



27th November – 4th December 2013 Sri Lanka

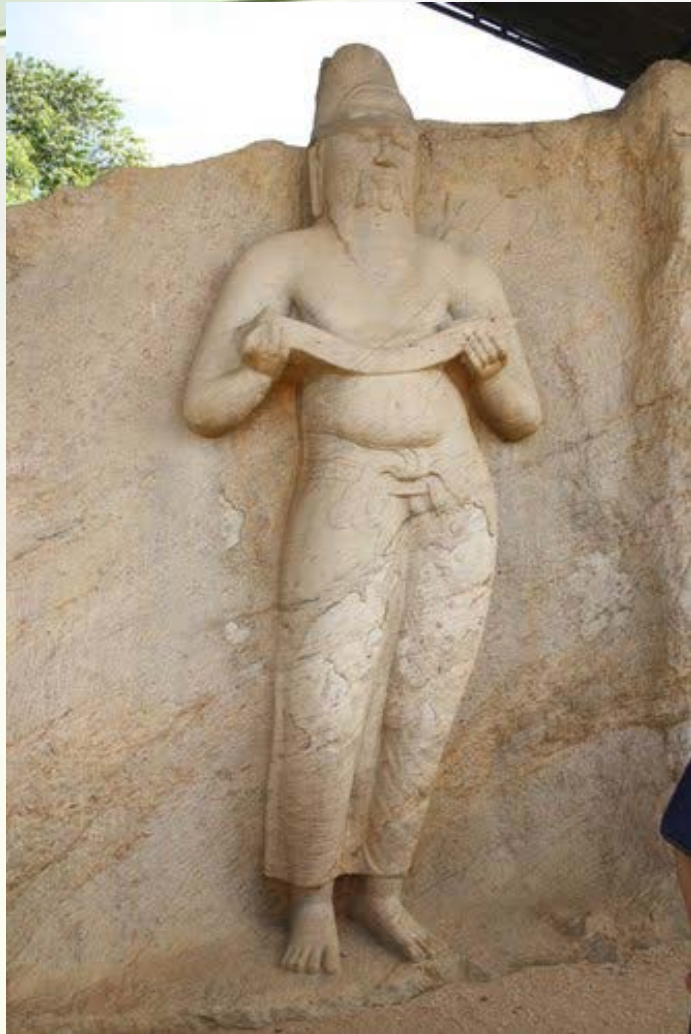
Importance of Ensuring Safety of Water Infrastructure to Enhance Water Security through IWRM

Experience in Dam Safety & Water Resources Planning Project (DSWRPP).

Sudharma Elakanda
Project Director (DSWRPP)
28th November, 2013



Water Security was addressed even in 11th Century in Sri Lanka.



King Parakrama Bahu (11th Century AD)

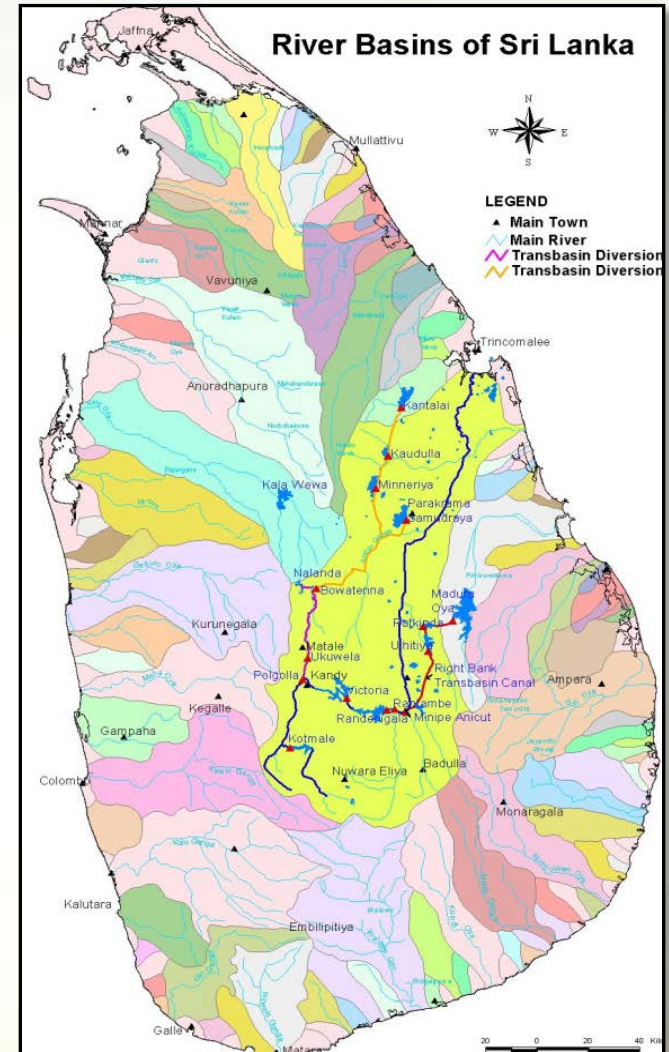
The Sri Lankan knew the wisdom of the words of their mediaeval king, *Parakrama Bahu* the Great, who declared that

“Not a single drop of water received from rain should be allowed to escape into the sea without being utilized for human benefit”.



Water Resources of Sri Lanka

- ❑ 103 River basins cover entire land area of Island enhancing the water resources.
- ❑ 17 River Basin >1000sqkm
- ❑ Mahaweli Basin is the Largest, 10327 sqkm.
- ❑ The major rivers of Sri Lanka originate from Central Hills (Mahaweli, Kalani, Kalu & Walawe).
 - ❑ Large/Medium Dams = 350
 - ❑ Large Dams = 80
 - ❑ Small Dams = 25,000
 - ❑ Annicuts (Weirs) = 12,940





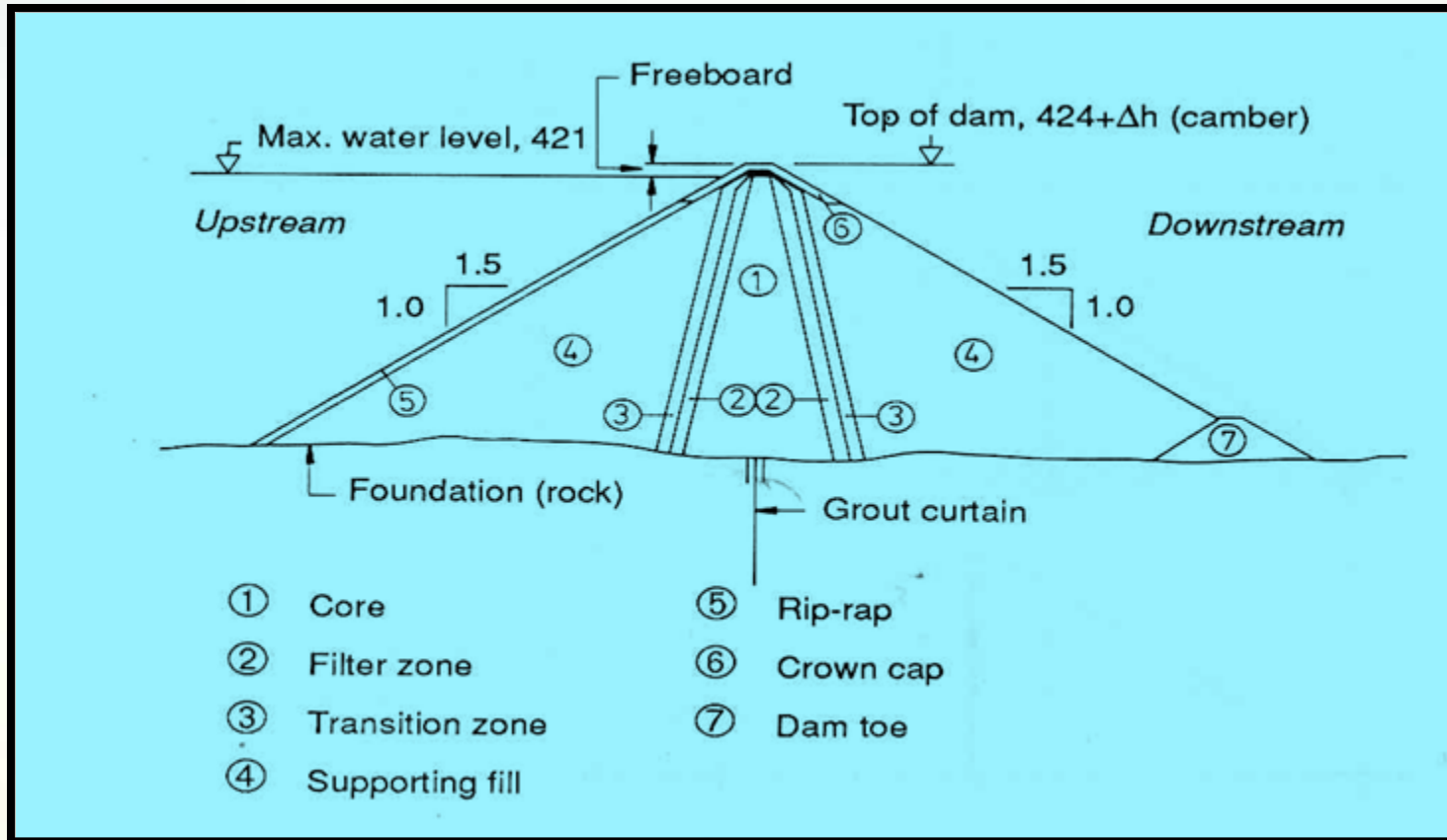
Why Dams are constructed?

- Dams are constructed to form reservoirs and impound water in, for **control release of water** for
 - Irrigation,
 - Hydro-power Generation,
 - Flood Control,
 - Domestic Water Supply and
 - Recreation activities





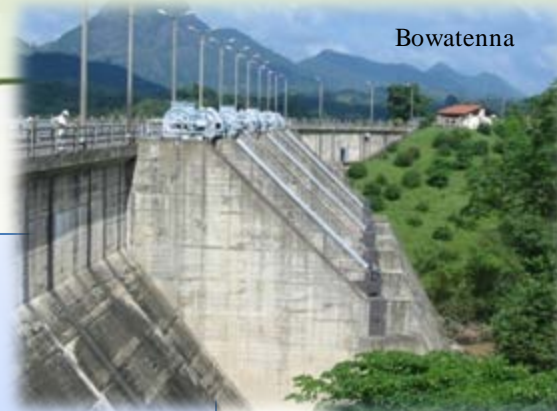
General Features of Dam Section





Type of Dams

- Concrete Gravity
- Concrete Arch
- Rock Fill
- Homogenous Earth / Embankment Dam
- Masonry



Bowatenna



Victoria



Maduru Oya



Kaudulla



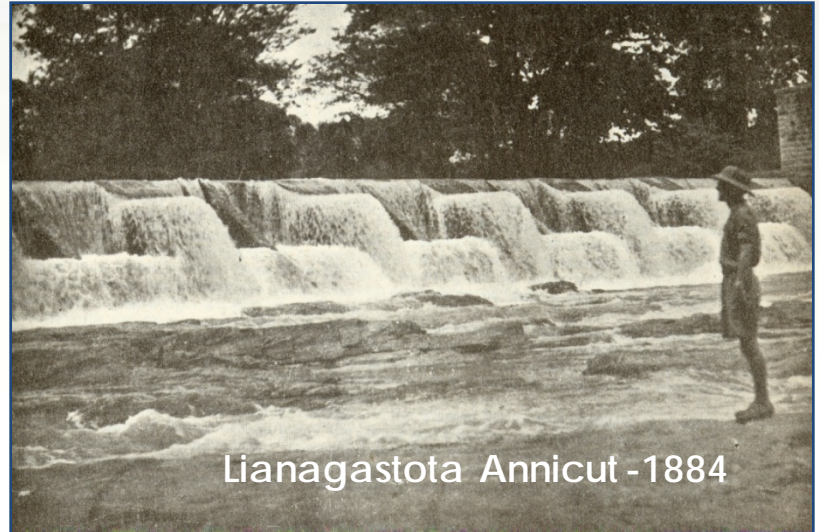
Kalatuwawa



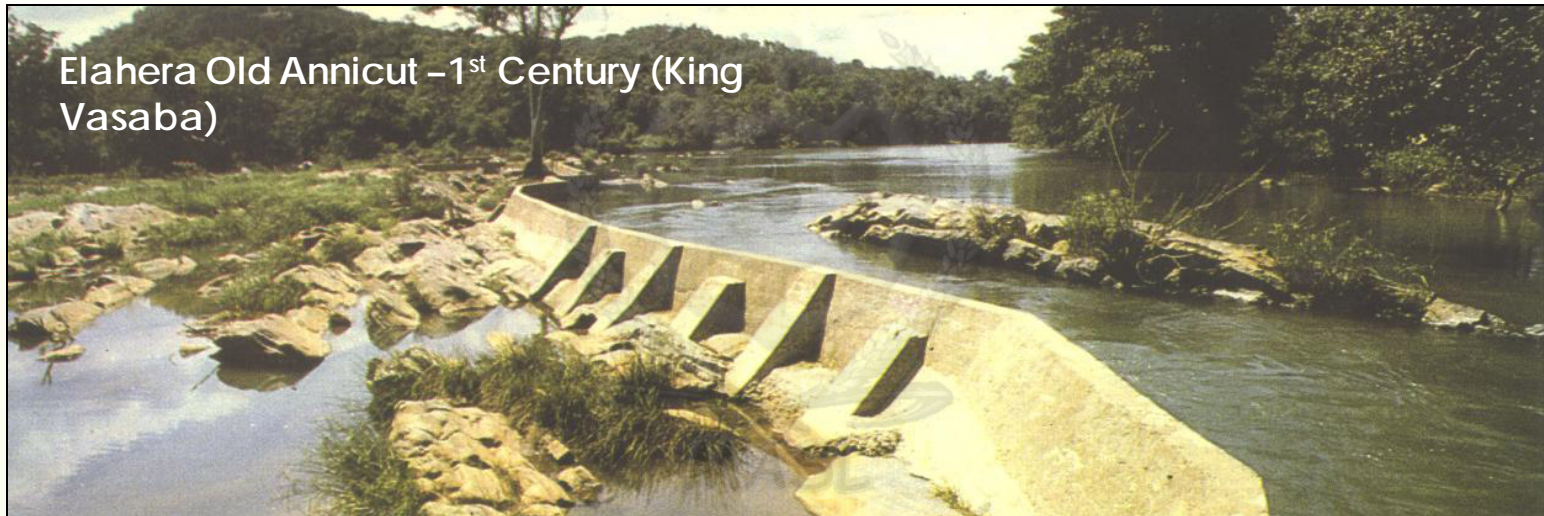
Ancient Irrigation Dams in Sri Lanka



Minipe Old Annicut - 6th Century (King 1 Aggabothi)



Lianagastota Annicut - 1884



Elahera Old Annicut - 1st Century (King Vasaba)



Modern Mahaweli Dams

Victoria



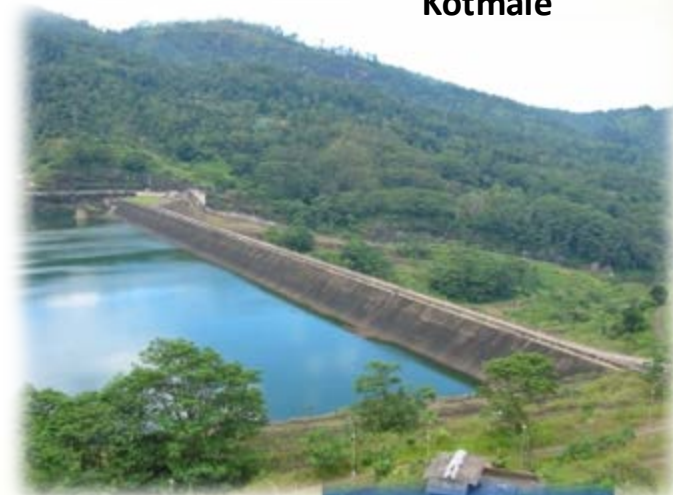
Rantambe



Maduru Oya



Kotmale



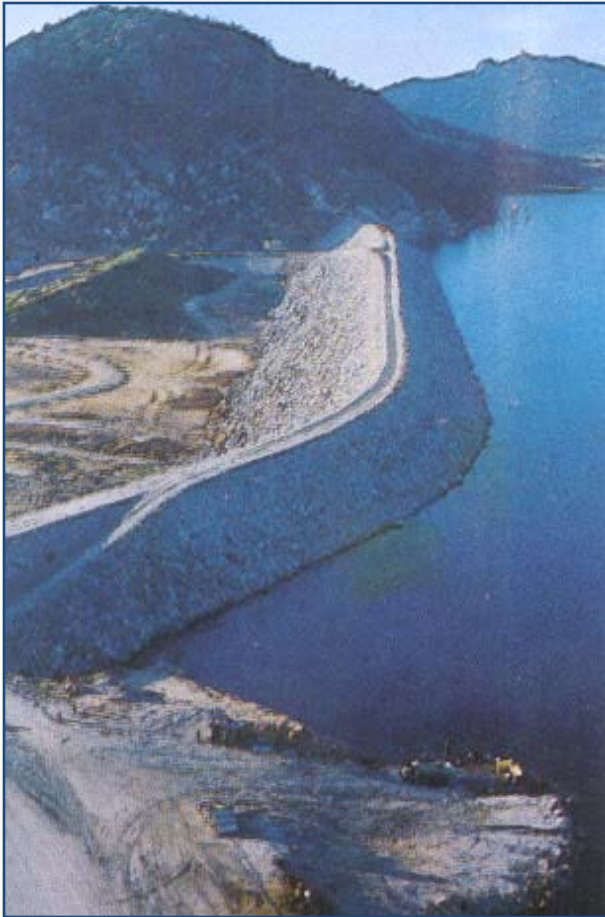
Randenigala





Historical Background of Dam Construction and Maintenance

- ❑ The Maduru Oya reservoir sluice more than 9 Centuries old, discovered in 1978, considered an engineering marvel.



New Maduru Oya Dam





What is a Dam Failure ... ?

- ❑ Dam failure is **the uncontrolled release of impounded water** resulting in downstream flooding, which can affect lives and properties.





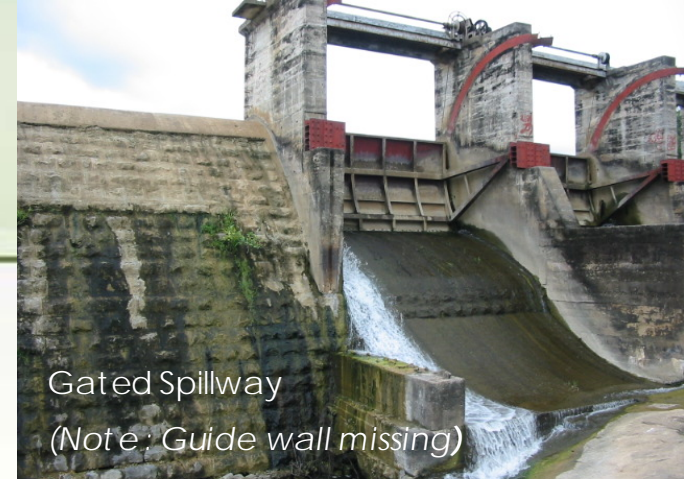
How Dams Fail?

1. By Overtopping

- ❑ Inadequate Spillway Design
- ❑ Debris Blockage of Spillway
- ❑ Settlement of Dam Crest
- ❑ Unusual Storm

2. Foundation Defects (Structural Failure)

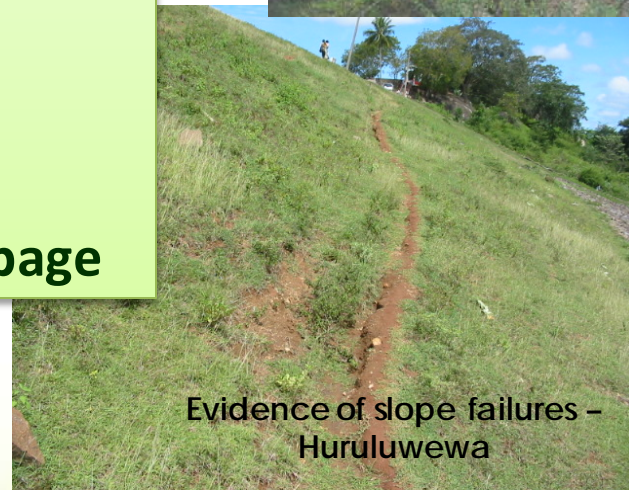
- ❑ Differential Settlement
- ❑ Sliding and Slope Instability
- ❑ High Uplift Pressures
- ❑ Uncontrolled Foundation Seepage



Gated Spillway
(Note: Guide wall missing)



Giritale



Evidence of slope failures –
Huruluwewa



Continue

3. By Piping & Seepage

- ❑ Internal Erosion through Dam Caused by Seepage-"Piping"
- ❑ Seepage and Erosion along Hydraulic Structures Such as Outlet
- ❑ Cracks in Dam





Less Common Cause for Dam Failure

During Earthquakes;

- ❑ Development of high pore pressure
- ❑ Possible liquefaction of saturated layers

The result of these can be excessive settlement or deformation of the embankment.



In 1994, Northridge earthquake cracked the surface pavement on the upstream slope of the Los Angeles Dam.



Result of a Dam Failure

- ❑ When dams fail due to structural problems or major flood events, the energy of the stored water is released without any control and can cause damage to areas downstream.

- ❑ Dam failures can result in;
 - ❑ Loss of Lives
 - ❑ Loss of Properties
 - ❑ Loss to the Economy
 - ❑ Environmental Damage





Example for Dam Failures in Sri Lanka

The Kantale Dam breached in 1986 resulting in a massive disaster;

- Killing 127 people,
- Affecting 10864 residents,
- Destroying 1200 houses and substantially damaging agriculture,
- Commercial and public infrastructure sector.

The cost to the Government's relief, rehabilitation, and re-housing expenditures for the affected downstream residents was about three times the cost of the Dam.





General...



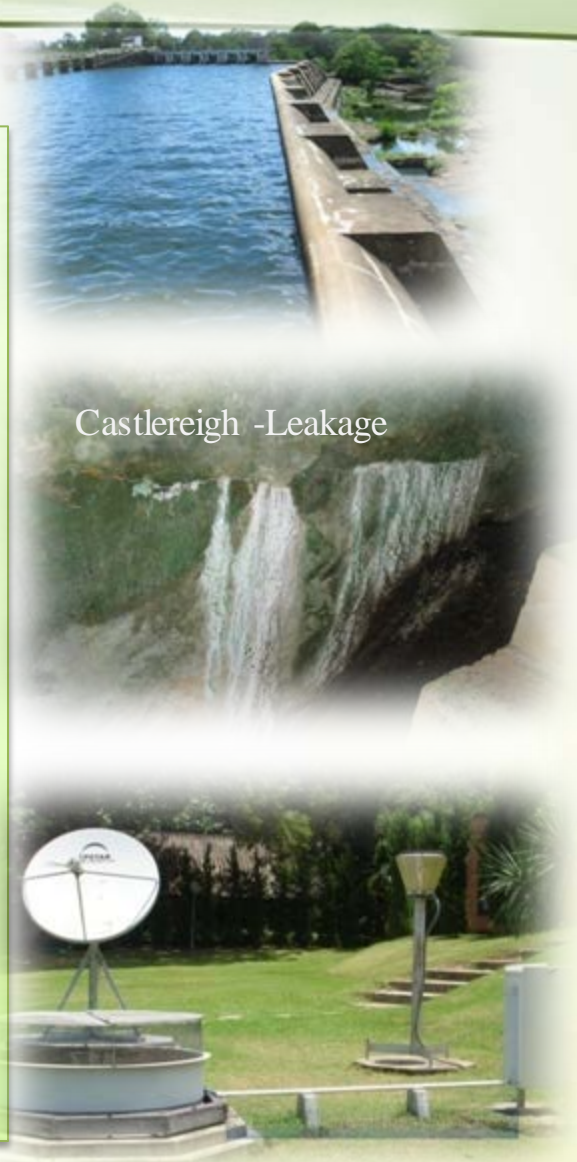
The risk of the Failure of a Dam is one of the inevitable burden of civilization. A primary duty of the Engineer is to minimize this hazard.

No other field of engineering has the responsibility to the public, heavier than this.



Challenges to the Water Sector...

- ❑ Over 350 Medium/80 Large Dams, Headworks and Trans-Basin canals of the country are *Aging, Suffering from various structural deficiencies and Shortcomings in Operation and Monitoring facilities.*
- ❑ Lack of real-time Hydrological and Hydro-meteorological data and information
- ❑ Competition among different sectors and users
- ❑ Weak institutional arrangements and coordination for efficient management of water infrastructure



Castlereigh -Leakage



To address these Challenges

- ❑ **“Dam Safety & Water Resources Planning Project (DSWRPP)”** initiated on July 2008 with the financial assistance of IDA/ World Bank.
- ❑ There are three component of the project
 - ❑ Component 01 - Dam Safety & Operational Efficiency Improvement
 - ❑ Component 02-Upgrade and Modernize current Hydro-Meteorological Information System (HMIS)
 - ❑ Component 02 - Multi Sectoral Water Resources Planning





Objectives of DSWRP Project



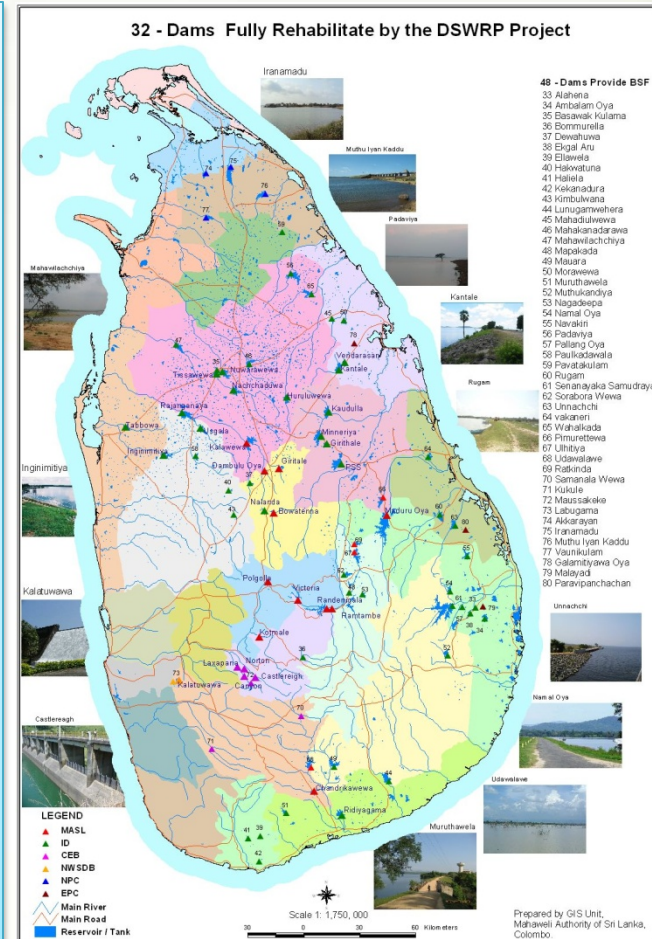
“Improve the development and management of water resources within the country, reduce water induced hazards to public, and enhance effectiveness of water related investments”





Key Project Activities of Component - 01

- ❑ Rehabilitation of 32 Large Dams identified as high risk to the Public Safety.
- ❑ Provision of Basic Safety Facilities for 80 Large Dams (including above 32 Dams).
- ❑ Provision of computer based maintenance management system to 6 selected dams.
- ❑ MASL - Kotmale, Polgolla, Victoria, Randenigala & Rantembe
- ❑ CEB - Samanlawewa
- ❑ Preparation of Emergency Action Plan for 8 dams.
- ❑ MASL- Kotmale, Polgolla, Victoria, Randenigala & Rantembe
- ❑ ID - Inginimitiya & Nachchaduwa
- ❑ CEB - Maussakele
- ❑ Preparation of O & M Manuals for 32 dams



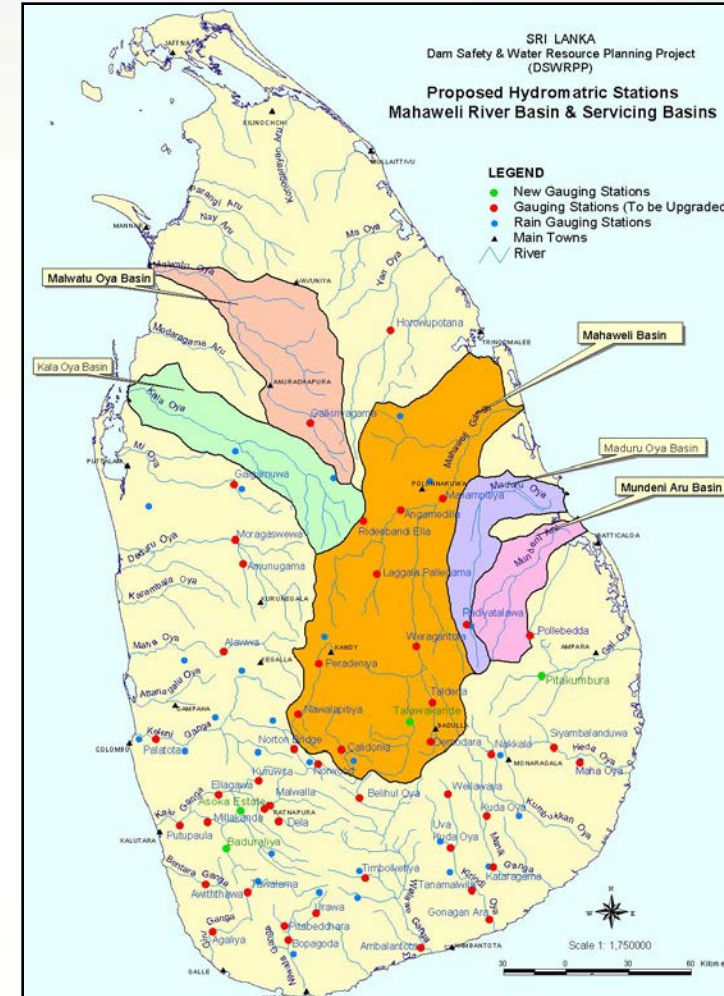
Enhance Water Security





Key Project Activities of Component - 02

- ❑ Establishment and upgrading of 122 hydrometric stations
- ❑ Establish 02 Data Centers at Hydrology Division of ID and Water Management Secretariat of MASL.
- ❑ Improvement of analytical capability of relevant implementing agencies

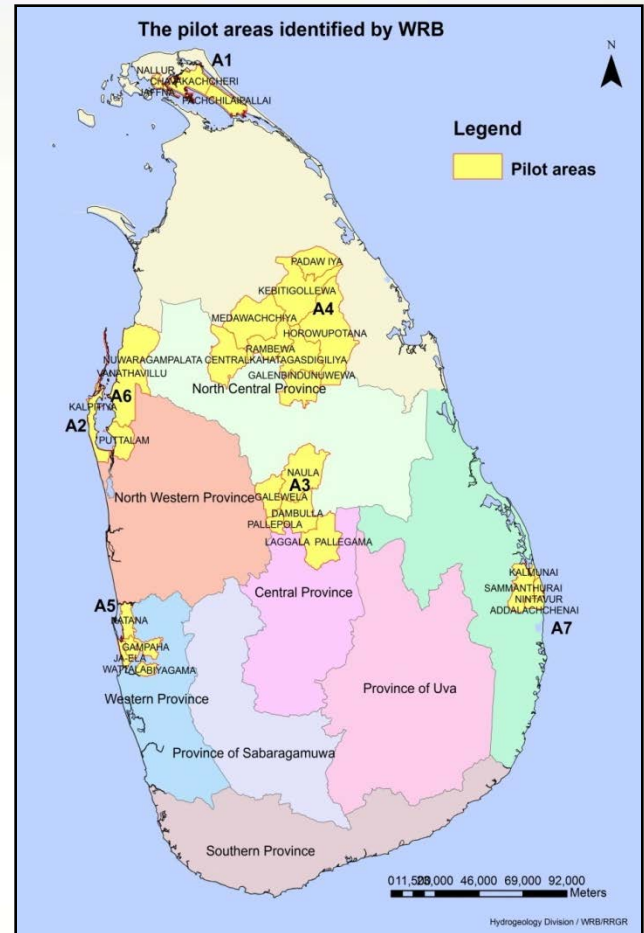


Enhance Water Security



Continue

- ❑ Establishment of Groundwater Monitoring Network for Sri Lanka through WRB.

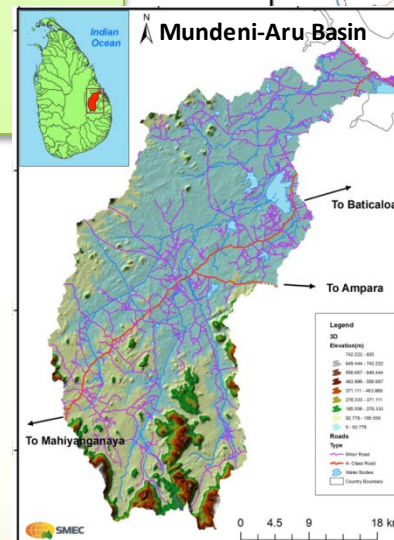
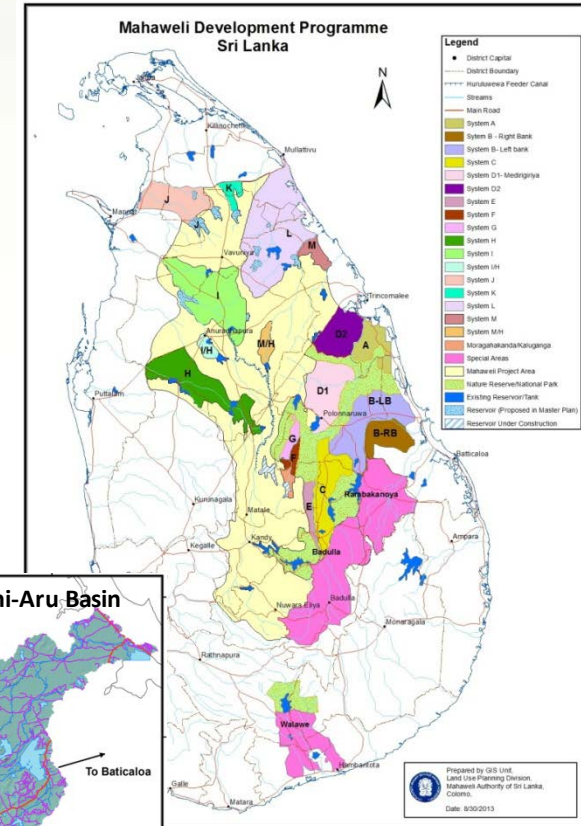


Enhance Water Security



Project Activities of Component -03

- ❑ Preparation of National Water Use Master Plan
- ❑ Update Mahaweli Water Resources Development Plan
- ❑ Preparation of Mundeni-Aru River Basin Development Plan

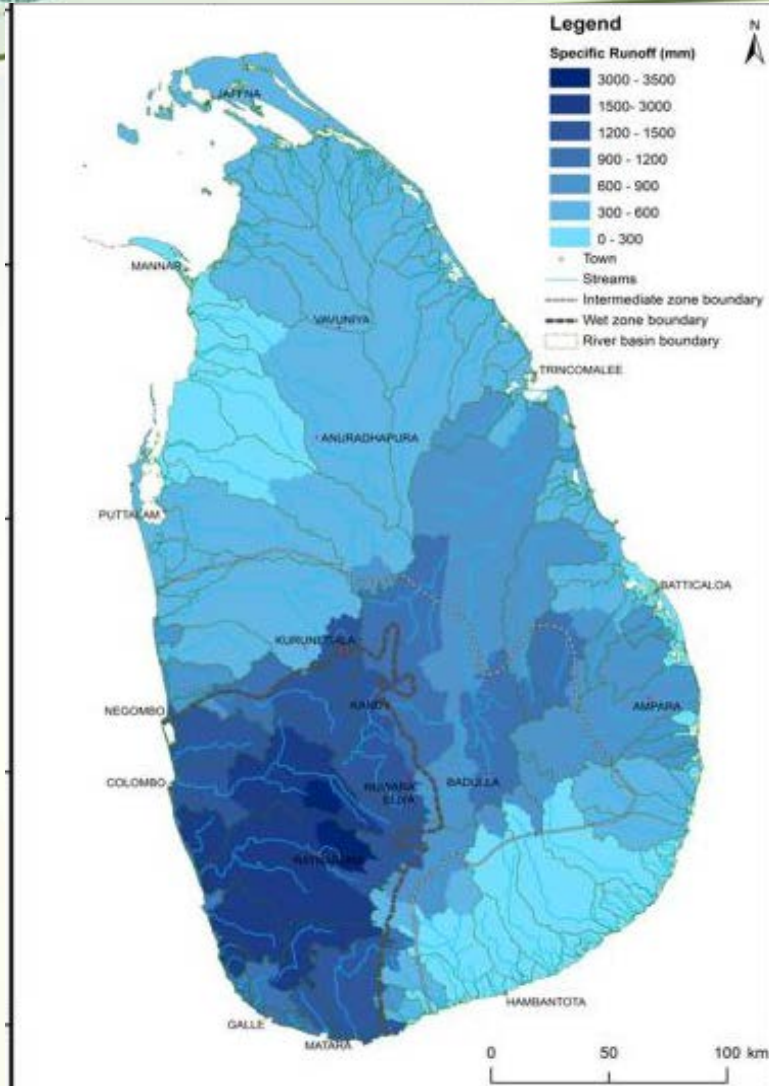


Enhance Water Security

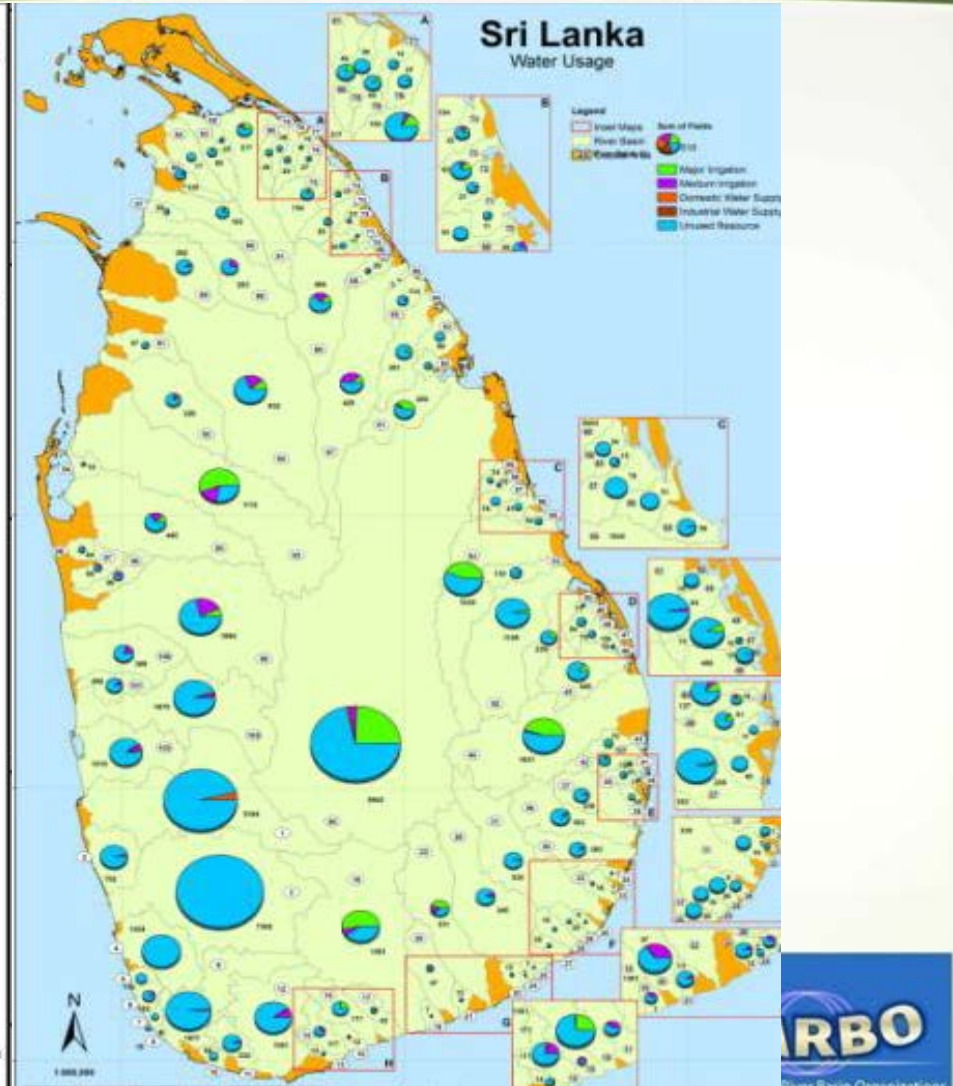




Water Availability and Water Usage



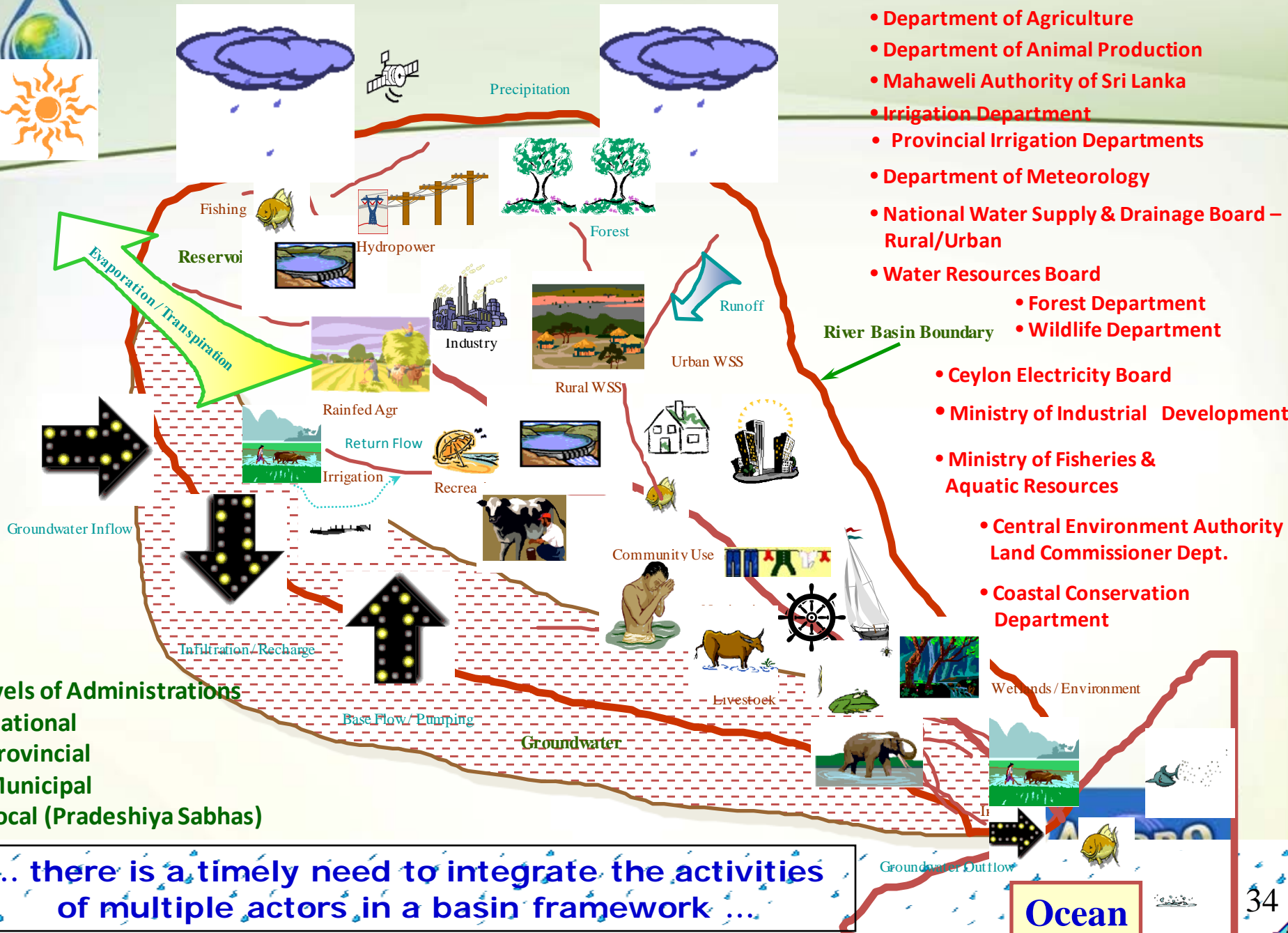
Water Supply Schemes



Major Reservoirs



A Typical River Basin in Sri Lanka

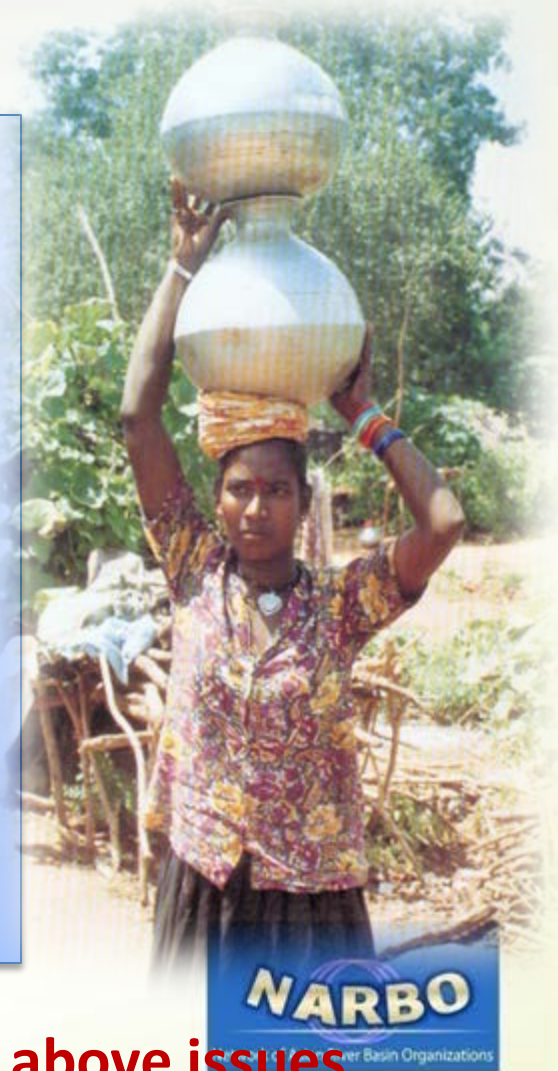


... there is a timely need to integrate the activities of multiple actors in a basin framework ...



Main Issues in Present Water Resources Planning

- ❑ Emphasis on sectoral development instead of integrated development.
- ❑ No strategic planning framework.
- ❑ Ad-hoc site specific development.
- ❑ Environmental & social aspects are not covered adequately.
- ❑ No stakeholder consultation.
- ❑ No scenario analysis.
- ❑ No usage of DSS for optimization.



Water Security enhance with the addressing of all above issues



Therefore, to Enhance the Water Security ...

- ❑ Need to establish Proper Institutional Arrangements to Manage all Water Infrastructure in the right manner.
- ❑ All Dam Owners and respective Governments should allocate sufficient funds for O & M and essential Structural Improvements appropriately.



Inginimitiya - ID



Bowatenna - MASI



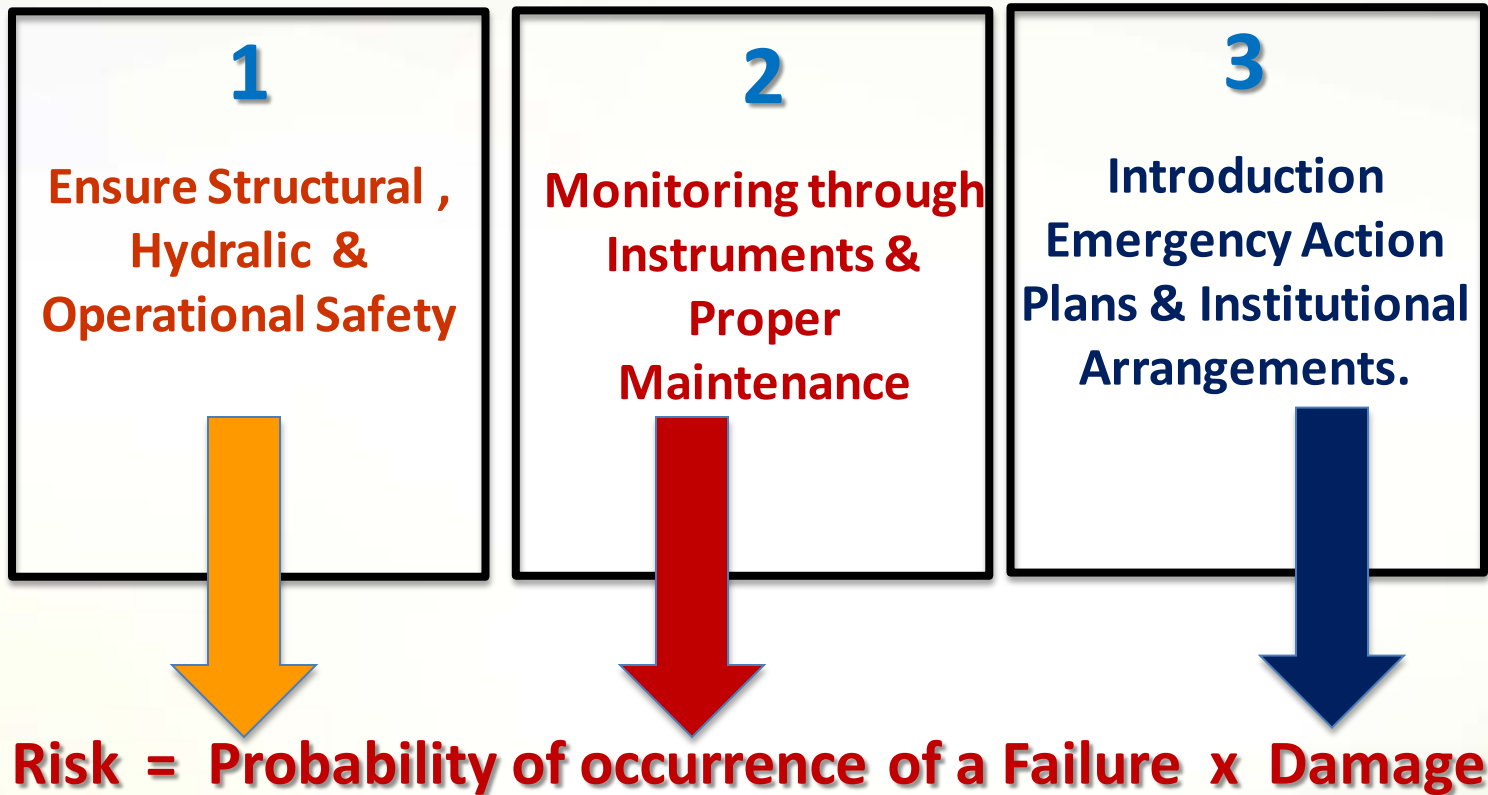
Kalatuwawa - NWSDB



Castlereigh - CEB



How DSWRP Project Ensure the Safety of the Water Infrastructure





After the DSWRP Project

1

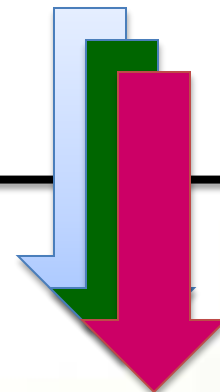
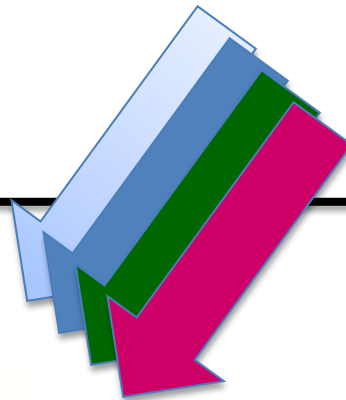
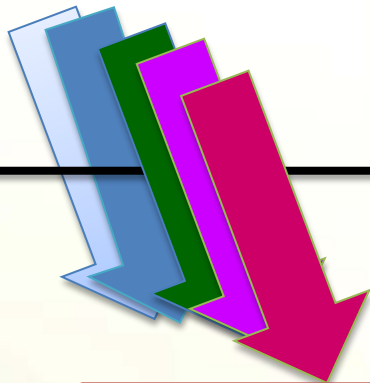
- Loading Berm
- Reno. of Rip-Rap
- Reno. of Spillway/Gates
- Replace by New Sluices
- Clay Cutoff - U/S Toe

2

- Piezometers
- V-Notches
- Survey Monuments
- Hydraulic Leveling devices

3

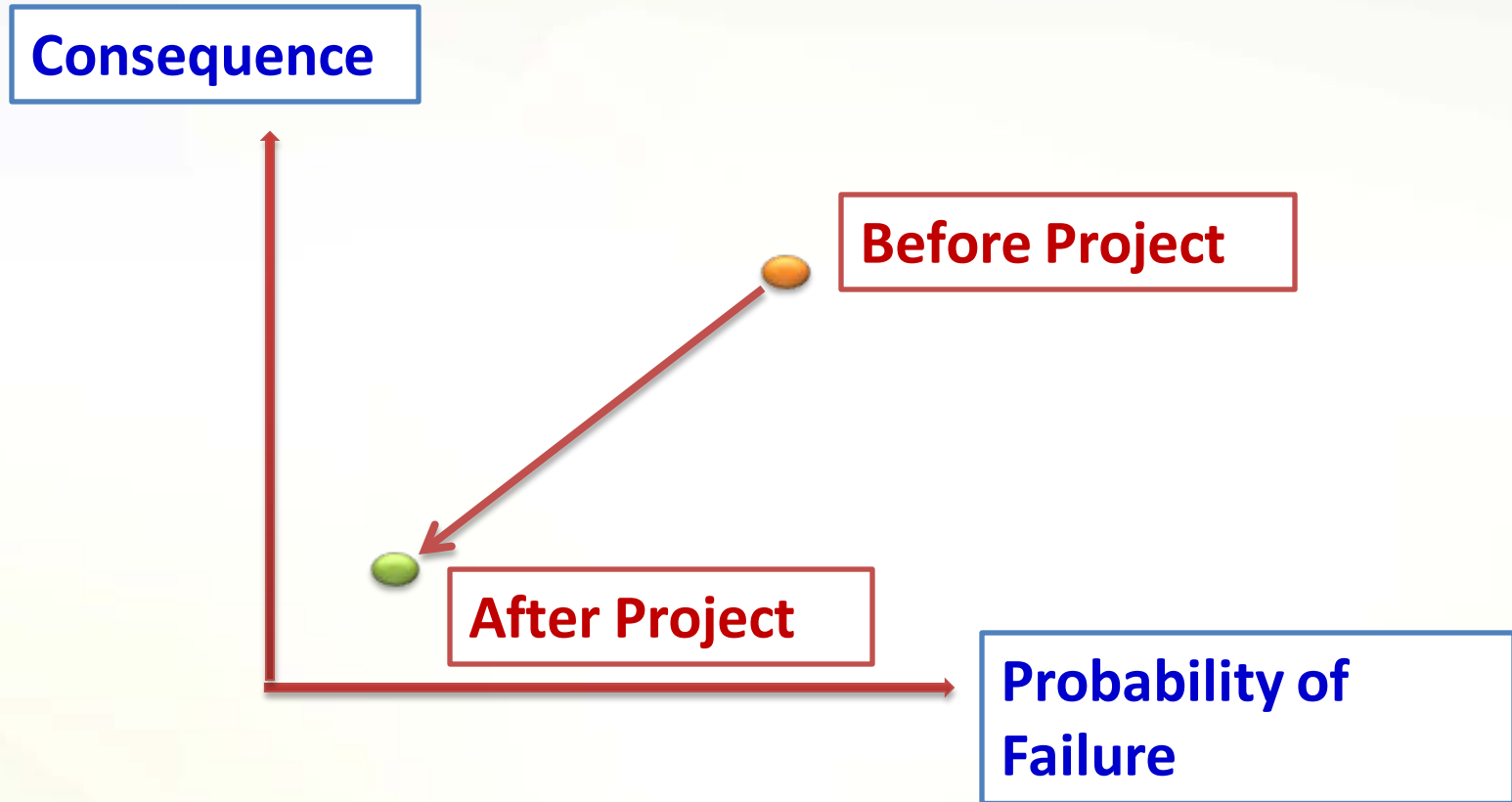
- Emergency Preparedness Plans (Early Warning, Inundation Maps)
- Institutional Arrangements
 - Schedule Inspections
 - Use O&M Manuals



Risk = **Probability of occurrence of a Failure** × **Consequences**



With the DSWRP Project, Risk of Dam Failure is Reduced and Enhance the Water Security





Enhance Water Security of the Country

Component - 01

Improve Dam Safety & Operational Efficiency

- Better Control of Water Releases.
- Increased storage
- Minimize of Seepage, leakage,
- Ensure storage up to FSL .
- Minimize the risk of failure of Water Infrastructure from hazards

Enhance Water Security of the Country with DSWRPP

Component -02

Upgrade & Modernize HMIS

- Through Real Time Data to make right decision at Right Time.

Component - 03

Water Resource Planning

- Assessment on water availability for various demands and locations.





2011 Assessment of the World Water Resources

Thank You for Your Attention

