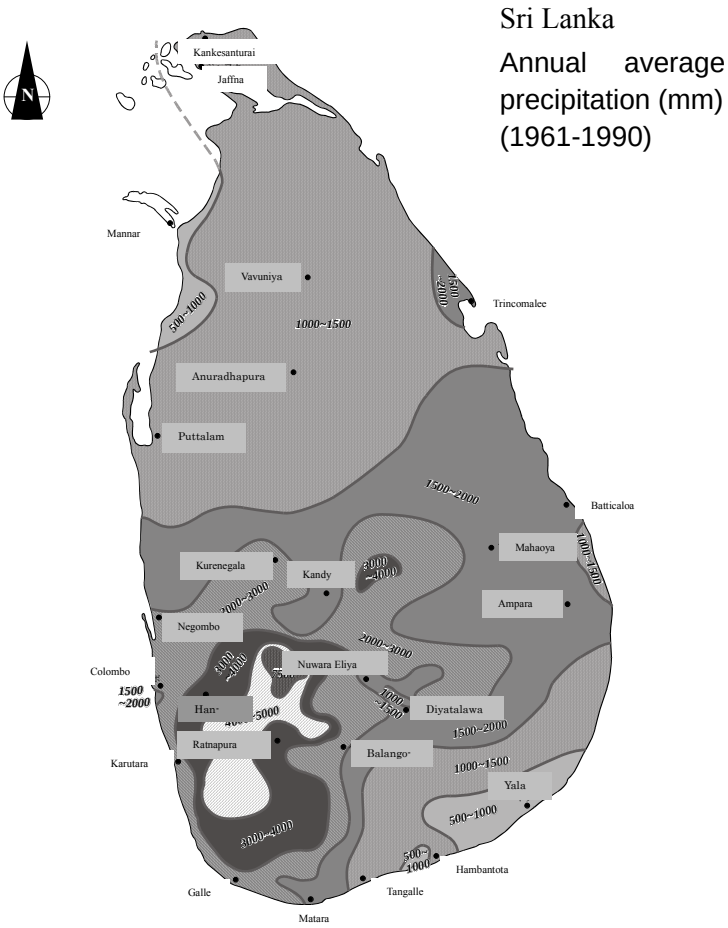
Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 4. Frequency of Cyclones in Ceylon

(2) Hydrological and Geographical Features [S03], [S19], [S23]

1) Precipitation

Fig. 5 is the precipitation map of Sri Lanka. Among the 3 types of climatic conditions mentioned in (1) 1), the dry zone covers about 3/4 of the island, with a mean annual rainfall of less than 1,900mm, and precipitation during the dry season of less than 500mm. Precipitation is higher than in the above-mentioned dry zone in the wet and intermediate zones, with mean annual rainfalls of 3,000 - 7,500mm and 2,000 - 3,000mm, respectively.



Source: 2002 Report on the Aid Policy Research (Democratic Socialist Republic of Sri Lanka) (S19)

Fig. 5. Precipitation Map

2) Features of the Major River Basins

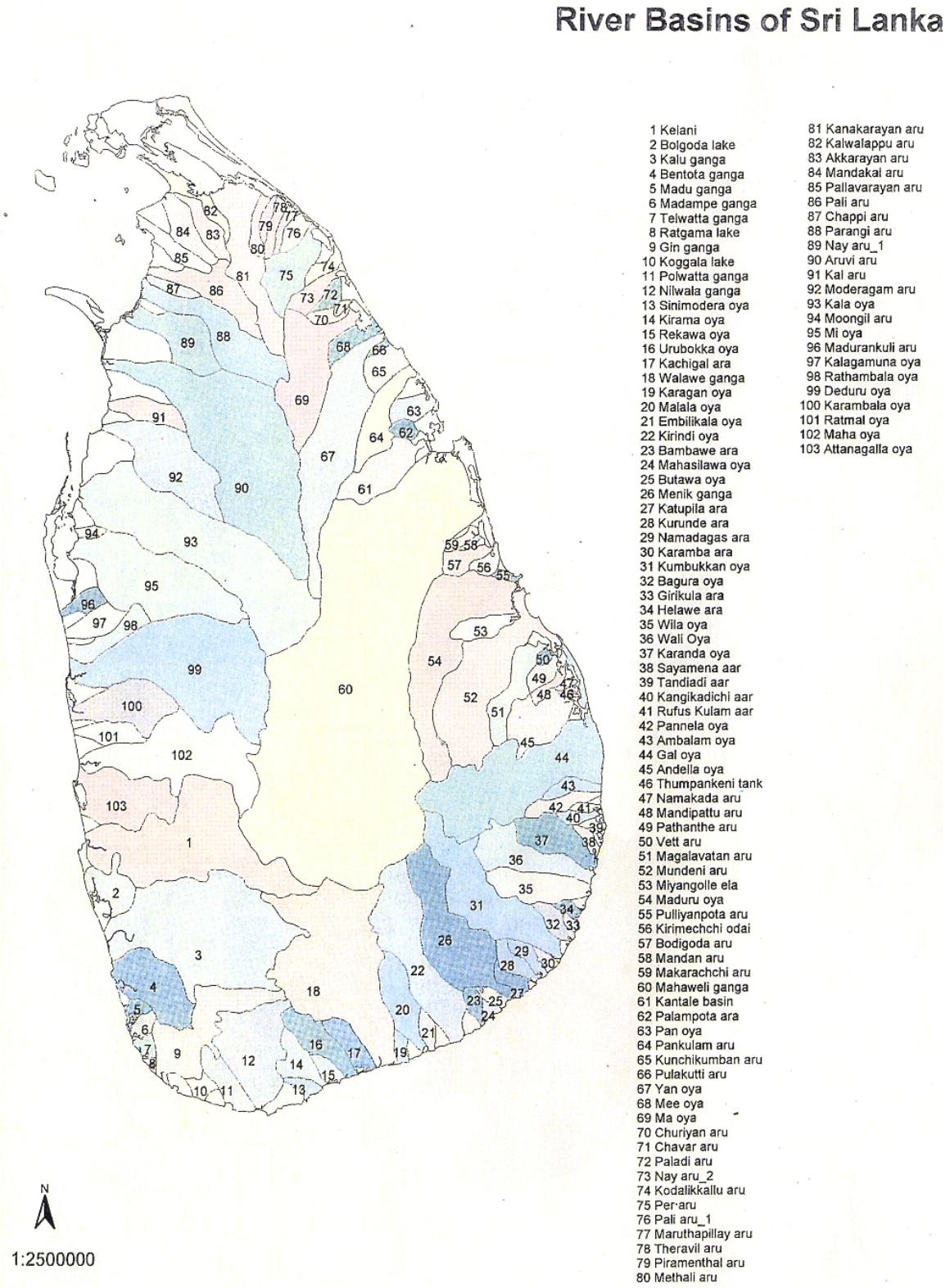
As shown in Fig. 6, Sri Lanka is divided into 103 river basins. The rivers of Sri Lanka flow in a radial pattern from central massif toward the sea. The river channels in the central highlands are often cut off from the main river due to discontinuous geological structures, and numerous waterfalls and rapid streams are formed on cliffs and steep slopes. The velocity of these rivers decreases as they reach the plains as they meander through flood plains and deltas. In Sri Lanka, large rivers are called GANGA, medium-sized rivers are called OYA, and small rivers are called ARU. However, most of the rivers on the island are small drainage basins, with only 17 rivers out of the 103 basins that have a basin area of more than

1,000km^2.

Sri Lanka's largest river is Mahaweli Ganga (No. 60 in Fig. 6) with a length of 335km and a basin area of 10,448km^2. In addition, 6 rivers have a basin area between 3,500km^2 and 2,000km^2, as follows:

2,000km^2	-	1,000km^2	10 rivers
1,000km^2	-	500km^2	11 rivers
500km^2	-	100km^2	32 rivers
100km^2	-		43 rivers

Meanwhile, there are 16 rivers whose lengths exceed 100km, among which 12 release 75% of the entire country's average river flow.



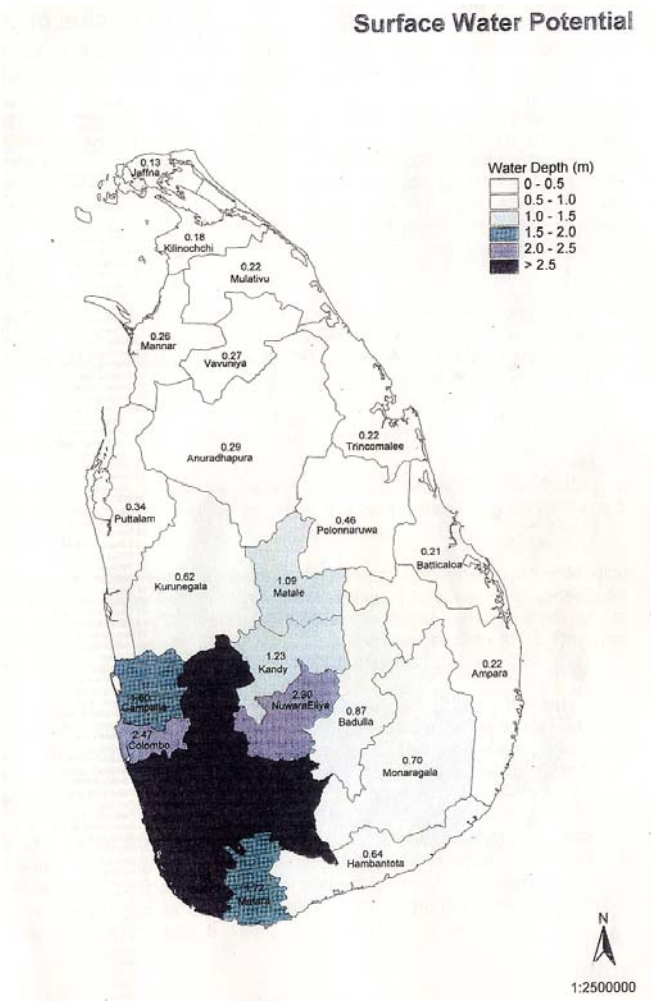
Source: 2002 Report on the Aid Policy Research (Democratic Socialist Republic of Sri Lanka) (S19)

Fig. 6. River Basins Map

In general, the water volume of most of the rivers excluding large rivers such as Mahaweli Ganga varies according to the season and many run dry during the dry season. However, the rivers that have a headstream on the humid western slope flow throughout the year. Even in terms of the surface water potentials by area (See Fig. 7), although the values are high from the central highlands down to the south-west area, they do not even reach 500mm in the dry zones.

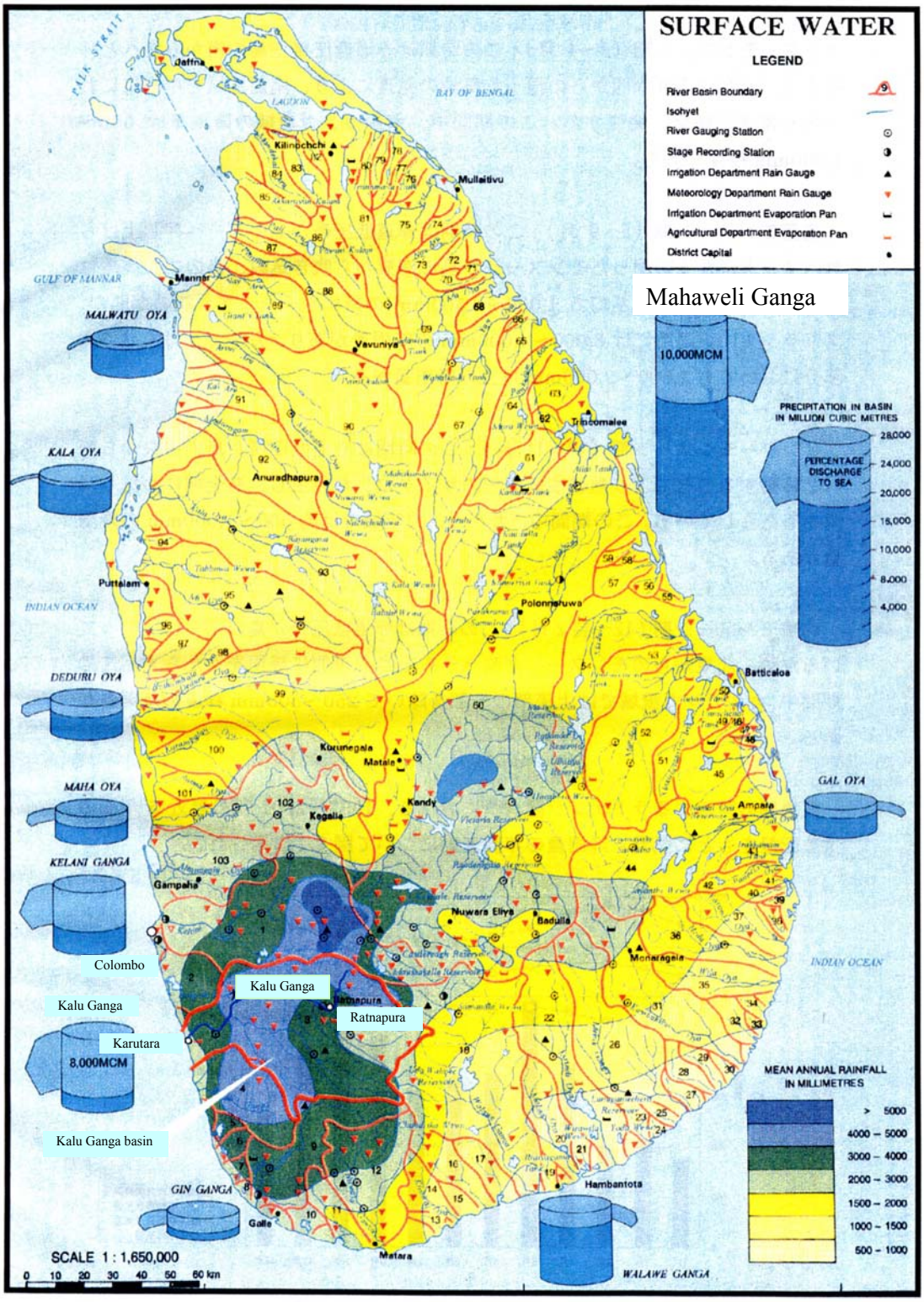
Rivers that are particularly vulnerable to floods include Kalu Ganga (No. 3 in Fig. 6), Kelani Ganga (No. 1 in Fig. 6), Gin Ganga (No. 9 in Fig. 6) and Nilwala Ganga (No. 12 in Fig. 6) that flow on the western slope, as well as the Mahaweli Ganga which originates from the central highlands and supplies large amounts of water to the eastern dry zone.

In addition to the precipitations shown in Fig. 5, Fig. 8 provides information on the different basins and runoff of major rivers. The column graphs in the figure represent the annual runoffs of the rainfall in the basins (height of the column) and percentage discharge to sea (lighter blue area). These show that water use is low in rivers that are vulnerable to floods (unable to use the large volumes of rain that fall over the course of the year, the water is discharged to the sea).



Source: 2002 Report on the Aid Policy Research (Democratic Socialist Republic of Sri Lanka) (S19)

Fig. 7. Surface Water Potential Map



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

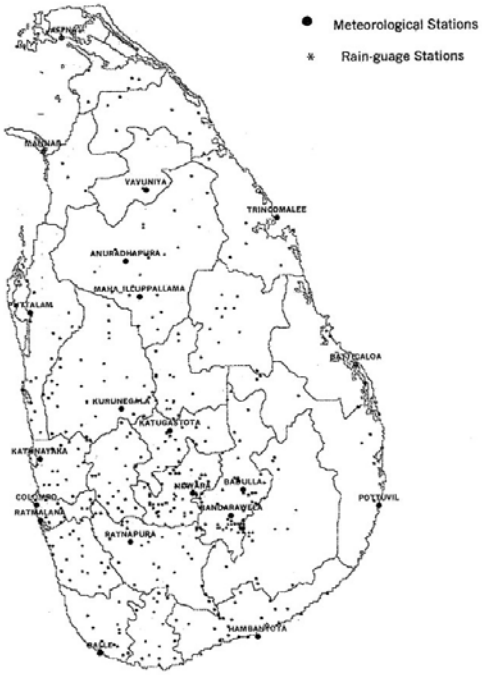
Fig. 8. Spatial Variability of Annual Runoff and Precipitation in Major Rivers

(3) Hydrological and Meteorological Network (S03), (S20), (S23)

1) Meteorological Observation

Overview

The history of meteorological observation in Sri Lanka in the form of rain gauging dates back to 1850, and the first systematic records of the results have been put together by the Ceylon Research Bureau between 1866 and 1883. Today, the Department of Meteorology enacted in the parliament in October 1948 has deployed a network of observations across the entire country. Fig. 9 shows the distribution of weather stations in Sri Lanka. There are 22 meteorological stations in the country, mainly in the major cities of each area. As for rain-gauge stations outside the Department of Meteorology, there are 42 agro-meteorology stations controlled by the Department of Irrigation and district agencies, as well as over 350 rain-gauge stations on private property. All these observing stations form the meteorological network.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 9. Spatial Distribution of Meteorological Stations

Network of Observation

As shown in Fig. 9, although Sri Lanka does not have an automated rain gauging network, its density is high. However, the rain gauging network is dense in the southwest area but low in the northeast area. The agro-meteorology stations under the jurisdiction of the Department of Irrigation are also not automated, but automated observation is carried out with the rain gauge installed at 8 gauging stations. Meanwhile, the observation data of the Department of Meteorology and those of the Department of Irrigation are not used together.

The oldest observing stations have been in operation since the 1920s, but the current number of stations has only been reached around 1990. Today new observing stations continue to be established as necessary.

Observation and Report System

Because all the operations of the observing stations under the direct jurisdiction of the Department of Meteorology are performed manually, real-time access to meteorological information is in fact impossible. Observations are done every 3 hours at meteorological stations and once a day (9:00 a.m.) at rain-gauge stations. Observations are carried out in meteorological enclosures and not by remote control. The data of the self-recording rain gauge are recorded every 3 hours on paper and stored, and hourly data can be read by staff members as necessary.

The transmission of observation data from meteorological stations and rain-gauge stations of each area to the Department of Meteorology is done by telephone (voice). Meteorological Stations have jurisdictional boundaries. First, the observed data of the rain-gauge stations within the jurisdictional boundaries are collected and then the data of each jurisdictional boundary are reported to the Department of Meteorology.

In Sri Lanka, there are no sophisticated rainstorm warning systems like there are in Japan. Sometimes a warning is issued when a cyclone is expected to develop in the vicinity. These warnings are issued through media including television and radio. As for government agencies, fax or telephone is used to issue the warning. Transmission of the warning by fax is always directly performed by the Department of Meteorology, even when sending it to local authorities.

2) Hydrological measurement

Overview

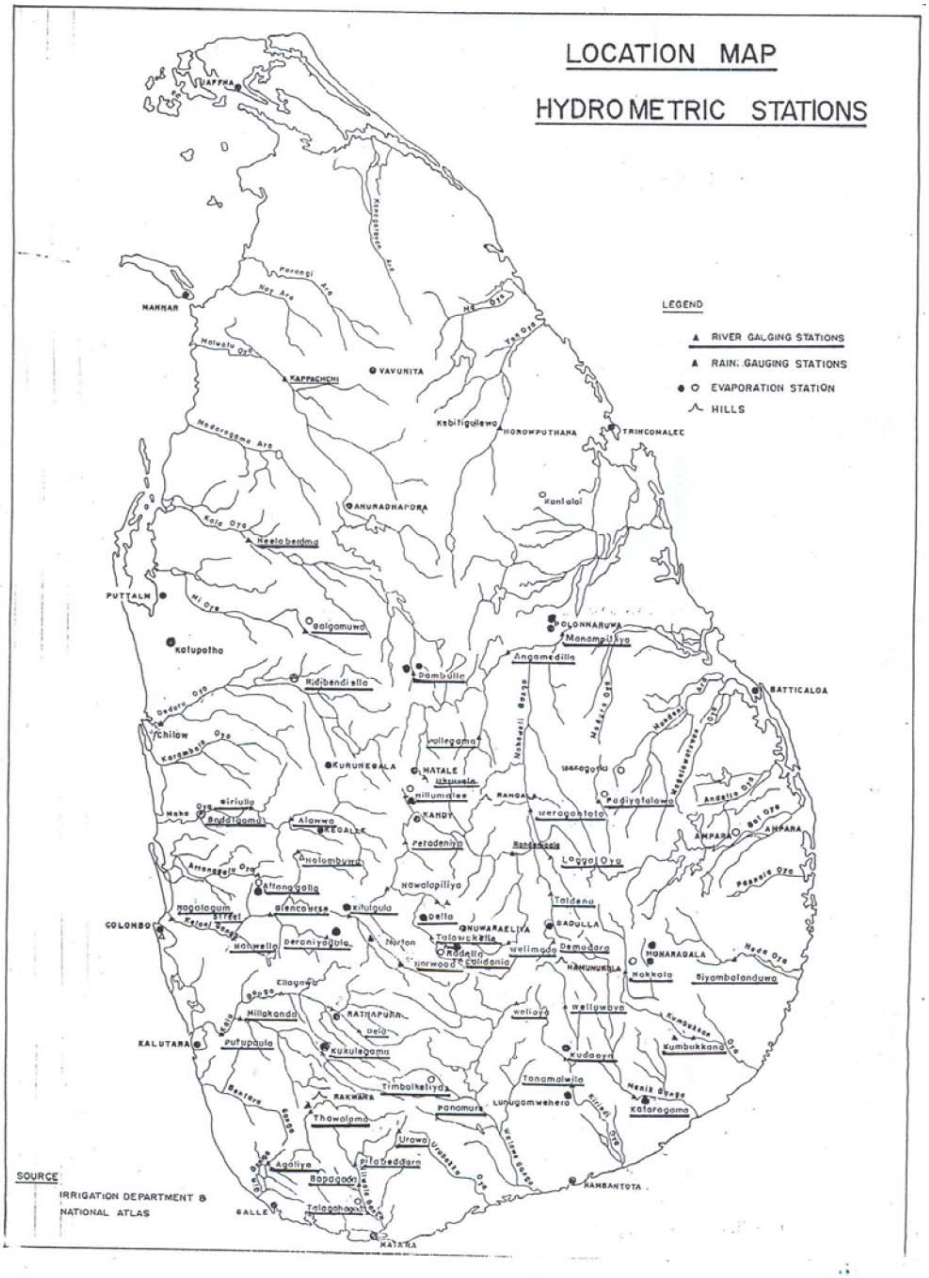
With regard to flood control, several ministries are involved. However, the responsibility of determining flood zones, developing flood-control plans that include structural measures to control flooding in flood zones, flood prevention, and official announcements of flood warnings lies in the Department of Irrigation at the Ministry of Agriculture, Irrigation and Mahaweli Development (MAIMD). In addition, hydrological measurement is controlled by the Hydrology Division of the Department of Irrigation. Duties of the Hydrology Division include the gathering, organization, storage and dissemination (disclosure) of hydrological data, hydrological studies as well as estimation of dam reservoir inflow and outflow rates.

The observation items are as follows: water level, flow, precipitation, evaporation, wind velocity, temperature, solar radiation and sediment level.

Network of Observation

Sri Lanka has 69 gauging stations installed at 17 river basins. Fig. 10 shows the locations of these gauging stations.

The 17 rivers listed in the figure are the Kelani Ganga, No.1 in Fig. 6), Kalu Ganga (No. 3 in Fig. 6), Gin Ganga (No. 9 in Fig. 6), Nilwala Ganga, No. 12 in Fig. 6), Walawe Ganga (No.18 in Fig. 6), Kirindi Oya (No. 22 in Fig. 6), Menik Ganga (No. 26 in Fig. 6), Kumbukkan Oya (No. 31 in Fig. 6), Wila Oya (No.35 in Fig. 6), Maduru Oya (No.54 in Fig. 6), Mahaweli Ganga (No.60 in Fig. 6), Malwatu Oya (Aruvi aru)No.90 in Fig. 6), Kala Oya (No.93 in Fig. 6), Mi Oya (No.95 in Fig. 6), Deduru Oya (No.99 in Fig. 6), Maha Oya (No.102 in Fig. 6) and Attanagalla Oya (No.103 in Fig. 6).



Source: Hydrometric Network & Flood Mitigation (S23)

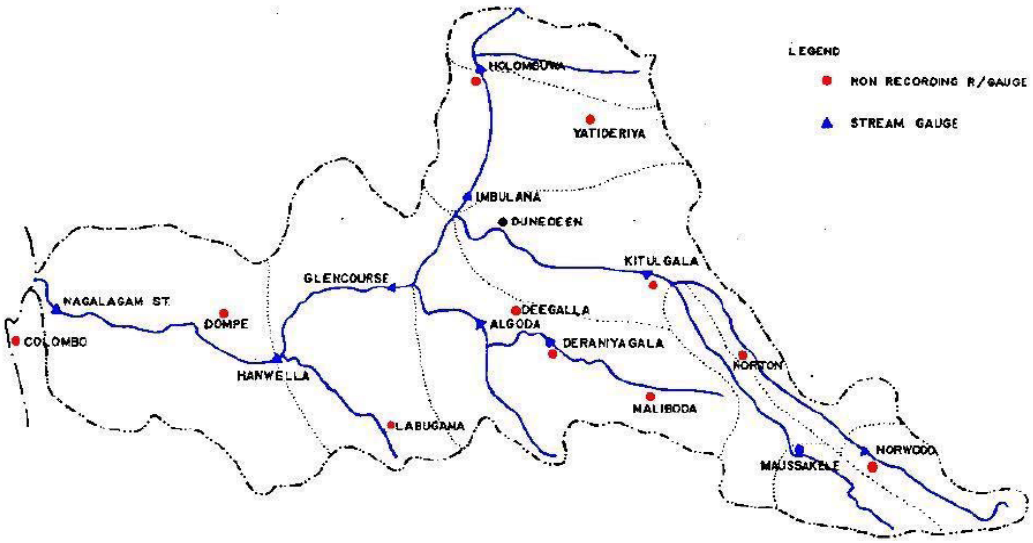
Fig. 10. Spatial Distribution of Gauging Stations

Observation and Report System

According to the Reference S23 (Hydrometric Network & Flood Mitigation), there are 39 (57%) observing stations among the 69 gauging stations with rating curves for flow calculations. Therefore it is believed that flow conversions are not performed at the other remaining observing stations. In addition, as records show that

among the 69 gauging stations, 16 observing stations have wage-stage recorders and are cable-connected, this most likely means that 16 gauging stations (23%) possess an automated wired observing network system. Unfortunately, information could not be obtained regarding which gauging stations in Fig. 10 have rating curves, an automated observing system, and how often the observations are carried out (once a day, twice a day, every hour, etc.).

Projects are underway to introduce flood warning systems as needed at major rivers in order to reduce the frequent flood damage in Sri Lanka. Currently the only river with such a flood warning system is Kelani Ganga, as shown in Fig. 11.



Source: Hydrometric Network & Flood Mitigation (S23)

Fig. 11. Flood Warning System of Kelani Ganga

A warning is issued based on the data obtained on precipitation and water levels at each of the points presented in the above figure (ex: start of flood monitoring in case of continuous rainfall of 120mm and water level exceeding 3m). Warnings are issued to the general public through broadcasting media. Water levels of Kelani Ganga are reported in real time using reserved radio frequencies to Colombo's Department of Irrigation.

3. Social Structure

(1) History [S16]

The following chronological table shows a brief background description of Sri Lanka.

483 B.C.	Landing of Prince Vijaya (known as the founding father of the Sinhalese people) in Sri Lanka Foundation of the Sinhalese Dynasty
250 B.C.	Introduction of Buddhism
1505	Arrival of the Portuguese (colonized the coastal areas)
1658	Arrival of the Dutch (colonized the coastal areas)
1802	By the Treaty of Amians the Dutch part of the island was formally ceded to Britain.
1815	The Kingdom of Kandy was invaded and the entire island became a colony of Britain.
1948	Receives dominion status in the Commonwealth of Nations
1956	Bandaranaike becomes Prime Minister. The Sinhala Only Bill passes making Sinhalese the only official language of the country.
1972	Country name becomes Free, Sovereign and Independent Republic of Sri Lanka. (Dominion of Ceylon granted full independence.)
February 1978	Jayewardene becomes President (introduces a presidential system).
September 1978	Country name becomes Democratic Socialist Republic of Sri Lanka.
July 1983	Major riots
July 1987	Signing of a peace accord between Sri Lanka and India Occupation of the Indian Peace Keeping Force (IPKF) in Sri Lanka
November 1987	Amendment of the Constitution (Both Sinhalese and Tamil become the official languages of Sri Lanka. Introduces the Provincial Councils System)
January 1989	Premadasa becomes President.
March 1990	Complete withdrawal of the IPKF
May 1993	President Premadasa assassinated

	Premadasa succeeded by Wijetunga
November 1994	Presidential elections, Kumaratunga becomes President.
December 1999	Presidential elections, Kumaratunga re-elected as President
December 2001	Opposition party United National Party (UNP) wins a major victory at the general elections. Wickremasinghe becomes Prime Minister.
February 2002	Agreement on a ceasefire between the government and LTTE
September 2002	Start of negotiations for peace between the government and LTTE
April 2003	Statement by LTTE of temporary interruption of the negotiations for peace
June 2003	Tokyo Conference on Reconstruction and Development of Sri Lanka
April 2004	The opposition party United People's Freedom Alliance (UPFA) wins at the general elections. Rajapaksa becomes Prime Minister.
December 2004	Due to the Great Sumatra Earthquake and Indian Ocean Tsunami, the entire coastline of Sri Lanka other than the northwestern area was struck, resulting in more than 30,000 victims.
August 2005	Foreign Minister Kadirgamar assassinated
November 2005	Rajapaksa becomes President.
February 2006	Talks on the Ceasefire Agreement between the government and LTTE
July 2006	Issue surrounding the closing of the Mavil Aru sluice gate leads to fierce violence.
October 2006	Talks between the government and LTTE

(2) Political System (S01), (S04), (S07), (S14), (S16), (S19), (S20)

Political System

Even before it gained independence from the British Empire in 1948, Sri Lanka was a democratic country with several parties where people had the right to vote for their leaders in democratic elections. Although the two main political parties, namely the United National Party (UNP：United National Party) with a strong liberalistic tendency and the socialism-oriented Sri Lanka Freedom Party (SLFP：Sri Lanka Freedom Party) had been alternately ruling Sri Lanka after gaining independence, there followed a long period of rule by the United National Party for 17 years from 1977.

With regard to economic policies, the J.R. Jayewardene administration of 1977 introduced

economic policies based on principles of a free market economy and in 1978 changed the name of the country to Democratic Socialist Republic of Sri Lanka under the Constitution, promoting efforts toward economic structural reforms to grow into an open market economy as a member of international society. In the late 1980s, the IMF and World Bank pressed the country to streamline the bloated public sector, to reduce foreign debt and to promote financial reform.

Even during the People's Alliance (PA) government led by President Kumaratunga between 1994 and 2001, the open economy was maintained and structural adjustments including privatization were put into effect. Furthermore, during the 2001-2004 UNP regime, a grand plan entitled "Regaining Sri Lanka" was elaborated in December 2002 to develop a market economy and revitalize the private sector through the creation of new employment, redistribution of resources and reduction of public debt, etc., and an economic structural reform policy aiming at increasing domestic productivity and developing the country's economy. The policy stated among other things that a Poverty Reduction Strategy Paper should be formulated to reduce poverty, and was highly valued by the World Bank, etc. Meanwhile, although a new administration, the United People's Freedom Alliance (UPFA) administration, was formed during the general elections in April 2004, this new administration continues to promote economic structural reforms in order to ensure Sri Lanka's medium- to long-term economic growth.

As a result, despite the change of government following the long period of rule that began in 1977 the government of Sri Lanka still pursues economic structural reforms centered on a market economy to improve national finance. In addition, the government has been making efforts to change from an agriculturally-dependent nation, that has since old times been cultivating rice and producing three major plantation products (tea, rubber and coconuts) to a more industrialized one in areas such as the textile industry. As a result, Sri Lanka has been maintaining its mean annual economic growth rate at about 5% since the 1990s (note: The real GDP growth rate for 2001 was negative (-1.5%) for the first time its independence due to factors such as stagnation of agricultural production caused by drought conditions, sluggish import-related manufacturing industry, and a drop in tourism caused by the bombing incident at the Colombo International Airport by The Liberation Tigers of Tamil Eelam (LTTE). In 2002 the economy took an upturn and recovered due to the Ceasefire Agreement with the LTTE.)

By taking advantage of its geopolitical position, Sri Lanka is aiming at strengthening diplomatic and economic ties with Southwest Asian Nations and the Association of Southeast Asian Nations (ASEAN) as a result of which it signed a Free Trade Agreement with India. In June 2005, the Free Trade Agreement with Pakistan also went into effect.

In Sri Lanka, the biggest issue in terms of internal affairs is the ethnic conflicts between the country's majority Sinhalese and minority Tamils. A civil war has been going on over a span

of about 20 years between the government and the LTTE whose aim is to carve out a separate state in the North Eastern area of Sri Lanka. However, a ceasefire agreement was signed in February 2002 through the facilitation of the government of Norway, and peace talks began in September of the same year.

In order to clarify the positive role Japan is to play in the peace negotiations, Akashi, former Undersecretary General of the United Nations, was appointed in October of the same year as representative of the Government of Japan for the peace building, rehabilitation and reconstruction in the Democratic Socialist Republic of Sri Lanka. Furthermore, the Tokyo Conference on Reconstruction and Development of Sri Lanka was held in June 2003, with the participation of Ministers and representatives from 51 countries and 22 international organizations.

In the Tokyo Declaration adopted during the said Conference, the international community jointly pledged a total of US$ 4.5 billion (US$ 1 billion over a period of 3 years for Japan) in aid over a four-year period. Moreover, while promptly dealing with the humanitarian and reconstruction assistance as the dividend of peace to carry forward the peace process, they agreed that for full-scale reconstruction assistance to the north and eastern areas, a clear commitment by both parties, in other words the government of Sri Lanka and the LTTE, to progress in the peace negotiations was necessary, and that assistance by the international community must be closely linked with the peace process.

Meanwhile, although a total of 6 peace talks were held with the government of Sri Lanka until March 2003, in April of the same year, the LTTE pulled out of the negotiations on the grounds that they were unhappy with how the government dealt with the peace talks. After the Tokyo Declaration, the government side proposed an interim administration in July of the same year, while the LTTE side submitted a counterproposal in October of the same year, and due to conflicts between Prime Minister Wickremasinghe and President Kumaratunga concerning how to carry forward the peace process, President Kumaratunga dissolved the parliament in February 2004 following which general elections were held in April of the same year. As a result, although Kumaratunga's UPFA did not win a single-party majority, it did win the elections, making Rajapaksa, leader of the opposition party (UPFA) the new Prime Minister.

Under the UPFA's rule, the People's Liberation Front (JVP), member of the ruling coalition, was reluctant to push forward the peace talks with the LTTE. On the other hand, the LTTE also faced a recent split in the organization following the rebellion of its former eastern commander "Colonel" Karuna, and thus did not take active part in the peace process from March 2004 onward.

Under such political circumstances, the Great Sumatra Earthquake and Indian Ocean Tsunami struck Southeast Asia in December 2004, claiming over 30,000 lives and injuring more than 800,000 (at most) people across Sri Lanka. What emerged was a call for cooperation, to put

aside religious and ethnic differences while dealing with this national crisis. As a result, discussions aimed at the establishment of a joint mechanism that would ensure assistance to the population affected by the tsunami was delivered in a fair and transparent manner began, and in June 2005, an agreement regarding the said mechanism was reached and signed. The JVP, which opposed the agreement, withdrew from the UPFA government.

On August 12, 2005, Foreign Minister Kadirgamar, who was a constant critic and opponent of the LTTE, was assassinated in his home. Many view this as a crime committed by the LTTE, which led to growing international pressure on the LTTE, including travel ban measures of the LTTE members by the EU.

Meanwhile, presidential elections were held on November 17 of the same year. This literally one-on-one battle between Prime Minister Rajapaksa of the ruling PA and Wickremasinghe (former Prime Minister) of the opposition UNP resulted in Wickremasinghe being defeated narrowly and Rajapaksa taking office as President on the 19th.

Following April 2003's suspension of the peace talks, the international community led by the agreed facilitator to the Peace Process continued its efforts in urging the government and the LTTE to discuss issues surrounding the implementation of a ceasefire agreement, but due to the closing of the Mavil Aru sluice gate in July 2006, violence has escalated between the government and the LTTE, there is now no predicting the fate of the Peace Process.

Political System

Sri Lanka has a republican system of government and the head of state is the President, who is elected by popular vote. The term of office for the President is 6 years. The country has a unicameral parliament with 225 seats.

Government Organization (Cabinet)

The government is comprised of the President, Prime Minister and Ministers listed in Table 2.

President: Mahinda Rajapaksa
Prime Minister: Ratnasiri Wickremanayake

Table 2 (1) List of Ministries (1/2)

Name of Ministry	Name of Minister (honorific titles omitted)
Ministry of Agrarian Services and Development of Farmer Communities	S. M. Chandrasena
Ministry of Agricultural Development	Chamal Rajapakse
Ministry of Agriculture, Irrigation and Mahaweli Development	Maithripala Sirisena
Ministry of Child Development and Women's Empowerment	Sumedha G. Jayasena
Ministry of Coconut Development	Salinda Dissanayake
Ministry of Constitutional Affairs and National Integration	Dew Gunasekera
Ministry of Co-operatives and Co-operative Development	Abdul Majeed
Ministry of Cultural Affairs and National Heritage	Mahinda Yapa Abeywarden
Ministry of Defence, Public Security, Law and Order	Mahinda Rajapaksa
Ministry of Disaster Management and Human Rights	Mahinda Samarasinghe
Ministry of Disaster Relief Service	Ameer Ali Shihabdeen
Ministry of Education	G. D. S. Premajayantha
Ministry of Enterprise Development and Investment Promotion	Rohitha Bogollagama
Ministry of Environment	Maithripala Sirisena
Ministry of Estate Infrastructure and Livestock Development	R M C B Ratnayake
Ministry of Finance and Planning	Mahinda Rajapaksa
Ministry of Fisheries and Aquatic Resources	Felix Perera
Ministry of Fisheries and Housing Development	Athaullah Ahamed Lebbe Marikkar
Ministry of Foreign Affairs	Mangala Samaraweera
Ministry of Foreign Employment Promotion	Rohitha Abeygunawardena
Ministry of Healthcare and Nutrition	Nimal Siripala de Silva
Ministry of Highways	Jeyaraj Fernandopulle
Ministry of Home Affairs	Chandrasiri Gajadheera
Ministry of Housing and Construction	(Mrs.) Ferial Ashraff
Ministry of Indigenous Medicine	Tissa Karalliyadde
Ministry of Industrial Development	Kumara Welgama
Ministry of Infrastructure Development and Fisheries Housing	Athaullah Ahamed Lebbe Marikkar
Ministry of Internal Administration	Ratnasiri Wickremanayake
Ministry of Irrigation	Anver Ismail
Ministry of Justice and Law Reforms	Amarasiri Dodangoda
Ministry of Labor Relations and Foreign Employment	Athauda Senevirathne
Ministry of Local Government and Provincial Councils	Janaka Bandara Tennakoon
Ministry of Mass Media and Information	Anura Priyadarshana Yapa
Ministry of Nation Building and Estate Infrastructure Development	Mahinda Rajapaksa
Ministry of New Railroad Development	Mahinda Amaraweera
Ministry of Parliamentary Affairs	W. A. Wiswa Warnapala
Ministry of Petroleum and Petroleum Resources Development	A. H. M. Fowzie
Ministry of Plan Implementation	Mahinda Rajapaksa
Ministry of Plantation Industries	Milroy Fernando
Ministry of Policy Development and Implementation	Keheliya Rambukwella
Ministry of Ports and Aviation	Mangala Samaraweera
Ministry of Post and Telecommunication	D. M. Jayarathna
Ministry of Power and Energy	John Senevirathna
	Bandula Basnayake
	Sarath Amunugama
	A. H. M. Fowzie

Ministry of Promotion of Botanical and Zoological Gardens Ministry of Public Administration and Home Affairs Ministry of Railways and Transport Ministry of Regional Development Ministry of Religious Affairs Ministry of Resettlement Ministry of Road Development	M. H. Gunarathna Weerakoon Mahinda Rajapaksa Abdul Risath Bathiyutheen T. B. Ekanayake

Table 2 (2) List of Ministries (2/2)

Name of Ministry	Name of Minister (honorific titles omitted)
Ministry of Rural Economic Development Ministry of Rural Industries and Self-Employment Ministry of Rural Livelihood Development Ministry of Samurdhi and Poverty Alleviation Ministry of Science and Technology Ministry of Skills Development and Public Enterprise Reforms Ministry of Social Services and Social Welfare Ministry of Sports and Youth Affairs Ministry of State Banks Development Ministry of Textile Development Industry Ministry of Tourism Ministry of Trade, Commerce, Consumer Affairs and Marketing Development Ministry of Urban Development and Water Supply Ministry of Vocational and Technical Training Ministry of Youth Empowerment and Social Economic Development	D. M. Jayaratne R. M. S. B. Navinne A. P. Jagath Pushpa Kumara (Mrs.) Pavithra Wanniarachchi Tissa Vitharana Sripathi Suriya Arachchige Douglas Devananda Jeevan Kumaratunga Wijeyadasa Rajapakse Jayatissa Ranaweera Anura Bandaranaike Jeyaraj Fernandopulle Dinesh Gunawardene Piyasena Gamage Arumugam Thondaman

Meanwhile, due to the extremely large number and consolidation of ministries, of the 66 ministries posted on the government of Sri Lanka website (http://www.gov.lk) as of December 2006, Table 2 lists 65 ministries minus one that is believed to be a repetition of the same ministry (confusion of name) (judged that the Ministry of Irrigation, Mahaweli and Rajarata Development either changed its name to Ministry of Agriculture, Irrigation and Mahaweli Development or underwent an integration process).

Disaster-Related Legal System / Framework

Due to the Indian Ocean Tsunami that occurred on December 26, 2004, Sri Lanka suffered unprecedented damage. Following this tragedy, the Sri Lanka Disaster Management Act, No.13 was established in May 2005 to provide a national framework for disaster guidelines and the country's disaster risk control actions. Moreover, the National Council for Disaster Management (NCDM) led by the President and comprised of concerned ministers was established to protect the life, assets and environment of the population from all disasters including natural disasters.

In addition, although the National Disaster Management Center (NDMC), which incorporates various aspects of disaster management such as the formulation of a disaster prevention plan, the arrangement of authorities concerned and emergency response, was, prior to the tsunami disaster, under the control of the Ministry of Women Empowerment and Social Welfare (MWESW) (from source of reference S04), following the tsunami disaster, it temporarily came under the direct jurisdiction of the President. Later, it was under the jurisdiction of the Ministry of Disaster Management and Human Rights (MDMHR) and today it is controlled by the Ministry of Disaster Relief Services (MDRS) (NDMC website: http://www.ndmc.gov.lk/). The NDMC also serves as the NCDM's office. Furthermore, the NDMC is focusing its efforts on disaster control by submitting in May 2006 a report put together with the assistance of the UNDP entitled "Towards a Safer Sri Lanka, Road Map for Disaster Management" that lists measures against disasters that should be taken.

Other legal systems related to disaster prevention exist besides the Sri Lanka Disaster Management Act, No.13, such as those related to Sri Lanka's rivers, urban development, land use and coastal protection. The following are the country's major legal systems.

"River management by local governments"

i. Municipal Council Ordinance (Chapter 252) No. 19 of 1987

ii. Urban Councils Ordinance (Chapter 255) No. 18 of 1987

iii. Pradeshiya Sabbas Act No. 15 of 1987 (river cleanup)

"Development actions and land use"

iv. Town & Country Planning Ordinance No.13 of 1946 (Chapter 269) reprint 1960 and the Amendment by Act No. 49 of 2000 on the creation of the National Physical Planning Department

v. Urban Development Authority Law No. 41 of 1978

vi. Land Development Ordinance (Chapter 464) as amended by Act No. 60 of 1961 and 16 of 1969

vii. Colombo District (Low Lying Areas) Reclamation and Development Board Act No. 15 of 1968, since superceded by the Sri Lanka Land Reclamation and Development Corporation Act No. 52 of 1982

viii. Draft National Land Use policy Paper prepared by the Land Use planning Division of the Ministry of Agriculture and Lands.

"Flood prevention / coastal protection"

ix. Flood Protection Ordinance No.4 of 1924 and Act No.22 of 1955.

x. Coast Conservation Act No. 57 of 1981

"Environment"

xi. National Environmental Act No. 47 of 1980

xii. Forest Ordinance No. 16 of 1907 and amendments by Act No.56 of 1979 and Act No. 13 of 1982

"Irrigation"

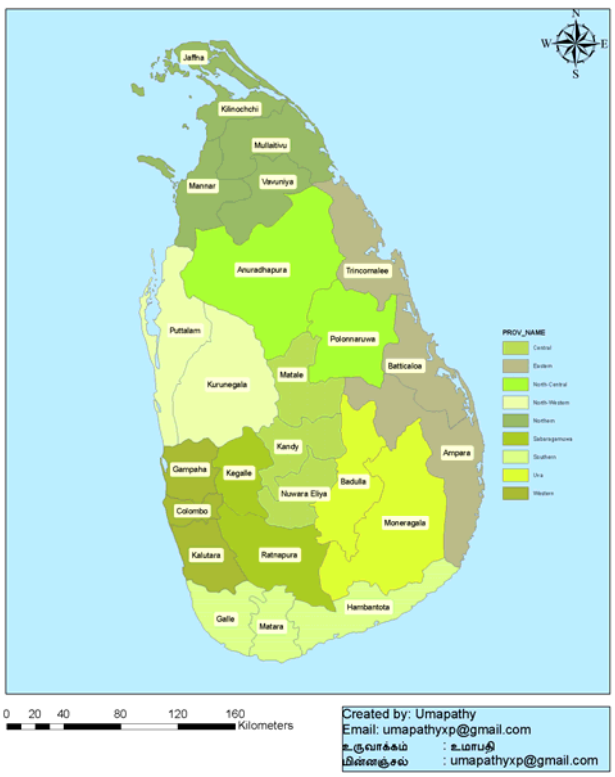
xiii. Irrigation Ordinance No.32 of 1946, Act No.1 of 1951, Act No.48 of 1968, and Law No. 37 of 1973

(3) Provinces and Districts, Self-government [S01), (S14), (S16), (S20)]

Local Administration

Sri Lanka is divided into 9 provinces, which consist of 25 districts (See Fig. 12). Each province is governed by the Provincial Council selected by elections.

Meanwhile, following the India - Sri Lanka agreement of 1987, the North-Eastern Province of Trincomalee which merged the Northern Province and Eastern Province was declared by the then-President Jayewardene. This merger was temporary and the decision on whether to make it official was supposed to be based on a subsequent local referendum. Unfortunately, because a local referendum was not conducted in the Eastern Province, a suit was filed by the JVP against the government, as a result of which on October 16, 2006, the supreme court of Sri Lanka ruled that the current merger of the Northern and Eastern Provinces into a single entity was unconstitutional and invalid.



Central Province (Kandy)

Eastern Province (Trincomalee)

North Central Province (Anuradhapura)

North Western Province (Kurunegala)

Northern Province (Jaffna)

Sabaragamuwa Province (Ratnapura)

Souther Province (Galle)

Uva Province (Badulla)

Western Province (Colombo)

Note: Cities in parentheses are the provincial capitals

Source: Wikipedia (http://ja.wikipedia.org/wiki/%E7%94%BB%E5%83%8F:Sri_Lanka_Districts.png)

Fig. 12 Map of Local Administrations

Disaster Prevention Organization

Using the Action Plan formulated in 1993, Sri Lanka's disaster management gained momen-

tum following the 2004 Indian Ocean Tsunami. The objectives of the Action Plan are as follows:

(a) Disaster prevention and reduction
(b) Protection of human life and assets
(c) Maintenance of order and recovery of devastated areas
(d) Provision of facilities for emergency response, rescue, rehabilitation and reconstruction

The Action Plan classifies the activities into the following categories:

(a) Preliminary activities (preparedness)
(b) Rescue activities
(c) Recovery, rehabilitation, reconstruction
(d) Public awareness and disaster prevention education

In addition, the following is the framework of the policies defined in the Action Plan.

(a) Introduce case examples of technical improvements in the fields of agriculture, land-use planning, construction and control of maintenance
(b) Promote the participation of non-governmental organizations (NGOs), private research institutes and individuals. Raise money and donate to non-affected areas.
(c) Promote scientific and technical research (ex: creation of a landslide hazard map) as a measures for sustainable development
(d) While maintaining and reinforcing the rescue, recovery and rehabilitation capacities needed after a disaster, also focus on the planning and preparations for disasters.
(e) Incorporate disaster prevention and preparation measures in the planning process not only on a national level but also on a local level

In addition, the said Action Plan requires that a committee is established at each administration level in order to organize disaster management activities at the hamlet, divisional, district and provincial levels. These committees are composed of members of both the public and private sectors.

The Provincial Council, district offices and divisional offices are each in charge of recovery activities. In other words, the Disaster Management Coordinating Committee at the district and divisional levels coordinate the disaster management activities at the district and divisional levels. The Ministry of Social Services (former) carries out all the disaster prevention, rescue and rehabilitation activities through the divisional offices. The Ministry of Social Services (former) and divisional offices have intermediate staff members called social services officials who support the implementation by the divisional offices of disaster prevention and rescue activities at the divisional levels. These offices also have hamlet-level administrative offices called Grama Niladary who carry out disaster-related activities. Hamlet-level Disaster Management Coordinating Committees are also established as grass-roots levels for the coor-

dination of all disaster-related activities at hamlet level.

(4) Economic Situation [S16], [S21]

Although traditionally Sri Lanka was an agriculturally-dependent nation that has since old times been cultivating rice and producing three major plantation products (See p.16), recently it has been devoting every effort to become an industrialized and economically diversified country. Today, garments are Sri Lanka's biggest exports.

Some of the expressions that define the country's economy from 1980 to the 1990s include "export-oriented foreign investment" and "most liberalized economy in South Asia". This image was achieved through economic deregulation. In 1977, Sri Lanka was the first among the South Asian nations to undertake a process to liberalize its economy. In the beginning, economic deregulation showed remarkable results. The GNP growth rate significantly increased from the average annual growth rat of 2.9% between 1970 and 1977, which was prior to deregulation, to 6.0% between 1978 and 1982. Moreover, in order to rebuild the economy that fell apart from 1983 onward, due to the outbreak and expansion of ethnic conflicts between the Sinhalese and Tamils, since 1988 Sri Lanka has been implementing structural adjustment policies whose contents include the reduction of government spending, privatization of public companies and the relaxation of regulations such as exchange control, based on the agreement with the World Bank and IMF.

As the 21st century dawned, although the real GDP growth rate for 2001 was negative (-1.5%) for the first time since its independence, due to factors such as stagnation of agricultural production caused by drought conditions, sluggish import-related manufacturing industry, and a drop in tourism caused by the bombing incident at the Colombo International Airport by the LTTE, the economy took an upturn in 2002, achieving dynamic growth toward the end of that year with a GDP of 4%. This was mainly due to the fact that the environment of the domestic economy improved with the progress of the peace process, as well as other factors, including monetary policies such as suppression of policy rates, efforts to improve finances, development of structural reforms, and changes in the international environment such as the recovery of global economy. From 2003 onward, despite the negative factors in recent years such as deterioration of public security, natural disasters including tsunamis, and soaring international oil prices, the country has been maintaining an overall growth rate of about 5 - 6% due to the steady performance of the service industry.

Table 3 shows the basic economic indicators during the 10 years from 1996 to 2005.

By taking advantage of its geopolitical position, Sri Lanka is aiming at strengthening diplomatic and economic ties with Southwest Asian Nations and the Association of Southeast Asian Nations (ASEAN) as a result of which it signed a Free Trade Agreement with India. In June 2005, the Free Trade Agreement (FTA) with Pakistan also went into effect.

(JETRO-FILE / Sri Lanka: Basic Economic Indicators)

Table 3. Basic Economic Indicators

(updated on July 28, 2006; Unit: local currency is the Rupee, rate =%)

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Real GDP growth rate	3.8	6.3	4.7	4.3	6.0	-1.5	4.0	6.0	5.4	6.0
Real GDP growth rate - remarks										provisional value
Total nominal GDP (local currency)	695,934,000,000	803,698,000,000	912,839,000,000	994,730,000,000	1,125,259,000,000	1,245,599,000,000	1,403,286,000,000	1,562,737,000,000	1,797,941,000,000	
Total nominal GDP ($)	12,591,213,539	13,623,246,873	14,163,500,134	14,082,598,810	14,612,785,387	13,935,524,652	14,669,195,010	16,190,642,451	17,767,268,810	
GDP per capita (nominal) ($)	794.6	852.5	880.7	859.9	884.4	840.6	870.0	948.8	1031.4	1198.5
Rate of increase in consumer price index	15.9	9.6	9.4	4.7	6.2	14.2	9.6	6.3	7.6	11.6
Rate of increase in consumer price index - remarks	Colombo CPI	Colombo CPI	Colombo CPI	Colombo CPI	Colombo CPI	Colombo CPI	Colombo CPI	Colombo CPI	Colombo CPI	Colombo CPI
Consumer price index	1906.7	2089.1	2284.9	2392.1	2539.8	2899.4	3176.4	3377.0	3632.8	4055.5
Consumer price index - remarks	Colombo CPI, 1952=100	Colombo CPI, 1952=100	Colombo CPI, 1952=100	Colombo CPI, 1952=100	Colombo CPI, 1952=100	Colombo CPI, 1952=100	Colombo CPI, 1952=100	Colombo CPI, 1952=100	Colombo CPI, 1952=100	Colombo CPI, 1952=100
Unemployment rate	11.3	10.5	9.2	8.9	7.6	7.9	8.8	8.4	8.3	7.7
Unemployment rate - remarks						Average for 1st, 3rd, 4th quarters			Average from the 1st to 3rd quarters	
Current account (balance of international payment basis) (local currency)	-37,456,000,000	-22,745,000,000	-13,795,000,000	-39,903,000,000	-78,857,000,000	-21,980,000,000	-22,693,000,000	-6,625,000,000	-65,458,000,000	-65,246,000,000
Current account (balance of international payment basis) (local currency) - remarks										provisional value
Current account (balance of international payment basis) ($)	-677,000,000	-393,000,000	-226,000,000	-563,000,000	-1,066,000,000	-215,000,000	-236,000,000	-71,000,000	-648,000,000	-650,000,000
Current account (balance of international payment basis) ($)										provisional value
Current account (balance of international payment basis) ($) - remarks										provisional value
Balance of trade (balance of international payment basis) (local currency)	-74,276,000,000	-71,833,000,000	-69,742,000,000	-96,702,000,000	-134,176,000,000	-102,592,000,000	-134,706,000,000	-148,324,000,000	-227,171,000,000	-253,082,000,000
Balance of trade (balance of international payment basis) (local currency) - remarks										provisional value
Balance of trade (balance of international payment basis) ($)	-1,344,000,000	-1,225,000,000	-1,092,000,000	-1,369,000,000	-1,798,000,000	-1,157,000,000	-1,406,000,000	-1,539,000,000	-2,243,000,000	-2,516,000,000
Balance of trade (balance of international payment basis) ($) - remarks										provisional value
Foreign currency reserves	1,961,550,000	2,024,140,000	1,979,770,000	1,635,550,000	1,039,000,000	1,286,810,000	1,630,950,000	2,264,930,000	2,132,110,000	2,650,910,000
Foreign debts (local currency)				718,352,000,000	808,211,000,000	884,095,000,000	999,632,000,000	1,131,088,000,000	1,336,373,000,000	1,330,986,000,000
Foreign debts (local currency) - remarks										provisional value
Foreign debts ($)				9,973,000,000	10,106,000,000	9,490,000,000	10,334,000,000	11,692,000,000	12,775,000,000	13,034,000,000
Foreign debts ($) - remarks										provisional value
Exchange rates (against the dollar) - (average rates)	55.2714	58.9946	64.4501	70.6354	77.0051	89.3830	95.6621	96.5210	101.1940	100.4980
Exchange rates (against the dollar) - (end-of-period rates)	56.7050	61.2850	68.2970	72.1700	82.5800	93.1587	96.7250	96.7382	104.6050	102.1170
Monetary growth	11.3	15.6	13.2	13.4	12.9	13.6	13.4	15.3	19.6	
Monetary growth - remarks	M2	M2	M2	M2	M2	M2	M2	M2	M2	
Export values (local currency)	226,801,000,000	274,193,000,000	310,393,000,000	325,171,000,000	420,114,000,000	430,372,000,000	449,850,000,000	495,426,000,000	583,967,000,000	638,267,000,000
Export values (local currency) - remarks										provisional value

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Export values ($)	4,103,406,102	4,647,764,372	4,816,020,456	4,603,513,253	5,455,664,625	4,814,920,063	4,702,489,283	5,132,831,197	5,770,767,042	6,351,041,812
Export values ($) - remarks										provisional value
Exports to Japan (local currency)				11,199,000,000	17,407,000,000	16,602,000,000	13,390,000,000	15,674,000,000	15,947,000,000	14,533,000,000
Exports to Japan ($)				158,546,564	226,049,963	185,740,018	139,971,838	162,389,532	157,588,395	144,609,843
Import values (local currency)	301,076,000,000	346,026,000,000	380,138,000	421,888,000,000	554,290,000,000	532,964,000,000	584,491,000,000	643,749,000,000	811,138,000,000	891,359,000,000
Import values (local currency) - remarks										provisional value
Import values ($)	5,447,229,489	5,865,384,289	5,898,175,488	5,972,755,870	7,198,094,672	5,962,699,842	6,109,953,681	6,669,522,695	8,015,672,866	8,869,420,287
Import values ($) - remarks										provisional value
Imports from Japan (local currency)				39,479,000,000	48,957,000,000	30,105,000,000	33,989,000,000	43,254,000,000	41,660,000,000	38,158,000,000
Imports from Japan ($)				558,912,387	635,763,086	336,809,013	355,302,675	448,130,459	411,684,487	379,689,148
Direct investments (local currency)	155,559,000,000	72,859,000,000	114,040,000,000	57,486,000,000	21,313,000,000	25,093,000,000	31,657,800,000	77,698,690,000	69,706,480,000	27,768,000,000
Direct investments ($)	2,814,457,387	1,235,011,340	1,769,430,924	813,841,218	276,773,876	280,735,710	330,933,567	804,992,592	688,840,050	276,304,006
Direct investments - remarks	BOI Law, Section 17, approval basis	BOI Law, Section 17, approval basis	BOI Law, Section 17, approval basis	BOI Law, Section 17, approval basis	BOI Law, Section 17, approval basis	BOI Law, Section 17, approval basis	BOI Law, Section 17, approval basis	BOI Law, Section 17, approval basis	BOI Law, Section 17, approval basis	BOI Law, Section 17, approval basis

Source: Japan External Trade Organization (JETRO) website (S21)

[Source]

Real GDP grows rate, total nominal GDP, rate of increase in consumer price index, consumer price index, unemployment rate, current account, balance of trade, foreign debts, export values, exports to Japan, gross domestic expenditure, GDP composition by sector Central Bank of Sri Lanka, “Annual Report 2005”

GDP per capita: IMF, “World Economic Outlook Database”

Foreign currency reserves, exchange rates: IFS CD-ROM

Momentary growth: IMF “International Financial Statistics Yearbook”

Direct investments: Board of Investment (BOI)

(5) Industrial Situation [S16], [S21], [S22]

As mentioned earlier on p.16 and 23, Sri Lanka used to be characterized by the fact that it was an agricultural-dependent economy based on the cultivation of rice and the production of three major plantation products, in other words a typical "plantation economy". The history of the establishment of the plantation economy dates back to the mid 19th century during the British rule. In the 1940s, the plantation sector made up 37% of the GNP, and in 1948 this sector was estimated to make up about 90% of total exports.

Meanwhile, under this plantation economy, the manufacturing industry stagnated, representing only 5.6% of the GDP in the early 1960s. Until the start of economic reforms in 1977, this percentage increased to almost 11%, but even in 1981, almost 80% of the population still lived in agricultural villages. However, starting from the late 1980s, the growth rate of the manufacturing industry began to exceed those of other sectors, revealing major changes in industrial structures. As shown in Table 4, the contribution of the manufacturing industry to total GDP had reached 17% by 2000. Another important point is that the service industry's share of GDP is positively continuing to increase. The growth in the service industry is mainly found in the "financial services, insurance and real estate" sectors and "transport and communication" sector. A look at the GDP composition by sector for 2000 reveals that services, agriculture/forestry/fishing, manufacturing, construction and mining sectors account for 54%, 20%, 17%, 7% and 2%, respectively.

Table 4: Changes in the Industrial Structure Between 1993 and 2000 (GDP share: %)

	1933	1994	1995	1996	1997	1998	1999	2000
1. Agriculture, forestry, fishing	24.6	23.8	23.0	22.4	21.9	21.1	20.7	20.0
2. Mining	1.9	2.0	1.9	2.0	2.1	1.9	1.8	2.0
3. Manufacturing	15.2	15.4	15.7	16.2	16.4	16.5	16.4	17.0
4. Construction	7.2	7.3	7.4	6.9	7.0	7.6	7.6	7.0
5. Services	51.1	51.5	52.0	52.5	52.6	52.9	53.5	54.0
a.Electricity, gas and water	1.4	1.5	1.5	1.3	1.4	1.5	1.5	n.a.
b.Transportation and communication	10.0	10.0	9.9	10.6	10.7	11.1	11.4	n.a.
c.Business	22.0	22.0	22.0	22.3	22.0	21.5	21.2	n.a.
d.Financial services, insurance and real estate services	6.1	6.8	7.2	7.1	7.4	7.6	8.1	n.a.
e.Households living in their own dwellings	2.3	2.2	2.1	2.0	2.0	1.9	1.8	n.a.
f.Government, national defense	5.0	4.8	5.2	5.1	5.1	5.3	5.3	n.a.
g.Others	4.3	4.2	4.0	4.0	4.0	4.0	4.1	n.a.

Source: Central Bank of Sri Lanka Annual Report 2000

Although the manufacturing industry's share has remained steady at around 16% as they entered the 21st century, the service industry's share has continued to grow and in 2005, it had reached close to 58% (See Table 4). However, due to this increase, the share of agriculture, forestry and fishing is declining. A look at the GDP composition by sector in 2005 reveals that the service, agriculture/forestry/fishing, manufacturing, construction and mining sectors account for 58%, 17%, 16%, 7% and 2%, respectively.

Table 5. GDP (Real) Composition by Sector Between 2001 and 2005

Country name: Sri Lanka

GDP (real) composition by sector

Unit: Rs in Million

%:as a share of GDP

Sector	2001		2002		2003		2004		2005 Provisional	
	Value	%	Value	%	Value	%	Value	%	Value	%
1. Agriculture, forestry and fishing	169,377	20.1	173,623	19.8	176,450	19.0	175,852	17.9	178.475	17.2
2. Mining	15,019	1.8	14,858	1.7	15,699	1.7	16,946	1.7	19,335	1.9
3. Manufacturing	142,909	16.9	145,864	16.6	151,951	16.3	159,712	16.3	169,337	16.3
4. Construction	61,292	7.3	60,796	6.9	64,115	6.9	68,332	7.0	74,414	7.2
5. Services	455,197	53.9	482,107	55.0	521,842	56.1	559,869	57.1	598,174	57.5
Electricity and water	12,130	104	12,044	104	14,651	1.6	14,287	1.5	17,610	1.7
Wholesale and retail trade, hotels and restaurants	181,733	21.5	191,505	21.8	206,507	22.2	219,041	22.3	224,652	21.6
Transportation, storage, communication	105,497	12.5	113,525	12.9	125,538	13.5	142,727	14.6	160,882	15.5
Financial services, insurance, real estate and business services	91,456	10.8	99,620	11.4	108,578	11.7	114,661	11.7	122,127	11.7
Public administration, other government services and defense, and other community, social and personal services	64,381	7.6	65,213	7.4	66,568	7.2	69,153	7.1	72,903	7.0
(of these, those that are public companies)	41857	5.0	41,869	4.8	42,125	4.5	42,987	4.4	45,180	4.3
Total	**843,794**	**100.0**	**877,248**	**100.0**	**930,057**	**100.0**	**980,720**	**100.0**	**1,039,735**	**100.0**

Source: Central Bank of Sri Lanka "Annual Report 2005"

Reference year: 1996

Note: Prepared based on the information on the Japan External Trade Organization (JETRO) website (S21)

Furthermore, Table 5 shows the details of the GDP (real) composition by sector shown in Table 4 for the years 2004 and 2005. An individual look at each of the agriculture, forestry and fishing sectors reveals trends that were not visible in Table 4. In other words, although agricultural production shows significant recovery between 2004 and 2005, the fishery production shows an enormous drop. The fishery's share of GDP declined from 2.3% to 1.3%, with the rate of change reaching a negative value of minus 42%.

Table 6. GDP (Real) Composition by Sector for 2004 and 2005

Gross National Product at Constant (1996) Prices

Item	Value (Rs. in million)		As a Share of GDP (%)		Rate of Change (%)		Contribution to Change (%)	
	2004 (a)	2005 (b)	2004 (a)	2005 (b)	2004 (a)	2005 (b)	2004 (a)	2005 (b)
Agriculture Sector	**175,852**	**178,475**	**17.9**	**17.2**	**-0.3**	**1.5**	**-1.2**	**4.4**
Agriculture	135,967	147,909	13.9	14.2	-0.9	8.8	-2.3	20.2
Forestry	17,107	17,400	1.7	1.7	1.3	1.7	0.4	0.5
Fishing	22,779	13,166	2.3	1.3	1.6	-42.2	0.7	-16.3
Industrial Sector	**259,286**	**280,696**	**26.4**	**27.0**	**5.2**	**8.3**	**25.4**	**36.3**
Mining and quarrying	16,946	19,335	1.7	1.9	7.9	14.1	2.5	4.0
Manufacturing	159,721	169,337	16.3	16.3	5.1	6.0	15.3	16.3
Electricity, gas and water	14,287	17,610	1.5	1.7	-2.5	23.3	-0.7	5.6
Construction	68,332	74,414	7.0	7.2	6.6	8.9	8.3	10.3
Services Sector	**545,582**	**580,564**	**55.7**	**55.8**	**7.6**	**6.4**	**75.8**	**59.3**
Wholesale and retail trade, and hotels and restaurants	219,041	224,652	22.3	21.6	6.1	2.6	24.7	9.5
Transport, storage and communication	142,727	160,882	14.6	15.5	13.7	12.7	33.9	30.8
Financial services, real estate and business services	114,661	122,127	11.7	11.7	5.6	6.5	12.0	12.7
Public administration, other government services and defence and other community, social and personal services	69,153	72,903	7.1	7.0	3.9	5.4	5.1	6.4
Gross Domestic Product (GDP)	**980,720**	**1,039,735**	**100.0**	**100.0**	**5.4**	**6.0**	**100.0**	**100.0**
Net factor income from abroad	-11,300	-16,526			19.3	46.2		
Gross National Product (GNP)	**969,421**	**1,023,209**			**5.3**	**5.5**		

(a) Revised
(b) Provisional

Source: Central Bank of Sri Lanka

Source：Central Bank of Sri Lanka Annual Report 2005 (S22)

One of the reasons for the decreased production is that the fishing industry was hit hard by the Indian Ocean Tsunami disaster on December 26, 2004, where fishing boats and harbors were greatly damaged, as a result of which the local people could not fish for an extended period of time.

(6) Culture, Religion, Language [S02], [S16], [S24]

Culture

Sri Lanka is a multiethnic nation, and in addition to ethnic and religious differences, lifestyles and customs are different in urban and rural areas.

Although not as marked as in India, caste discrimination still exists. For example, earning a living from washing clothes is looked down upon. Fishermen also have a low social status.

Among the few things that form the cultural foundation of Sri Lanka, astrology constitutes one of the most valued traditions. Astrology is used to determine the time and date of many of the country's important events and holidays. It is also deeply rooted in the lives of the people.

In addition, with 6 cultural heritages and 1 natural heritage, Sri Lanka has a total of 7 UNESCO World Heritage sites. The Indian Ocean Tsunami caused enormous human loss as well as significant damage in historic cities on the south coast. The recovery of cultural heritages in the old town and fortifications of Galle registered as a World Heritage in 1988, its neighboring historic cities, in particular Mathara and Hambatota, which suffered extensive damage is an issue that is being addressed.

[Cultural Heritages]

Sacred City of Anuradhapura	:	registered in 1982
Ancient City of Polonnaruwa	:	registered in 1982
Ancient City of Sigiriya	:	registered in 1982
Sacred City of Kandy	:	registered in 1988
Old Town of Galle and its Fortifications	:	registered in 1988
Golden Temple of Dambulla	:	registered in 1991

[Natural Heritage]

Sinharaja Forest Reserve	:	registered in 1988

Religion

Buddhism is the major religion, with 70% of the population as followers, followed by Hinduism (10%), Islam (8.5%) and Christianity (11.3%).

The country's southwest side is the Buddhist area inhabited by the Sinhalese, and polit-

ical and armed conflicts continue with the Hindu Tamils who are mostly concentrated on the northeast side. Meanwhile, although the conflicts between Sinhalese and Tamils are often interpreted as animosity between races and religious conflicts between Buddhism and Hinduism, the distinctive Sinhalese and Tamil identities, with their corresponding languages and religions were formed after 1948's independence, and thus perhaps making a sweeping judgment on the reasons behind their conflicts is risky. Instead, the Sinhalese superiority policy which the Sinhalese government adopted, is of decisive importance when considering the ethnic conflicts. This issue will further be discussed in section (8) Minorities.

Buddhism was first introduced from India to Ceylon in the 3rd century B.C. as Theravada Buddhism. Although Buddhism waned for various historical reasons in India, its birth land, it is still practiced in Sri Lanka in its original form. In addition, Theravada Buddhism was also introduced from Sri Lanka to Southeast Asia. Meanwhile, although Theravada Buddhism is sometimes referred to as Hinayana Buddhism, this name was created to imply that it is a Lesser Vehicle as opposed to Mahayana Buddhism, or the Greater Vehicle, and is simply a derogatory term based on the superiority of Mahayana Buddhism. Therefore, Theravada Buddhists would never use this term to describe themselves. Those who leave home to become a monk withdraw from the world and discipline themselves while living a communal life in temples to become exceptional beings excelling in virtue. Anyone wishing to become a monk can become one regardless of family background, but there are many restrictions, such as not being able to get married or have a relationship with a member of the opposite sex. As for ordinary people, while continuing life in the real world, they accumulate good deeds by serving the temple and monks, improve their karma and hope for happiness in the next life. As a result, monks are revered in Sri Lanka, forming a sort of privileged class.

Language

Both Sinhalese and Tamil are Sri Lanka's national languages, while English is constitutionally recognized as the link language. For example, government publications are prepared in 3 languages, while signs and street names of public institutions or related institutions are also in Sinhalese, Tamil and English.

Although, on a daily basis most of the population use their own language (Sinhalese people use the Sinhalese language and Tamils use the Tamil language), 10% of the people use English as their first language. These English-speaking people live mostly in Colombo and have leadership positions in Sri Lankan society.

An estimated 15 million people speak Sinhalese, and as will be described later, the Tamil-speaking population worldwide is greater than those who speak Sinhalese. In terms of families of languages, it belongs to the Indo-European language family, Indo-Iranian language group and Indo-Aryan language. The basic work order is SOV, and with many open syllables, its linguistic system is often compared to that of Japanese. The Sinhalese language uses the Sinhala alphabet, a descendent of the Brahmi script (Bonji means Brahmi script, used in India).

Meanwhile, Tamil belongs to the Dravida language family which originally was the language used by Tamils living in the south of India. The name Tamil is a variant of Dramila (or Dravida). Although its affinity to Malayalam from the same Dravida language family is most striking, Malayalam has a huge quantity of loanwords from Sanscrit, Tamil has relatively few of them. Tamil is restricted in terms of vocabulary and thus communication is not easy. It is the official language of the Indian state of Tamil Nadu as well as one of the official languages of Singapore. With 74 million Tamil speakers, it is the 18th most spoken language in the world. Tamil is the oldest written language in the Dravida language family, and it is said that the oldest remaining document dates back around the historical boundary between B.C. and A.D. Today, Tamil mainly uses its own alphabet. The basic word order is, as in Japanese, SOV. This sometimes changes to OSV, but in cases where the meaning of a sentence is obtained after an affix is attached to the verb, the word order is basically SOV. However, like Malayalam, in some rare cases, OVS is also seen where only the subject comes at the end of the sentence. Although sometimes considered an inversion, this is also seen in print, such as in newspapers, studies show that this is not intended as a rhetorical device.

(7) Gender (S24)

The percentage of women in Sri Lanka with careers as administrative officers, politicians, physicians and lawyers is high, and their role in labor productivity is significant, while in the family, the husband or the father has the authority. This shows the country has both of the features of the old Japanese feudal society.

First, from the perspective of retention of equal rights regardless of gender, universal franchise including women's political participation and decision making representative of the modern western democratic values as well as a parliamentary government system based thereon, were introduced in Sri Lanka as early as 1931, which is considered to be

exceptionally early in Asia. In addition, in 1960 Sirimavo Bandaranaike became the world's first female Prime Minister. Apparently, common laws that allowed polyandry and matrilocal residence existed in the Sinhalese society prior to British rule, revealing that women had always been well-placed socially. In addition, at the University of Colombo which produced many social elites in Sri Lanka, the key members of the administration, such as the university president, executive director, finance officer, chief librarian, dean of the medical school, dean of the Faculty of Science and dean of the School of Law (as of 1999). The percentage of women is slightly higher not only among faculty members but also among students. As a result, the ratio of women with professional careers including physicians and lawyers is increasing. This should be described as being a result of Sri Lanka's unique tradition instead of a change that occurred following independence.

Meanwhile, although remittance by workers abroad concentrated mainly in Arab oil countries can be named as the second source of foreign exchange following the apparel industry, already in the 1990s, more than 70% of the migrant workers who make up close to 10% of the entire laboring population are unmarried women. According to a survey by the Sri Lanka Bureau of Foreign Employment, about 60% of the female migrant workers are working under long-term contracts in West Asia, leaving behind their husband and at least 2 children. Such an increase in the ratio of female workers is a characteristic that emerged after Sri Lanka gained its independence. Later, society began to rely mostly on women for the backbone of the workforce involving product commercialization in the labor market, such as farm work, factory work and work abroad. The increased presence of women in areas that were until the 1970s restricted to men, such as soldiers and police officers, is also significant.

Unfortunately, the hardships of female workers who leave their village to work in farms, city plants, abroad or who go off to war have barely been improved. Moreover, Sri Lankan society operates within a framework of strict hierarchy not only at work but also inside the family and at school, showing a resemblance with old Japanese feudal society. In the family, the husband or the father has the authority, and the wife and children are required to be submissive.

For example, when making important decisions such as marriage, the opinions of the parents and brothers are taken into great consideration, and although adult males are relatively free to choose their path when making life-altering decisions, restrictions are imposed on women as they must listen to what male family members have to say.

Moreover, women are prohibited to smoke, drink alcohol, and wear clothing that expose their legs, such as mini skirts and shorts.

(8) Minorities [S02], [S24]

History and Factor Analysis of the Conflicts

According to the survey of Sri Lanka's ethnic composition the Sinhalese make up more than 70% (72.9%), forming the largest ethnic group in the nation. This is followed by the Tamils who live in the north-eastern area (18%) and the Sri Lankan Moors (8%), constituting the minority groups. Meanwhile, although the conflicts between Sinhalese and Tamils are often interpreted as animosity between races and religious conflicts between Buddhism and Hinduism, the distinctive Sinhalese and Tamil identities with their corresponding languages and religions were formed after 1948's independence.

Instead, the numerous Sinhalese superiority policies which the Sinhalese government adopted following the country's independence are of decisive importance when considering the ethnic conflicts. Some claim that this is a backlash by the Sinhalese against the colonial governance (intentionally treating ethnic minorities preferentially that ensured the backlash against dominance was directed toward not the British but the ethnic minorities) the British had been pursuing prior to the independence where the Tamils were treated preferentially. In fact, at the time when Sri Lanka gained its independence, the percentage of Tamils in the population with professional careers or in the government service was not low and thus the fact that a certain degree of racial superiority existed can not be denied. However, just like the Sinhalese, the Tamils were also classified into the elite class and low class. Prior to independence, conflicts that existed in Sri Lanka were at most conducted along caste lines or conducted to reinforce distinctions between highland Sinhalese and lowland Sinhalese, and so it is more appropriate to consider that the Sinhalese and Tamils became much more conscious about their respective identities after the country's independence.

The growth of Sinhalese nationalism led by Sinhalese Buddhist monks that intensified following independence was not initially intended to eliminate the Tamils. What they wanted was the country to consider the independence from the British merely as a change from colonial rule to a rule by the social elites who speak English or by the wealthy class, for Buddhist monks to revive Buddhism while playing a leading role in society, for Sinhalese, the people's language, to be made an official language to achieve a real independence for the people. In fact, they brought social reforms, worked on re-

building rural villages, made efforts toward improving the lives of the poor, and therefore were popular with the Sinhalese people. However, because this movement was based on the protection of Buddhism, Sinhalese-oriented slogans such as making Sinhalese an official language, and the superiority of their group, they inevitably promoted the elimination of other groups including the Tamils and headed toward conflicts. As a result of taking measures that were supported by the majority Sinhalese in the post-independence political process, the possibility of a multiethnic coexistence was lost. Table 7 shows the structural factors of the conflicts in Sri Lanka including the Sinhalese superiority policy.

Table 7. Structural Factors of Conflicts (prior to 1983) and their Effects and Alternatives

		Factors	Effects	Alternatives
1	Language policy	Make Sinhalese an official language	Disadvantages Tamils	Make Tamil an official language
2	Irrigation projects	Delay of the large-scale irrigation projects in the northeast area including the Mahaweli Development Programme	Beneficiary zones restricted to Sinhalese areas	Expand toward the Tamil areas in the northeast
3	Settlement project	Priority to settle in new farmlands given to the Sinhalese people	Relative decline in Tamil population size in Tamil villages living in the northeast area	Ensure equality in the settlement in new farmlands
4	Decentralization of authority	Centralization of authority by the national government	Political superiority of the majority Sinhalese, segregation tendency in the North Eastern Province	Extend the autonomy of provincial governments
5	University enrollment	Adjustments of the GCE (AL) records	Decline in the university enrollment rate of Tamils	Enrollment in order of school performance
6	Development investment	Concentration in the southwest areas	Regional divide, misappropriation of military spending	Development of projects in the northeast areas

7	Economic policy shift	Increased social inequality associated with liberalization resulting from structural adjustments	Tamils feeling increasingly rejected and frustrated	Development of basic industry protection policies and safety nets
8	Poverty of workers	Low wages of Indian Tamils	Joint struggles in the mountain and northern areas	Increase wages and improve social welfare
9	Employment opportunities	Increased unemployment rate	Increased soldiers, militiamen, and participation in guerilla organizations	Industrial promotion and employment creation
10	Issues surrounding acquirement of nationality of Indian Tamils	Denial of citizenship to Indian Tamils	Indian Tamils lose their national identity	Political participation by granting citizenship, improved social welfare

Note 1) GCE refers to General Certificate of Education and AL to Advanced Level.

Source: Conflict and Development: Roles of JBIC (Development Assistance Strategy for Peace Building and in Sri Lanka) (S02)

The Tamil movement began with a peaceful political movement in the mid 1950s and then shifted toward a civil disobedience movement at the beginning of the 1960s, and further transformed into violence in the 1970s. The violent conflicts, which started off as temporary local incidents eventually adopted more organized forms and directly targeted national assets and police defense forces. Finally at the beginning of the 1980s, they became a threat to Sri Lankan society as a whole. The increasingly violent nature of the movement corresponds to the intensification of the separatist movement.

Initially the purpose of the movement was the expansion of regional autonomy in Sri Lanka, but gradually the Tamils began seeking not a single nation but a federal state. In the end, the movement became an armed struggle to separate the island's north and east areas (Tamil homeland) into an independent nation.

The genocide of Tamils in Colombo in 1983 triggered a full-scale armed conflict and the LTTE gained support from the north-eastern Tamils. Along with the intensification of conflicts, a selection process also proceeded within the Tamil community, as a result of which the Tamil force was placed under the LTTE who extended their power through

violent attacks such as suicide bombings.

Mechanism of the Persistence of Ethnic Conflicts

Sri Lanka was divided into the Government-control area (Cleared Area) and the LTTE-control area (Uncleared Area), following which, conflicts continued for 20 years. A ceasefire agreement was signed in February 2002, and in September of the same year peace talks began, but unhappy with how the government handled the peace talks, the LTTE announced in April 2003 that it was temporarily suspending the negotiations. Later, due to the closing of the Mavil Aru sluice gate in July 2006, violence has escalated between the government and the LTTE, there is no predicting the fate of the Peace Process. How did the conflicts persist in such a small island? This can in part be explained if we look at the numerous failed peace talks and trace the process that led to a further stalemate. However, this is not sufficient to have a structural understanding of the mechanism of the ethnic conflicts that persisted for so long. Although an attempt to simplify such complex issues is extremely difficult, Table 8 lists a few points that would allow a general understanding of the conflicts in Sri Lanka.

Table 8. Factors that Contributed to Sri Lanka's Continued Conflicts

		Factors	Effects
1	Military expenditures	Increased military budgets	Development of the military industry = escalation of hostilities
2	Intervention of outside countries	Intervention of the Indian military	Prolonged conflicts become increasingly complex
3	JVP armed uprising	Frustration of young men who lost their jobs in rural villages	Respond to the LTTE's call for ethnic conflicts = anti-government uprising in the south area, as a result of which conflicts become more complex
4	Conflicts between ethnic groups	Conflicts of interest between Tamils and Muslims, expulsion by the LTTE of Muslims from the northeastern area	Increased Muslim refugees in Sri Lanka, resulting in new conflicts
5	Conflicts within ethnic groups	Conflicts between upper and lower castes	Participation of the lower caste into the LTTE, further development of the military organization
6	Economic development	Commercialization of social relations[2], isolation of the economy from the social and cultural infrastructures	Growing class disparities, breeding ground for the dissatisfaction of the public
7	Overseas remittances	Support by Tamils working abroad	Strengthening of the LTTE military

Note 2) Traditionally these were nothing more than specific social relations of communities. Workforce, possession of land, and credits which until then had no economic values became objects of sale.

Source: Conflict and Development: Roles of JBIC (Development Assistance Strategy for Peace Building and in Sri Lanka) (S02)

Characteristics of the Conflicts in Sri Lanka

In contrast with the separatist movements in Myanmar, Thailand, Indonesia and the Philippines, the Tamil separatist movement in Sri Lanka possesses the following characteristics.

First, it took a long period of about 25 years for the relatively nonviolent movement between the 1950s to the 1960s to develop into a violent separatist movement.

Second, as part of the Tamil struggle for independence many chiefs of state, leading politicians and other leaders have been assassinated through suicide bombing, etc.

Third, is the sense of minority felt by both the Sinhalese and Tamils. The Tamil ethnic movement in Sri Lanka is not simply a request for the minorities to have increased rights within the nation state. Although Tamils are a minority in Sri Lanka, Sinhalese people developed a relative minority consciousness in southern India including Tamil Nadu state, and it can be said that this cast a shadow over the relationship between both ethnic groups.

Fourth, it is a conflict involving the ensuring of a rightful social position through the improvement of the language issue. In the process of formation of the nation state following independence, an attempt was made to make the people's languages, namely Sinhalese and Tamil, official languages and to offer real independence to the people. However, due to the existence of a covert agreement that placed those who spoke fluent English in a socially privileged class, and thus in classes that included major industries, public positions and specialized professions, English still plays a central role as it did under the British rule. Despite the overwhelming majority of Swabhasha (refers to those who speak only Sinhalese or Tamil, as opposed to the elite class who speak English) graduating university, these Sri Lankans are not offered positions in such fields. Although various national measures are taken, political and social conflicts have repeatedly broken out as a result these issues not being resolved (the discontent people consisted not only of Tamils but also of Sinhalese People's Liberation Front (JVP) who display animosity toward English language dominance.

These deep and complex issues must be addressed in order to bring lasting peace.

4. Overview of Water Damage in Sri Lanka [S15]

The main natural disasters in Sri Lanka are floods, landslides, cyclones, droughts, storms and littoral erosions. Sometimes, the country also suffers from an outbreak of infectious diseases.

Tables 9 to 12 show the data obtained in the Emergency Disasters Database (EM-DAT) disclosed by the Centre for Research on the Epidemiology of Disasters (CRED) of the Louvain Catholic University in Belgium regarding national disasters that hit Sri Lanka.

Table 9. Top 10 Numbers of Deaths Caused by Natural Disasters

Type of disaster	Date of disaster	Number of deaths
Tsunami	December 26, 2004	35,399
Cyclone	November 24, 1978	740
Flood	May 30, 1989	325
Flood	May 17, 2003	235
Cyclone	December 22, 1964	206
Cyclone	December 25, 1957	200
Landslide	October 08, 1993	65
Flood	December 25, 1969	62
Infectious disease (See note)	November 1987	53
Flood	May 24, 1984	45

Note: Infectious diseases include malaria, diarrhea / cholera, arborvirus infection, measles and dengue fever.
Source: EM-DAT: The OFDA/CRED International Disaster Database (S15)
http://www.em-dat.net - Louvain Catholic University, Brussels, Belgium (as of November 6, 2006)

Table 10. Top 10 Numbers of Victims Caused by Natural Disasters

Type of disaster	Date of disaster	Total numbers of victims
Drought	1987	2,200,000
Drought	September 1982	2,000,000
Flood	December 1983	1,250,000
Tsunami	December 26, 2004	1,019,306
Cyclone	November 24, 1978	1,005,000
Flood	December 25, 1969	1,000,000
Drought	September 2001	1,000,000
Drought	August 1988	806,000
Flood	May 17, 2003	695,000
Flood	May 30, 1989	501,000

Source: EM-DAT: The OFDA/CRED International Disaster Database (S15)
http://www.em-dat.net - Louvain Catholic University, Brussels, Belgium (as of November 6, 2006)

Table 11. Top 10 Amounts of Damage Resulting from Natural Disasters

Type of disaster	Date of disaster	Total damage (US$ 1,000)
Tsunami	December 26, 2004	1,316,500
Flood	June 05, 1992	250,000
Cyclone	November 24, 1978	100,000
Cyclone	December 22, 1964	37,300
Flood	May 30, 1989	35,000
Flood	June 02, 1991	30,000
Flood	May 17, 2003	29,000
Flood	December 25, 1969	8,500
Flood	September 1966	5,000
Flood	October 18, 1967	3,000

Source: EM-DAT: The OFDA/CRED International Disaster Database (S15)
http://www.em-dat.net - Louvain Catholic University, Brussels, Belgium (as of November 6, 2006)

Table 12. Overview of the Natural Disasters that Occurred in Sri Lanka Between 1957 and 2005

Type of disaster	Frequency	Number of deaths	Number of injured	Number of homeless	Number of victims	Total number of victims	Total amount of damage (US$ 1,000)
Drought	8	0	0	0	6,256,000	6,256,000	0
(per disaster)		0	0	0	782,000	782,000	0
Infectious disease (See note)	5	58	0	0	206,177	206,177	0
(per disaster)		12	0	0	41,355	41,355	0
Flood	37	948	1,000	2,746,601	6,455,127	9,202,728	370,444
(per disaster)		26	27	74,232	174,463	248,722	10,012
Landslide	3	119	0	0	130	130	0
(per disaster)		40	0	0	43	43	0
Tsunami	1	35,399	23,176	480,000	516,130	1,019,306	1,316,500
(per disaster)		35,399	23,176	480,000	516,130	1,019,306	1,316,500
Cyclone	5	1,151	5,000	100,000	1,913,000	2,018,000	137,300
(per disaster)		230	1,000	20,000	382,600	403,600	27,460

Note: Infectious diseases include malaria, diarrhea / cholera, arborvirus infection, measles and dengue fever.
Source: EM-DAT: The OFDA/CRED International Disaster Database (S15)
http://www.em-dat.net - Louvain Catholic University, Brussels, Belgium (as of November 6, 2006)

The EM-DAT defines the victims mentioned in Table 12 as follows:
"People requiring immediate assistance during a period of emergency; it can also include displaced or evacuated people (quoted directly from the website)."
In addition, the total number of victims is calculated using the following formula. The number of death is not included in the total number of victims.

(Total number of victims) = (number of injured) + (number of homeless) + (number of victims)

Meanwhile the flood and landslide disaster that will be the subject of focus in this report is the flood that hit Sri Lanka on May 17, 2003. The flood that claimed the most lives was the one on May 30, 1989 with 325 people dead and even in terms of total number of victims, there were more victims during the December 1983 flood or December 25, 1969 flood. However, although the flood on May 17, 2003 is regarded as the worst flood and landslide disaster on the Sri Lankan side since 1947, 2003 being more recent means more detailed information is available and the data are more reliable. The flood and landslide

disasters at the 3 rivers on the western slopes, namely Kalu Ganga, Gin Ganga and Nilwala Ganga, which are considered particularly vulnerable to floods, occurred almost simultaneously. This flood was thus considered to be an appropriate selection for a comparative study of responses to the disaster.

Meanwhile, as for water-related disasters other than flood and landslide disasters, we decided to study the December 26, 2004 Indian Ocean Tsunami which caused extensive damage due to lack of precautions because tsunamis in Sri Lanka are rare.

4.1 Overview of Floods and Landslide Disasters (S03), (S07), (S15), (S23)

(1) Period

Generally, most floods occur due to monsoons that hit the country twice a year, the southwest monsoon or Yala season from May to September in the Western Province, Southern Province and in Sabaragamuwa Province and the northeast monsoon or Maha season from December to the following February in the Eastern Province, Northern Province and North Central Province.

From May 17 - 18, 2003, a record rainstorm hit the south of Sri Lanka for the first time in about 50 years. The heavy rainfall caused floods and landslides over extensive areas and resulted in extensive human and physical damage, such as claiming the lives of 235 people, partially or completely destroying houses, damaging agricultural products and breaking down the infrastructure network, as a result of which about 700,000 people became victims to this disaster. The rainfall that caused the floods and landslides were characterized by the following three points.

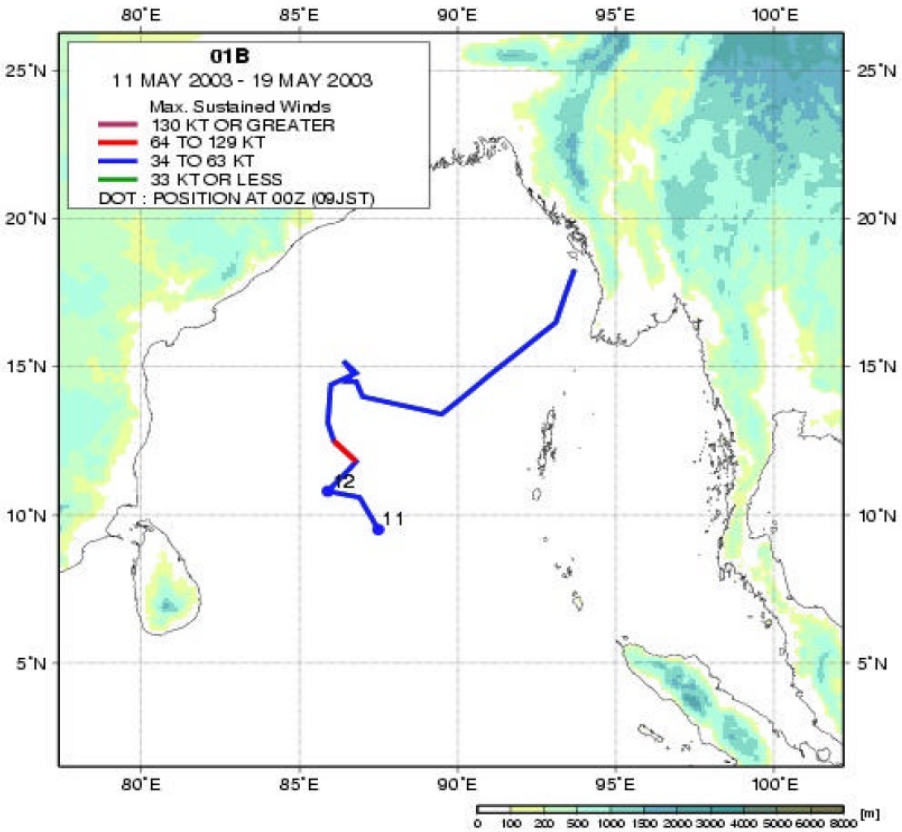
1) Stalling of the cyclone, something rarely seen in May

2) Continuous rain resulting from the stalling of the cyclone

3) Concentrated downpour following soil moisture saturation

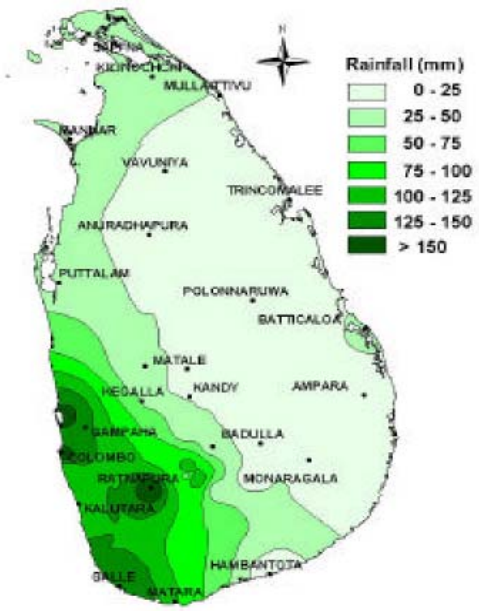
As shown in Fig. 4, there have been less than 20 cyclones during the last 100 years, and they are mostly all concentrated in November and December. Meanwhile, Fig. 13 shows the path of the cyclone from May 11 - 19, 2003. The cyclone that slowly moved up the Bay of Bengal set up the monsoon and brought heavy rain in the southwest area of Sri

Lanka. Fig. 14 shows the rainfall distribution in Sri Lanka prior to the disaster (May 16 - 18) during the one week from May 6 - 13. According to the data, 1 week of rain exceeding 100mm was recorded in the southwest area of the country.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

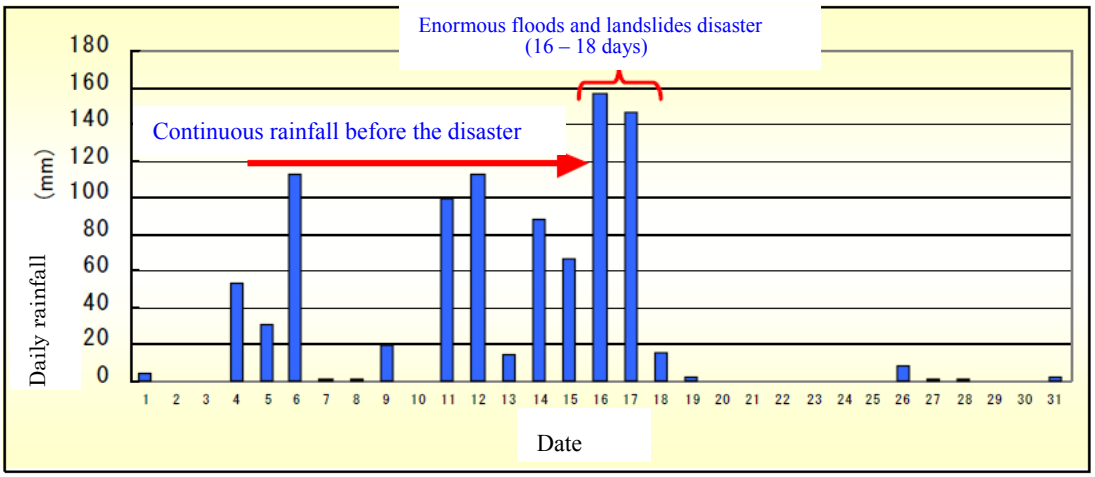
Fig. 13. Path of the Cyclone that Affected the Concentrated Heavy Rain



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

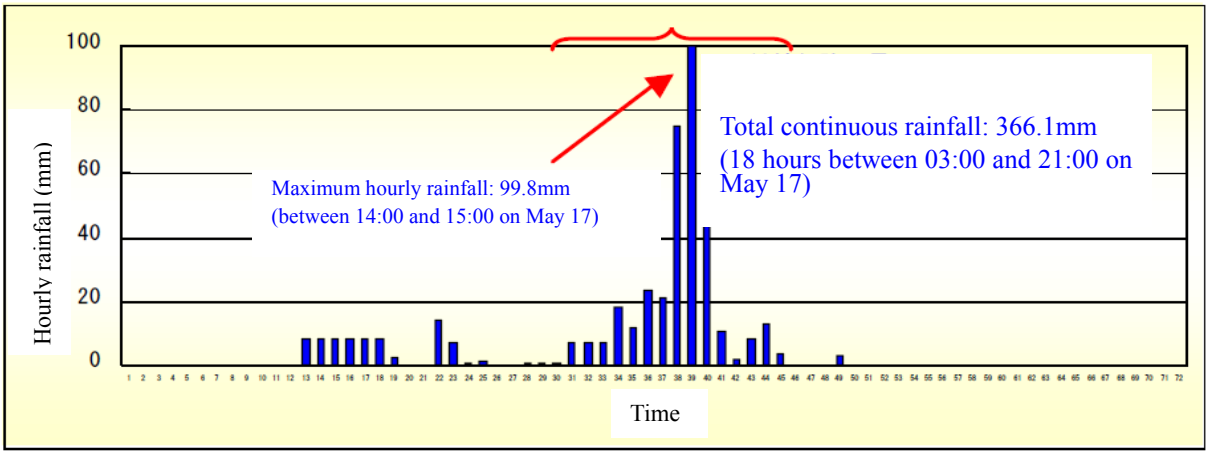
Fig. 14. May 6 - 13, 2003 Weekly Rainfall

In particular, as shown in Fig. 15, total rainfall exceeding 600mm was recorded in the Kalu Ganga's basin around Ratnapura from May 1 until May 15, the day prior to the disaster. It is believed that due to this continuous rainfall, the soil moisture in the area of the disaster was already saturated. On May 16, heavy rains were recorded in Ratnapura, with 156mm on May 16 and 146.5mm on May 17. Fig. 16 shows the hourly rainfall during 72 hours, between 00:00 on May 16 and 24:00 on May 18. In particular, continuous rain for 18 hours between 03:00 and 21:00 on May 17 was recorded for a total of 366.1mm, during which an hourly rainfall of 99.8mm was recorded between 14:00 and 15:00. In other words, the concentrated downpour following saturation of the soil moisture may have directly contributed to the events that caused the floods and landslides disaster.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 15. Daily Rainfall in May 2003 Observed at Ratnapura Rain-gauge Station



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 16. Hourly Rainfall Observed at Ratnapura Rain-gauge Station (72 hours between may 16, 00:00 and May18, 24:00)

(2) Frequency

Although the enormous damage caused by the recent December 26, 2004 Indian Ocean Tsunami is still fresh in the memory, the most frequent disasters in Sri Lanka are landslides caused by heavy rains, in other words, floods and landslide disasters.

Table 12 presents an overview of natural disasters that occurred in Sri Lanka during the 49 years between 1957 and 2005. While the country was hit by a tsunami disaster only

once, it suffered floods and landslides disasters 37 times in 49 years. In particular, in the southwest area where precipitation is high, the rivers flood every year, as a result of which 325 lives and 235 lives in 1989 and 2003 respectively, have been claimed, (See Table 9).

Records show that major floods in Sri Lanka occurred in 1913, 1940, 1947, 1957, 1967, 1969, 1978, 1989 and 1992.

Among these, the basin mean rainfall rates of Kalu Ganga, Gin Ganga and Nilwala Ganga during the 5 major floods in the past, namely 1947, 1957, 1969 and 1978 when the extent of the damage was severe as well as the May, 2003 floods are shown in Table 13. In addition, Fig. 17 shows a comparison of rainfall rates between the past 5 major floods.

Although in all basins, the most extensive damage was during the floods of May 2003, data show that they did not involve record-high rainfalls. Moreover, while rainfalls were evenly distributed across the country during the other major floods, the area where rain fell was limited to southwest Ceylon in May 2003.

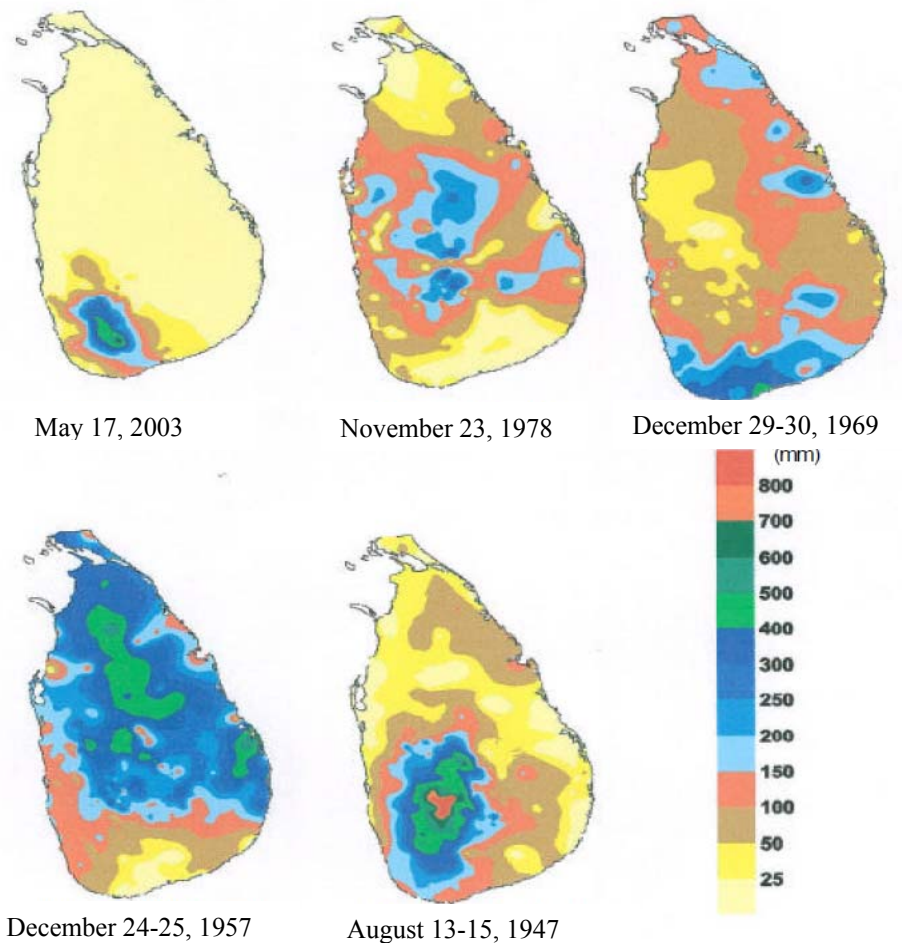
Table 13. Comparison of Basin Mean Rainfall Rates between the Past 5 Major Floods

(mm)

Name of basin	August 13-15, 1947	December 24-25, 1957	December 29-30, 1969	November 23, 1978	May 17, 2003
Kalu Ganga	369	109	102	55	219
Gin Ganga	249	83	223		227
Nilwala Ganga	221		305	52	233

Note: Figures in red represent the maximum mean rainfall rates for the basins.

Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

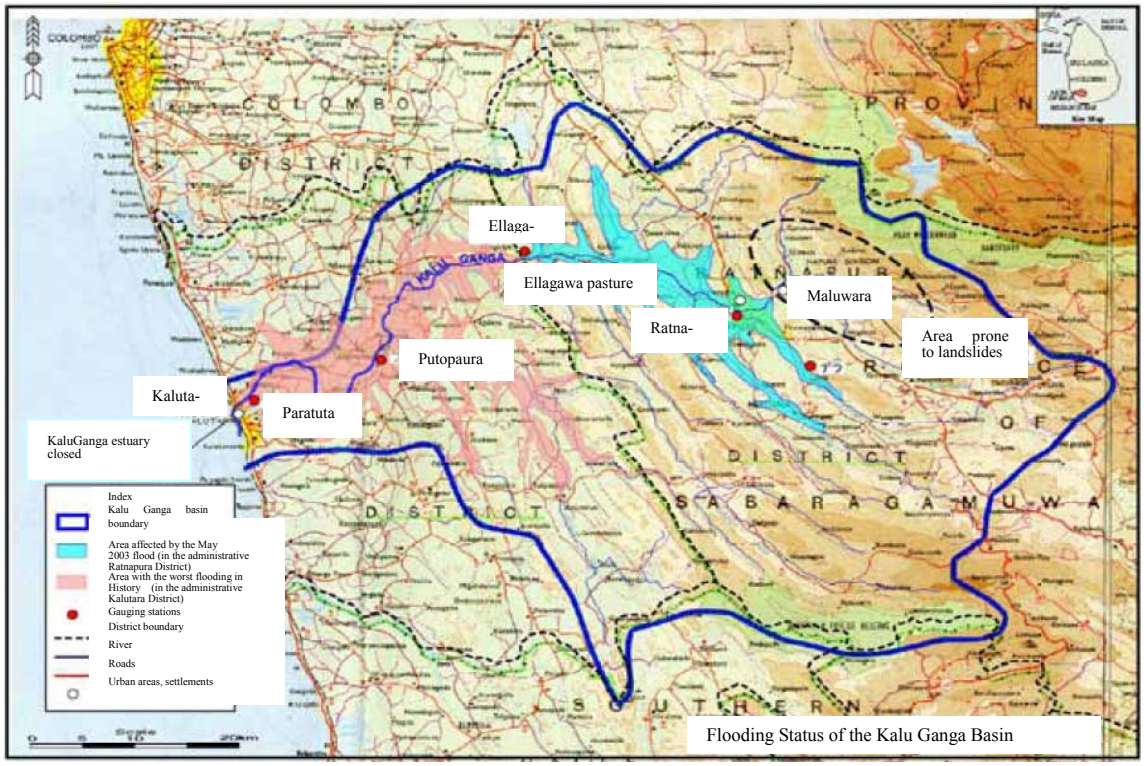
Fig. 17. Comparison of Rainfall Rates Between the Past 5 Major Floods

(3) Characteristics

<u>Kalu Ganga</u>

Kalu Ganga (Fig. 6, No.3) is a river located in the central area of Sri Lanka whose basin area is 2,690km^2 and river channel length is about 100km. According to the Department of Irrigation, annual mean rainfall is 4,000mm, and total annual discharge is 7.3 billion cubic meters. As shown in Fig. 18, the Kalu Ganga basin covers the upstream basin area (Ratnapura district) and the downstream low-lying area (Kalutara district). Although the altitude difference between the mountainous region of the riverhead and the estuary is about 2,250m, because the river drops from an altitude of 2,250m to 14m within 36km from the upstream border, most of the river is a low-gradient river, with a gradient of about 1/5,000. Moreover, another feature of this basin is that the boundary point of the

downstream low-lying area and upstream basin is a narrow area whose channel width is about 50m, which constitutes a factor contributing to the flooding in the upstream basin.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 18. Kalu Ganga Basin Map

Ratnapura city, at the center of the upstream basin area, is located at a point where rivers from the surrounding mountains meet, and because the gradient suddenly becomes gentle at the meeting point, this city is prone to floods. According to data obtained by the Department of Irrigation, the flood scales according to flood levels are classified as shown in Table 14. Ratnapura city's ground height is just about 20mMSL, and so when the flood level reaches the "minor level", a flood occurs in Ratnapura city. Ratnapura has seen a few major floods in the past, and Table 15 shows the 5 highest flood levels recorded.

Table 14. Ratnapura's Flood Classification

Classification	Water level (mMSL)
Normal	18.3
Minor	20.1
Major	21.3
Critical	24.4

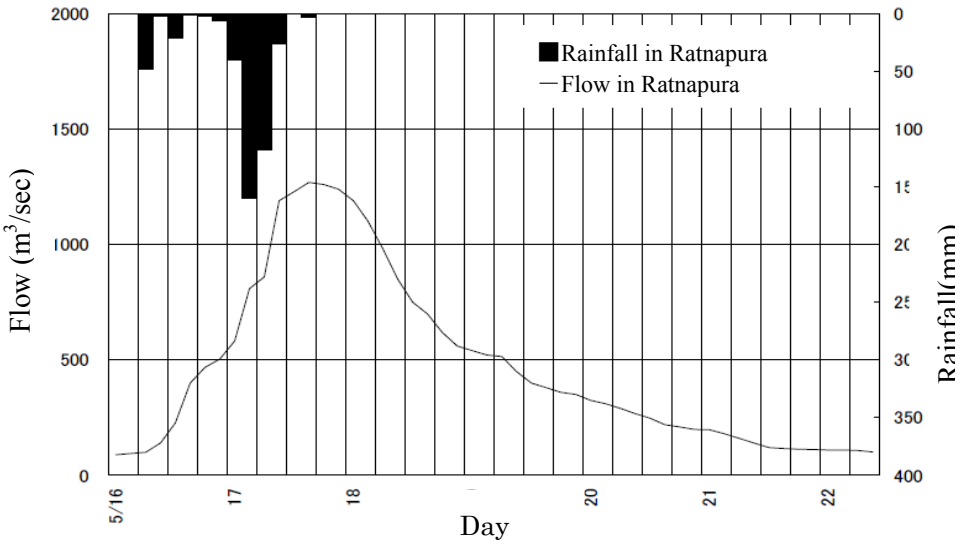
Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Table 15. Ratnapura's Previous Flood Levels

Rank	Year	Max. water level (mMSL)
1	1947	24.8
2	1913	24.6
3	1941	24.4
4	1903	23.9
5	1940	21.5

Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

The flood level in May 2003 reached a maximum of 23.9 mMSL, making it the fourth-highest level in recorded history. The city's flood depth exceeded 3m, submerging the first floor of most houses. Fig. 19 shows the rainfall and flow in Ratnapura during this period while Table 16 shows the peak flows at the reference points.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 19 Rainfall and Flow in Ratnapura during the May 2003 Flood

Table 16. Catchment Areas of Kalu Ganga's Reference Points and Peak Flows

During the May 2003 Flood

Reference point	Catchment area (km^2)	Peak flow (m^3/s)
Ratnapura	604	1,300
Ellagawa	1,393	2,620
PUTSUPAURA	2,598	1,020

Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

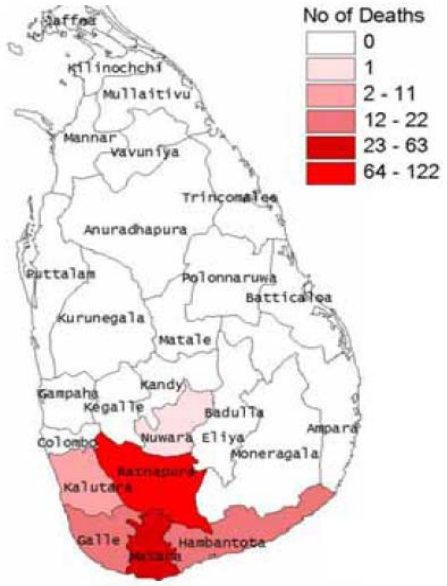
According to the Department of Irrigation, the maximum flow in Ratnapura is estimated at about 1,300m^3/s, which corresponds to a probable flood level in a period of 50 years. The estimated flooded area in Ratnapura District for this particular flood is the light blue area in Fig. 18. Meanwhile, because the flooded area of the downstream low-lying area (Kalutara District) was still under investigation (in the source of reference S03), as reference the flood area prepared based on prior major floods is shown in pink in the same figure.

Records on water levels show that the duration of this flood in Ratnapura was about 3 days. Although the duration of floods in this region is said to be usually around 3 days, a period of about 1 month is required for a return to normal economic activities.

According to the Department of Irrigation, the causes of this flood disaster can be summarized into the following 3 points.

(1) Extremely low gradient (1.0ft/1mile ＝ 30.48cm/1,609m 1/5,280)
(2) Far too much rain: 275 - 525mm
(3) Weir created by the narrowed area at Ellagawa

Meanwhile, due to torrential rain after May 16, 2003, landslides and avalanches occurred on May 17 in the mountainous areas of Ratnapura, Matara, Galle, Hambantota and Kalutara, which caused great human damage. Fig. 20 shows the statistics on the numbers of deaths and missing persons resulting from this landslide disaster. It is believed that many of the dead and missing persons were farmers with agricultural lands, such as tea plantations on the mountain sides which were directly affected by the mass movement of sediments. Moreover, on the upstream of Kalu Ganga, the collapsed sediments formed a natural dam, and the dam break may have washed away the downstream bridge.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

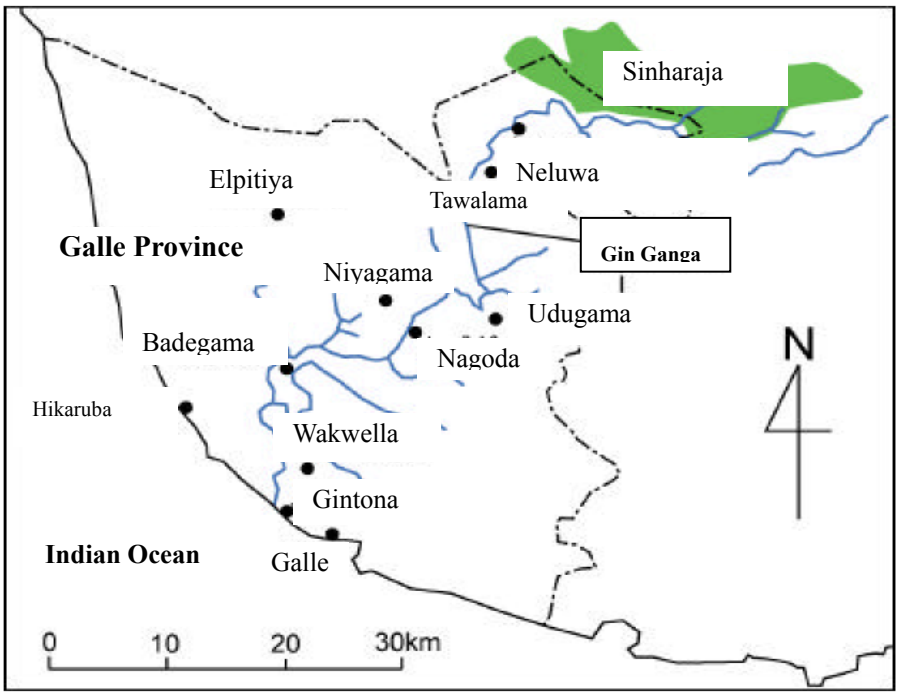
Fig. 20. Number of Deaths and Missing by District following the May 17 Landslide Disaster

Gin Ganga

Gin Ganga (Fig. 6, No.9) is a river flowing in the Galle District in the south of Sri Lanka, whose basin area is 947km^2 and river channel length is 112km (See Fig. 21). Heavy rain fell mainly on the upstream of the Gin Ganga until early morning of May 17, 2003. A flood occurred at Neluwa on the upstream of Gin Ganga, located at 20km upstream from the estuary, and the flood water flowed down the protected lowland downstream for 3-4 days. It seems that the water that overflowed in the protected lowland could not be discharged even after opening the floodgate. In some places during the flood, the current of the water was rapid and water depth exceeded 2m, and because roads leading up the shelters were also inundated with water, evacuation was extremely difficult in some areas. There were cases where helicopters were required to rescue the isolated residents. In Gin Ganga basin, 17 people were killed by this disaster. Six died due to landslides and the remaining 11 due to the flood. Compared to other districts, the number of deaths caused by the flood is high. The damage to infrastructure facilities and agricultural crops was also extensive.

Early in the morning of the 17, the Sinharaja forest reserve was hit by heavy rain exceeding 350mm. At that point, the water level was not particularly high but before noon it suddenly rose steeply. Then by night, Neluwa was swamped, and the water level of Gin Ganga rose to an unprecedented level. The low-lying area of Neluwa was inundated with water, and the village people were faced with a massive flood. That night, Tawalama faced a similar situation as a result of which the roads were completely cut off. Early morning on May 18, Nagoda and Niyagama were also affected by the flood and by that night, Badegama, Elpitiya, HIKARUBA and Galle were flooded.

At noon on May 19, the water level of the river gradually decreased at the upstream end, and districts and municipalities began loss assessment and the rescue of victims. Meanwhile, at the Gin Ganga estuary of Gintona, because the flow of the flood water was too weak to flow down from upstream, the water level of the river rose. As a result, at the bridge pier of the Galle-Colombo highway situated in the suburbs of Galle, the water level rose to 0.6m under the floor of the bridge. Due to such circumstances, in Galle District, sand bars that accumulated near the bridge pier were partially removed on May 20, which prevented Galle city from flooding.

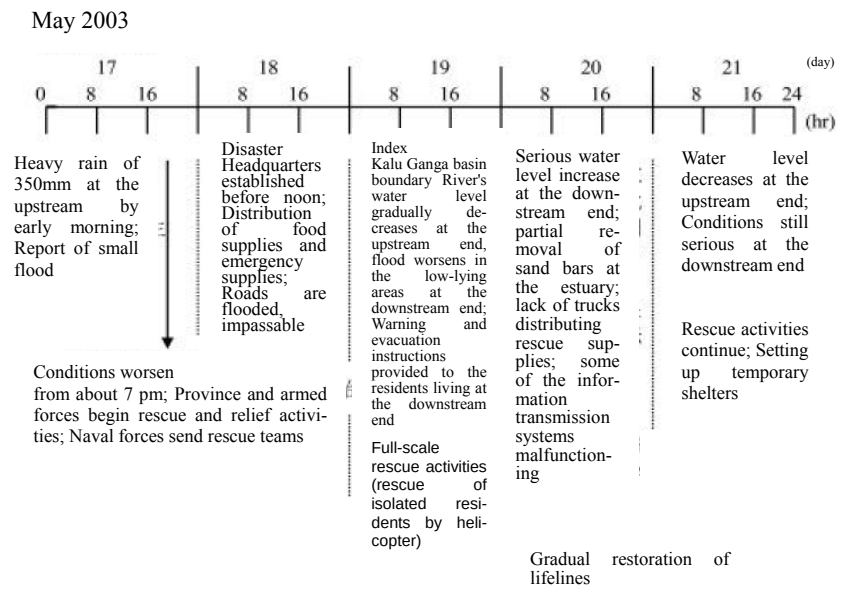


Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 21. Gin Ganga Basin Map

Fig. 22 shows the temporal changes in the Gin Ganga flood conditions and measures against disasters.

Although some residents had knowledge about the flood conditions through media, such as the radio and television, it is believed that disaster information in the affected areas was mainly transmitted by word of mouth including the use of loudspeakers. Moreover, the armed forces (naval forces) vigorously engaged in rescue and relief activities. Schools and public institutions were used as shelters, and boats used for evacuations and rescues were provided by fishermen.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 22. Temporal Changes in the Gin Ganga Flood Conditions and Measures Against Disasters

Nilwala Ganga

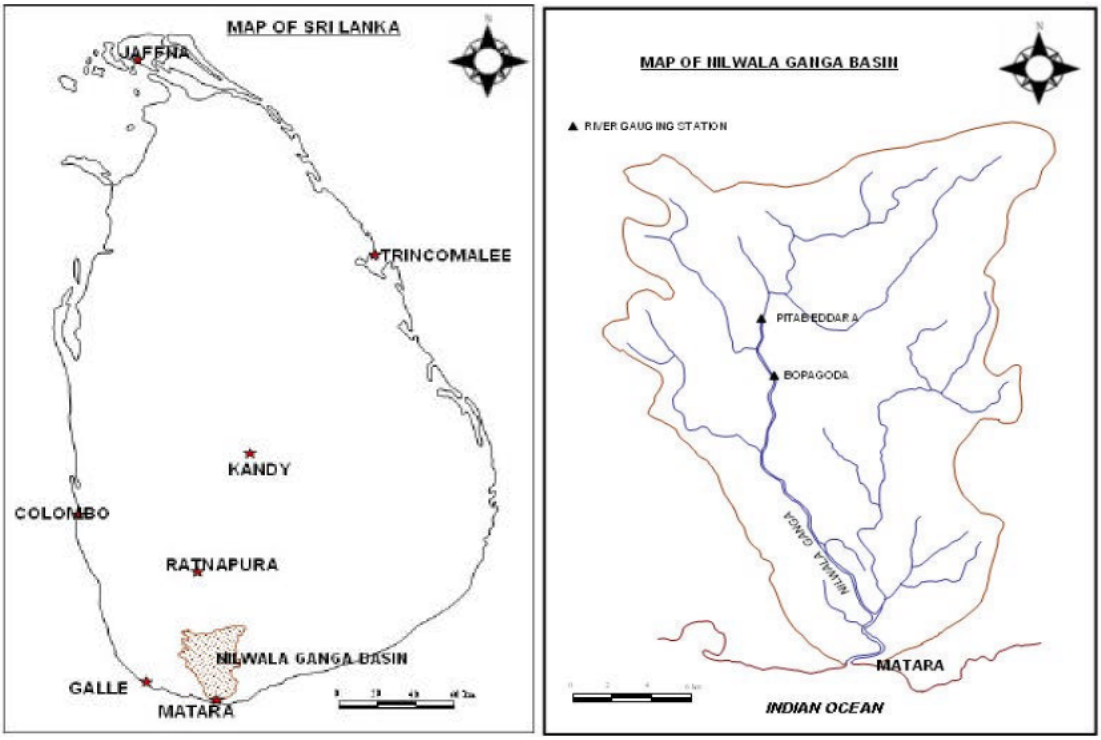
Nilwala Ganga (Fig.6, No.12) is located in Matara District in the south of Sri Lanka, between latitude 6°13' - 5°55' and longitude 80°25' - 80°38' (See Fig.23). It starts from the hill country in Deniyaya and Rakwana at an altitude of 1,050m. The length of the river channel is 70km. It reaches the city of Matara, the district capital (population: 110,000) and joins the Indian Ocean. The basin area is 1,070km^2, and the mountain area at the head is a forest covered with red-yellow podzols. On the mountainsides are rubber, tea and spice plantations, and most of the downstream lowlands are rice paddies. While the riverbed in the mountain area is a steeply sloping land of rocks, the gradient at the downstream end is relatively gentle.

As in Ratnapura at the upstream of Kalu Ganga, landslides occurred in precipitous mountainous terrain at the upstream of Nilwala Ganga following the long period of heavy rain in May 2003, as a result of which many roads were cut off. Moreover, slope failures caused the death of 34 people.

Meanwhile, with regard to flood conditions associated with heavy rain, the gentle river bed gradient in Pitabeddara combined with the land feature of the catchment basin at the upstream end which spreads out laterally led the flow to increase drastically and caused

a flood. However, the duration of the flood was short and depth was not significant. Therefore, the flood in this area seems to not have been a major problem. Meanwhile, because the local residents in the downstream area cut the dikes, the flood caused inundation to an extensive area, claiming the lives of 30 people.

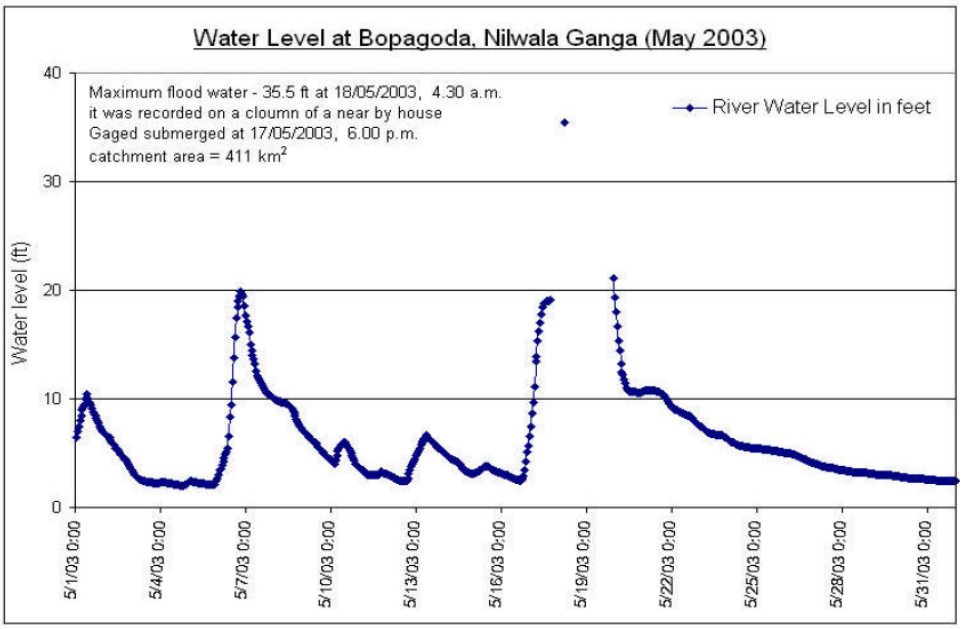
However, because no flood had occurred in the past 30 years in Nilwala Ganga, most of the residents had never experienced one. This is believed to be one of the reasons why the damage was so significant.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

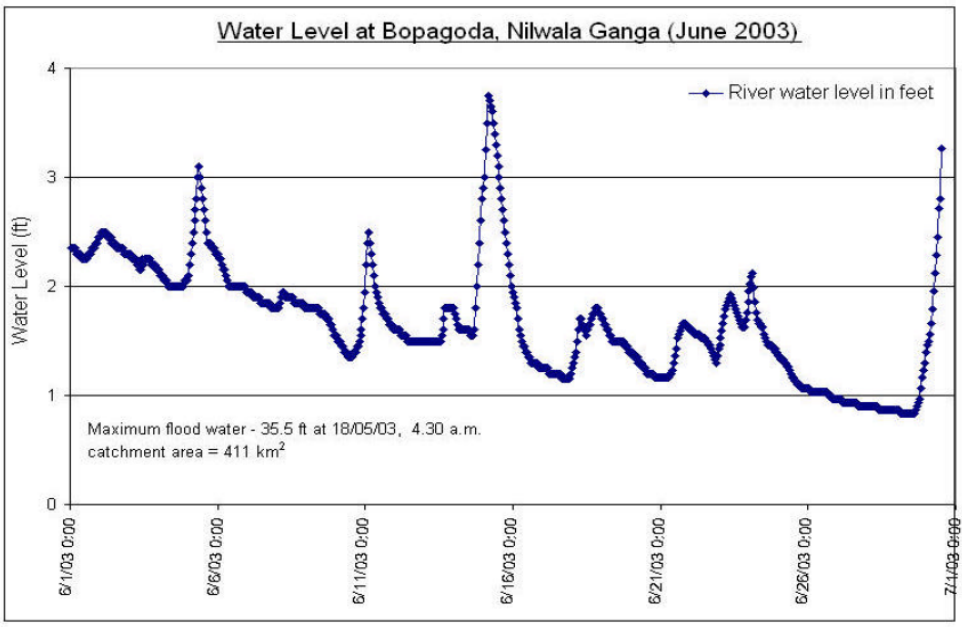
Fig. 23. Nilwala Ganga Basin Map

One of the features of the flood studied in this report is the sudden rise in water levels between May 17 and 18. Fig. 24 and 25 each show the time history of the water levels at Bopagoda at the upstream of Nilwala Ganga in May and June 2003.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 24. Time History of the Water Levels at Bopagoda in May 2003

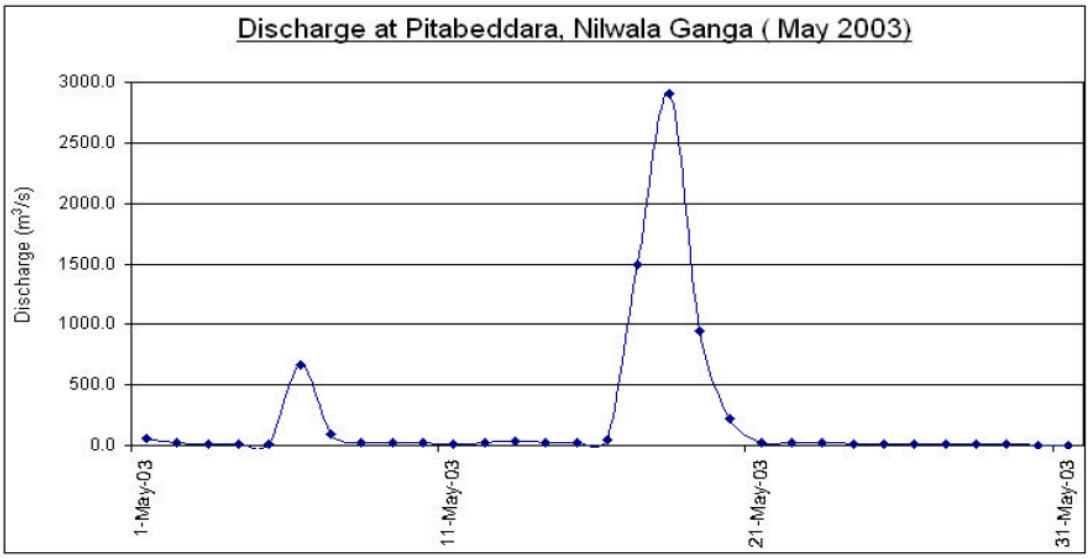


Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 25. Time History of the Water Levels at Bopagoda in June 2003

A comparison between Fig. 24 and 25 reveals that the water levels during the flood of May were much higher than the levels recorded during the flood in June. As opposed to

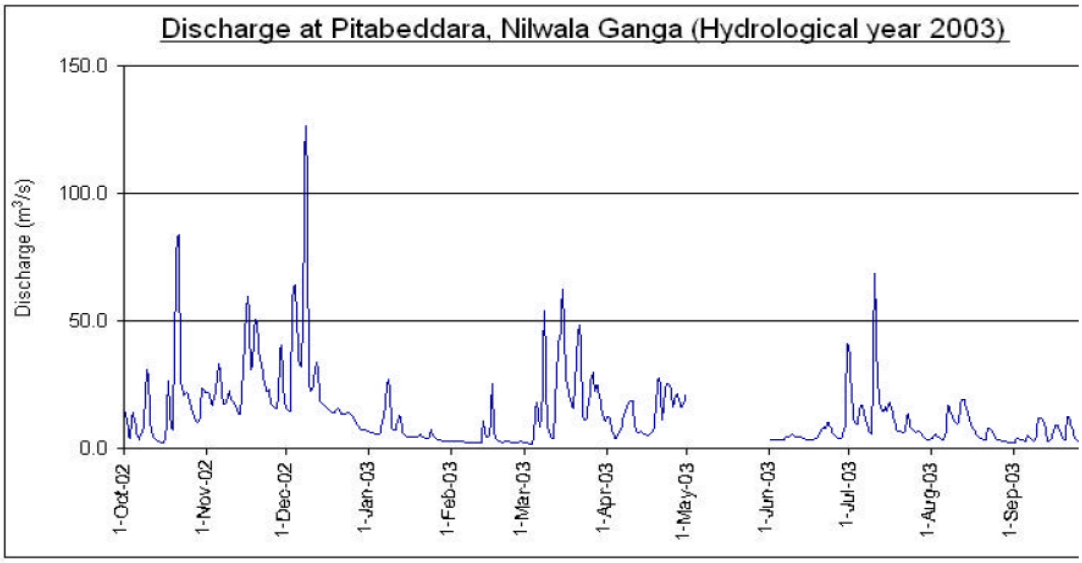
3.8ft (1.2m) during the one in June, water levels had reached 35.5ft (10.8m) during the flood that occurred on May 17. Because the water level at that time had exceeded the observable range of the automatic recording system, Fig. 24 shows the records obtained using traces. The maximum water level is estimated to have been reached at around 4:30 a.m. on May 18. Moreover, the data observed at Pitabeddara, located further upstream of Bopagoda, were converted into flow, and on the 18, the daily flow was 2,900m^3/s (See Fig. 26).



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

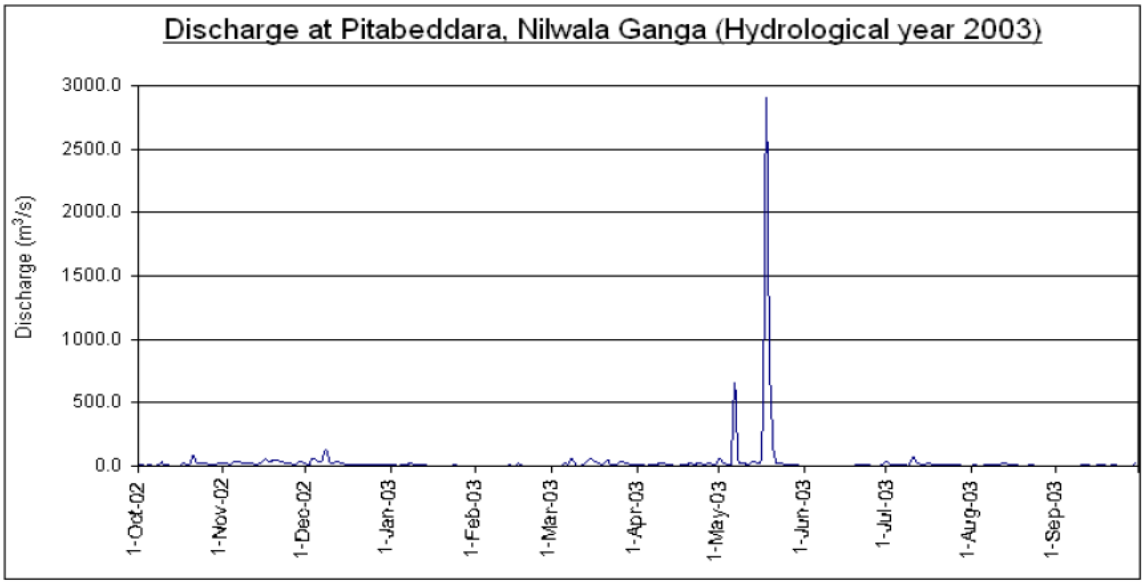
Fig. 26. Data on the Discharge at Pitabeddara in May 2003

Next, Fig. 27 and 28 each show the annual flow data at Pitabeddara from December 2002, using a different flow scale. While Fig. 27 shows that the daily flow rarely exceeds the normal 100m^3/s, Fig. 28 reveals that in May 2003 alone, the flow twice exceeded 500m^3/s. This shows that the rainfall in May 2003 was different from normal times and that the scale of the flood that occurred on May 17 2003 was out of the ordinary.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 27. Data on the Daily Discharge at Pitabeddara during Hydrological Year 2003 (1)



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 28. Data on the Daily Discharge at Piabeddara during Hydrological Year 2003 (2)

(4) List of Damages

Overview

Although discrepancies exist in the information contained in the sources of reference S03 and S15, Table 17 shows a list of the damages for each of the river basins, namely Kalu Ganga, Gin Ganga and Nilwala Ganga, and for the whole country, as will be discussed later.

Table 17. Damage Caused by the May 2003 Flood

	Kalu Ganga	Gin Ganga	Nilwala Ganga	Total for the 3 basins	National total (See note)
1. Damage to residents					
1-1.Deaths	133	17	64	214	235
Missing	0	0	17	17	-
1-2.Damaged housing units	58,675	32,000	47,637	138,312	-
Victims	-	-	145,875	-	695,000
1-3.Damaged houses					
(1) Complete	3,488	-	2,138	-	-
(2) Partial	11,108	-	5,562	-	-
2. Amount of damage by sector (unit: 1 million Rs)					
2-1. Electricity	88.9	-	-	-	-
2-2. Roads	263.1	-	-	-	-
2-3. Education	34.2	-	-	-	-
2-4. Irrigation facilities	44	-	-	-	-
2-5. Hygiene, healthcare	43.2	-	-	-	-
2-6. Dairy farming	20.1	-	-	-	-
2-7. Commerce and industry	97.1	-	-	-	-
2-8. Home equity, personal assets	795.9	-	-	-	-
2-9. Government agencies	6.4	-	-	-	-
Total	1,393.3	-	-	-	2,799.1

Note: The national totals are based on the data in the source of reference S15 (Table 11). Meanwhile, because the amounts of damage were in US$, they were converted into Rs using the exchange rate in 2003, as shown in Table 3 (average rates).
The figures other than the national totals are based on the source of reference S03 (Tables 18 and 19). Here, the "-" refers to figures that could not be confirmed.

Kalu Ganga

Table 18 shows the damage of Kalu Ganga basin caused by the May 2003 flood for both the upstream (Ratnapura area) and downstream (Kalutara area), based on the Sri Lanka's government survey.

Table 18. Damage of Kalu Ganga Basin Caused by the May 2003 Flood

	Ratnapura area	Kalutara area	Total
1. Damage to residents			
1-1.Deaths	122	11	133
1-2. Damaged housing units	37,008	21,667	58,675
1-3.Damaged houses			
(1) Complete	2,544	944	3,488
(2) Partial	8,683	2,425	11,108
2. Amount of damage by sector (unit: 1 million Rs)			
2-1. Electricity	62.7	26.2	88.9
2-2. Roads	205.2	57.9	263.1
2-3. Education	29.0	5.2	34.2
2-4. Irrigation facilities	33.4	10.6	44.0
2-5. Hygiene, healthcare	37.0	6.2	43.2
2-6. Dairy farming	9.6	10.5	20.1
2-7. Commerce and industry	78.4	18.7	97.1
2-8. Home equity, personal assets	600.7	195.2	795.9
2-9. Government agencies	1.0	5.4	6.4
Total	1,057.0	336.3	1,393.3

Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Gin Ganga

While 17 people died from the flood of May 2003, 6 died from landslides. As for the remaining 11, the flood was the actual cause of their death. Compared to other districts, the high number of deaths due to the flood is a feature to be noted. The number of damaged housing units amount to 32,000, and the places most severely affected were

Neluwa, Tawalama, Nagoda, Niyagama, Badegama and Galle.

The following is a summary of the damage within Galle District.

Damage to bridge piers

Concrete bridges: 16, culverts: 194, suspended and wooden bridges: 19

Damage to roads

Important roads: 419, general roads: 88

Damage to flood control facilities

Damaged levee area: 30km, sediment deposition at pumping stations: 10, area of sediment deposition in channels: 15km, partial damage to weirs: 3

Damage to telecommunications facilities

Poles that required replacement: 86, span wires: 197, telecommunications area: 33km

Damage to electricity facilities

High-voltage electrical power lines area: 85km, low-voltage electrical power lines area: 575km, electrical poles: 660, household electricity meters: 12,000, transformers: 25

Damage to other infrastructures

Temples, mosques, churches: 9, hospital (number of beds: 115): 1, public schools (damage caused by the flood alone): 19, public schools (damage caused by the flood and strong winds): 31, public buildings: 94

Damaged agricultural crops

Coconut plantations: 63 acres (estimated damage costs: 880,000 Sri Lanka rupees)
Tea plantations: 3,098 acres (estimated damage costs: 2,783,000 Sri Lanka rupees)
Rice paddies: 2,000 acres (estimated damage costs: 3,196,000 Sri Lanka rupees)
Cinnamon: 643 acres (estimated damage costs: 40,000 Sri Lanka rupees)
Banana: 497 acres (estimated damage costs: 1,360,000 Sri Lanka rupees)
Vegetable plantations (estimated damage costs: 211,500 Sri Lanka rupees)
Note: 1 acre = about 4,047m^2, 1 Sri Lankan rupees = about 1.25 JPY (as of April 2003)

Damage to companies

Tea factories: 5, small power plants: 11, stores: 853, gas stations: 4, rice mills: 5, village markets: 6

Nilwala Ganga

In the end, the extent of the damage turned out to be one of the worst ever seen, as shown in Table 19. This was the largest flood since 1947. The damage not only included inundated houses and damaged crops. Roads were cut off and bridge piers and culverts were destroyed. Moreover, 26 schools suffered damage. Some of the schools were used as shelters. For the reconstruction of houses, 100,000 Sri Lankan rupees and 50,000 Sri Lankan rupees were offered to completely destroyed houses and partially destroyed houses, respectively. The army cleaned the 2,941 polluted wells. A few international agencies provided tents and medical supplies. More than 300,000 people from local NGOs participated in voluntary activities.

Table 19. Damage of Nilwala Ganga Basin Caused by the May 2003 Flood

	Number of cases	Total number
Damaged houses	47,637 (25.6%)	185,668
Victims	145,875 (19.1%)	761,240
Partial damage	5,562	
Complete damage	2,138	
Casualties		
Floods	30	
Landslides (slope failure)	34	
Missing	17	

Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

(5) Measures (structural, non-structural)

Overview

Table 20 shows the status of structural and non-structural measures against floods and landslides for the basins of Kalu, Gin and Nilwala Ganga in May 2003.

Table 20. Status of Structural and Non-structural Measures for Kalu, Gin and Nilwala Ganga

Name of river	Basin area (km^2)	Channel length (km)	Status of measures against floods and landslides	
			Structural	Non-structural
Kalu Ganga	2,690	About 100	<u>Downstream (Kalutara)</u> • Existing facilities **Levees (partial)** • Other temporary measures Artificial cut and cover of river mouth sand bank <u>Upstream (Ratnapura)</u> • Existing facilities None • Plans Construction of multi-purpose dam in the upstream area and plans for levees in the surroundings of Ratnapura, etc.	• Flood prediction and warning system **None** • Flood hazard map **None** • Landslide hazard map Completed for Ratnapura (1996-1999) Plans to prepare one for Kalutara (2005-2007) • Disaster prevention education Publication of a disaster prevention textbook (2000) However, they were apparently not widely promoted
Gin Ganga	947	112	• Probable maximum precipitation Probability of 20 years • Target area 182km^2 covering the 22km or so from Agaliya to the estuary • Existing facilities **Levees,** overflow levees (spillway), pumping stations for drainage (10 stations), water gates, bridges, discharge channels, flood prevention of 5,000ha of rice paddies (based	• Flood prediction and warning system **None** • Flood hazard map **None** • Landslide hazard map Map for Matara not completed No plans to create a map for Galle • Disaster prevention education Publication of a disaster

			on a 10-year probable maximum precipitation), diversion aqueducts of about 30m in width around the downstream area, etc.	prevention textbook (2000) However, they were apparently not widely promoted
Nilwala Ganga	1,070	70	• Existing facilities Reservoirs, levees, drainage basins, pumping stations (Tudawa and two other places) • Levees Worsened the flood damage because the residents cut the levee on the right bank during the flood • Tudawa pumping station Largest pumping station in Nilwala Ganga Number of pumps: 8 (spout capacity: 3.5m^3/s) Note: Among the 8, 4 did not operate during the flood due to poor maintenance	• Flood prediction and warning system **None** • Flood hazard map **None** • Landslide hazard map • Map for Matara not completed • Disaster prevention education Publication of a disaster prevention textbook (2000) However, they were apparently not widely promoted

Note: Prepared based on 2003 Sri Lanka's Flood Damage Survey Report (S03)

The 4 rivers situated in the southwest, namely Kalu Ganga, Gin Ganga and Nilwala Ganga that suffered extensive floods in the past and Kelani Ganga have been receiving support from abroad since the 1960s and the government of Sri Lanka has put together a master plan on the measures against floods. However, more than 30 years have passed since the creation of the master plan, and because the status of land use within the basin has greatly changed, the validity of the master plan is now called into question. Moreover, although non-structural measures such as community disaster prevention and early warning and evacuation plans are necessary due to the fact that reduction of damage through structural measures alone can be financially and technically challenging under the current conditions in Sri Lanka, much work is still needed in this area.

Meanwhile, with regard to the hazard map-related project, which constitutes one of the non-structural measures, the National Building Research Organization (NBRO) has

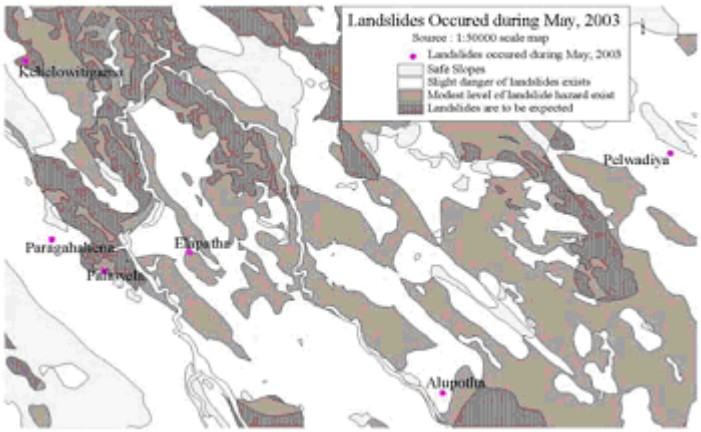
been working on the Landslide Hazard Mapping Programme (LHMP) since 1995 with the support of the UNDP/UNCHS. The LHMP targets 8 districts that are most prone to landslides, namely, Badulla, Nuwara Eliya, Kegale, Ratnapura, Kandy, Matale, Kalutara and Matara. Table 21 shows the status of the creation landslide hazard maps. As shown in the table, the LHMP is divided into 4 phases. During phase I, a hazard map was created in 1995 for Badulla and Nuwara Eliya. During the 1996-1999 phase II, a hazard map was created for Kegale and Ratnapura, during the 2000-2004 phase III, a hazard map was created for Kandy and Matale. During phase IV, which is between 2005 and 2007, a hazard map is expected to be completed for Kalutara and Matara.

Table 21. Status of the Creation of Landslide Hazard Maps

Phase	Area	Period of creation
I	Badulla, Nuwara Eliya	1995
II	Kegale, Ratnapura	1996-1999
III	Kandy, Matale	2000-2004
IV	Kalutara, Matara	2005-2007

Note: Prepared based on the 2003 Sri Lanka's Flood Damage Survey Report (S03)

The hazard maps were created using scales of 1/50,000 and 1/10,000, showing the 4 degrees of risk while taking into consideration information on land use, land forms, steepness of slopes, soil, geology and hydrology. Fig. 29 is an example of a hazard map. The figure also shows where landslides occurred in 2003. Landslides do not necessarily arise at the most vulnerable places, they also occur where the degree of risk is lower. According to a local interview survey, one of the factors explaining this is the change in the use of land.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

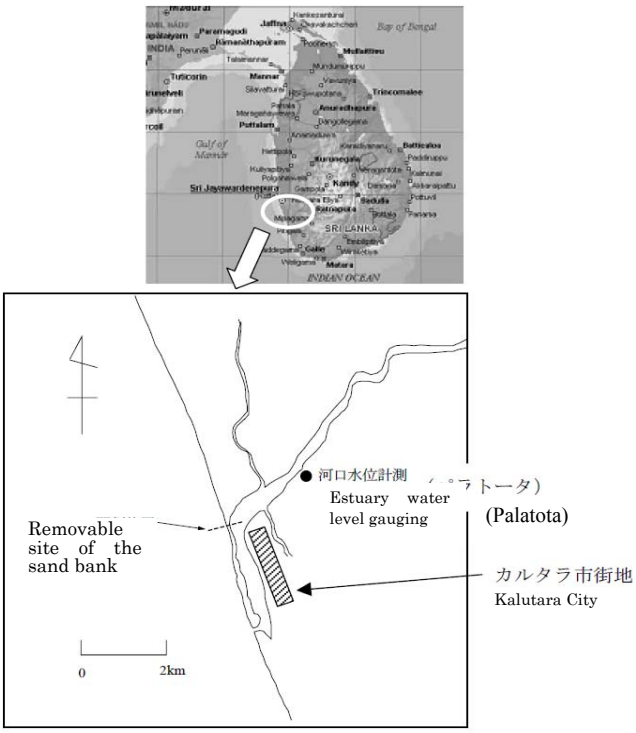
Fig. 29. Example of Landslide Hazard Map

Kalu Ganga

Even though in terms of existing structural measures, a levee was partially built at the most downstream point around Kalutara, measures against floods for flood-prone zone Ratnapura consist only of plans to build a multi-purpose dam at the upstream area and a levee around Ratnapura, nothing concrete has yet been implemented.

A major problem regarding the measures against floods for Kalu Ganga is the treatment of the estuary. Fig. 30 provides an overview of Kalu Ganga's river mouth topography. Because the city of Kalutara lies on the left bank of the estuary, the treatment of the estuary is an important aspect in flood control. Near the estuary the river channel changes its direction south, its width is about 100 to 200m and has a 3km-long estuary sand bar. This indicates that at this estuary, the coastal sand drift moving south is most troublesome. The width of the sand bar at the estuary is narrower at the base than at the end.

During the May 2003 flood, when the water level rose to +1.1mMSL at the Palatota point (estuary water level gauging site), the sand bar was artificially removed. Fig. 30 shows where the sand bar had been removed. However, due to active sand drift as mentioned earlier, it is difficult to maintain the opening for an extended period of time as it closes about 2 months later.



Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 30. Kalu Ganga River Mouth Topography

If the level of ＋1.1mMSL is taken as the starting level in the river channel project, then it would signify that the current river channel can only accommodate water up to the longitudinal water level that is less than ＋1.1mMSL. Meanwhile, during the May 2003 flood, the traces of flood at Palatota had reached about 2.1m, which goes to show how serious this flood was. Based on such circumstances, although maintenance of the estuary using artificial structures such as training levees is a possibility, some of the concerns include salt water intrusion into the river channel associated with the increased cross-sectional area at the river mouth and the effects of structures controlling coastal sand drifts on neighboring beaches. Thus radical measures that would replace artificial removal have still yet to be taken.

As for non-structural measures, the LHMP as mentioned earlier is being undertaken. Of the 8 districts whose degree of landslide risk is high, Kalu Ganga basin extends through 2 districts, namely Ratnapura District and Kalutara District. Mapping for the upstream

Ratnapura District was already completed prior to May 2003. Despite this fact, it seems it was not of much use during the disaster, and the lessons learned must surely be applied in the event of future disasters.

Gin Ganga

First, with regard to measures against floods using structures, levees are built and maintained only in the downstream zone of the river channel from the mouth to around 12km. Because the downstream region of the Gin Ganga is a low-lying area with much rain during the rainy season, it seems that emphasis is put on the protected lowland's drainage behind the levee. As water levels of Gin Ganga rise during the rainly season, drainage is carried out using pumps because the tributary stream water can not naturally flow down to Gin Ganga.

One of Gin Ganga's measures against floods, which include the abovementioned maintenance of levees and pumping stations, is the Gin Ganga Regulation Project (GRP) realized with the assistance of the Chinese Government. The GRP involves flood control of the 182km^2 area in the 22km or so interval between Agaliya and the mouth, based on a 20-year precipitation probability. It consists of structures such as levees, overflow levees (spillway), drainage pumping stations (10) from the tributary stream to this river, water gates, bridges and discharge channels. The GRP was made and entered by and between the Chinese and Sri Lanka Governments in 1972. Constructions began in 1976 and were complete in 1982. In addition China seems to have worked on flood control of 5,000ha of paddy lands (based on a 10-year probability precipitation) and on a hydraulic design of a diversion aqueduct of about 30m in width around the downstream area.

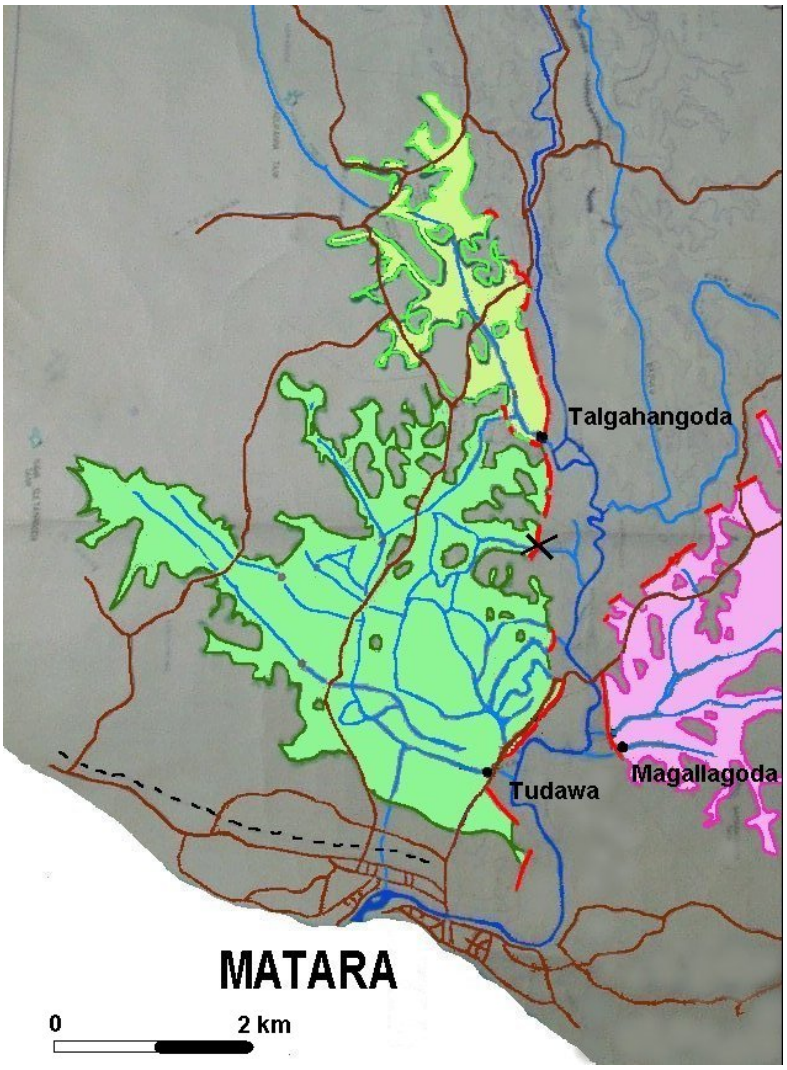
Meanwhile, an estuary barrage (lift gate) is under construction (as of 2004) to prevent salt water intrusion that accompanies the recent increases in water intake and decreased river bed. Because there are few dams at the upstream of Gin Ganga the supply of sediments is large, but sediment deposition on the upstream of the estuary barrage is not taken into consideration because the gate is opened fully during the rainy season. There are also no plans to create a fish pass due to the full opening of the gate during the rainy season, which is the spawning season for fish. The construction of the estuary barrage is sponsored by ADB and performed by the consortium of Korea's Kolon and Samsung as well as Sri Lanka's CML Edwards as their subcontractor.

In terms of non-structural measures, no particular plans were implemented, such as

flood forecasting and warning systems or flood hazard maps, while disaster prevention education that generates awareness about the risks of flood disasters were also not sufficient. Moreover, while Gin Ganga basin extends through 2 districts, namely Galle District and Matara District, a landslide hazard map of Matara District has yet to be completed, and Galle District is not included in the LHMP's list of districts.

Nilwala Ganga

Flood prevention works on Nilwala Ganga were conducted with the assistance of France by the then Ministry of Irrigation in 1979. The main projects included the building of reservoirs, and the establishment of levees, drainage basins and pumping stations. As shown in Fig. 31, the hilly area of the river's lower reach was used successfully in constructing a levee like a mountain ridge, which has been protecting the flatland. However, during the May 2003 flood, a substantial amount of water flowed within the levee due to the cutting of the levee, which created a situation where the pumping stations could no longer operate. In addition, many protected lowlands suffered from the floods as they were not prepared to deal with such sudden inundations.



Note: The ● marks refer the locations of the pumping stations, the × marks refer to areas where levees were cut, the red lines represent levees, and the 3 colored areas each represent the areas protected by levees.

Source: 2003 Sri Lanka's Flood Damage Survey Report (S03)

Fig. 31. Flood Prevention Works of the Lower Nilwala Ganga

The main flood prevention works by the French Government consist of 3 pumping stations and levees. In particular, the Tudawa pumping station is the largest with 8 pumps. Meanwhile, although the spout capacity per pump is 3.5m^3/s, it was revealed that 4 out of the existing 8 did not operate during the flood due to poor maintenance. In addition, these flood prevention works also included drainage basins with overflow levees in some places, which are useful during normal floods, but it seems that the large-scale

floods of May 2003 were much too extensive.

In terms of non-structural measures, just as with Gin Ganga, no particular plans were implemented such as flood forecasting and warning systems or flood hazard maps. With regard to landslide hazard maps, although Nilwala Ganga basin is located in Matara District and is thus included in the LHMP's list of districts, no map has been completed yet. In addition, because no flood had occurred in the past 30 years in Nilwala Ganga, most of the residents had never experienced a flood, and disaster prevention education that generates awareness about the risks of flood disasters were also not sufficient.

4.2 Overview of the December 2004 Tsunami Damage in Sri Lanka (S05), (S06), (S09), (S12), (S13)

(1) Overview

Introduction

On December 26, 2004 at 7:58:53 am local time (Japan Standard Time (JST): 9:58:53 am, Coordinated Universal Time (UTC): 0:58:53 am), an earthquake whose epicenter was 30km beneath the Indian Ocean occurred at 250km (latitude 3.316° north, longitude 95.854° east) south of the provincial capital Aceh located on the west coast of the Province of Nanggroe Aceh Darussalam, off the west coast of Indonesia's Sumatra Island, reporting a moment magnitude (magnitude defined by common logarithm of the energy of fault movements, Mw) of 9.0 (See note). This earthquake triggered a massive tsunami that devastated the coastline of not only Sri Lanka but also that of other nations on the coast of the Indian Ocean including Indonesia, India, the Maldives, Thailand and Malaysia. Even countries as far as in East Africa such as Kenya and Somalia were affected by the tsunami, resulting in a global-scale catastrophic disaster that claimed the lives of more than 200,000.

There are no official names for this earthquake and tsunami as they vary according to each media and website. For the purpose of this report, the above earthquake will be called the "Sumatra Earthquake" and the tsunami the "Indian Ocean Tsunami".

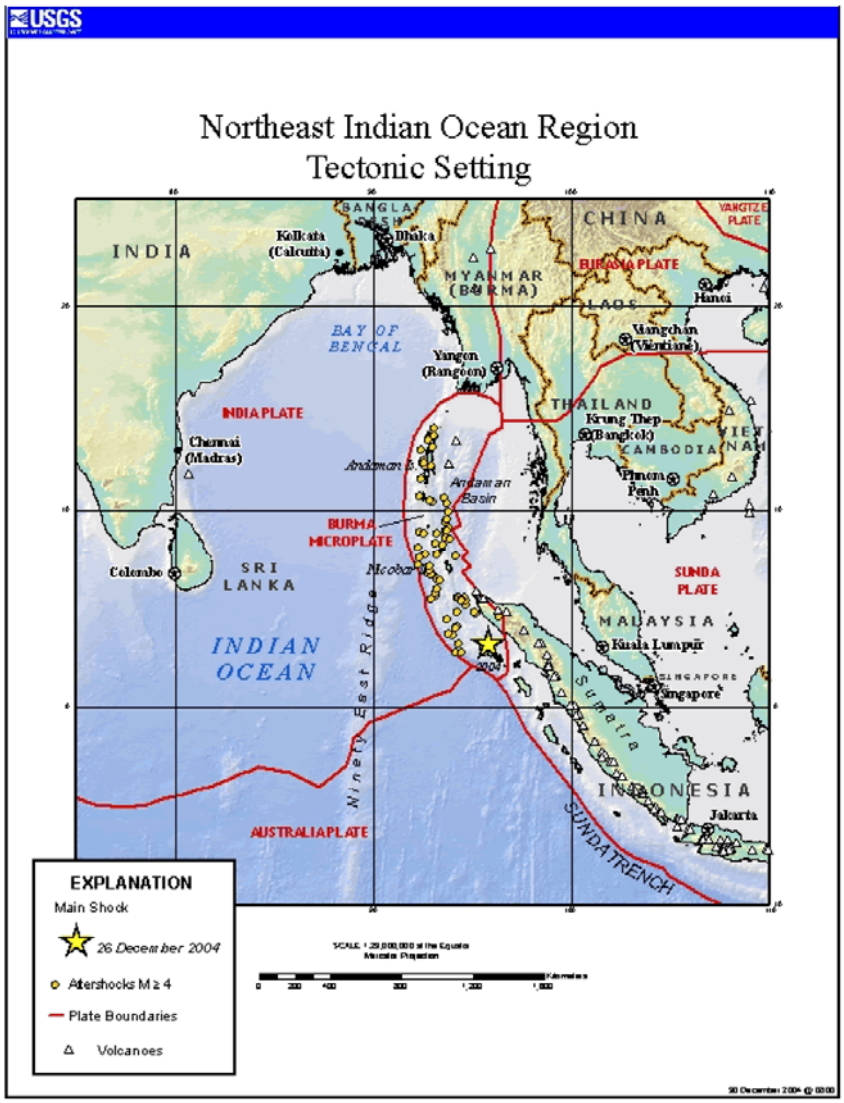
Although in Sri Lanka there was almost no damage caused by the Sumatra Earthquake, the Indian Ocean Tsunami that followed caused extensive damage. In mid January, there were over 35,000 dead or missing person, and more than 400,000 residents were forced

to take shelter.

Note: This report uses moment magnitude Mw=9.0 which is the value found in the sources of reference S06 and S12. Meanwhile, as of 2006, the United States Geological Survey (USGS) claims the Mw to be 9.1 and research groups such as Northwestern University claim it to be 9.3.

Overview of the Earthquake

The waters off the coast of Sumatra where the Sumatra Earthquake occurred is the Sunda Trench that runs past Indonesia's Sumatra and Java's southwest side (formed along the boundary where the Indo-Australian and Eurasian Plates meet). One of the features is that the epicenter of the earthquake that occurred along the Sunda Trench was relatively shallow (occurred at a depth that easily triggers tsunamis). Moreover, according to USGS, the scale of the faulting that occurred at the plate boundary had reached about 1,000km south north. Fig. 32 shows the epicenter and aftershock area of this earthquake. The number of aftershocks after the December 26 earthquake exceeding magnitude 6 amounted to 21 in a single month.



Source: Grant-in-Aid for Scientific Research (Grant-in-Aid for Special Purposes) Report on the "Understanding of the Overall Picture of the December 2004 Asian Tsunami Disaster" (S12)

Fig. 32. Epicenter and Aftershock Area of the Sumatra Earthquake

Overview of the Tsunami

The tsunami that followed the Sumatra Earthquake traveled in the Andaman Sea and Indian Ocean and smashed its way through Thailand, Malaysia, Indonesia's Sumatra, India, Sri Lanka, the Maldives, and even reached as far as the east coast of Africa.

Table 22 shows a comparison between the magnitudes (Mt) of the Indian Ocean Tsunami and other major tsunamis in the past. Here, Mt was calibrated to obtain a similar scale with Mw and is the scale to assess the size of the tsunami at the wave source

Table 22. Magnitudes of Past Tsunamis

Year of tsunami	Wave source	Tsunami magnitude (Mt)
1837	Valdivia (Chile)	9.3
1841	Kamchatka	9.0
1868	Africa (Chile)	9.0
1877	Iquique (Chile)	9.0
1946	Aleutians	9.3
1952	Kamchatka	9.0
1957	Aleutians	9.0
1960	Chile	9.4
1964	Alaska	9.1
2004	Sumatra (Indonesia)	9.1

Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of "Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (S06)

The above table shows that the size of the Indian Ocean Tsunami was one that ranks right behind the tsunami that followed the 1960's Chile Earthquake and the 1946 Aleutians Tsunami and is the same as the 1964 Alaska Tsunami, indicating that it was the second or third largest tsunami of the 20th century.

Furthermore, Table 23 lists past tsunamis that occurred on the Sunda Trench. According to this table, the oldest tsunami whose size (m) is assessed as 3 dates back to about 140 years ago in 1861. Even in terms of more recent ones, it was about 100 years ago in 1907 (m=2). This indicates that the Indian Ocean Tsunami was the type of tsunami that occur once every 100 to 150 years.

Table 23. Past Tsunamis that Occurred in Sumatra's Southwest Region

Date of tsunami	North latitude	West longitude	Earthquake size	Tsunami size (m)
1797/02/10	0°N	99°E	8	3
1833/11/24	2.5°N	100.5°E	8.25	2.5
1843/01/05	1.5°N	98°E	7.25	2
1861/02/16	1°N	97.5°E	8.5	3
1907/01/04	1.5°N	97°E	7.5	2

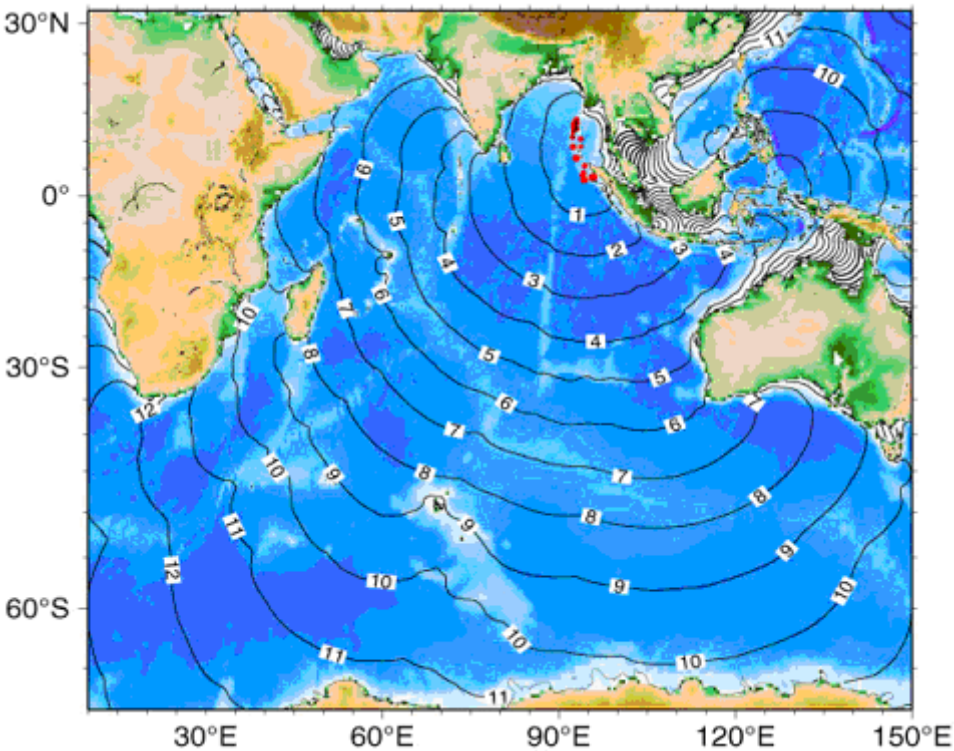
(Soloviev and Go (1975) Tsunami Catalog)

(Reference) Tsunami size (m)
Imamura-Iida Scale

Scale	Tsunami height	Level of damage
-1	50cm or lower	No damage
0	About 1m	Extremely little damage
1	More or less 2m	Damage to the coastline and boats
2	4 - 6m	Some inland damage and human cost
3	10 - 20m	Significant damage of more than 400km from the coastline
4	30m or higher	Significant damage of more than 500km from the coastline

Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of "Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (S06)

The Indian Ocean Tsunami occurred at the boundary where the Indo-Australian plate subducts under the Eurasian Plate. It is believed that directly above, the fault was raised and on the east side the sea floor subsided. With the faulting, the sea level around the wave source (about 1,000km) rose and fell and created a tsunami. Fig. 33 shows the propagation of the waves based on tsunami simulation results. The numbers in the figure refer to propagation time, based on the fact that the area where aftershocks were activated within 24 hours of the earthquake is the wave source.



Source: Report on the "Understanding of the Overall Picture of the December 2004 Asian Tsunami Disaster" (S12)

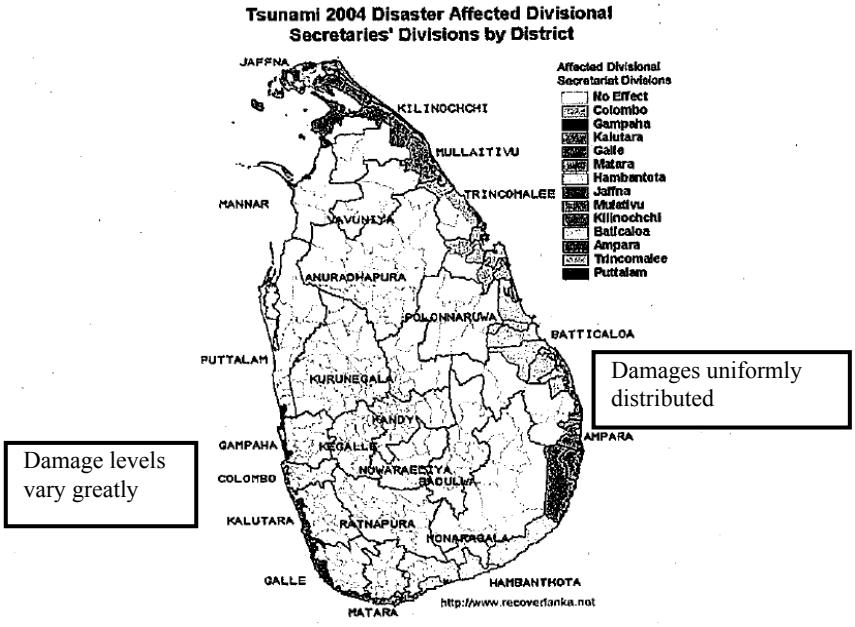
Fig. 33. Map of the Indian Ocean Tsunami Propagation (numbers refer to propagation time)

The above figure indicates that the time of arrival of the tsunami is about 2 hours to Phuket (Thailand) and east coast of Sri Lanka, 2 hours and a half to the east coast of India and southwest coast of Sri Lanka, and about 3 hours and a half to the Maldives. Moreover, the tsunami that traveled in the Indian Ocean reached Madagascar 8 hours later and the east coast of Africa 9 to 10 hours later.

Overview of the Tsunami Damage in Sri Lanka

Because Sri Lanka was 1,700km away from the epicenter of the Sumatra Earthquake, no one physically felt the earthquake. However, the tsunami that hit the east coast of Sri Lanka about 2 hours after the earthquake gradually moved south clockwise and even hit the southwest coast on the opposite side of the epicenter. As a result, 3/4 of the coastline of Sri Lanka suffered catastrophic damage. In the end, the devastated areas extended from Jaffna District on the northeast coast to Gampaha District on the southwest coast,

covering 11 coastal districts except the west coast.



Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of " Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (S06)

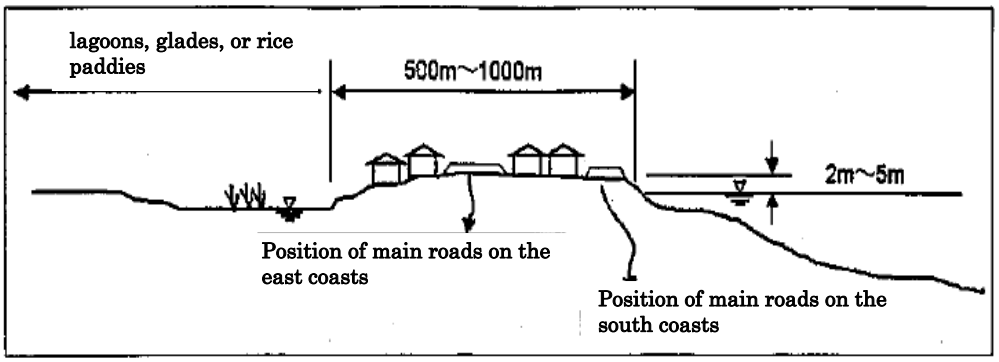
Fig. 34. Areas in Sri Lanka Affected by the Tsunami

The followings are geomorphic characteristics of affected areas (See Fig. 35 for a sketch).

(1) The coast of Sri Lanka consists of a series of roads and communities on the slightly elevated ground of the coastal dune.

(2) On the inland side of these communities are a series of lagoons, glades, or rice paddies (particularly so on the east coast).

(3) Main roads are all positioned high above sea level.



Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of "Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (S06)

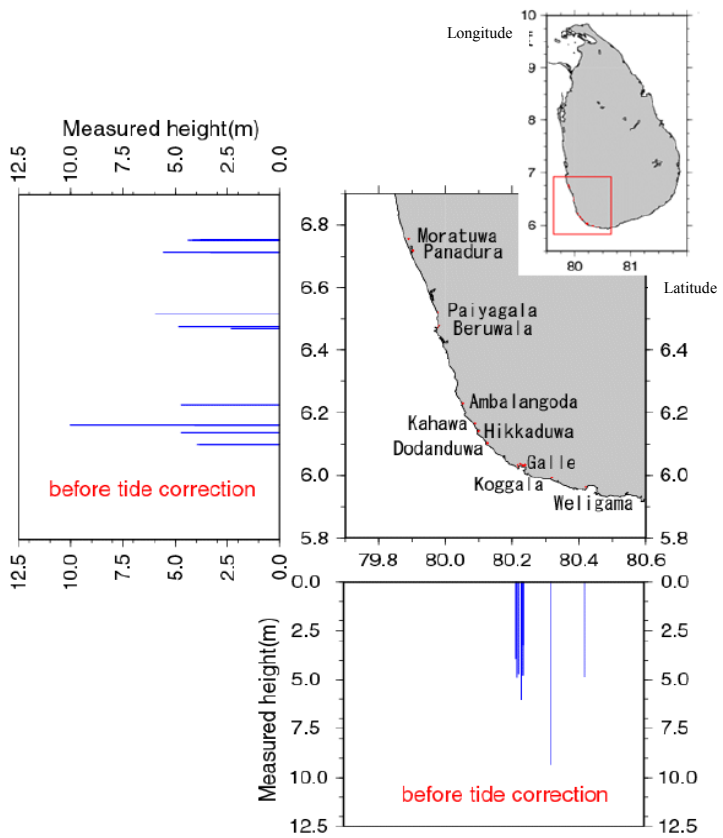
Fig. 35. Geomorphic Characteristics of Afflicted Areas

The damages were limited to areas of a few hundred meters along the coast. However, as shown in Fig. 34, while damages are almost uniformly distributed on the east coasts, the damage levels on the west coasts vary greatly. Table 24 shows the results of a survey of traces regarding the tsunami's wave heights (Hv) on the southwest coast and damage area from the coastline toward the inland region (Dh). Moreover, Fig. 36 shows the distribution of wave heights.

Table 24. Results of Study on Tsunami Traces at Each Location

Location	H_v (m)	D_h (m)	Position of trace	Survey time
Waligama	4.9	54	Exterior wall of a house	11:02, 05, Jan
Koggala Airport	9.3	64	Roof of a house	11:30, 05, Jan
Galle Port	6.0	190	Exterior wall of an office	13:35, 05, Jan
Dodanduwa	4.0	24	Exterior wall of a house	16:35, 05, Jan
Hikkaduwa Fishery Harbour	4.7	54	Interior wall of a house at second floor	09:40, 06, Jan
Kahawa	10.0	228	Palm tree	10:02, 06, Jan
Ambalangoda beach	4.7	50	Exterior wall of a house	11:50, 06, Jan
Beruwala Fishery Harbour	2.4	6	Interior wall of a building	13:10, 06, Jan
North Beach of Beruwala	4.8	50	Washed up tree	14:10, 06, Jan
Paiyagala Station	6.0	36	Interior wall of a house on the second floor	14:40, 06, Jan
Panadura	5.6	150	Roof of a house	15:50, 06, Jan
Moratuwa Beach	4.4	10	Exterior wall of a house	17:10, 04, Jan

Source: Report on the "Understanding of the Overall Picture of the December 2004 Asian Tsunami Disaster" (S12)



Source: Report on the "Understanding of the Overall Picture of the December 2004 Asian Tsunami Disaster" (S12)

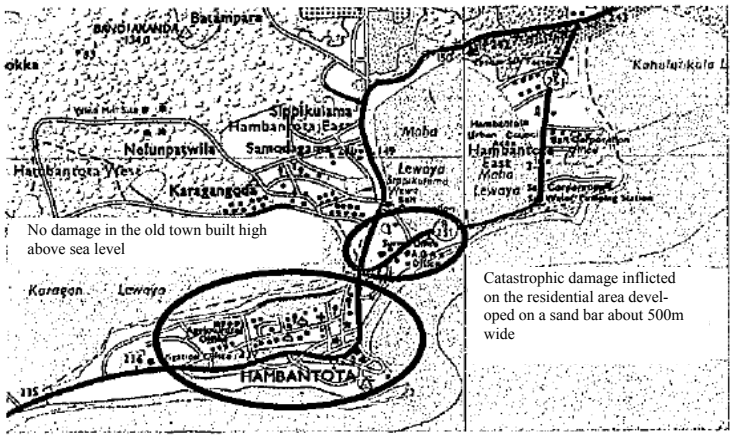
Fig. 36. Wave Height Distribution in Southwest Sri Lanka Based on Research on Tsunami Traces

A few reasons for the great variations in the levels of damage on the southwest coast include the fact that the tsunami that traveled toward the west of the island from the epicenter reflected off the south coast of Sri Lanka and hit the southwest coast as boundary waves (See Fig. 37), and that not only are there geomorphic differences on land but also slight differences in the geological formation of the seabed.

Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of " Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (S06)

Fig. 37. Tsunami Movement at the Southwest Coast

In addition, towns with geomorphic features that could not absorb the energy of the tsunami due to the short distance to the lagoon and the fearful energy of the incoming tsunami suffered devastating damage. For example, because the old town of Hambantota in Hambantota District is positioned high above sea level, there was no damage. However, the residential area on the slightly elevated sand bar about 500m wide suffered catastrophic damage. These conditions are shown in Fig. 38.



Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of " Research on the Management of Projects in the Field of Disaster Prevention (Project Research)"

Fig. 38. Extent of the Tsunami Damage in Hambantota (case where the valley floor is narrow and the tsunami reaches the lagoon)

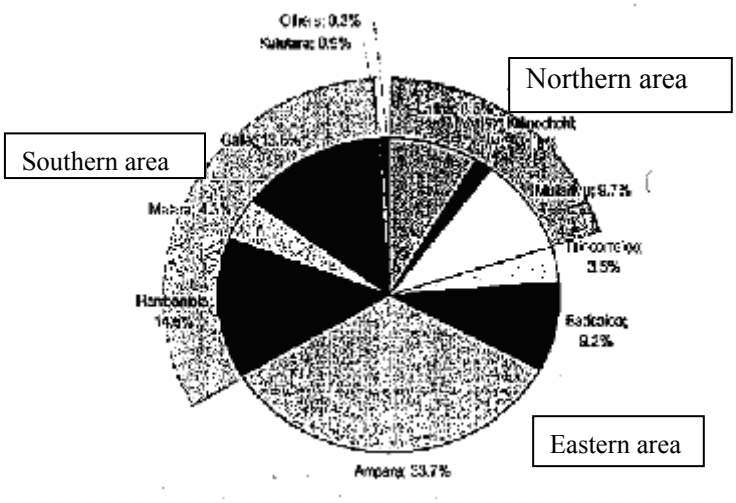
(2) Human Damage

As of February 1, 2005, the total number of deaths in Sri Lanka was 30,974 and that of missing persons was 4,698. Furthermore, as shown in Table 9, although the EM-DAT declares the number of deaths to be 35,399 (as of November 6, 2006) this section uses the figures of February 1, 2005 because details regarding the numbers by Province and District were unknown.

Damage was particularly severe in the Eastern Province where the tsunami directly hit the coast, resulting in about half of the total number of deaths (46.4%). This is followed by the Southern Province, and then the Northern Province, the Western Province, and the Northwestern Province.

In terms of districts, the tsunami killed the most people in Ampara District in the Eastern Province, with 19,436 deaths which is about 1/3 of the total number of deaths. This was followed by Hambantota District in the Southern Province, with 4,500 deaths, which accounts for 14.5% of the total number of deaths.

Fig. 39 shows the number of people who were killed by the tsunami by province and district, and Table 25 provides details on human damage across the country.



Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of "Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (S06)

Fig. 39. Number of Deaths Due to the Tsunami by Province and District

(as of February 1, 2005)

Table 25. Human Damage Caused by the Tsunami (as of February 1, 2005)

(Province)	(District)	Number of damaged households	Number of sheltered households	Population of sheltered people: Shelters	Population of sheltered people: Friends' or relatives' house	Population of sheltered people: Total	Death	Injured	Missing	Number of damaged houses: complete	Number of damaged houses: partial
(Northern)	Jaffna	12,714	10,639	10,198	29,919	40,117	2,640	1,647	540	6,084	1,114
	Killinochchi	2,295	318	305	1,298	1,603	560	670	1	1,250	4,250
	Mullaitivu		6,007	11,993	10,564	22,557	3,000	2,590	433	5,033	400
(Eastern)	Trincomalee	30,545	30,545	19,515	64,055	83,570	1,078	1,328	45	4,830	3,835
	Batticaloa	63,717	12,494	26,827	35,409	62,236	2,840	2,375	952	15,477	5,541
	Ampara	53,132	37,801	57,595	76,402	133,997	10,436	6,771	404	18,977	8,628
(Southern)	Hambantota	16,994	3,334	574	17,168	17,742	4,500	361	963	2,303	1,744
	Matara	20,675	2,779	2,655	9,017	11,672	1,342	6,652	612	2,362	5,659
	Galle	24,583	864	2,863	119,071	121,934	4,218	313	554	5,970	6,529
(Western)	Kalutara	6,905	6,905	2,953	21,740	24,693	271	401	174	2,780	3,116
	Colombo	9,647	5,290	5,565	26,086	31,651	79	64	12	3,398	2,210
	Gampaha	6,827	308	876	573	1,449	6	3	5	292	307
(North Western)	Puttlam	232	18	66		66	4	1	3	23	72
		248,266	117,302	141,985	411,302	553,287	30,974	23,176	4,698	69,779	43,405

Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of " Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (S06)

(3) Social Damage

Damage to Infrastructures

Because the country was devastated by the tsunami along its coastal belt, damage to its infrastructure remained minimal. Below is an overview of the damage each sector experienced.

[Roads and bridges]

- As mentioned in 2.4.2. (1) the levels of damage were low because the roads are situated on the most elevated parts of the coast.
- Although most of the causeways (road elevated by a bank across a wetland or seashore) and causeway bridges were struck, damage was minimal.
- Causeways were mainly damaged due to the washout of the embankment that came into contact with the bridge. Regarding bridges, most of the damage was due to the washout of abutment and subsequently of the structure above it. In addition, some bridge supports had sunk into the water, which may have been caused by the scouring mechanism associated with the tsunami and vibrations of the structures above.

[Ports]

- Small-scale port facilities were equally damaged.

- Of the 12 fishery harbors, 10 were damaged. In the southern area, most of the piers, breakwaters, ice facilities, and shore-based facilities, including workshops, administration buildings and a total of 9 fishery harbors, can no longer be used.

[Electricity]

- Among the lifelines, electricity has mostly been restored due to the prompt recovery operations by power companies after the disaster.
- The power companies are taking this opportunity to quickly replace the old power poles with new ones.

[Water Facilities]

- The water facilities on the northern and eastern coasts are mainly used by shallow wells, and due to saltwater, they are temporarily out of use.
- Meanwhile, with regard to some shallow wells whose underground water layer has been destroyed due to the water pressure of the tsunami and whose seepage layer may have been connected to the sea, future use may be difficult.

[Housing]

- The houses along the coasts are inhabited by fishermen and even in small fishing villages; most of them are nice stand-alone houses. However, because they are made of sun-dried brick walls, they are extremely vulnerable to external forces such as a tsunami and thus the area about 200m from the coastline is virtually all destroyed.

Damage to Industries

Because most of the damage occurred on the coast, the fishing industry was most affected by this tsunami disaster. According to the February 3, 2005 data, of the 31,343 fishing boats that existed prior to the tsunami, 20,552 (65%) were affected the tsunami as they were destroyed, washed away or damaged. In addition, more than 100,000 fishermen, 80,000 distributors, and 20,000 related workers lost their job. If their family members are included, this amounts to 800,000 people affected by the tsunami.

In particular, the damage was more serious on the northern and eastern coasts due to the large population of poor fishermen. Because their boats and fishing nets have been lost and they were supporting themselves, regaining their fishing equipment and rebuilding their lives are major issues.

(4) Disaster Countermeasures

Following the December 26, 2004 tsunami, the Sri Lanka Government declared a State of National Disaster, made an appeal for international assistance, and the President established 3 task forces to respond to the situation. Moreover, a Center for National Operations office was established at the President's office to be able to respond to emergency situations involving a tsunami. The CNO promoted emergency response activities in cooperation with concerned ministries and the United Nations. The names of each task force and their roles are as follows:

(1) Task Force for Rescue and Relief (TAFRER)

Chairperson: Tare del Mel (undersecretary of the Ministry of Education, director of the CNO)

Role: Emergency response: Coordination with national and international agencies involved in the understanding the conditions of the damage, emergency assistance and recovery, coordination with emergency aid and assistance donors, operation of the CNO, etc.

(2) Task Force to Rebuilding Nation (TAFREN)

Chairperson: Mano Tittawella (President's senior advisor)

Role: Mid and long-term recovery / rehabilitation response: damage assessment and development, creation of an action plan for infrastructure recovery, coordination with Sri Lanka's concerned departments including the private sector, coordination of donor assistance, etc.)

(3) Task Force for Logistics and Law and Order (TAFLOL)

Chairperson: Tilak Ranaviraja (Ministry of Public Security, Law and Order (undersecretary (at the time))

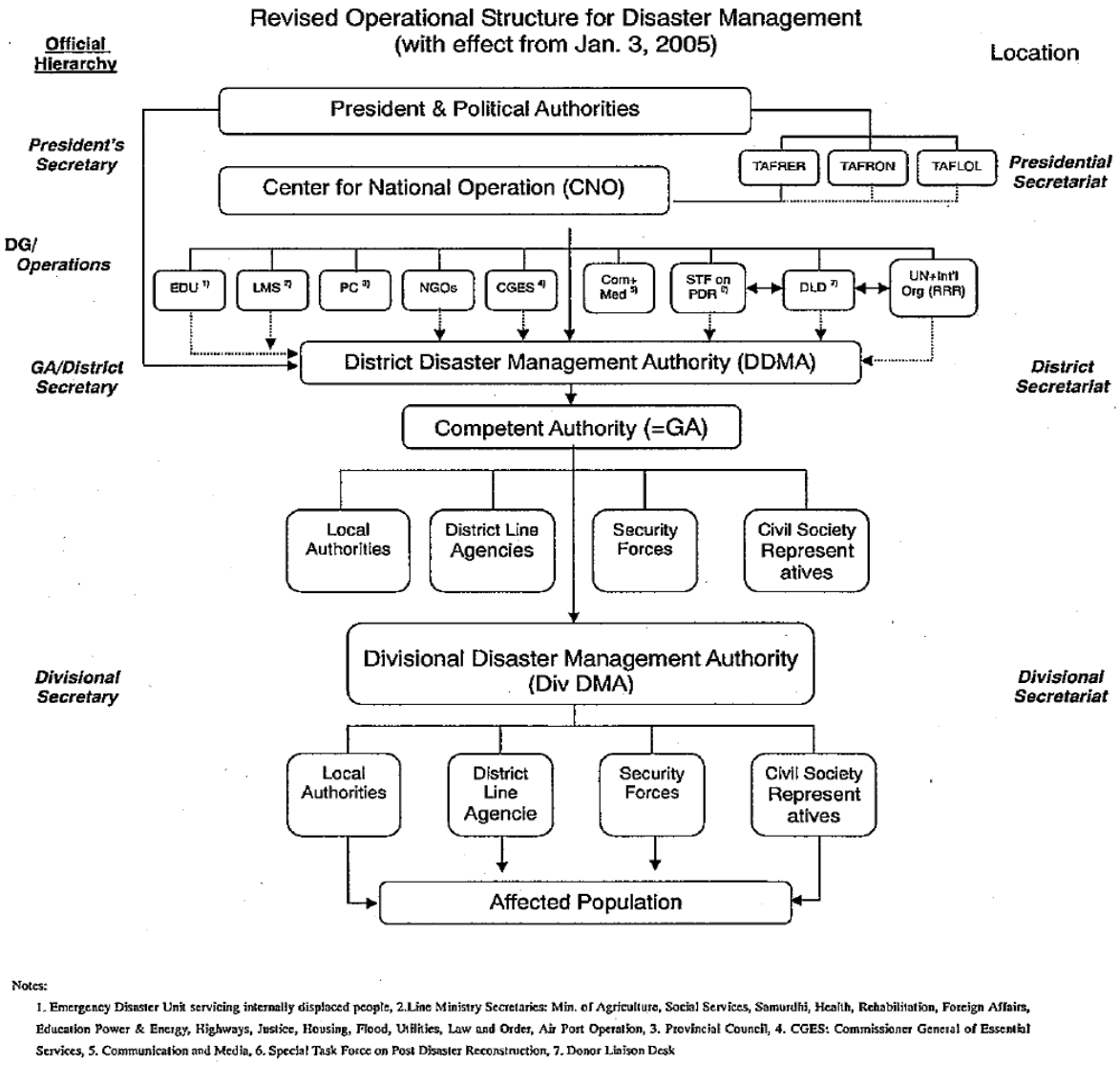
Role: Coordination of logistics of matters such as emergency assistance: Arrangement and coordination of the storage, distribution and shipping of emergency supplies, maintenance of law and order in affected areas

In addition to coordination with the above 3 agencies, the CNO also worked on logistics, food aid, water supply, hygiene, education, the fishing industry, psychosocial care and childcare, as well as establishing offices for each sector related to the tsunami disaster to determine the extent of the damage and keep track of the status of support. Moreover, in order to share this information, exchange opinions, and perform coordination, they held regular meetings twice every week. Furthermore, they held coordination meetings

with bilateral assistance agencies, UN agencies and NGOs, etc. for the coordination of emergency assistance. Fig. 40 shows the structure of the Sri Lanka Government's (central, district, division) for tsunami disaster management.

However, there are reports that in regard to the monitoring and coordination of relief activities by the CNO, national coordination has not been strong enough, and as will be discussed later, each district managed the coordination with the district agent as leader, and there seems to be considerable differences between each district and division in terms of the status of coordination.

Furthermore, the CNO was composed of volunteers from various organizations. One month into the activities, the response to the tsunami disaster shifted from the emergency assistance to the recovery and rehabilitation phase, and as the recovery and rehabilitation activities of each task force and ministry were on track, the CNO accomplished its task at the beginning of February 2005 and dissolved. After dissolution, the activities related to emergency assistance which they were working on were each passed on to concerned ministries, and TAFRER became the coordinator and the main organization to promote recovery and rehabilitation.



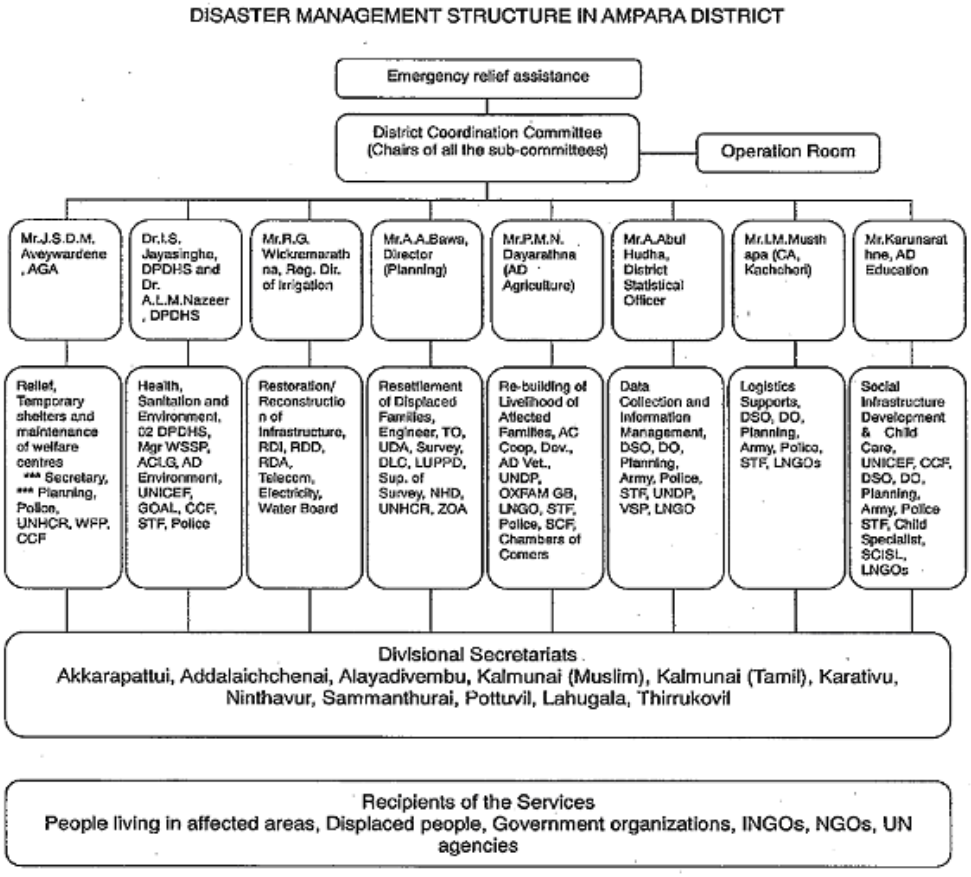
Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of " Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (S06)

Fig. 40. Structure of the Government of Sri Lanka in Response to the December 2004 Tsunami Disaster (Central, District, Division)

On a local administrative level, a District Disaster Management Authority (DDMA) was established in each district, which was led by a government agent (GA) sent directly by the Sri Lanka Government. For example in Ampara District, offices were established for "Relief, Temporary Shelters and Maintenance of Welfare Centres", "Health, Sanitation and Environment", "Restoration / Reconstruction of Infrastructure", "Resettlement of Displaced Families", "Rebuilding of Livelihood of Affected Families, "Data Collection

and Information Management", "Logistics Supports" and "Social Infrastructure Development and Child Care". Fig. 41 shows the district disaster management structure in Ampara District.

As for divisions, a Division Secretary (DS) was designated and a Division Disaster Management Authority (Div DMA) was established. As the lowest organization level, the DS directly responded to the affected population. The DS also monitored and updated information on the status of casualties and missing persons, numbers of displaced persons, and conditions of camps such as the status of food aid. In addition, they selected the sites of temporary shelters and occupants.



Source: Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of "Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (S06)

Fig. 41. District Disaster Management Structure (DDMA) in Response to the December 2004 Tsunami Disaster (Ampara District)

5. Damage Analysis

5.1 Damage Analysis of the May 2003 Flood and Landslide Disaster

(1) Flood and Landslide Disaster of Kalu Ganga (S03), (S07), (S15), (S23)

Fig. 42 shows the results of the damage factor analysis of the Kalu Ganga flood and landslide disaster. Meanwhile, Fig. 43 shows a diagram of the particular items obtained from the sources of reference for the factor analysis.

Below are the analyzed results regarding each factor.

[Natural Factors]

1) Continuous rain resulting from the stalling of the cyclone and concentrated downpour following soil moisture saturation

As mentioned in 4.1 (1), from May 17 - 18, 2003, a record rainstorm hit the south of Sri Lanka for the first time in about 50 years. However, it is believed that the previous heavy rain resulting from the stalling of the cyclone in the Bay of Bengal, something rarely seen in May, triggered the following flood and landslide disaster.

As shown in Fig. 15, total rainfall exceeding 600mm was recorded in the Kalu Ganga's basin around Ratnapura from May 1 until May 15, the day prior to the disaster. It is believed that due to this continuous rainfall, the soil moisture in the area of the disaster was already saturated. On May 16, heavy rains were recorded in Ratnapura, with 156mm on May 16 and 146.5mm on May 17. In particular, continuous rain for 18 hours between 03:00 and 21:00 on May 17 was recorded for a total of 366.1mm, during which an hourly rainfall of 99.8mm was recorded between 14:00 and 15:00 (See Fig. 16). In other words, the concentrated downpour following saturation of the soil moisture may have directly contributed to the events that caused the floods and landslides disaster.

2) Concentrated rain in southwest Ceylon

As mentioned in 4.1 (2), while the country suffered floods and landslides disasters 37 times in 49 years between 1957 and 2005, during the 4 major floods in 1947, 1957, 1969 and 1978 when the extent of the damage was severe, rainfalls were evenly distributed across the country but the area where rain fell during the May 2003 flood was limited to southwest Ceylon (See Table 13 and Fig. 17).

3) Geomorphic characteristics of Kalu Ganga whose middle and lower reach is of anextremely low-gradient and that also has a narrowed section

Most of the rivers in Sri Lanka are of high gradient in the upper river basin and then become extremely low gradient at the middle and lower reach. As a result, while landslides are frequent in the upper river basin, because the rivers are low gradient in the middle and lower reach, flood water can not promptly flow down and thus often overflow.

As shown in Fig. 18, the Kalu Ganga basin covers the upstream basin area (Ratnapura district) and the downstream low-lying area (Kalutara district). Ratnapura city, at the center of the upstream basin area, is located at a point where rivers from the surrounding mountains meet, and because the gradient becomes suddenly gentle at the meeting point, this city is prone to floods.

Moreover, another feature of this basin is that the boundary point (Ellagawa) of the downstream low-lying area and upstream basin is a narrow area whose channel width is about 50m, which constitutes a factor contributing to the flooding in the upstream basin.

[Social Factors]

4) Villagers live on dangerous mountainsides and do not respond to evacuation instructions

As mentioned in 4.1 (3), due to torrential rain after May 16, 2003, landslides and avalanches occurred on May 17 in the mountainous areas of Ratnapura, which caused great human suffering. It is believed that many of the dead and missing persons were farmers with agricultural lands such as tea plantations on the mountain-side who were directly affected by the mass movement of sediments. Although the Sri Lankan Government had prior to the disaster strongly advised the residents to evacuate, the residents prioritized the convenience of location for agricultural work and refused to leave their homes. This can be considered as one of the factors that spread the damage.

5) Increased potentials of flood and landslide disasters associated with the disorderly cultivation of slopes in mountain areas

In relation with 4), according to the source of reference S03, the 122 deaths in Ratnapura area as shown in Table 18 were all due to landslides. Although it is a matter of course that the risk of farmers living on hillsides and slopes of facing a landslide disaster is high, if they cut forest trees and cultivate mountain areas in a disorderly fashion, the artificial change of land use, such as transforming the area into a tea plantation, causes the forest's water retaining capacity to decrease and the risk of sediment washout to increase, and therefore the possibility that flood and landslide disaster potentials have increased compared to before the cutting of trees and cultivation can not be denied.

[Status of Measures (flood control facilities, shelters, etc.)]

6) No flood control facilities (structures) in Ratnapura, a flood-prone zone

As mentioned in 4.1 (5), although in terms of existing structural measures a levee is partially built at the most downstream point around Kalutara, measures against floods for flood-prone zone Ratnapura consist only of plans to build a multi-purpose dam at the upstream area and a levee around Ratnapura, nothing concrete has been implemented yet.

7) Unused landslide hazard map

As mentioned in 4.1 (5), hazard mapping for the Ratnapura District, which is included in the Kalu Ganga basin, was already completed prior to May 2003. Despite this fact, it seems it was not of much use during the disaster.

8) Insufficient disaster prevention education

Surveys reveal that the disaster prevention textbook published in 2000 was not sufficiently promoted. However, because the content of the textbook is unknown, it may not be safe to assume that sufficient promotion would have alleviated this flood and landslide disaster. Nevertheless, according to the field survey results indicated in the source of reference S03, local disaster prevention education seems to have been insufficient.

[Status of Response (evacuation status, etc.)]

9) Surprisingly long evacuation time

According to the residents, the flood did not rush down in a torrent, both in Ratnapura city and in neighboring villages. Instead, it gradually inundated and thus there seems to have been enough evacuation time. The reason for the flood is believed to have been the increased water level of the dam due to the narrowed passage gradually affected the upstream area. Meanwhile, as mentioned in 5), the 122 deaths in Ratnapura area were all due to landslides, indicating that they had not evacuated or that the situation was not at a crisis point that could lead to death.

Natural Conditions of Sri Lanka

- Located about 29km south of India, Sri Lanka is an island surrounded by sea, with a coastline of 1,340km.
- Sri Lanka's climate conditions are briefly divided into three zones. The island's southwest area including the central highlands is a wet zone with high precipitation.
- It is affected by the southwest monsoon or Yala season from May to September and the northeast monsoon or Maha season from December to the following February. Due to these monsoons, the meteorological conditions are categorized into 4 periods. During the Yala period, rain falls abundantly in the southwest area including the island's central highlands.
- It is often hit by cyclones because it is located at a low altitude, but they are not frequent.

Heavy rain resulting from the stalling of the cyclone in the Bay of Bengal, something rarely seen in May
Ratnapura's total rainfall exceeding 600mm (May 1-15)

Rainfall limited to southwest Ceylon.

Concentrated downpour following soil moisture saturation (rainfall at Ratnapura)
Daily rainfall: 156mm (May 16), 146.5mm (May 17)
Hourly rainfall: 366.1mm (3:00 - 21:00 = 18 hrs,
99.8mm (14:00 - 15:00 = 1 hr)

Boundary point of the downstream low-lying area and upstream basin (Ellagawa) is a narrow area whose channel width is about 50m

[Explanatory notes]
◆Measure status (flood control facilities, shelters, etc.): ■blue
◆Measure status (evacuation status, etc.): ■green
◆Damage status
Human: ■red solid line
Physical: ■red dotted line
◆Natural factors (external force, geography, land features: ■orange
◆Social factors (poverty, vulnerability): ■purple

No flood control facilities (structural) at the upstream flood-prone zone (only plans of construction of multi-purpose dam in the upstream area and of levees in the surroundings of Ratnapura, etc. Because the water cannot flow down the narrowed passage, water levels rose.

The flood did not rush down in a torrent both in Ratnapura city and in neighboring villages. Instead, it gradually inundated and thus there seems to have been enough evacuation time.

Although there is a 100 to 200m wide and 3km-long sand bar at the estuary, because the city of Kalutara lies on the left bank of the estuary, the treatment of the estuary is an important aspect of flood control. To lower the water level of the river, the sand bar was artificially removed.

The National Building Research Organization (NBRO) has been working on the Landslide Hazard Mapping Programme (LHMP) since 1995, targeting 8 districts whose risk of landslides is high. Of the 8 districts, Kalu Ganga basin extends through 2 districts, namely Ratnapura and Kalutara district. Mapping for the upstream Ratnapura District was already completed prior to May 2003.

However it was not used effectively during the disaster.

Details regarding the reasons why it wasn't used is unknown.

Farmers with agricultural land on mountainsides such as tea plantations prioritized the convenience of location for agricultural work and refused to leave their home.
Despite the Sri Lanka Government's recommendations to the residents to evacuate, most the residents did not respond.

The residents on mountainsides cut forest trees and cultivated mountain areas in a disorderly fashion, and the artificial change of land use such as transforming the area into a tea plantation caused the forest's water retaining capacity to decrease and the risk of sediment washout to increase and therefore the possibility of flood and landslide disaster potentials have increased compared to before the cutting of trees and cultivation.

Damage costs per sector (1 million Rs)

Electricity	88.9
Roads	263.1
Education	34.2
Irrigation facilities	44.0
Hygiene and healthcare	43.2
Dairy farming	20.1
Commerce and industry	97.1
Housing and personal assets	795.9
Government-related agencies	6.4
Total	1,393.3

Damaged houses

Complete: 3,488

Partial: 11,108

Deaths: 133 (Ratnapura area: 122, Kalutara area: 11)
Victims: 58,675 households
Among these, the 122 deaths in Ratnapura area were due to landslide disasters. It is believed that many of the dead and missing were farmers with agricultural land on the mountain-side such as tea plantations who were directly affected by the mass movement of sediments.

Fig. 42. Damage Factor Analysis of the May 2003 Flood and Landslide Disaster (Kalu Ganga) (Summary of facts)

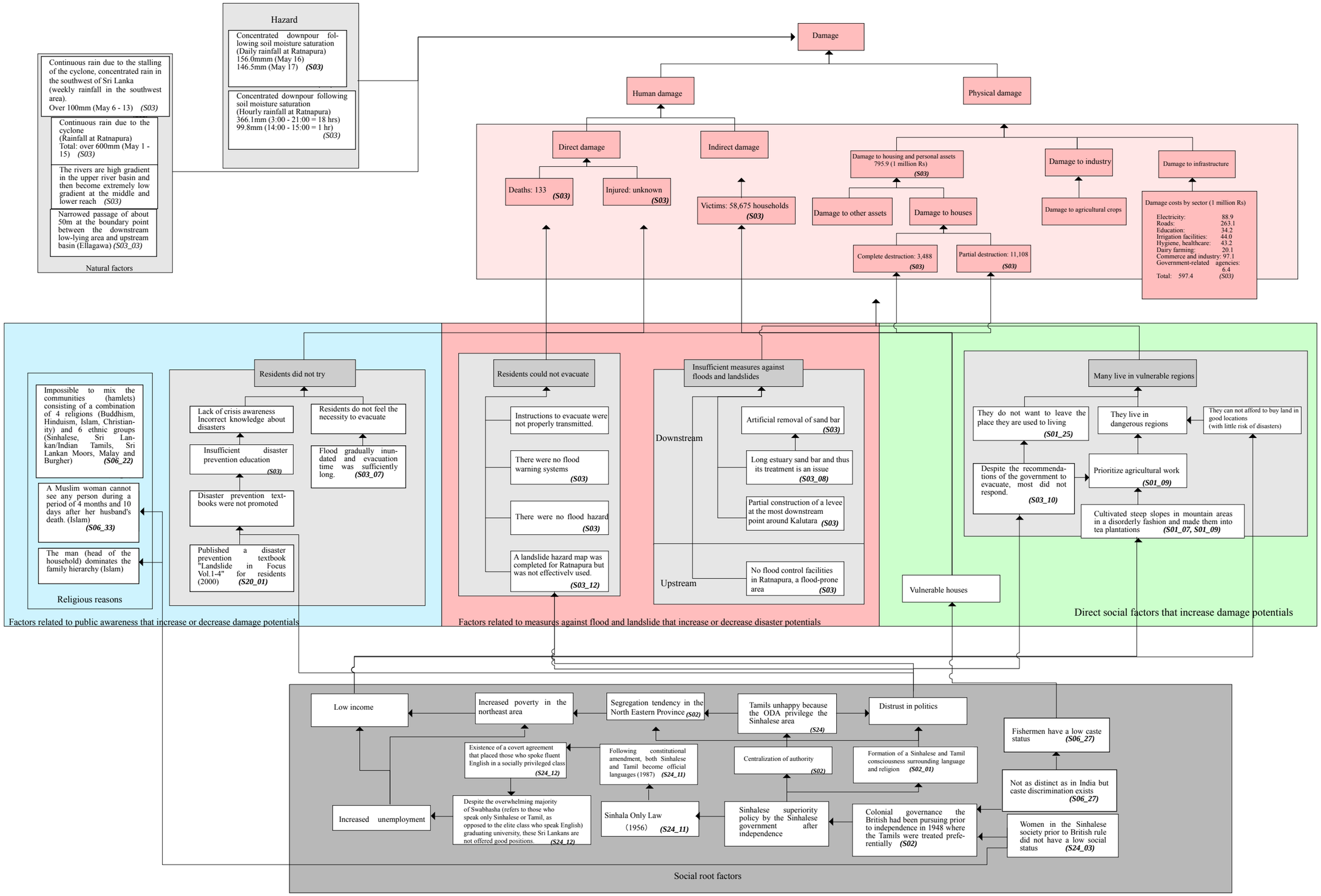


Fig. 43. Damage Factor Analysis of the May 2003 Flood and Landslide Disaster (Kalu Ganga) (Diagram)

(2) Flood and Landslide Disaster of Gin Ganga [S03), (S07), (S15), (S23)]

Fig. 44 shows the results of the damage factor analysis of the Gin Ganga flood and landslide disaster. Meanwhile, Fig. 45 shows a diagram of the particular items obtained from the sources of reference for the factor analysis.

Below are the analyzed results regarding each factor.

[Natural Factors]

1) Continuous rain resulting from the stalling of the cyclone and concentrated downpour following soil moisture saturation

As mentioned in 4.1 (1), from May 17 - 18, 2003, a record rainstorm hit the south of Sri Lanka for the first time in about 50 years. However, it is believed that the previous heavy rain resulting from the stalling of the cyclone in the Bay of Bengal, something rarely seen in May, triggered the following flood and landslide disaster.

Early in the morning of the 17, the Sinharaja forest reserve located in the Gin Ganga basin was hit by heavy rain exceeding 350mm. Although this downpour is believed to have directly contributed to the flood, prior to this, continuous rain of a total of over 600mm was recorded at Ratnapura in the Kalu Ganga basin between May 1 and May 15 (See Fig. 15). It is believed that the rainfall conditions in the upper river basin are similar due to the fact that the Kalu Ganga basin and Gin Ganga basin are located close to each other and thus it is appropriate to believe that soil moisture in the disaster area was already saturated due to continuous rainfall.

2) Concentrated rain in southwest Ceylon

As mentioned in 4.1 (2), while the country suffered floods and landslides disasters 37 times in 49 years between 1957 and 2005, during the 4 major floods in 1947, 1957, 1969 and 1978 when the extent of the damage was severe, rainfalls were evenly distributed across the country but the area where rain fell during the May 2003 flood was limited to southwest Ceylon (See Table 13 and Fig. 17).

3) Geomorphic features characterized by the tributary stream water were not able to naturally flow down to Gin Ganga during the floods and lack of capacity for the estuary water to flow down

Most of the rivers in Sri Lanka are high gradient in the upper river basin and then be-

come extremely low gradient at the middle and lower reach. As a result, while landslides are frequent in the upper river basin, because the rivers are low gradient in the middle and lower reach, flood water can not promptly flow down and thus often overflow.

The geomorphic features of the Gin Ganga basin also apply to the above. Because the downstream region of the Gin Ganga is a low-lying area with much rain during the rainy season, as water levels of Gin Ganga rise during the rainy season, drainage is carried out using pumps because the tributary stream water cannot naturally flow down to Gin Ganga.

In addition, with regard to the May 2003 flood, because the water levels of the river rose due to lack of capacity for estuary water to flow down, the sand bar that had formed at the estuary was partially removed.

[Social Factors]

Generally speaking, it is believed that due to factors such as poverty, some people in Sri Lanka have no other choice but to live on waterside land within the river area. However, no particular social factors could be found to explain the flood disaster in the Gin Ganga basin.

[Status of Measures (flood control facilities, shelters, etc.)]

4) Maintenance of levees limited to the downstream zone

As mentioned in 4.1 (5), with regard to structural measures against floods, levees are built and maintained only in the downstream zone of the river channel from the mouth to around 12km.

These levees were built as a measure against floods in Gin Ganga as part of the GRP realized with the assistance of the Chinese Government. The GRP involves flood control of the 182km^2 area in the 22km or so interval between Agaliya and the mouth, based on a 20-year probability precipitation. It consists of structures such as levees, overflow levees (spillway), drainage pumping stations (10) from the tributary stream to this river, water gates, bridges and discharge channels.

Although the May 2003 flood started at Neluwa (See Fig. 21) located 20km upstream from the mouth, no levees were built in this zone.

5) Pumps that somewhat functioned

Because the downstream region of the Gin Ganga is a low-lying area with much rain during the rainy season, as water levels of Gin Ganga rise during the rainy season, the tributary stream water cannot naturally flow down to Gin Ganga. For this reason,

through the GRP as mentioned in 4), drainage pumping stations (10) have been built for the water to flow from the tributary stream to Gin Ganga.

The GRP was made and entered by and between the Chinese and Sri Lanka Governments in 1972. Constructions began in 1976 and were complete in 1982. According to the plate on the pumps the year of completion is 1977, which means that close to 30 years have passed since completion. However, maintenance was effective, the pumps are still operable, and during the May 2003 flood, they seem to have been effective in the drainage behind the levee.

6) Undeveloped flood warning systems and flood hazard maps, etc.

As mentioned in 4.1. (5), in terms of non-structural measures, no particular plans were implemented such as flood forecasting and warning systems or flood hazard maps. Moreover, while the Gin Ganga basin extends through 2 districts, namely Galle District and Matara District, a landslide hazard map of Matara District has yet to be completed, and Galle District is not included in the LHMP's list of districts.

7) Insufficient disaster prevention education

Surveys reveal that the disaster prevention textbook published in 2000 was not sufficiently promoted. However, because the content of the textbook is unknown, it may not be safe to assume that sufficient promotion would have alleviated this flood and landslide disaster. Nevertheless, according to the field survey results indicated in the source of reference S03, local disaster prevention education seems to have been insufficient.

[Status of Response (evacuation status, etc.)]

8) Evacuation procedures generally good

Surveys reveal that residents had knowledge about the flood conditions through media, such as the radio and television. However, it is believed that disaster information in the affected areas was mainly transmitted by word of mouth including the use of loudspeakers. Evacuation instructions were first given in each district, which were then transmitted to each village and in the end to village communities.

As a result, although some were caught behind in the evacuation, evacuation procedures were generally good.

9) Evacuation difficult in some areas

Although this seems to contradict 8), some residents were isolated during the flood be-

cause water velocity was significant in some places with depths exceeding 2m and also because the roads leading to the shelters were inundated with water. These residents needed to be rescued by helicopter.

While the residents in the above 8) lived in the downstream area, those who were left isolated lived in the upper river basin. It is believed that with the existing flood evacuation information system and the residents' levels of disaster awareness, the flood in the upper river basin occurred and progressed faster than the residents could handle.

10) Building of temporary shelters for the evacuees

It seems that there were no specific disaster shelters. During this disaster, schools and public institutions were used as shelters, but whether these buildings were designated as disaster shelters beforehand is unknown.

Natural Conditions of Sri Lanka

- Located about 29km south of India, Sri Lanka is an island surrounded by sea, with a coastline of 1,340km.
- Sri Lanka's climate conditions are briefly divided into three zones. The island's southwest area including the central highlands is a wet zone with high precipitation.
- It is affected by the southwest monsoon or Yala season from May to September and the northeast monsoon or Maha season from December to the following February. Due to these monsoons, the meteorological conditions are categorized into 4 periods. During the Yala period, rain falls abundantly in the southwest area including the island's central highlands.
- It is often hit by cyclones because it is located at a low altitude, but they are not frequent.

Heavy rain resulting from the stalling of the cyclone in the Bay of Bengal, something rarely seen in May
Total weekly rainfall in the southwest: over 100mm (May 6-13)

Rainfall limited to southwest Ceylon

Concentrated downpour after soil moisture saturation (rainfall at Sinharaja)
Over 350mm (early morning on May 17)

Because water levels of Gin Ganga rise during the rainy season, the tributary stream water cannot naturally flow down to Gin Ganga.

[Explanatory notes]
◆Measure status (flood control facilities, shelters, etc.): ■blue
◆Measure status (evacuation status, etc.): ■green
◆Damage status
Human: ■red solid line
Physical: ■red dotted line
◆Natural factors (external force, geography, land features: ■orange
◆Social factors (poverty, vulnerability): ■purple

One of Gin Ganga's measures against floods is the Gin Ganga Regulation Project (GRP) realized with the assistance of the Chinese Government. The GRP involves flood control of the 182km^2 area in the 22km or so interval between Agaliya and the mouth, based on a 20-year probability precipitation. It consists of structures such as levees, overflow levees (spillway), drainage pumping stations (10) from the tributary stream to this river, water gates, bridges and discharge channels.

Close to 30 years have passed since completion of the pumps maintained through the GRP. However, maintenance was effective, the pumps are still operable, and during the May 2003 flood, they seem to have been effective in the drainage behind the levee.

The levees maintained through the GRP are limited to the downstream zone of the river channel from the mouth to around 12km. Although the May 2003 flood started at Neluwa located 20km upstream from the mouth, no levees were built in this zone.

Water levels at the estuary of the river rose because the flood water from the upstream area could not flow down. In Galle District, partial removal of the sand bar prevented Galle city from flooding.

The NBRO has been working since 1995 on the Landslide Hazard Mapping Programme (LHMP) targeting 8 districts most prone to landslides. While Gin Ganga basin extends through 2 districts, namely Galle District and Matara District, a landslide hazard map of Matara District has yet to be completed, and Galle District is not included in the LHMP's list of districts.

Details regarding Ging Ganga basin are unknown.

Generally speaking, it is believed that due to factors such as poverty, some people in Sri Lanka have no other choice but to live on waterside land within the river area.

Damage to agricultural crops

Coconut plantations:	63 acres
Tea plantations:	3,098 acres
Rice paddies:	2,000acres
Cinnamon:	643acres
Bananas:	497acres
Vegetable fields:	21acres

In addition to bridge supports, roads, flood control facilities, telecommunications facilities and power facilities, 9 temples, mosques and churches, 1 hospital (number of beds 115), 19 public schools (damage caused floods only), 31 public schools (damage caused by floods and strong winds) and 94 public buildings were damaged.

Details regarding damaged houses are unknown

Deaths: 17
Victims: 32,000 households
Among the deaths, 6 died due to landslides and the remaining 11 died due to floods.

Although generally speaking evacuation proceeded smoothly, is believed that with the existing flood evacuation information system and the residents' levels of disaster awareness, the flood in the upper river basin occurred and progressed faster than the residents could handle.

Fig. 44. Damage Factor Analysis of the May 2003 Flood and Landslide Disaster (Gin Ganga) (Summary of facts)

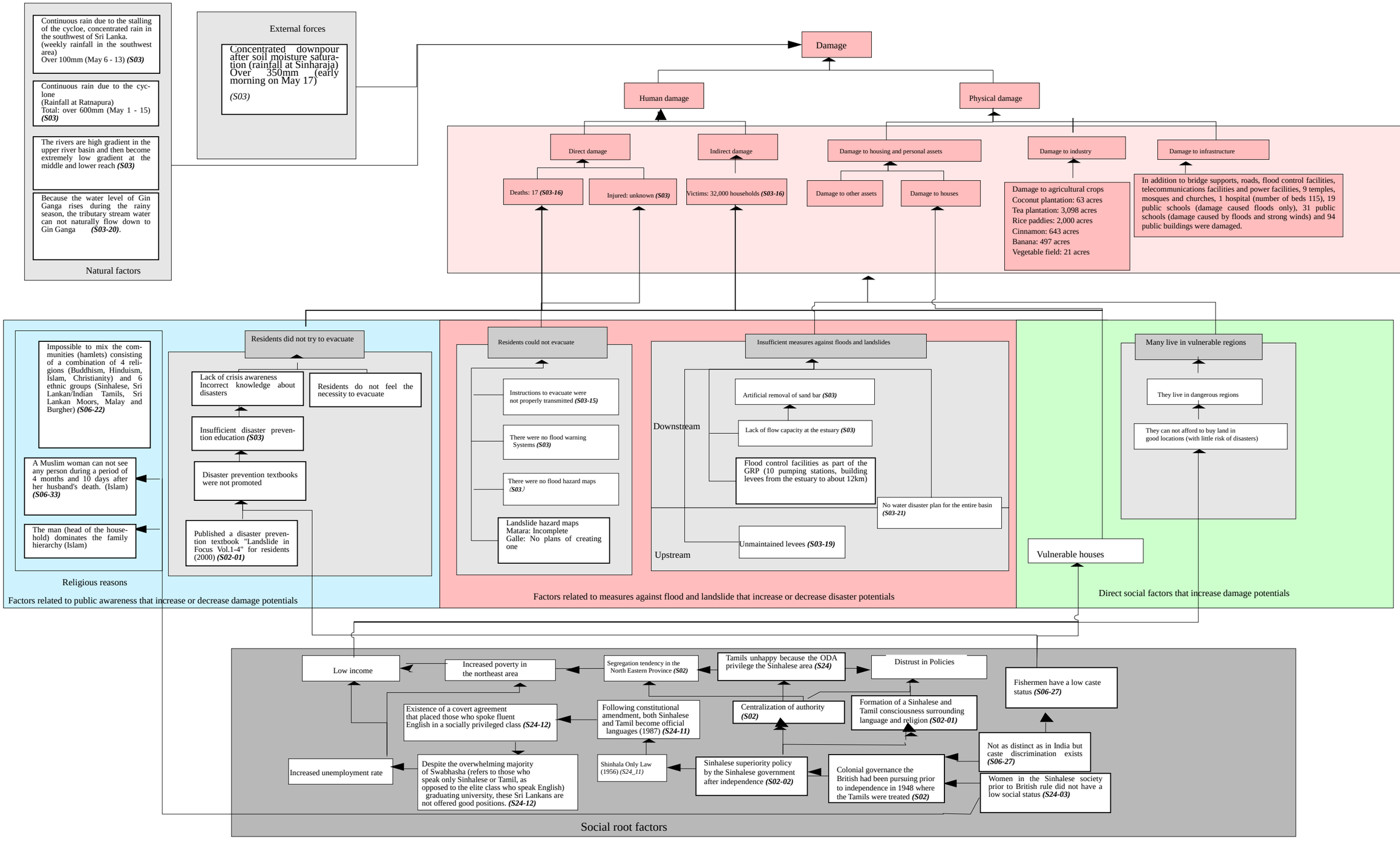


Fig. 45. Damage Factor Analysis of the May 2003 Flood and Landslide Disaster (Gin Ganga) (Diagram)

(3) Flood and Landslide Disaster of Nilwala Ganga [S03), (S07), (S15), (S23)]

Fig. 46 shows the results of the damage factor analysis of the Nilwala Ganga flood and landslide disaster. Meanwhile, Fig. 47 shows a diagram of the particular items obtained from the sources of reference for the factor analysis.

Below are the analyzed results regarding each factor.

[Natural Factors]

1) Continuous rain resulting from the stalling of the cyclone and concentrated down-pour following soil moisture saturation

As mentioned in 4.1 (1), from May 17 - 18, 2003, a record rainstorm hit the south of Sri Lanka for the first time in about 50 years. However, it is believed that the previous heavy rain resulting from the stalling of the cyclone in the Bay of Bengal, something rarely seen in May, triggered the following flood and landslide disaster.

In the Nilwala Ganga basin the rain that had continuously been falling since the 11^{th,} increased from the 16th, causing a flood in Cotopora area as well in other regions.

As a result, although this flood and landslide disaster occurred directly because of the increased rainfall from the 16th, as with Kalu Ganga and Gin Ganga, it is appropriate to believe that soil moisture in the disaster area was already saturated due to continuous rainfall prior to that.

2) Concentrated rain in southwest Ceylon

As mentioned in 4.1 (2), while the country suffered floods and landslides disasters 37 times in 49 years between 1957 and 2005, during the 4 major floods in 1947, 1957, 1969 and 1978 when the extent of the damage was severe, rainfalls were evenly distributed across the country but the area where rain fell during the May 2003 flood was limited to southwest Ceylon in May 2003 (See Table 13 and Fig. 17).

In addition, as can be seen from Fig. 27 and 28, which show the annual flow data at Pitabeddara from December 2002, while Fig. 27 shows that the daily flow rarely exceeds the normal 100m^3/s, Fig. 28 reveals that in May 2003 alone, the flow twice exceeded 500m^3/s. This shows that the rainfall in May 2003 was different from normal times and that the scale of the flood that occurred on May 17 2003 was out of the ordinary.

3) Geomorphic characteristics of Nilwala Ganga basin that is prone to floods in the downstream area

Although precipitous woodland is seen at the upstream of Nilwala Ganga, in the downstream area the gradient is relatively gentle. Most of the rivers in Sri Lanka are high gradient in the upper river basin and then become extremely low gradient at the middle and lower reach. As a result, while landslides are frequent in the upper river basin, because the rivers are low gradient in the middle and lower reach, flood water can not promptly flow down and thus often overflow. It can be said that Nilwala Ganga basin's geomorphic features apply to these conditions as well.

4) Geomorphic and geological features of the Nilwala Ganga basin that is prone to landslides and slope failures in the upper river basin

The mountain area at the head of Nilwala Ganga is a forest covered with red-yellow podzols. As in Ratnapura at the upstream of Kalu Ganga, landslides occurred in precipitous mountainous terrain at the upstream of Nilwala Ganga following the long period of heavy rain in May 2003, as a result of which many roads were cut off. Moreover, slope failures caused the death of 34 people.

[Social Factors]

5) Villagers live on dangerous mountainsides (inference)

As mentioned in 2.5.1. (1) 4), one of the factors that contributed to an increase in human suffering in Ratnapura's mountain area involves the farmers who lived on dangerous mountainsides.

As a result of this downpour, 34 people lost their life due to slope failures in the Nilwala Ganga basin. Kalu Ganga and Nilwala Ganga in the upper river basin are situated close to each other and thus land use in both basins is also believed to be similar. Although this remains an inference, it is believed that in the upstream Nilwala Ganga as well, farmers prioritizing the convenience of location for agricultural work lived on dangerous mountainsides.

6) Villagers live on waterside land

Generally speaking, it is believed that due to factors such as poverty, some people in Sri Lanka have no other choice but to live on waterside land within the river area. In the Nilwala Ganga basin, people living on waterside land are seen here and there, and with regard to the cutting of the levee, they may have done it to protect their houses which eventually led to a major flood in the protected lowland on the right bank.

7) Cutting of the downstream levee by the residents

As mentioned in 4.1. (5), with the assistance of the French Government, the hilly area of the river's lower reach was used successfully in constructing a levee like a mountain ridge, which has been protecting the flatland (See Fig. 31). However, during the May 2003 flood, a substantial amount of water flowed within the levee due to the cutting of the levee by local residents, which caused the flood to spread over an extensive area and claiming the lives of 30 people.

Meanwhile, with regard to the reason why the residents cut the levee, there is a theory that when the Minister suggested to the local officials of the then Irrigation Ministry to cut the upstream levee to protect Matara City, local residents living on waterside land cut it instead. However, according to the officials, it is impossible that the residents could have heard the above story before cutting the levee, and thus the reasons for the cutting are unclear.

[Status of Measures (flood control facilities, shelters, etc.)]

8) Pump facilities did not effectively operate due to poor maintenance

As mentioned in 4.1. (5), the main flood prevention works by the French Government consist of 3 pumping stations and levees. In particular, the Tudawa pumping station is the largest with 8 pumps. Meanwhile, although the spout capacity per pump is 3.5m^3/s, it was revealed that 4 out of the existing 8 did not operate during the flood due to poor maintenance.

9) Scale of the flood more extensive than the flood control basin could handle

These flood prevention works also included drainage basins with overflow levees in some places, which are useful during normal floods, but it seems that the large-scale floods of May 2003 were much too extensive.

10) Undeveloped flood warning systems and flood hazard maps

As mentioned in 4.1. (5), in terms of non-structural measures, no particular plans were implemented such as flood forecasting and warning systems or flood hazard maps. With regard to landslide hazard maps, although Nilwala Ganga basin is located in Matara District and thus included in the LHMP's list of districts, no map has been completed yet.

11) Insufficient disaster prevention education

Surveys reveal that the disaster prevention textbook published in 2000 was not sufficiently promoted. However, because the content of the textbook is unknown, it may not be safe to assume that sufficient promotion would have alleviated this flood and landslide disaster. Nevertheless, according to the field survey results indicated in the source of reference S03, local disaster prevention education seems to have been insufficient.

[Status of Response (evacuation status, etc.)]

12) With no experience of floods, residents underestimated the necessity to evacuate

Because no flood had occurred in the past 30 years in Nilwala Ganga, most of the residents had never experienced one. This is believed to be one of the reasons why the damage was so significant.

Because the rain started on the 11th, the risk of landslides and floods were reported by the media, such as television, radio and newspaper. The residents were also aware about this

information. Unfortunately, with regard to the flood expansion at the downstream point on the 18th, the residents were unaware of the risks until they were informed by loudspeaker, as will be described later, and thus they did not take precautions and did not evacuate.

13) Some residents could not evacuate due to tardiness of bureaucratic response

Due to continuous rain, the Department of Irrigation in Matara held a meeting on measures against floods on the 17th. A flood warning was issued to each local office by telephone and fax. The local offices then informed the residents about evacuation and shelters using loudspeakers. These loudspeakers through which they spoke from their three-wheelers or cars were in fact used as an emergency measure as there were no "disaster prevention loudspeakers" per se. These loudspeakers were set up at electric appliance shops in big communities, and when transmission of certain information was necessary, this was done with the cooperation of NGOs.

On the 18th, a large area was flooded and thus a conference on measures against floods was held by Sri Lankan Government officials and cabinet members. Moreover, at this stage, a request to the army and police for rescue and relief operations was made. It is said that evacuation instructions on this day led to the evacuation of about 8,000 people. Unfortunately, because in some areas, the flood spread before the residents received instructions to evacuate, these areas ended up being isolated. The isolated residents were rescued using boats that were brought in from the coasts, but by that time, water levels were below the maximum levels. Therefore, it can be said that response was undeniably slow.

Natural Conditions of Sri Lanka

- Located about 29km south of India, Sri Lanka is an island surrounded by sea, with a coastline of 1,340km.
- Sri Lanka's climate conditions are briefly divided into three zones. The island's southwest area including the central highlands is a wet zone with high precipitation.
- It is affected by the southwest monsoon or Yala season from May to September and the northeast monsoon or Maha season from December to the following February. Due to these monsoons, the meteorological conditions are categorized into 4 periods. During the Yala period, rain falls abundantly in the southwest area including the island's central highlands.
- It is often hit by cyclones because it is located at a low altitude, but they are not frequent.

Heavy rain resulting from the stalling of the cyclone in the Bay of Bengal, something rarely seen in May.
Total weekly rainfall in the southwest: over 100mm (May 6-13)

Rainfall limited to southwest Ceylon.

Concentrated downpour following soil moisture saturation (flow at Pita-beddara) 2,900m^3/s (May 18)

The mountain area at the head is a forest covered with red-yellow podzols and is a precipitous landscape.

[Explanatory notes]
- Measure status (flood control facilities, shelters, etc.): ■blue
- Measure status (evacuation status, etc.): ■green
- Damage status
  - Human: ■red solid line
  - Physical: ■red dotted line
- Natural factors (external force, geography, land features: ■orange
- Social factors (poverty, vulnerability): ■purple

At Nilwala Ganga, the then Ministry of Irrigation undertook flood control projects with the assistance of France in 1979.

The flood prevention works also included drainage basins with overflow levees in some places, which are useful during normal floods, but it seems that the large-scale floods of May 2003 were much too extensive.

Although there are pumping stations, 4 of the 8 pumps at the largest Tudawa pumping station did not operate during the flood due to poor maintenance.

The hilly area of the river's lower reach was used successfully in constructing a levee like a mountain ridge, which has been protecting the flatland.

A substantial amount of water flowed within the levee due to the cutting of the levee on the right bank by local residents living on waterside land, which caused the flood to spread over an extensive area and claiming the lives of 30 people.

The reason why the levee was cut is unknown.

Generally speaking, it is believed that due to factors such as poverty, some people in Sri Lanka have no other choice but to live on waterside land within the river area or on dangerous mountainsides. .

The NBRO has been working since 1995 on the Landslide Hazard Mapping Programme (LHMP) targeting 8 districts most prone to landslides. While Nilwala Ganga basin is situated in Matara District, a landslide hazard map of Matara District has yet to be completed.

Because no flood had occurred in the past 30 years in Nilwala Ganga, most of the residents had never experienced one. Risk of landslides and floods was announced on television and radio, and although the residents had knowledge of the situation, they were not sufficiently aware of the necessity to evacuate.

Because bureaucratic response was slow and the flood spread faster than expected, it created isolated areas that could not receive official announcements as a result of which some residents could not evacuate.

Roads were cut off and bridge piers and culverts were damaged. Moreover, 26 schools suffered damages. Among these, some were used as shelters. The army cleaned the 2,941 wells that were polluted

Damaged houses
Completely destroyed: 2,138
Partially destroyed: 5,562

Deaths: 64
Missing: 17
Victims: 47,637 households (145,875 people)
Among the deaths, 30 people died due to floods, and the remaining 34 died of landslides (slope failures). Most likely, even in the Nilwala Ganga basin, farmers who prioritize the convenience of location for agricultural work live on dangerous mountainsides, which contributed to expansion of damage.

Fig. 46. Damage Factor Analysis of the May 2003 Flood and Landslide Disaster (Nilwala Ganga) (Summary of facts)

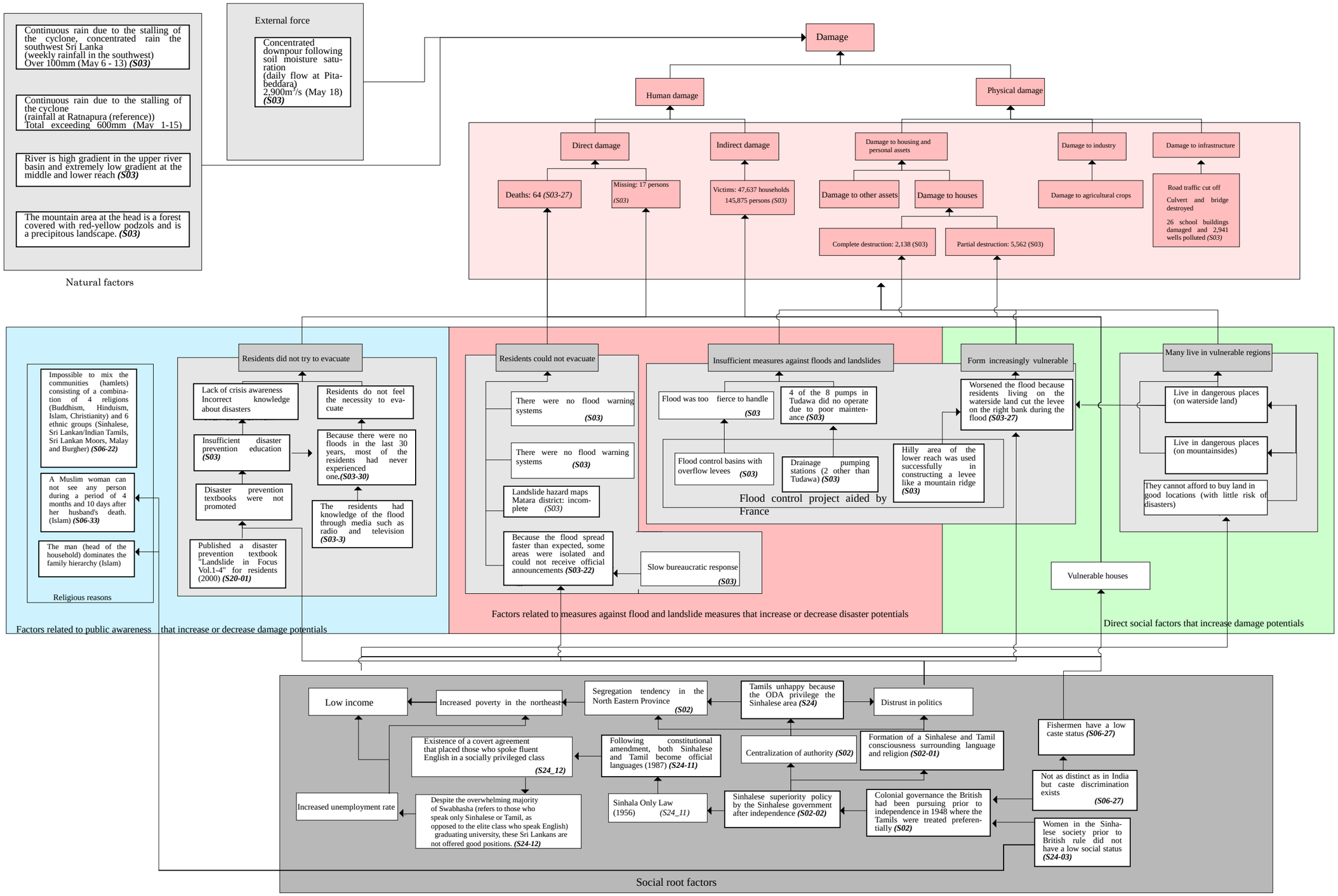


Fig. 47. Damage Factor Analysis of the May 2003 Flood and Landslide Disaster (Nilwala Ganga) (Diagram)

5.2 Damage Analysis of the December 2004 Tsunami [S05], [S06], [S08], [S09], [S12], [S13]

Fig. 48 shows the results of the damage factor analysis of the December 2004 tsunami disaster. Meanwhile, Fig. 49 shows a diagram of the particular items obtained from the sources of reference for the factor analysis.

Below are the analyzed results regarding each factor.

[Natural Factors]

1) Tsunami whose scale is one that is seen once every 100 to 150 years in the Indian Ocean

As mentioned in 2.4.2. (1), the size of the Indian Ocean Tsunami was one that ranks right behind the tsunami that followed the 1960's Chile Earthquake and the 1946 Aleutians Tsunami and is the same as the 1964 Alaska Tsunami, indicating that it was the second or third largest tsunami of the 20th century (See Table 22).

Furthermore, according to the past tsunamis that occurred on the Sunda Trench (See Table 23) the Indian Ocean Tsunami can be considered as the type of tsunamis that occur once every 100 to 150 years.

Meanwhile, although the scale of the earthquake itself was significant as it recorded Mw=9 and caused damage to Sumatra which was close to the epicenter, because Sri Lanka was 1,700km away from the epicenter, no one physically felt the earthquake.

2) Coasts of Sri Lanka consist of a series of roads and communities on the slightly elevated ground of the coastal dune

As mentioned in 2.4.2. (1), the damage caused by the Indian Ocean Tsunami involved only the few hundred-meter coastal belt along the coastline. One of the geomorphic features is the fact that the coasts of Sri Lanka consist of a series of roads and communities on the slightly elevated ground of the coastal dune (See Fig. 35). In other words, because there are no natural obstacles that would absorb the energy of the tsunami, such as forests between the coastline and communities, and because the communities are situated at extremely low levels of a few meters above sea level, it can be said that the geomorphic features of the coastline make it prone to tsunamis.

3) Influence of the geological formation of the seabed on the southwest coast of Ceylon on the movement of the tsunami

As mentioned in 2.4.2. (1), the Indian Ocean Tsunami that hit the east coast of Sri Lanka about 2 hours after the earthquake gradually moved south clockwise and even hit the southwest coast on the opposite side of the epicenter. However, although the damage on

the east coast was uniformly distributed, damage levels varied greatly on the southwest coast (See Fig. 34).

A few reasons for the great variations in the levels of damage on the southwest coast include the fact that the tsunami that traveled toward the west of the island from the epicenter reflected off the south coast of Sri Lanka and hit the southwest coasts as boundary waves (See Fig. 37), and that not only are there geomorphic differences on land but also slight differences in the geological formation of the seabed.

[Social Factors]

4) Due to the influence of civil wars, development of the northeast area is 25-30 years behind that of other regions

As mentioned in 2.3. (6) and 2.3. (8), the country's southwest side is the Buddhist area inhabited by the Sinhalese, and political and armed conflicts continue with the Hindu Tamils who are mostly concentrated on the northeast side. Because this northeast area is mostly controlled by the LTTE (Uncleared Area), government investment for social infrastructure development was delayed. In addition, the damage due to civil wars with government forces that lasted closed to 20 years was extensive, and thus development of the northeast area is 25 to 30 years behind that of other regions.

5) Low social status of fishermen

Although not as marked as in India, caste discrimination still exists and is affecting social statuses. For example, fishermen have a low social status.

Of course one of the main reasons why fishermen live near the coastline is because it is more convenient when they go fishing, but it is believed that sufficiently wealthy fishermen have both a house where they store their boats and another one in which they live, built in a nicer place away from the coastline. One of the reasons why they cannot do that is poverty, and a reason why they cannot get out of their situation is that social status of fishermen is low.

[Status of Measures (flood control facilities, shelters, etc.)]

6) Almost no breakwater facilities nor floodgates on the extensive coastline

Sri Lanka is an island surrounded by either the Indian Ocean or Bay of Bengal and has a coastline of 1,340km. Developing breakwater facilities or floodgates on the extensive coastline which would be compatible with the occurrence probability of the Indian Ocean Tsunami would be unrealistic. In addition, no one had imagined before the tsunami disaster that it would hit Sri Lanka and thus there were only breakwater facilities and

floodgates in limited places such as Colombo and Galle where important ports are located.

7) Undeveloped tsunami forecasting and warning systems

Because volcanic activities are common in the Pacific Ocean area and earthquakes and tsunamis are frequently observed, an earthquake and tsunami information network had been established in the surrounding countries since a long time ago. However, no such network existed in the Indian Ocean.

In the wake of the Indian Ocean Tsunami, the United Nations, led by UNESCO'S Intergovernmental Oceanographic Commission (IOC), has been working in cooperation with the International Strategy for Disaster Reduction (ISDR) and the World Meteorological Organization (WMO) on activities toward the development of the Indian Ocean Tsunami Warning and Mitigation System (IOTWS). The agencies in Sri Lanka that are part of this project are the Geological Survey and Mines Bureau and the Department of Meteorology. A receiving system of the tsunami warning system is installed in the Geological Survey and Mines Bureau, allowing them to receive information from the Pacific Tsunami Warning Center (PTWC) and the Japan Meteorological Agency.

8) Insufficient disaster prevention education

According to a survey conducted after the tsunami disaster to local residents living in affected areas, although many people escaped to higher grounds when the tsunami hit the island, quite a few people also went to take a look at the ocean during the backwash (23%). In addition, 94% of the residents had no knowledge about tsunamis, while 90% believe that the damage could have been mitigated if they had knowledge about tsunamis. Moreover, according to a survey conducted to school children, 71% of the students are aware that tsunamis occur due to earthquakes, but the remaining 30% or so still had no knowledge of this fact.

As a result, it can be said when the tsunami occurred, disaster prevention education to better understand tsunamis was not sufficiently given to the general public and in schools.

[Status of Response (evacuation status, etc.)]

9) Incorrect response to the tsunami increased human damage

As mentioned in 8), the lack of knowledge about natural phenomena such as tsunamis and incorrect response to the tsunami on an individual level may have contributed to the increased human suffering.

For example, according to some reports, because local residents along the coast had never experienced a tsunami, when the water receded about 300-400m from the usual coastline between the first and second wave, children went to the beach to pick the fish lying on the sand or tried to throw them back to the sea, the second wave came, which aggravated the damage.

10) Sri Lanka Government declared a State of National Disaster immediately after the tsunami

Following the December 26, 2004 tsunami, the Sri Lanka Government declared a State of National Disaster, made an appeal for international assistance, and the President established 3 task forces to respond to the situation. Moreover, a Center for National Operations office was established at the President's office which promoted emergency response activities in cooperation with concerned ministries and the United Nations (See Fig. 40).

11) Insufficient overall monitoring and coordination of relief activities and considerable differences between each district and division

In addition to coordination with the above 3 agencies, the CNO also worked on logistics, food aid, water supply, hygiene, education, fishing industry, psychosocial care and childcare, as well as establishing offices for each sector related to the tsunami disaster to determine the extent of the damage and keep track of the status of support. Moreover, in order to share this information, exchange opinions, and perform coordination, they held regular meetings twice every week. Furthermore, they held coordination meetings with bilateral assistance agencies, UN agencies and NGO, etc. for the coordination of emergency assistance.

However, there are reports that with regard to the monitoring and coordination of relief activities by the CNO, national coordination has not been strong enough, and each district managed the coordination with the district agent as leader, and there seems to be considerable differences between each district and division in terms of the status of coordination.

12) Building of temporary shelters for the evacuees

There were no shelters reserved for tsunami disasters per se, and thus schools around the affected areas temporarily closed and were pressed into use as camps. The Sri Lanka prioritized the evacuees staying in schools and recommended them to move to temporary houses in order to reopen the schools as soon as possible. In addition to the building of temporary houses, schoolyards, gardens of mosques and temples, and even private prop-

erties were used to shelter the evacuees.

Natural Conditions of Sri Lanka

- Located about 29km south of India, Sri Lanka is an island surrounded by sea, with a coastline of 1,340km.
- The entire coastal area is low and a series of roads and communities are found on the slightly elevated ground of the coastal dune.
- There are geomorphic differences on land but also slight differences in the geological formation of the seabed.

The tsunami magnitude (Mt) of the Indian Ocean Tsunami was 9.1, a magnitude that ranks right behind the tsunami that followed the 1960's Chile Earthquake and the 1946 Aleutians Tsunami and is the same as the 1964 Alaska Tsunami, indicating that it was the second or third largest tsunami of the 20th century.

According to the past tsunamis that occurred on the Sunda Trench the Indian Ocean Tsunami can be considered as the type of tsunamis that occur once every 100 to 150 years.

[Explanatory notes]
- □Measure status (flood control facilities, shelters, etc.): ■blue
- □Measure status (evacuation status, etc.): ■green
- □Damage status
  - Human: ■red solid line
  - Physical: ■red dotted line
- □Natural factors (external force, geography, land features: ■orange
- □Social factors (poverty, vulnerability): ■purple

The tsunami's time of arrival from the epicenter to Sri Lanka was about 2 hours at the east coast and 2.5 hours at the southwest coast. However, unlike in the Pacific Ocean area where volcanic activities are common and earthquakes and tsunamis occur frequently, there were no earthquake and tsunami information network in the Indian Ocean and because Sri Lanka had no system to receive tsunami warnings, the Government could not inform in advance the residents living along the coast of the incoming tsunami.

There were only breakwater facilities and floodgates in limited places such as Colombo and Galle where important ports are located.

Due to the long civil wars between the government forces and the LTTE, development in the northeast area is 25 to 30 years behind that of other areas.

Although not as marked as in India, caste discrimination still exists and is affecting social statuses. For example, fishermen have a low social status.

The un-wealthy residents living (particularly fishermen) living around the coastline were those on whom the tsunami took a drastic toll.

Most of the residents living on the coastline had never experienced a tsunami and thus 94% of them had no knowledge about tsunamis.

Disaster prevention education on tsunamis was insufficient.

When the water receded about 300-400m from the usual coastline between the first and second wave, while children went to the beach to pick the fish lying on the sand or tried to throw them back to the sea, the second wave came, which aggravated the damage.

Damage to infrastructures
Roads and bridges
Harbors
Power
Water supply

Damage to agricultural crops

This day was Unduvap poya day, a holiday, and thus fishermen were not out fishing.

Most of the fishing boats were anchored in the harbors or left on the sand.

Damage to fishing industry

1	Fishing boats:	20,552
2	Fishermen:	more than100,000
3	Distributors:	80,000
4	Related workers:	20,000
5	Total including family members form 2-4:	800,000

Destroyed houses
Complete 68,779
Partial: 43,405

Deaths: 30,974
Injured: 23,176
Unidentified: 4,698
Victims: 248,266 households

Fig. 48. Damage Factor Analysis of the December 2004 Tsunami Disaster (Summary of facts)

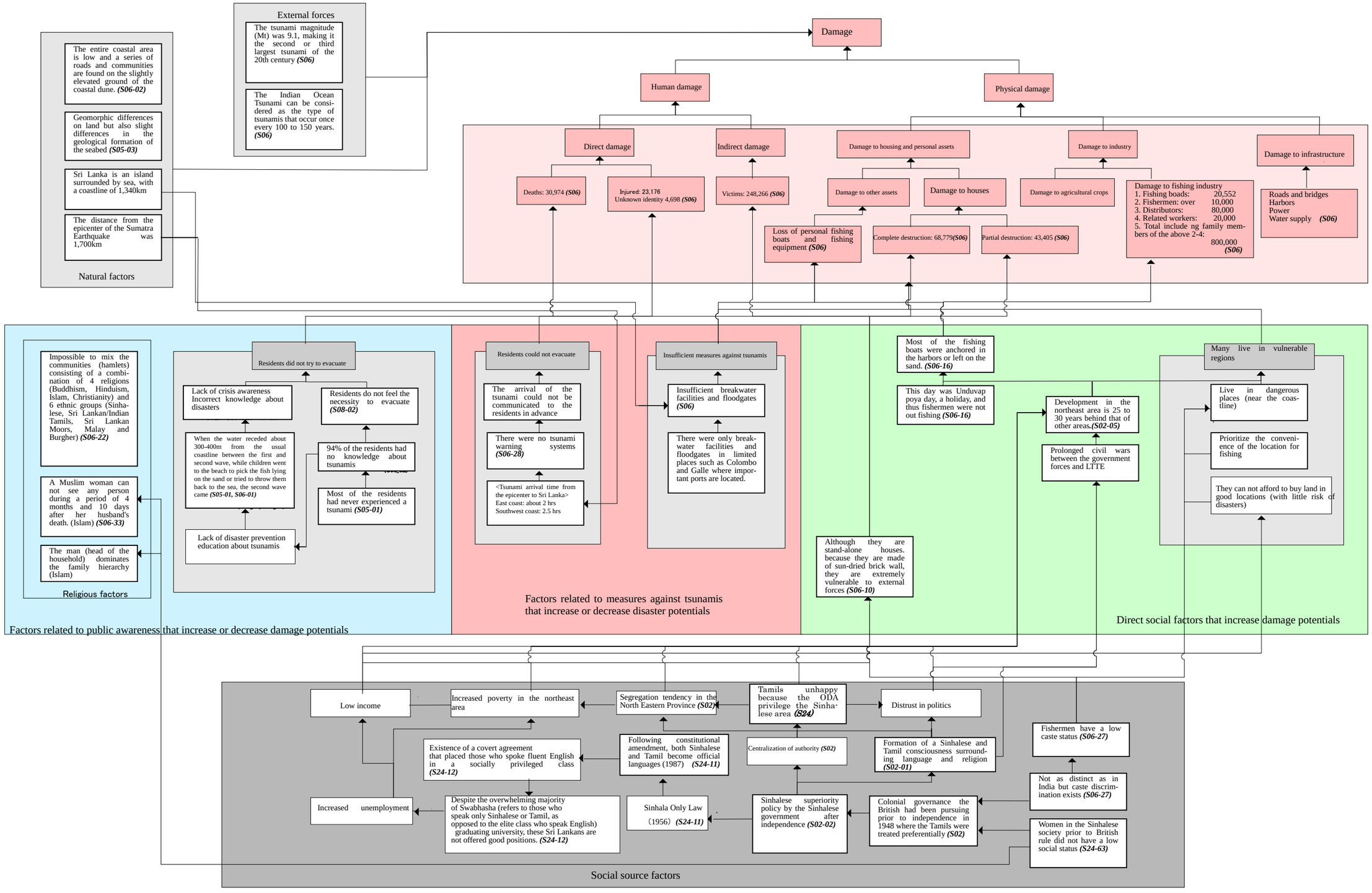


Fig. 49. Damage Factor Analysis of the December 2004 Tsunami Disaster (Diagram)

Appendix

List of Documents Related to Sri Lanka

Ref. No	Document	Date of Publication	Publisher	Author
S01	Sri Lanka Country Report 1999 (Japanese Version)	Unknown	Asian Disaster Reduction Center	National Disaster Management Centre of Sri Lanka
S02	Conflict and Development: Roles of JBIC (Development Assistance Strategy for Peace Building and Reconstruction in Sri Lanka) (Japanese Version)	August 2003	Japan Bank for International Cooperation	JBIC Institute
S03	2003 Sri Lanka's Flood Damage Survey Report (*in Japanese*)	September 2004	Committee on Hydroscience and Hydraulic Engineering, JSCE	
S04	National Report and Information on Disaster Reduction Sri Lanka - Country Paper (for World Conference on Disaster Reduction, Kobe - Japan, January 2005)	Unknown	UNDP Disaster Risk Management Programme	National Disaster Management Centre of Sri Lanka
S05	Investigation Report on the Indian Ocean Tsunami Damage in Sri Lanka (Flash Report)	January 2005	Japan Water Forum (JWF)	
S06	Field Survey Report on the Indian Ocean Tsunami Damages in Sri Lanka and the Maldives as a part of "Research on the Management of Projects in the Field of Disaster Prevention (Project Research)" (*in Japanese*)	March 2005	Japan International Cooperation Agency	Pacific Consultants International
S07	Taking Stock of Disaster Management Efforts in Sri Lanka	April 2005	UNDP Disaster Risk Management Programme	National Disaster Management Centre of Sri Lanka
S08	Report on the Results of the Survey on Tsunami Awareness in Sri Lanka	April 2005	Asian Disaster Reduction Center	
S09	Preliminary Report on Sri Lanka's Urgent Indian Ocean Tsunami Disaster Recovery and Rehabilitation Program (*in Japanese*)	May 2005	Japan International Cooperation Agency	
S10	AFTER THE TSUNAMI Human Rights of Vulnerable Populations	October 2005	Human Rights Center University of California, Berkeley East-West Center	
S11	SRI LANKA Post Tsunami Recovery and Reconstruction - progress, challenges, way forward -	December 2005	Joint Report of the Government of Sri Lanka and Development Partners	
S12	Report on the "Understanding of the Overall Picture of the December 2004 Asian Tsunami Disaster"	December 2005	Research Group on the December 26, 2004 Earthquake Tsunami Disaster of Indian Ocean	
S13	Recovery, rehabilitation and development project for tsunami affected area of southern region in the Democratic Socialist Republic of Sri Lanka final report : executive summary (Japanese Version)	March 2006	Japan International Cooperation Agency	PADECO Co. Ltd NIPPON KOEI Co., Ltd. Overseas Agro Fisheries Consultants, Inc.
S14	Sri Lanka Country Report 2006 (Japanese Version)	Unknown	Asian Disaster Reduction Center	National Disaster Management Centre of Sri Lanka
S15	EM-DAT: Sri Lanka Country Profile - Natural Disasters	November 2006	EM-DAT: The OFDA/CRED International Disaster Database	
S16	Country Index on Democratic Socialist Republic of Sri Lanka in the Website of Ministry of Foreign Affairs	Updated as needed	Ministry of Foreign Affairs of Japan	
S17	Official Development Assistance (ODA) Data Book by Country, Version 2005 II Southwest Asian Regions [2] Sri Lanka	Unknown	Ministry of Foreign Affairs of Japan	

Ref. No	Document	Date of Publication	Publisher	Author
S18	THE WORLD FACTBOOK 2006	November 2006	Central Intelligence Agency (USA)	
S19	2002 Report on the Aid Policy Research (Democratic Socialist Republic of Sri Lanka) (*in Japanese*)	March 2003	Infrastructure Development Institute - Japan	
S20	Report on the 2005 Research Survey on International Technical Cooperation in the Field of Disaster Prevention (*in Japanese*)	March 2006	Ministry of Land, Infrastructure and Transport & Infrastructure Development Institute - Japan	
S21	Website of Japan External Trade Organization (JETRO)	Updated as needed	Japan External Trade Organization	
S22	Central Bank of Sri Lanka Annual Report 2005	April 2006	Central Bank of Sri Lanka	
S23	Hydrometric Network & Flood Mitigation	March 2006	ITU Workshop on Emergency Telecommunications for Disaster Management in Sri Lanka	Eng(Miss) P. P. G. Dias Deputy Director of Hydrology Division, Irrigation Department
S24	Current Status and Future Issues on the Economy of Neighboring Asian Countries Research Institute on the Economic Situation of Neighboring Asian Countries, Report (*in Japanese*)	June 2000	Institute of Fiscal and Monetary Policy, Ministry of Finance	