

COMPARISON STUDY OF EXISTING FLOOD MANAGEMENT SYSTEM IN JAPAN AND SRI LANKA

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SPECIFIC AIMS OF MY RESEARCH:

- (1). Study all available flood mitigation methods, real time data acquiring methods, flood early warning dissemination methodologies, quick response and evacuation procedures in Japan.
- (2). Make a comparison between Japan and Sri Lanka in terms of flooding and flood management activities.
- (3). Identify all the appropriate ways, which can be used to upgrade the proposed early warning and flood management system in Sri Lanka with the help of Japanese methodology.
- (4). Introduce new methodology, which can be adapted in Sri Lanka to disseminate real time early warning to vulnerable communities in flood prone area.

Long term objective of this research is to adaptation of suitable methodologies through its outcomes to the river network within the district of Kegalle in Sri Lanka.

RESEARCH ACTIVITIES:

(1). STUDY OF DATA ACQUISITION METHODS;

- Water level data acquiring methods
- Rainfall data acquiring methods
- Use of available air photos/satellite imageries etc.
were studied in Japan and Sri Lanka.

(2). STUDY OF DATA ANALYSIS

- Analytical methods used to develop a prediction between increases in river water level accordance with rainfall were studied in Japan and compare it with the Sri Lanka.

(3). FLOOD EARLY WARNING

- Methodologies used to disseminate real time flood early warning to the vulnerable community and,
- Flood forecasting methods in Japan were studied and compared it with Sri Lankan scenarios.

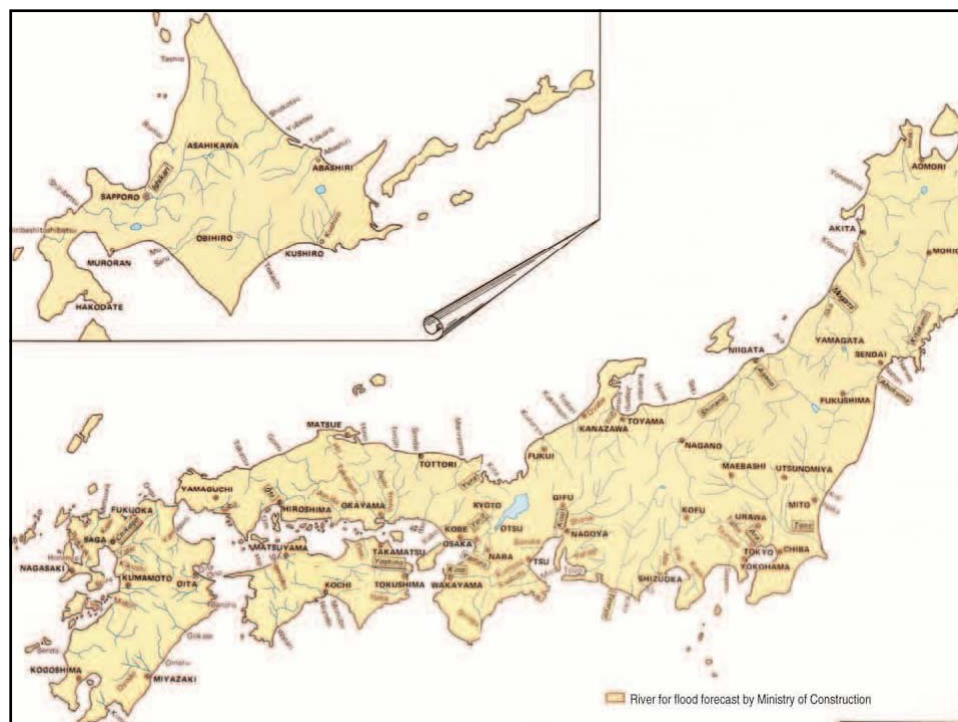
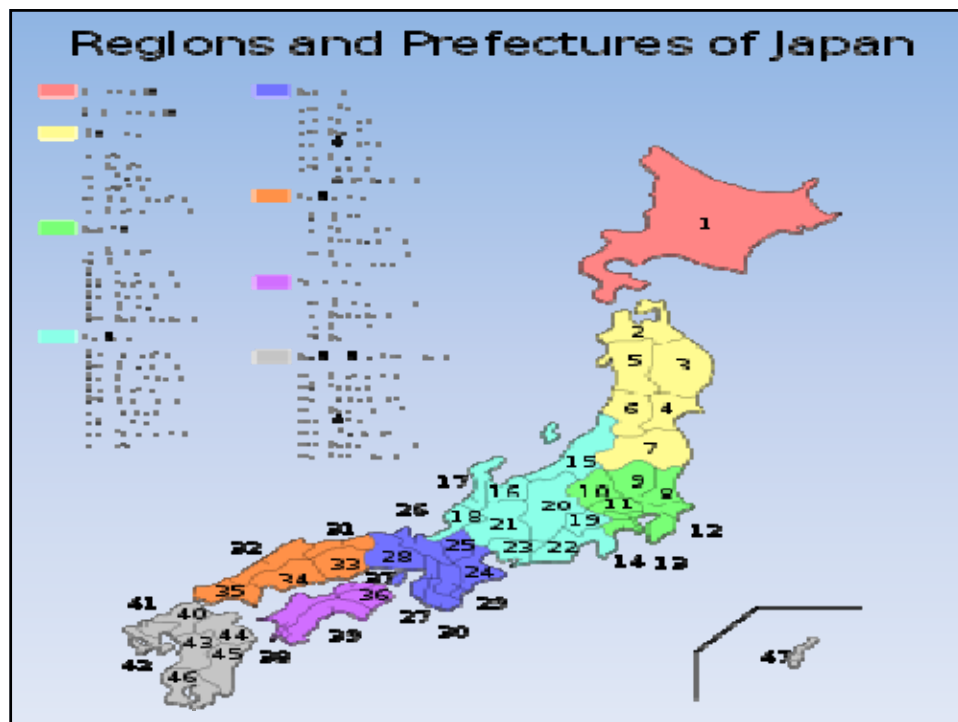
(4). EVACUATION PROGRAMS

- Evacuation methodologies in Japan were studied and they were compared with Sri Lankan scenarios.

FLOOD MANAGEMENT IN JAPAN

Administration in Japan





Geographic Condition and Climate in Japan

- 70% of land is covered with forests and mostly mountainous
- Heavy rainfall occur during rainy season (June-July) and in the typhoon season (August-October)
- Rivers are short and steep, causing sharp hydrograph
The ratio of maximum/minimum discharge is extremely high (about 100 for Tone River)
- 50% of population are concentrated in flood plains (10% of land)
- Japan is vulnerable for water related disasters

Causes of Flood in Japan

- Rivers are steep and short distance, resulting rapid flow.
- Most of urban areas are located in low-lying areas that are lower than the water level during floods.
- Population and city functions are concentrated in bellow zero-meter sea-level in some areas (Coastal areas in three major bays). Catastrophic flooding can be anticipated once the embankments are failed
- Half of the population and three-quarters of total assets are concentrated in low-lying areas. Major damage can be anticipated when flooding occurs.

Causes of Flood in Japan.....

- **Rapid Urbanization.**

Normally, the flow rate of rivers in urban areas is extremely low, but urban-type floods frequently occur when typhoons hit . The rain water falls to the catchments, flows down rapidly and overflows within a short period.

- **High intensity rainfalls.**

(1961- 342 mm per day ;

July 13, 2004 - 421 mm per day

Over 100 mm per hour in the Tokyo Metropolitan Area

Over 600 mm per 24 hours in Okinawa in 2010

- **Typhoons** are landing

River Law Amendment(1997) in Japan

- Establishment of comprehensive river administration system for flood control, water use and environmental conservation.
 - Improvement and Conservation of river environment
 - Introduction of river improvement planning system designed to incorporate the opinions of local residents.

New System for River Improvement Planning

Includes procedures for incorporating the opinions of the head of the local govt. and the local residents

(1) Basic River Management Policy

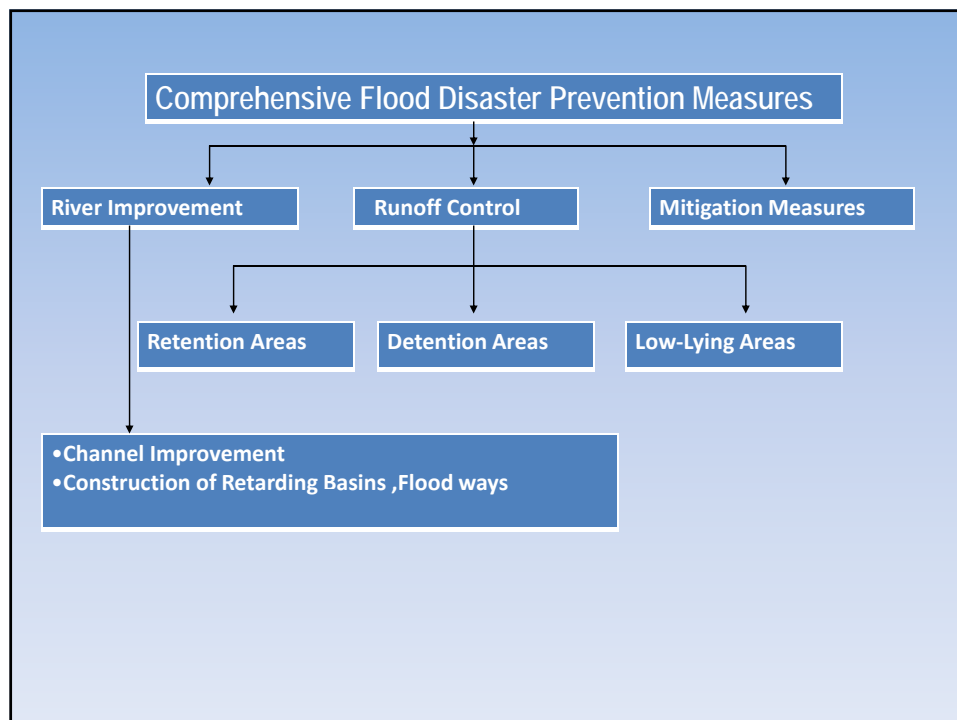
Dealing with matters basis for river improvement.

- Unregulated peak discharge
- Design flood discharge

(2) River Improvement Plan

Dealing with matters specifics concerning river improvement

River projects, River maintenance



Comprehensive Flood Disaster Prevention Measures.....

Retention areas

- Maintenance of controlled urbanization districts
- Conservation of nature
- Construction of reservoirs and regulating basins
- Installation of permeable pavements and seepage sumps

Detention areas

- Preservation of urbanization control zones
- Control of landfill
- Promotion of conditions favorable to agricultural activities

Low-lying areas

- Development of drainage facilities
- Construction of storage facilities
- Encouragement of use of flood-proof buildings

River Categorization in Japan

- **Class A rivers**-Rivers or part of river systems considered to be particularly important for the maintenance of the land or national economy.
- **Class B rivers**-Rivers or part of river systems (not part of class A rivers) considered to be particularly important for the interest of the public.
- **Law applicable rivers**

River Management in Japan

- **Class A rivers**- managed by the Minister of Land, Infrastructure and Transport(7% of the total length) (some designated segments are managed by Governor of the prefecture or mayor of Municipality.)
- **Class B rivers**- managed by governors of Prefectures or mayor of municipalities for designated cities.
- **Law applicable rivers** (small-scale rivers)- managed by the municipal mayors.

Tasks of River Administrator

- **Flood management**
- **River water use management**
- **River environment management**

Activities of River Administration Offices

- Observe rainfall, river water level, river water quality
- Conducting Research on improvement of environment and the river
- Plan, design and construct river structures
- Patrol to observe problems of structures, illegal acts

Japan Meteorological Agency

(on the water related disasters)

- **One goal of JMA**-Prevention and Mitigation of Natural Disasters
- **Responsibility**- Issuing weather/tsunami warnings and advisories, provide reliable and timely information to governmental agencies and residents for the purposes of natural disaster prevention and mitigation.

FLOOD EARLY WARNING IN JAPAN

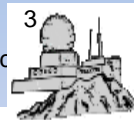
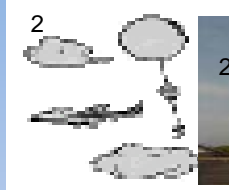
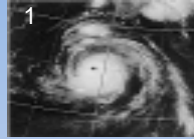


Sustainable, effective and Reliable FLOOD Early warning systems are available in Japan through continuous monitoring procedures

JMA's Meteorological Services

Observations

- (1) Satellite Observation
- (2) Upper-air Observation
- (3) Radar Observation
- (4) Surface Observation by AMEDA systems (Automated Meteorologic Data Acquisition System)- Rainfall, Wind, Temperature, Sunshine
- (5) Ocean Observation
- (6) International Data Exchange
- (7) Measuring soil water Index



Framework of Forecast Operation (JMA)

Operates a number of observatories and whether stations across the country

National Forecast Center



Regional Forecast Centers (11)



Local Meteorological Observatories (47)

LMO:

- LMO is responsible for provide information on weather for each prefectural and sub- prefectural level as well as 8 weather stations.
- Numerical System for Weather Prediction
- Real time information on rivers could be easily obtained through Internet.
- Internet Portal in Hyogo-weather warnings/advisories are readily available. Through this, river Information (Rainfall, water level), road Information (rainfall, snow), Sea Information (elevation of tide) can be obtained.

Main Objective of Local Meteorological Observatories (47)

Disaster Forecasting to save lives

- Collecting weather and EQ data
- Analysis and Prediction of Weather
- Issuing Warnings and Meteorological Information

Kobe Local Meteorological
Observatory office



Methods used to acquire real time weather data by Kobe Local Meteorological Observatory Office



- (1) Using AMeDAS (Automated Meteorological Data Acquisition System)
- Wind
 - Temperature
 - Rainfall
 - Sunshine

All the systems are computerized and data can be monitored through the screen.

There are 26 AMeDAS installed in Hyogo Prefecture.
There are 1,300 AMEDA Systems in Japan.

Methods used to acquire weather data by Kobe Local
Meteorological Observatory Office.....



(2) There are 258 Rain-gauges installed by Local Govt. with corporation with National Govt. in Hyogo prefecture.

All the systems are computerized and data can be monitored through the screen.

Methods used to acquire weather data by Kobe Local
Meteorological Observatory Office.....



Method for Observe Weather Condition (Small rain drops, snow...) – Can not measure the amount

Snowfall observation



Methods used to acquire weather data by Kobe Local Meteorological Observatory Office.....



Plants to observe variations due to seasonal difference

Methods used to acquire weather data by Kobe Local Meteorological Observatory Office.....

- (3) Using Radar Systems

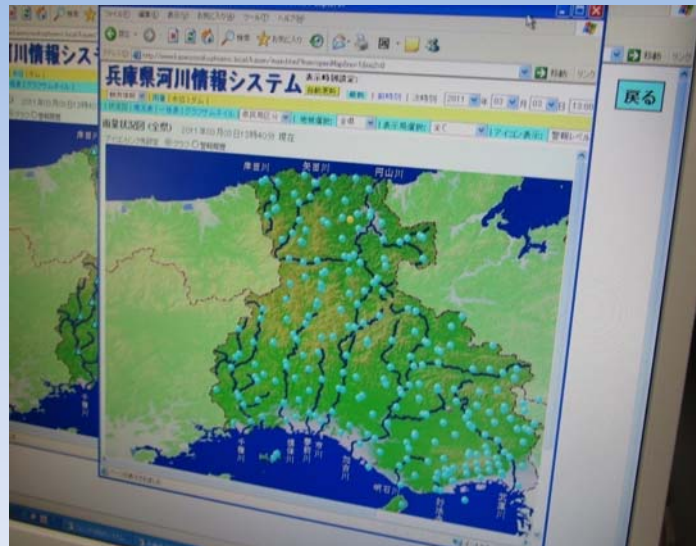
There are 20 radar systems in Japan.

One in Osaka Prefecture.

Area information (Approximate Rainfall and Cloud information can be observed from Radar.

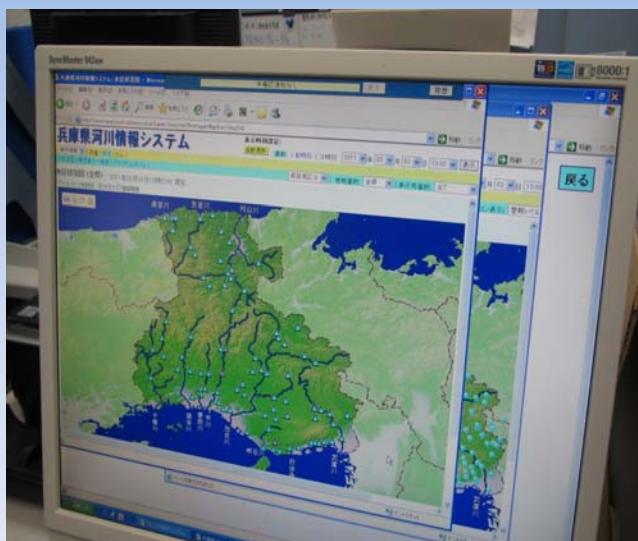


Weather Analysis and Prediction System
in collaboration of Hyogo Prefecture & Kobe Local
Meteorological Observatory Office



Dots indicate the
rain-gauges
installed in Hyogo
Prefecture

Weather Analysis and Prediction System
in collaboration of Hyogo Prefecture & Kobe Local
Meteorological Observatory Office



Triangles indicate the
Water level measuring
gauges in Hyogo
Prefecture

Weather Analysis and Prediction by Kobe Local Meteorological Observatory Office.....

- By analyzing data collected by AMeDAS, Rain-gauges and Radar systems, 1 km² precise data can be observed.

Show rainy clouds in some area



Hyogo Prefecture Govt. Office

- Responsible for disaster prevention
- 684 rivers in Hyogo Prefecture.
- Total Length : 3,494 km
- Published Hazard map to the public through internet giving information of inundation level and evacuation centers.



Dissemination of River Information by River Management Improving Division ,Hyogo Prefectural Govt. Office

- Automatic system to warn municipalities.
- 113 alarming systems to warn the public.
- 32 Cameras are fixed in Hyogo prefecture in major flood points along major rivers. They are going to increased the number of cameras up to 124.
- Municipalities also fixed cameras along the river. 30 cameras are fixed by Kobe Municipality.
- National Govt. installed cameras along A rivers.

But in heavy rainy situations it is difficult to observe camera images from the screen.

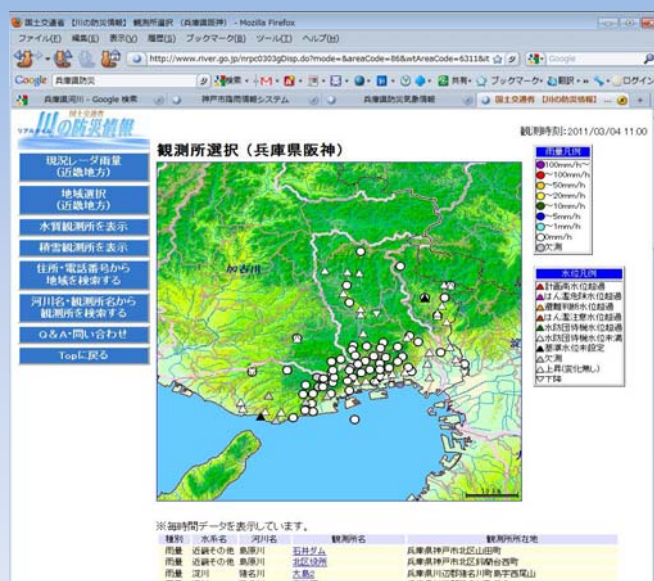
Hyogo Prefecture Disaster Management Weather Information Top Page: Warning and Advisory



Hyogo Prefecture Disaster Management Weather Information Current Precipitation Data Through Radar



Hyogo Prefecture Disaster Management Weather Information: Link (MLIT Page) Observation Station



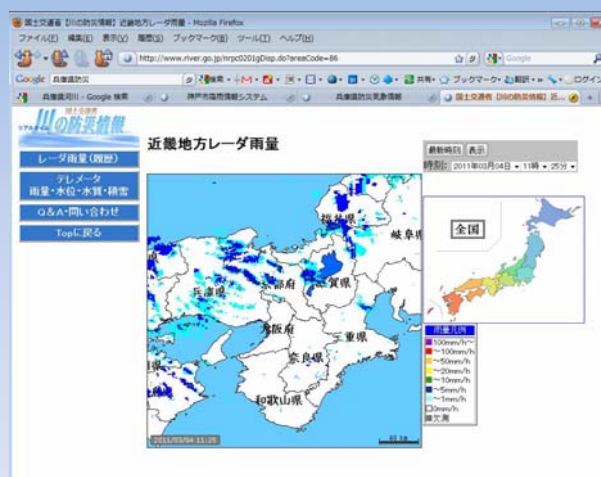
<-Rain gauge

<-Water Level gauge

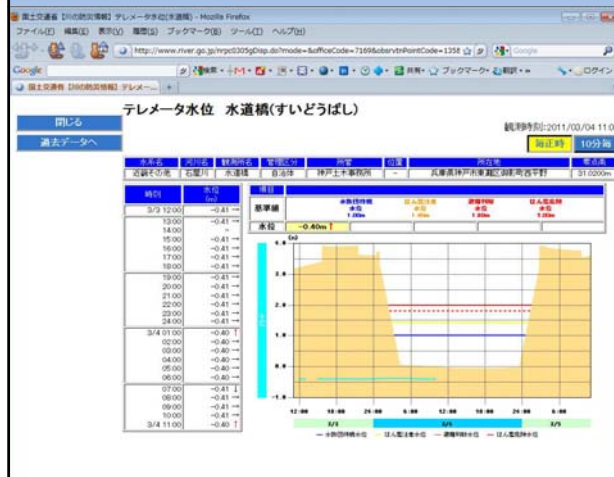
Indication of Rainfall in the Screen

- Blue color - Normal rainfall
- Yellow color - Rainfall > 15 mm/hr
- Red color - Rainfall > 20 mm/hr
- Red color- Rainfall exceed 50 mm in 24 hours

Hyogo Prefecture Disaster Management Weather Information: Link (MLIT Page) Current Precipitation by Radar



Hyogo Prefecture Disaster Management Weather Information:
Link (MLIT Page)
Current Water Level by Water Level Gauge



- - Warning Level
- - Alert level
- - Normal Level

- Calculation method is used to predict water level.
- Flood predictions updated in every 10 minutes

Responsibility of Municipalities

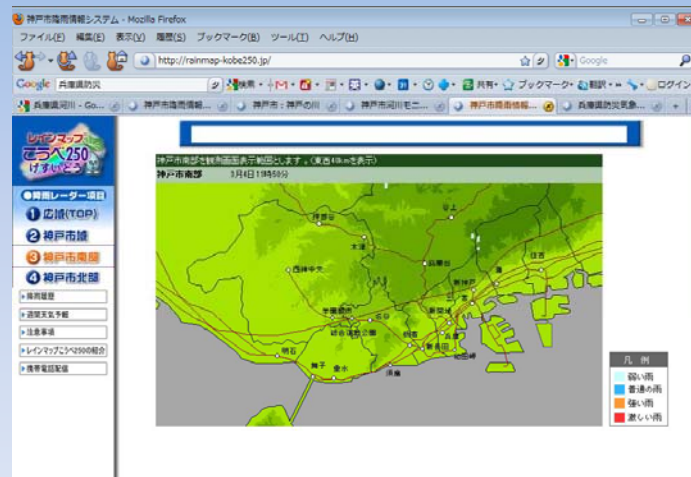
- Flood management of law applicable rivers.
- Flood observation and prediction.
- Issuing Evacuation orders.

Evacuation Procedure:

- Municipalities work 24 hours in heavy rainy periods.
- Each Municipality has fire dept.(7* 24 hr.)

This take the necessary action for issuing early warning to the public and evacuation.

Kobe Municipality Precipitation Information System Current Precipitation by Radar



Kobe Municipality River Monitoring System Location of Observation Cameras



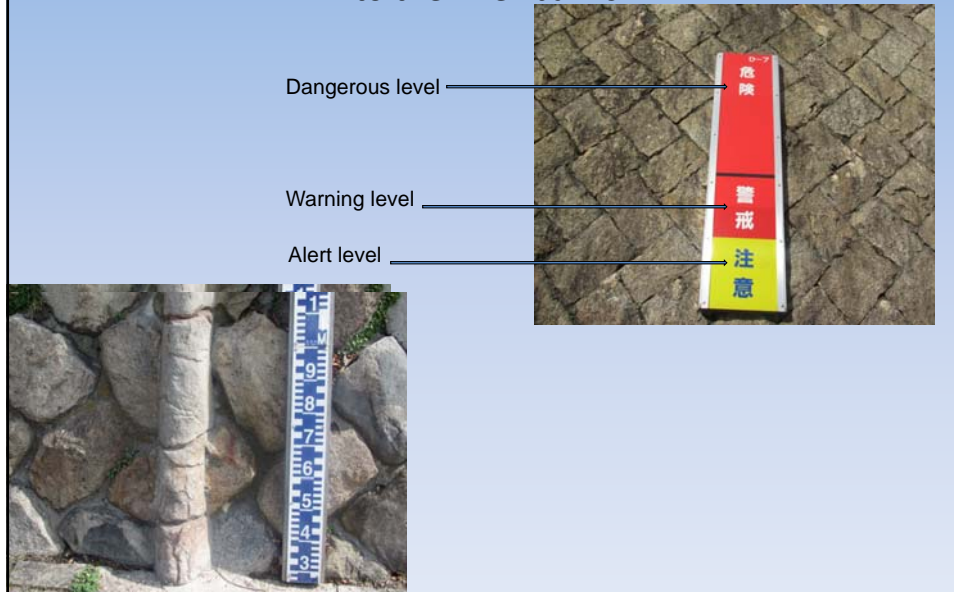
Early warning activities in the Toga River in Kobe Municipality



CC Cameras (**CLOSED –CIRCUIT TELEVISION**) fixed to the river banks to monitor the river water



Water level measuring gauges and senses are fixed to the river banks



Speakers are installed along the river to give announcement



Flash lights are installed along the river to warn community



Sign Boards are fixed to the river banks



Kobe Municipality River Monitoring System The Image taken by Monitoring Camera in the TOGA river

Current condition



Water Level

Normal Situation

The Image taken when a flash flood occurred at the TOGA river in 2009



The Image taken when a flash flood occurred at the TOGA river in 2009



Flood Mitigation Activities in Japan

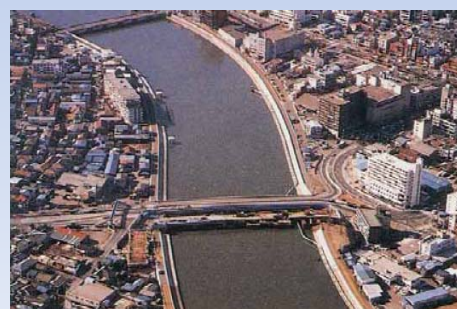


River Improvement

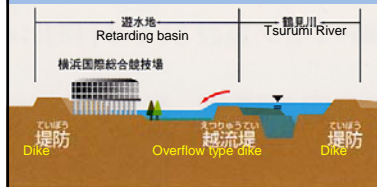
Tsurumi River



After improvement



River Improvement



Multipurpose Retarding Basin for Tsurumi River



Example of Use as Multipurpose Facilities

Kirigaika regulating reservoir ,Kanagawa Prefecture



normally used as a tennis court

Kirigaoka Regulating Pond
(Tsurumi River)

In flood times



Aerial view of a group of storm water detention ponds



Storm water detention ponds covered with bluish green screens

Basin Measures

Example of general storm water detention pond



River management activities at Amagasaki in Hyogo prefecture

- . Land surface is lower than the sea level in this area.

Sea-gates to prevent sea water intrusion in Amagasaki in Hyogo Prefecture



Lock 1

Kyuu samondo River mouth

Lock 2



Wall around the sea beach to prevent sea water intrusion



Pump Kyu samondo river water to the sea

Control Center of Lock in Amagasaki



Tohin drainage pumping station
(Water pumping capacity 72 m³ /s)

Water-gauge beside of the water control centre



water levels in 1934 and 1950 are marked in this gauge.

Samondo River in Hyogo Prefecture

Matsushima Drainage pumping station to pump river water to sea

Water pumping capacity : 91 m³ /s



Gate across the river to prevent garbage flow down to the sea

Low-height old dam across the Shoge river to overflow water



Keep water level steady in upside.
This provide facility to catching fish.

Primary stage of construction in upper part of Shoge river



Instruction Board fixed to the river bank

Underground Drainage Channel to retain and circulate flood water



This is situated in upper part of Shoge river



Koyagawa Drainage Pumping Station



4 pumps are in here
Drainage capacity:
25 m³/s
Water pumps to the
Inagawa river .



Construction of Inagawa river



FLOOD MANAGEMENT IN SRI LANKA

TYPES OF FLOODS IN SRI LANKA

- RIVER OVER FLOW
- FLOODING DUE TO SEA WATER
 - Storm Surge/Cyclone
 - Tsunami
- FLASH FLOODS
- URBAN FLOODS
- FLOODING DUE TO BREAKING OF DAMS IN RESOURVORS AND RIVERS



RIVERS IN SRI LANKA

Out of the 103 river basins, Kelani, Kalu, Gin, Nilwala and Mahaweli experience floods every year.

Flood occurrences in the eastern slopes and plains coincide with the North-East rainfall season, September to January.

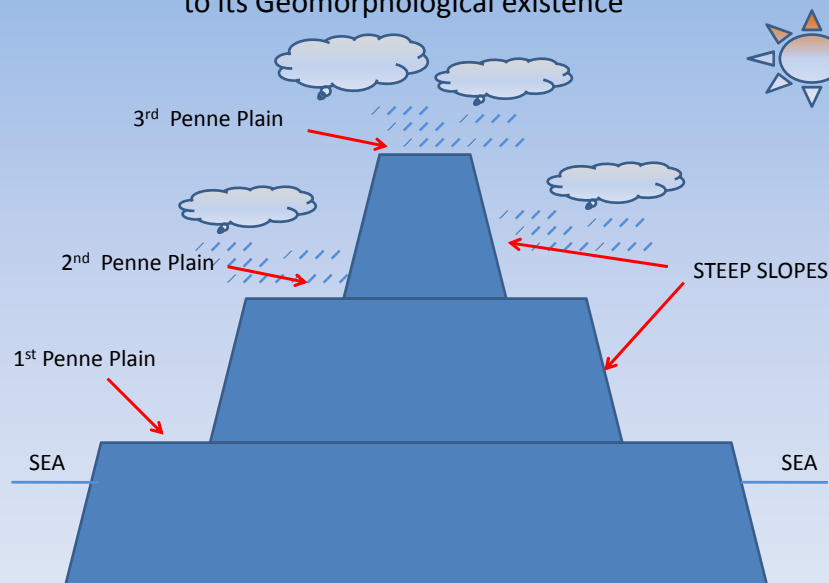
In western slopes floods occur during North-East rainfall season, but more common in South-West season from May to August.

Flooding in Sri Lanka

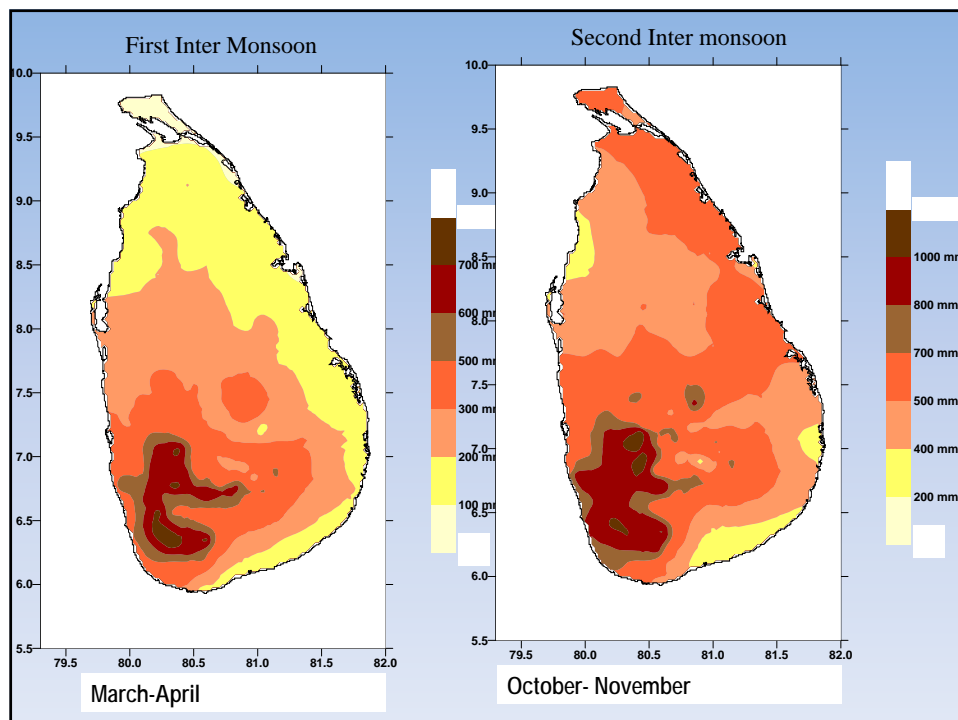
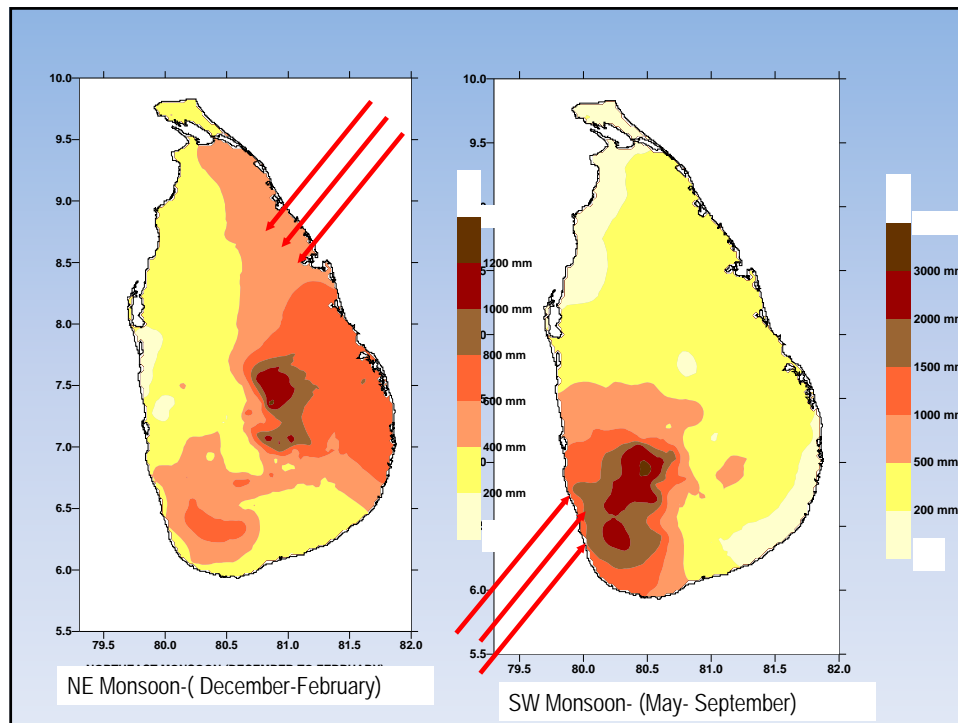
Physiography of Sri Lanka

- There are three major penne-plains in terms of elevation in Sri Lanka and the area between each adjacent penne-plains usually consists of steep slopes, steep and narrow valleys, spurs.
- All major rivers start from the central hills. When the mountainous areas receive intensive rainfall, all flatten areas that are situated surrounded by this hilly region gets flooding within a short period of time because of rapid water flow down steep valleys to increase the water level suddenly in highly populated downstream planer areas

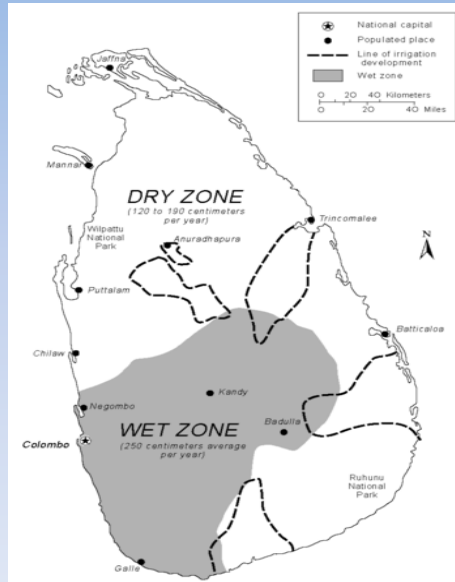
In Sri Lanka, sudden floods are experienced by lowland areas due to its Geomorphological existence







Precipitation and irrigation map of Sri Lanka



Wet zone of SRI LANKA :

- This area is prone to severe flooding frequently.
- A large number of major rivers are flowing through this Zone.
- Human settlements located on the riverbanks and low-lying areas are mainly subjected to flooding.

During the heavy rain in 2011, most of earth bunts of ancient irrigation tanks (lakes) were broken causing damages to agricultural lands, properties and even to human lives. (North-East part of the country)

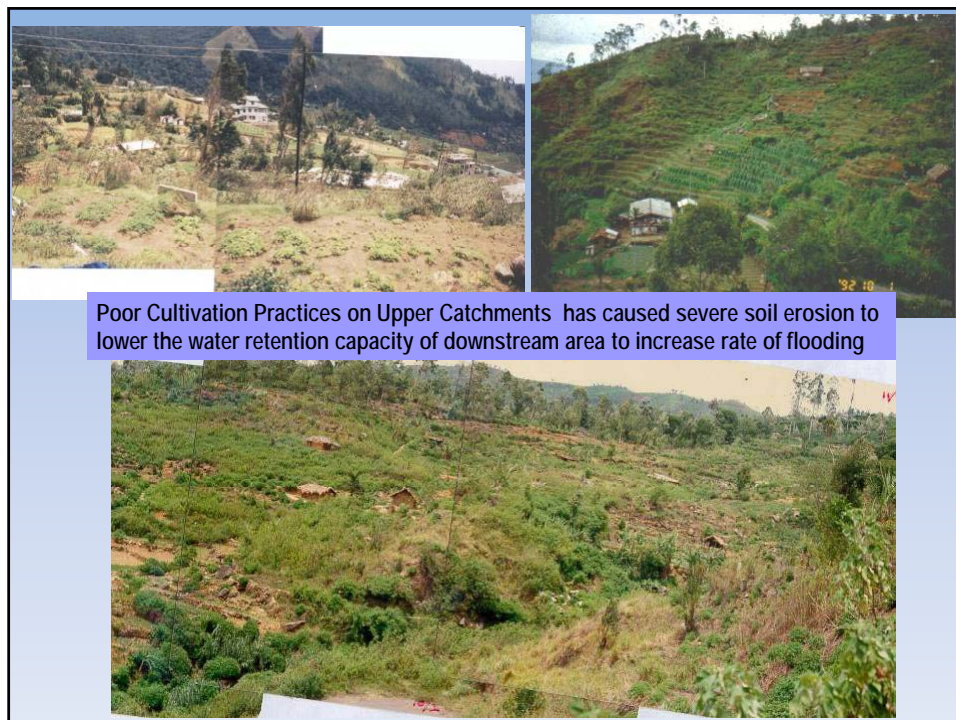
School



MAN MADE CAUSES

Deforestation in catchments has drastically reduced water retention capacity and has increased the silt in down stream area





Construction by blocking water ways



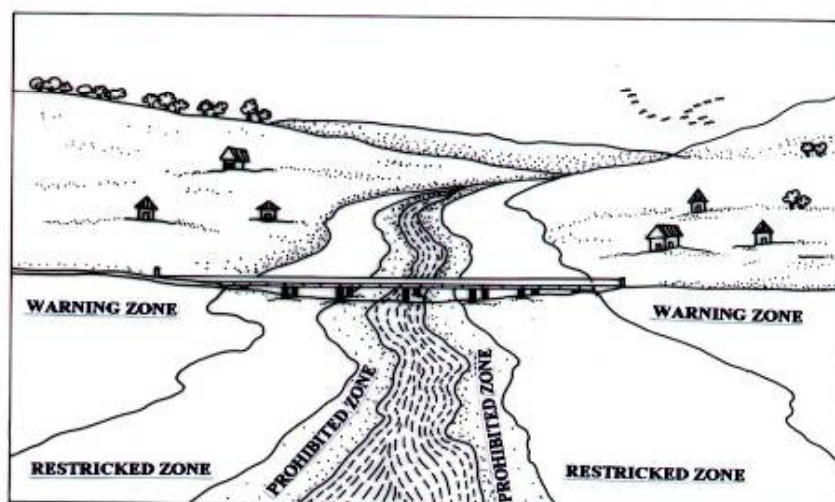
ILLEGAL LAND FILLING



A recent land fill has caused flash flood to adjacent populated area



Zoning must be done along the River Valley- Flood Prone area



Unplanned and Illegal settlements in flood prone area in Sri Lanka- (Restricted and Prohibited area)

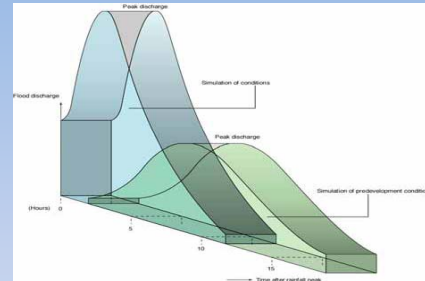


CONSTRUCTION IN BUFFER ZONES- RATHNAPURA-SRI LANKA





Effect of urbanization on flood runoff



After



In the recent past, highly populated areas were severely affected by flash floods, which were totally caused by

- ❖ Unplanned human activities such as illegal and inappropriate construction, blocking of water ways through unplanned construction, poor waste dumping procedures,
- ❖ Unplanned land use practices,
- ❖ Low land reclamation
- ❖ River sand mining
- ❖ cultivation on hill slopes without applying soil erosion prevention practices

Flooding in 2011 caused by heavy rainfall due to sudden change of climatic condition. Improper land use practices worsened the situation.

EVEN THOUGH INFORMATION ON RAINFALL DATA AND WATER LEVEL DATA ARE COLLECTED REGULARLY, FLOOD EARLY WARNING SYSTEMS NEED TO BE FURTHER IMPROVED

NEED OF BETTER COORDINATION, COMMUNICATION AND INFORMATION SYSTEM AMONG DATA COLLECTORS, GOVERNMENT, VULNERABLE COMMUNITIES AND PEOPLE LIVING IN CATCHMENT AREAS
FLOOD EARLY WARNING DISSEMINATION ARE STILL NOT IN PROGRESS

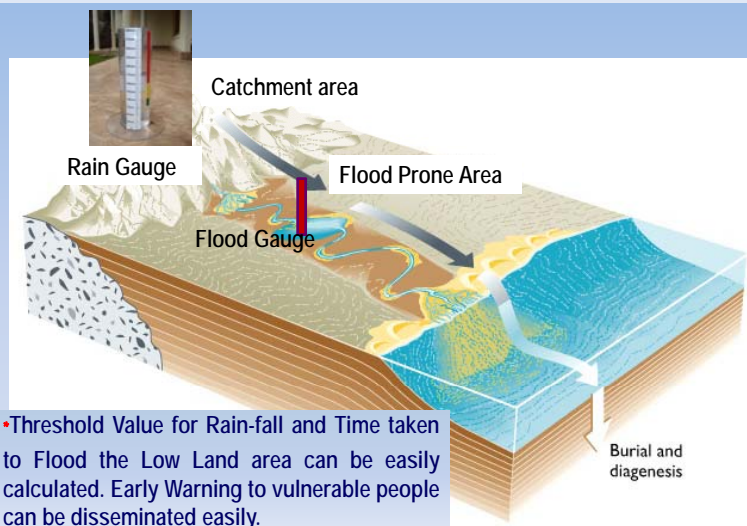
FLOOD EARLY WARNING IN SRI LANKA

Every year, during rainy seasons people who are living in the downstream areas are severely affected by flood. However, unfortunately, there is still no proper early warning system established to issue flood warning to people escape from the incidence. Timely Warning, Quick response, evacuation procedures are yet to be commenced

PROBLEMS ENCOUNTERED IN MITIGATION OF FLOODS IN SRI LANKA

- All the riverbanks are highly populated Construction of flood retention levees is a difficult task.
- Negligence of the people
 - Although, the institutions are carrying out public awareness programs, public participation is still unsatisfactory.
- Although, Government has introduced several favorable construction methodologies for flood prone areas, people never follow such construction methodologies.
 - Reason : Most of the people living in flood prone areas are not having the required financial strength.
- Currently, river gauging stations are operated in most of the rivers but their use is still limited to measuring of discharge and rainfall intensity.

Early warning can be issued by measuring Precipitation in Catchments and Flood Level in Flood Prone area

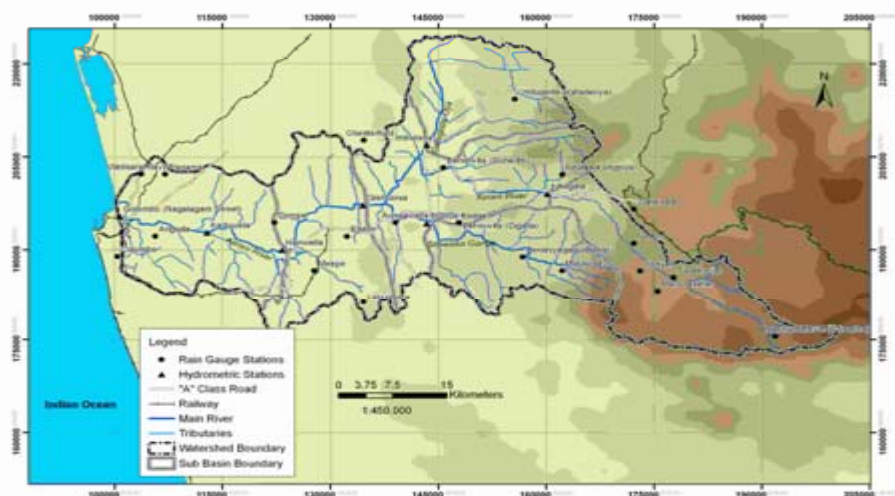


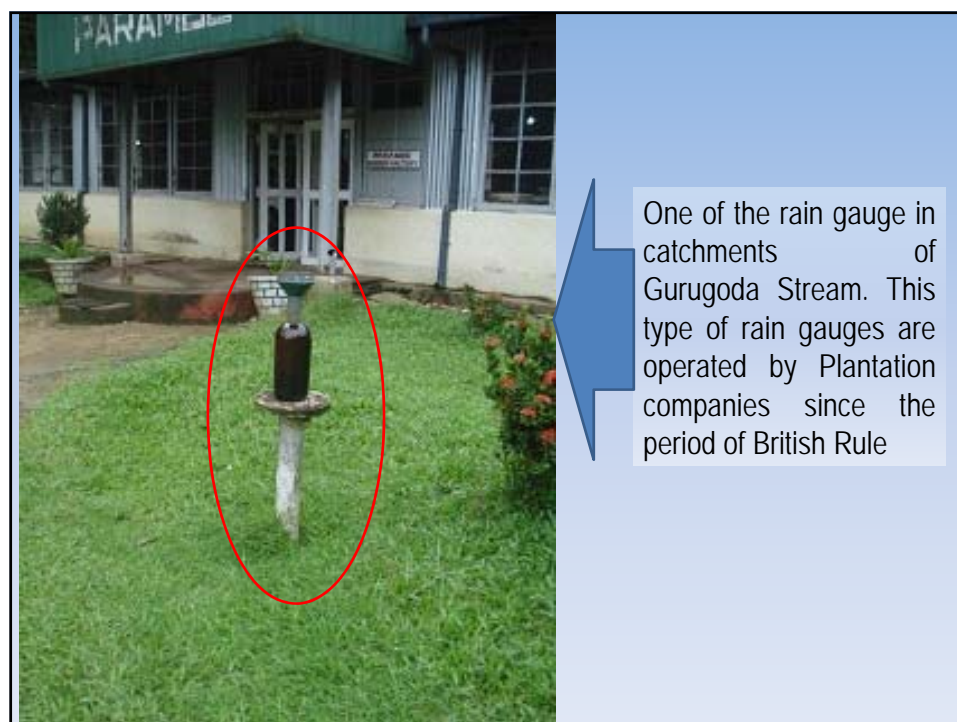
- Threshold Value for Rain-fall and Time taken to Flood the Low Land area can be easily calculated. Early Warning to vulnerable people can be disseminated easily.

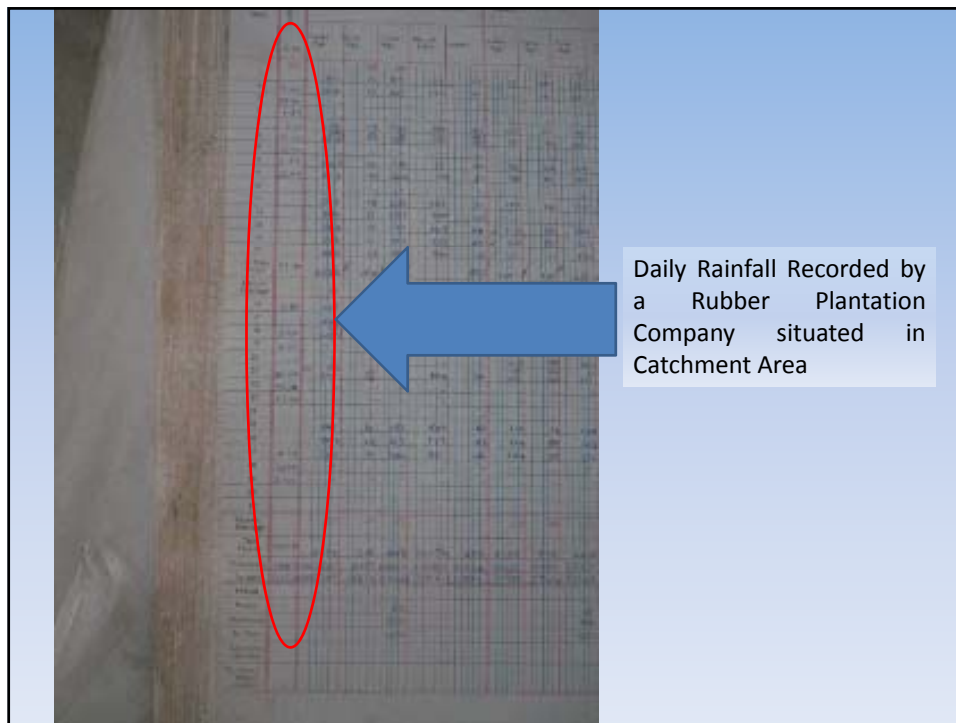
Flood Management in Sri Lanka

- Irrigation Department is responsible for planning, design, construction, operation and management of all major and medium Irrigation schemes and works related to flood control, drainage and salinity extrusion.
- Disaster Management Centre is responsible for Dissemination of warnings to the public.

Rain gauges and Water level gauges are installed in Kalani River catchment







- **Need of proper coordination between data collectors, govt. departments, community in flood prone areas and community in the catchments .**
- **Timely Warning, Quick response, evacuation are yet to be commenced .**

RESULTS

Output of this research is immense help for establishing a real time early warning methodology to all flood prone areas in Sri Lanka since at present; such a sophisticated and effective system is not present in the country.

