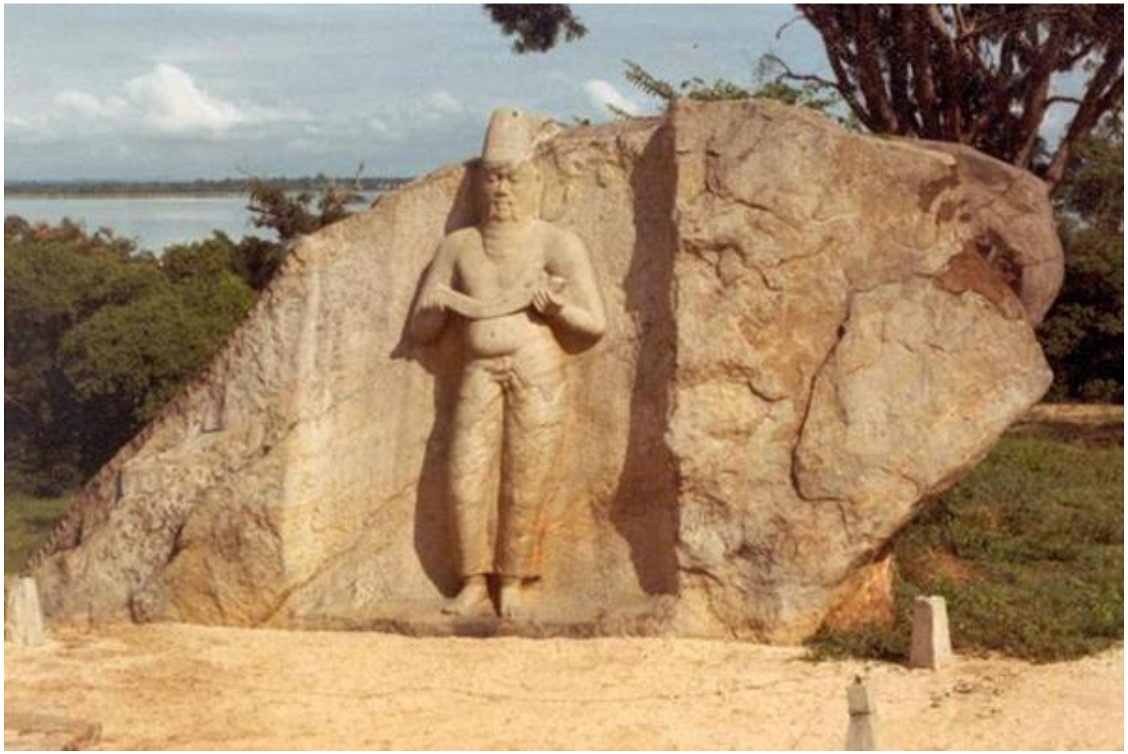
Challenges, Technological and Policy Interventions for Sustainability of Water in Sri Lanka

W J L S Fernando

Chairman, NERD Centre, Sri Lanka

King Mahā Parākaramabāhu (1123–1186 AD)



"Not even a little water that comes from the rain must flow into the ocean without being made useful to man"
During his reign Sri Lanka was known as the Granary of the East

Presentation Overview

- Water Resources Availability and Challenges
- Ancient Water Management Systems
- Water Policy in Sri Lanka
- Technological and Institutional interventions for sustainable and safe drinking Water
- New Technological Legislative interventions
- Way Forward

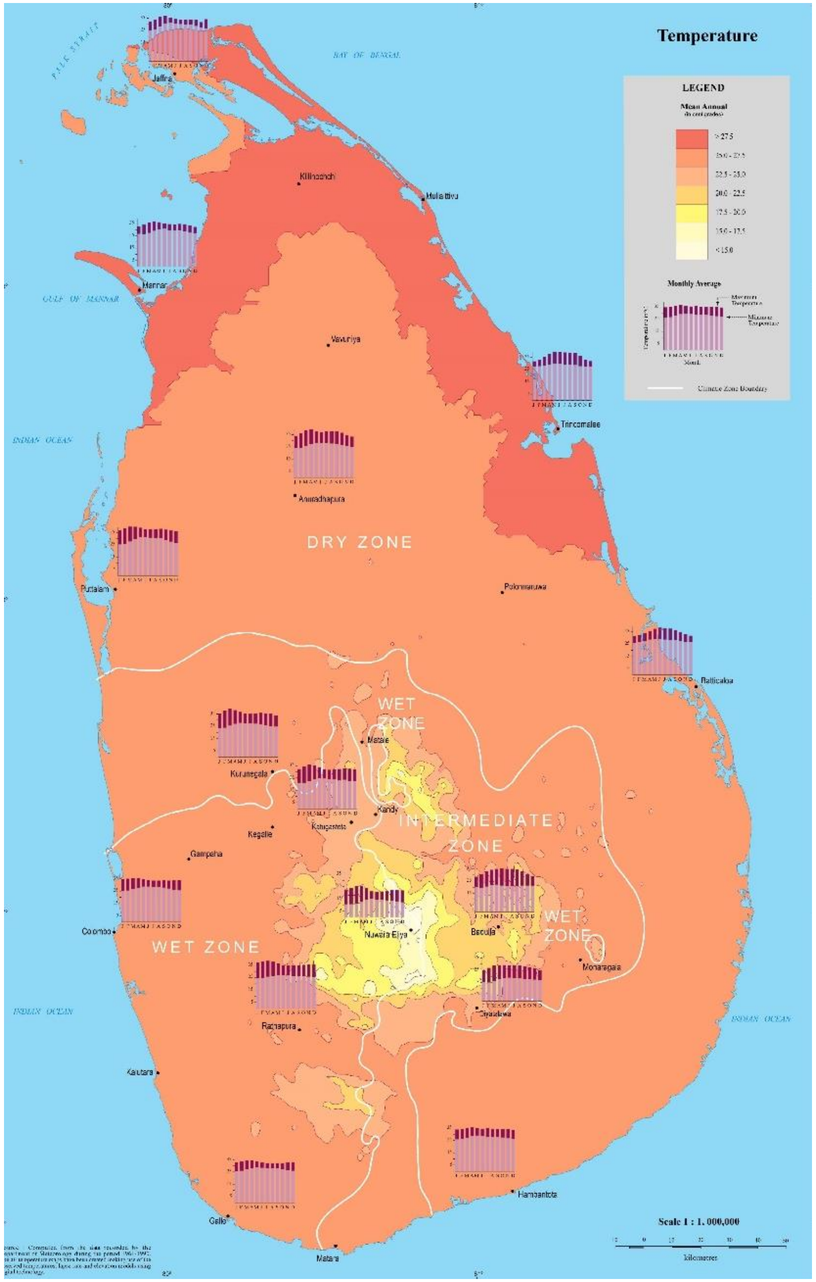
Water Resources Availability and Challenges

- Sri Lanka is considered as a water rich country
- Being an Island Nation Sri Lanka depends entirely on rainfall

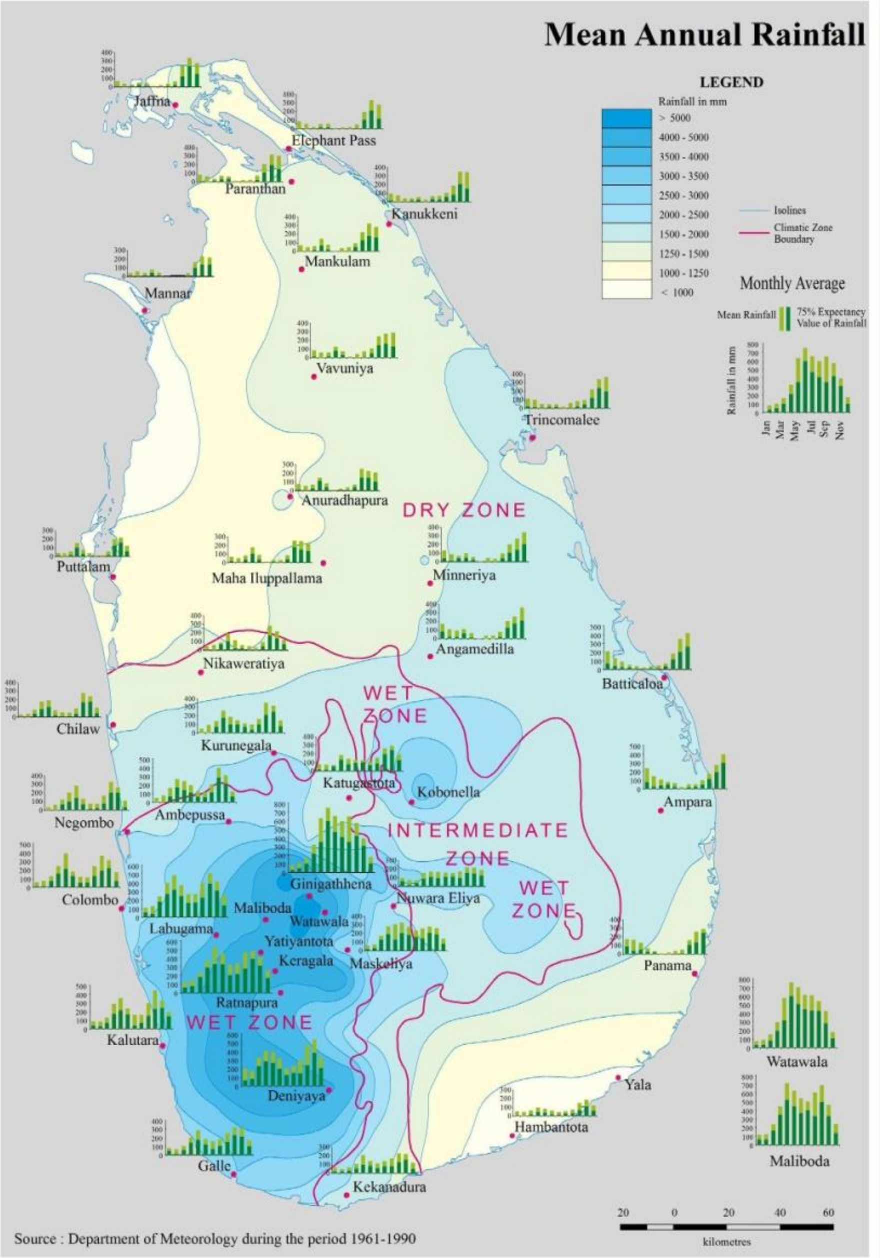
- Rainfall in Sri Lanka is of multiple origins with monsoonal, convectional and depressional rainfall types accounting for a major share of the annual rainfall with an annual average in the region of 2000 mm

- Sri Lanka being an agricultural country, the irrigation has had a unique contribution towards country`s agro economy from history to this date. The water resource in addition has become a prominent source and a requirement in industry, supply of services, consumption (drinking) as well as recreation activities (Water sports, local and foreign tourism) and hydro power generation.
- Over 80 percent surface water is utilized by the irrigation and agriculture sectors
- There are gaps in demand and supply in the provision of water for irrigation, and drinking proposes due to geographical and temporal variability - Sri Lanka has the second highest annual variability of rainfall of 22 Asian and Pacific countries. Twenty out of the 103 rivers in Sri Lanka are classified as wet zone rivers, which carry about half of the annual surface runoff
- This has been the main reason for a well managed and an ancient water civilisation that existed for well over two and a half millennia in the country

Climate of Sri Lanka

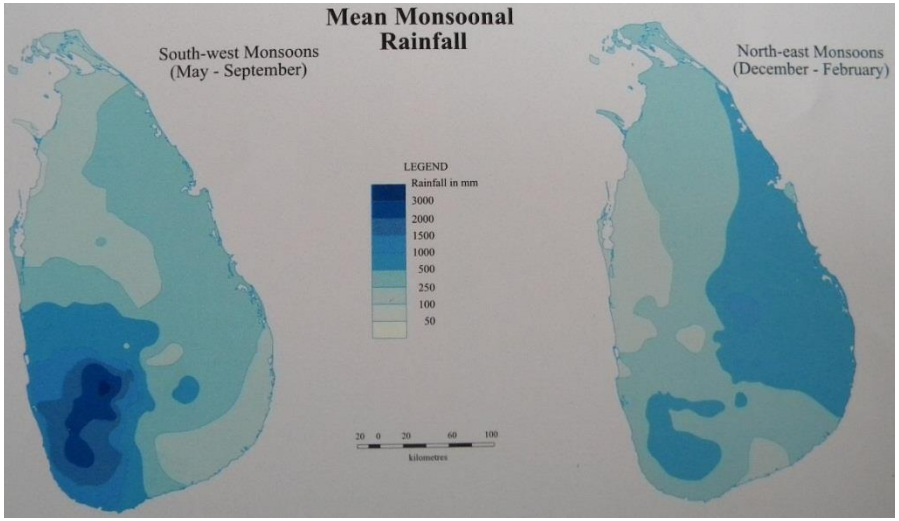


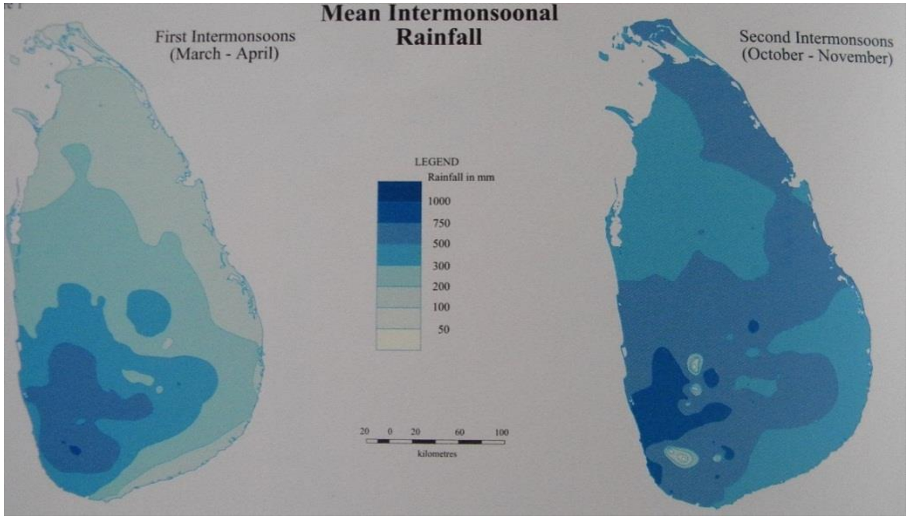
Climate of Sri Lanka



Rainfall

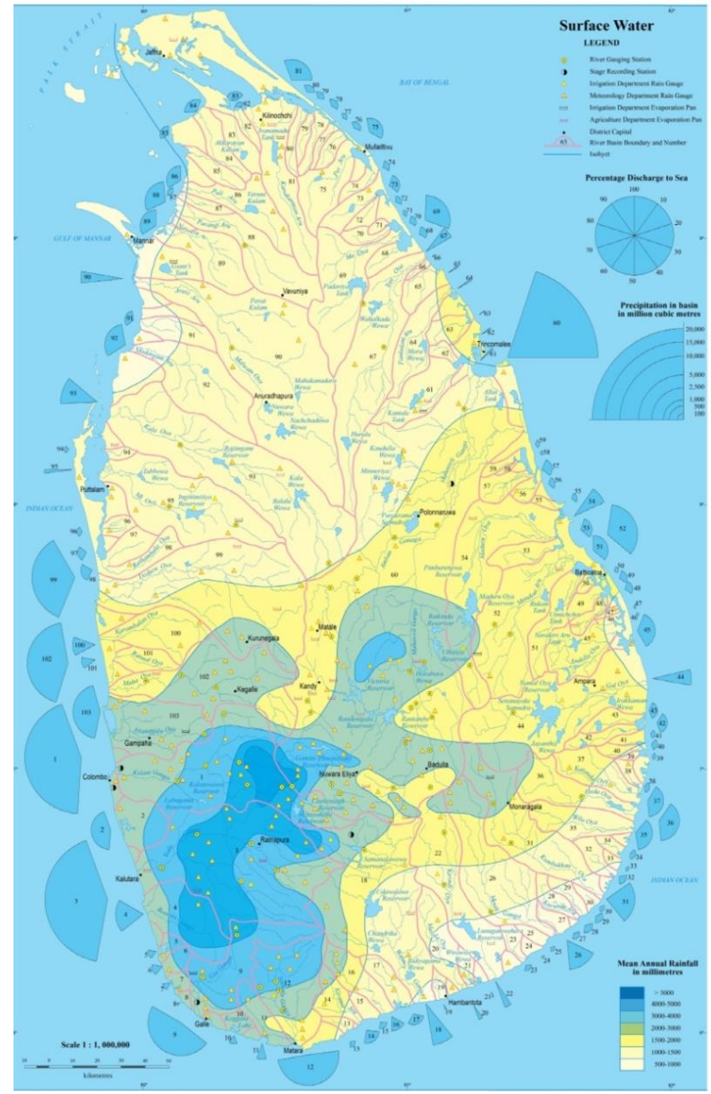
- Rainfall in Sri Lanka has multiple origins.
- Monsoonal, Convectional and depression rain accounts for a major share of the annual rainfall.
- And the four seasons recognized in the rainfall calendar of SL based on the monsoons. These are
  - First Inter monsoon _ March-April
  - South-West Monsoon_ May-September
  - Second Inter monsoon _ October-November
  - North-East Monsoon_ December- February





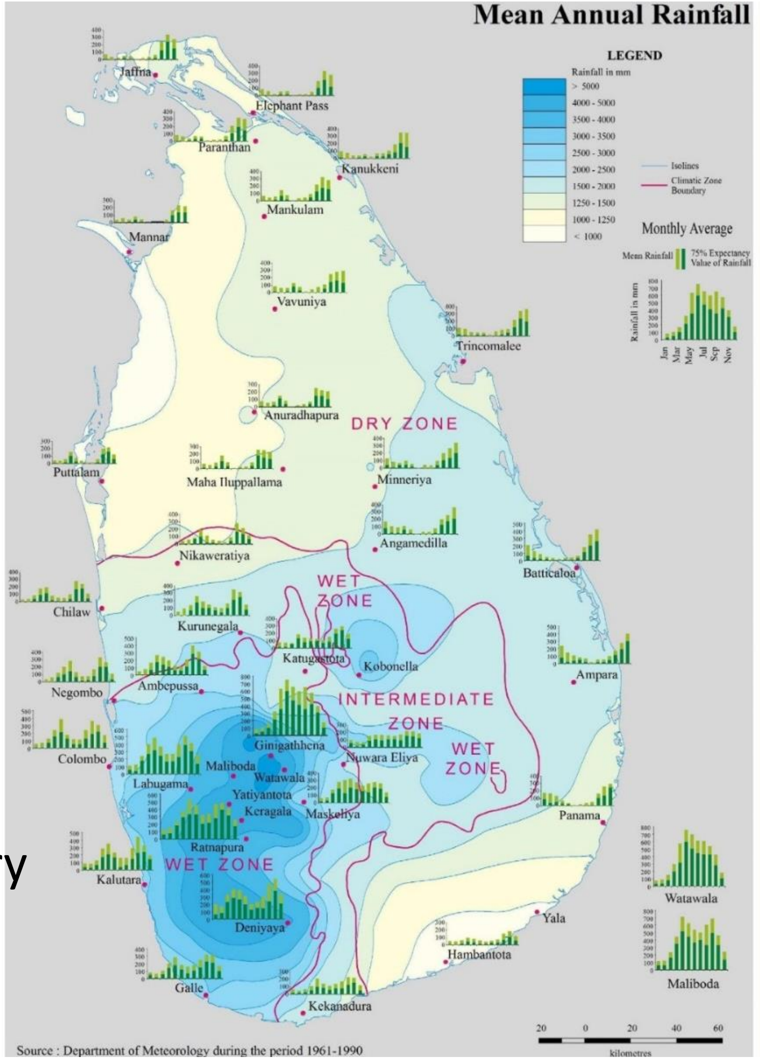
Surface Water

- SL is well endowed with water resources.
- However, about two thirds of the Island is considered as dry, and faces seasonal shortages and recurring droughts.
- A relatively high percentage of precipitation is finally converted to runoff as over 90% of the Island is underlain by crystalline rocks of low permeability
- There are 103 distinct river basins
- However, many of the dry zone rivers are seasonal and they are given the suffix ‘Oya’ or ‘Ara’ while other rivers are perennial and they are given the suffix ‘Ganga’.



Main soil water related features of *Dry Zone* Area

- Almost all the streams are *Seasonal Streams* – *Oyas/Ara*
- *Mahaweli* river (the longest and perennial) is flowing by the Dry Zone
- Seasonal water scarcities are frequent and can be very severe
- rainfall is usually confined to the October-January having flooding due to almost flat terrain
- Can get bright sun light entire year being conducive to agriculture – Hence most of the dry zone produce rice with water from ancient and modern irrigation schemes.
- Bed rock is closer to the earth surface, water table is shallow
- Water retaining capacity of soil is low



These are the main characteristics of the dry zone

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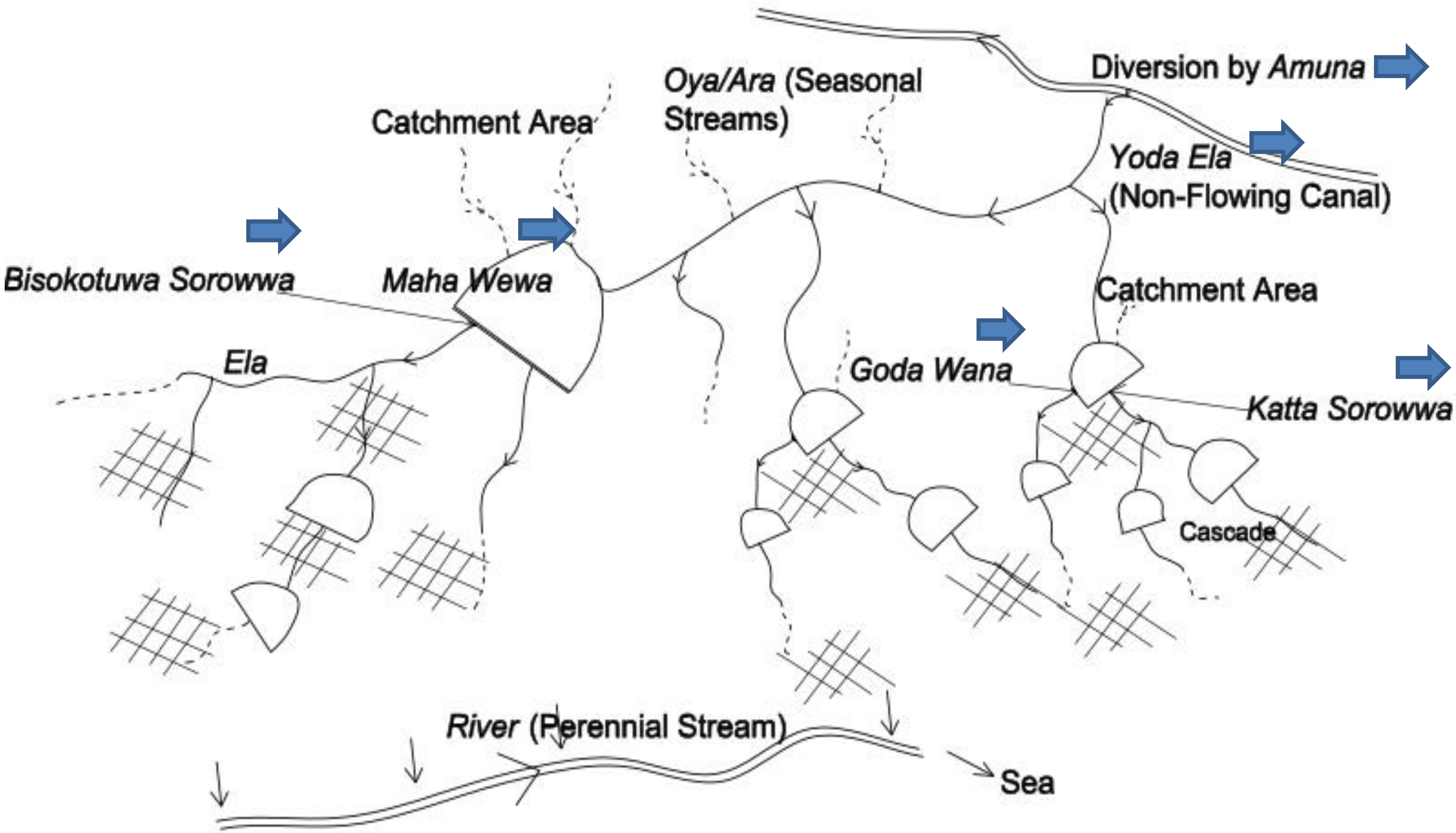
Ancient Water Management Systems

- Comprised of Large Water Tanks
- Cascade of medium to small tanks scattered in the vicinity of villages and crop lands
- Simple devices that released water depending on the availability and the need
- Well maintained soil water eco – system
- Natural salinity reduction techniques
- Preservation of catchment with adequate forest cover.

Typical portion of the artificial (built by ancients) soil-water ecosystem in Dry Zone (Rajarata) area



Main hydraulic structures of ancient system

1. **Sluice- Sorowwa**
2. **Spill Way - Vana**

Sorowwa- eg. 1) Bisokotu sorowwa
2) Katta sorowwa

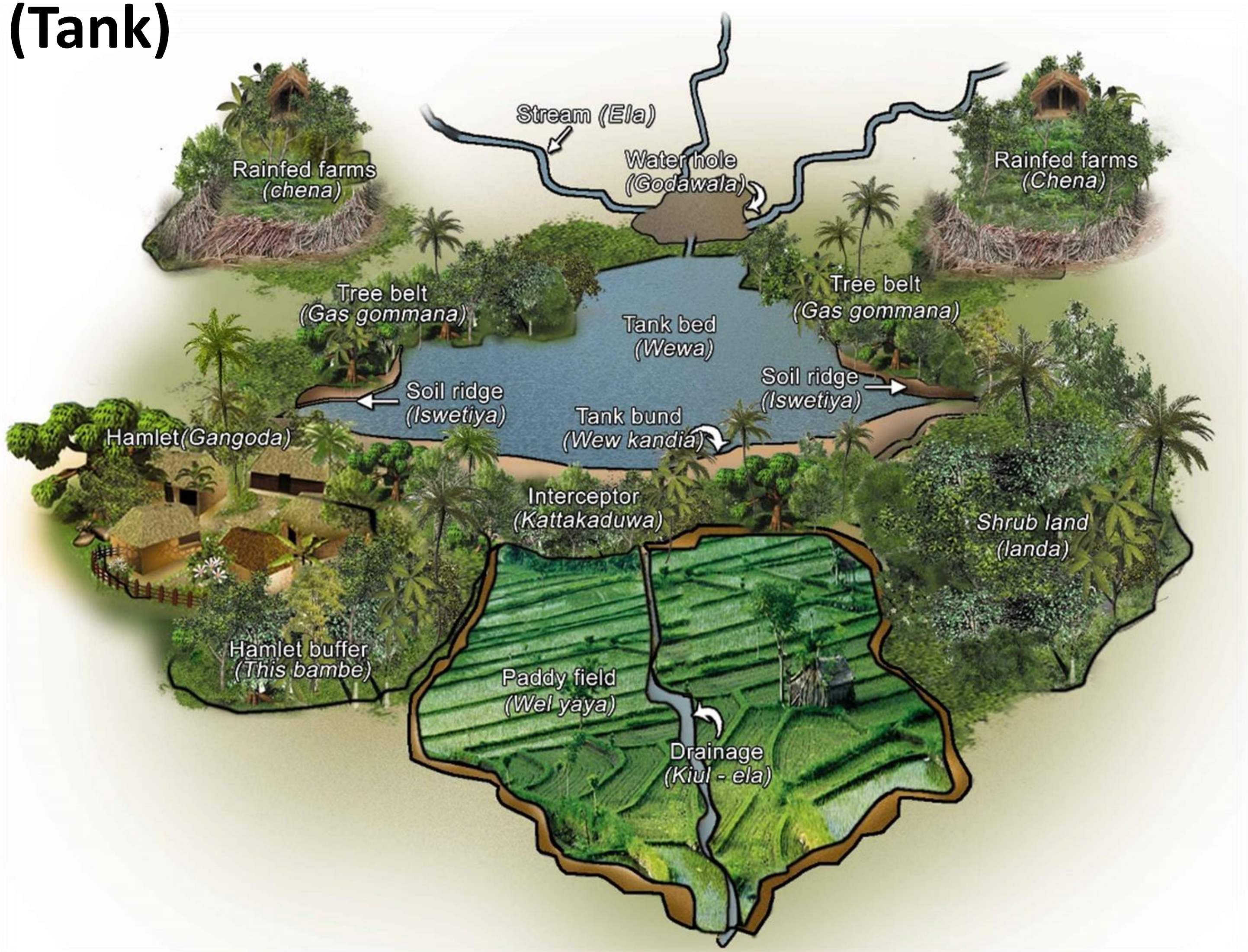
To release the water in a storage (in upstream) to down stream area as required by down stream. Flow was controllable in some cases.

Vana – eg)1. Goda vana
2. Pita vana
3. Amuna

To release the excess water in upstream to down stream and to maintain the required water head is upstream.

Typical features of a Gam (Vilage level) wewa (Tank)

Soil-Water Ecosystem



Some other Features of Village Level *Wewa*

Soil-Water Ecosystem

Gasgommana (catchment protection)

Goda Wala (Stilling Basin)

Iswatiya

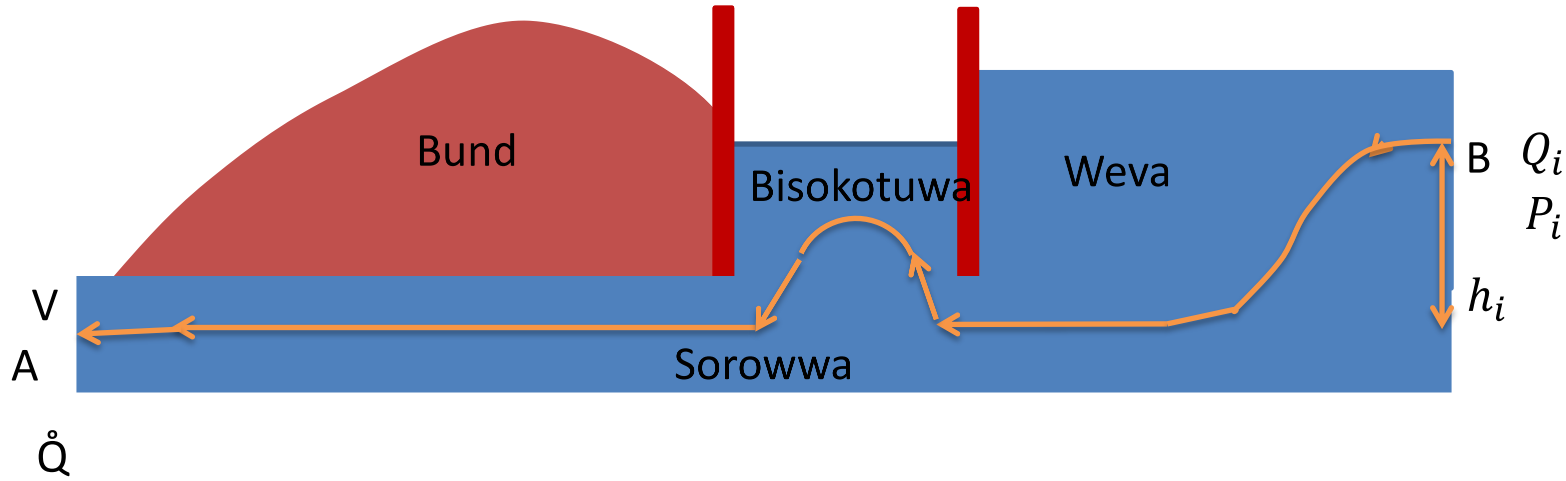
Bund of the *Wewa*

Bisokotuwa Sorowwa (found in ancient structures dating back to 300 Century AD)

The **Bisokotuwa** an invention of by our ancestors it was able to control the water discharged from **Maha Wewa** (large tanks with depths about 30-40ft) through outlet tunnels located *within the dam of maha wewa*

Bisokotuwa Sorowwa **at** ***UrusitaWewa***

Explanation the function of Bisokotuwa by modern mechanics



Apply energy equation for a ‘stream line’ (AB)

$\sum h_i\, \delta Q_i \rho g + \sum p_i \delta\, Q_i$-[Losses due to viscous effect + turbulence in the bissokotuwa] $= \sum \frac{1}{2} \delta Q_i \rho v^2$

$\sum h_i\, \rho g + \sum p_i$-[Losses due to viscous effect + turbulence in the vicinity of bissokotuwa] $= \sum \frac{1}{2} \rho v^2$

Velocity of out flow will be decreased and the flow controled.

Function and principles of operation of *Bisokotuwa*

- Water discharges through the outlet tunnels from 30-40ft high heads get calm and become free flow state due to the function of *Bisokotuwa*

  - However In natural flow, high velocity creates erosion, thereby large volume and spaces are created. At these spaces water will get calmed. E.g. Manmade formation in the ancient *Yodha Ela -Diya Kaliya*

With the ancient soil-water system

- Our forefathers were able to convert a highly variable seasonal rain fall, with less water retaining capacity in the soil to a more controllable water release stored in the soil, *wewas(tanks), ela (streams), etc.*
- Maintain the water content of the soil closer to its retention capacity which is the optimum condition for biological activities <u>not only for cropland but for entire eco system</u>
- Accordingly use of water was made more productive
- Soil fertility was increased
- Salinity was decreased
- Water flows were almost self controlled
- Natural dry zone was converted to a **'wet zone'**

Accordingly this was a cyclic -sustainable system practiced by our ancients.

Comparison of water management Ancient Vs. modern

Ancient : water from rain is distributed throughout the soil strata and soil fertility increased. Always excess water is send to down stream. Self controlled by ‘sorowwa’(Sluice) & ‘vana’ (Spill ways). Reuse of water is enhanced.

Modern : water from rain is stored in tanks (Reservoirs) then distributed to crop land with complex controlling systems with often many conflicts (it is very difficult to control and give the required amount of water to each crop land at the required time through a system of open canals). soil fertility is reduced, salinity increased – more sensitive to droughts and floods. No re use of water.

Flap Gates re-introduced by NERDC making use of certain principles of ancient systems
(The gate is hinged to shaft at the bottom of the canal situated across the canal)

Existing Sluice gate this has many draw backs and the gates were more an obstacle and often either misused or malfunctioned

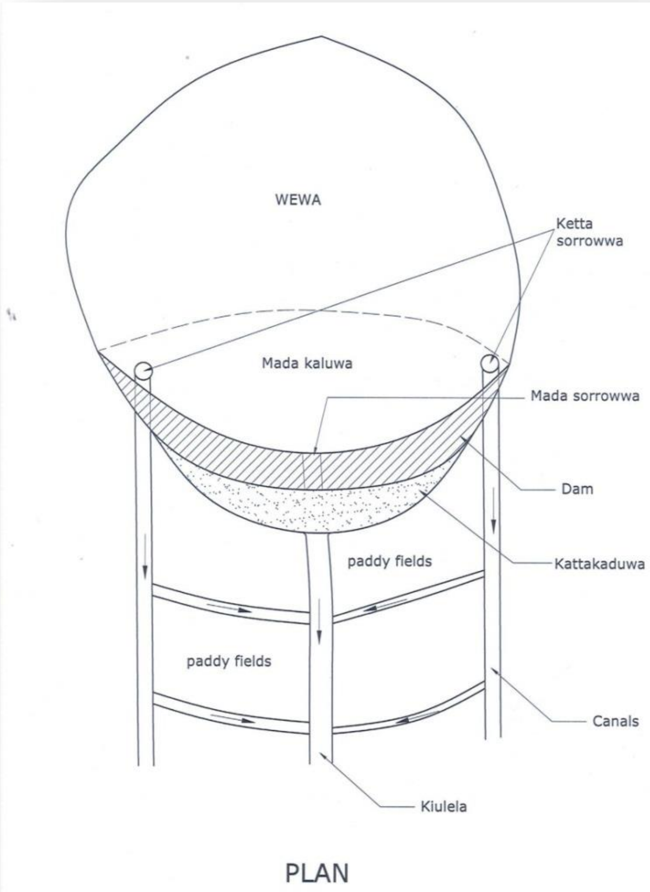
Reincarnation of ancient Amuna with modern technology. Either using manual or electrically operated control gear

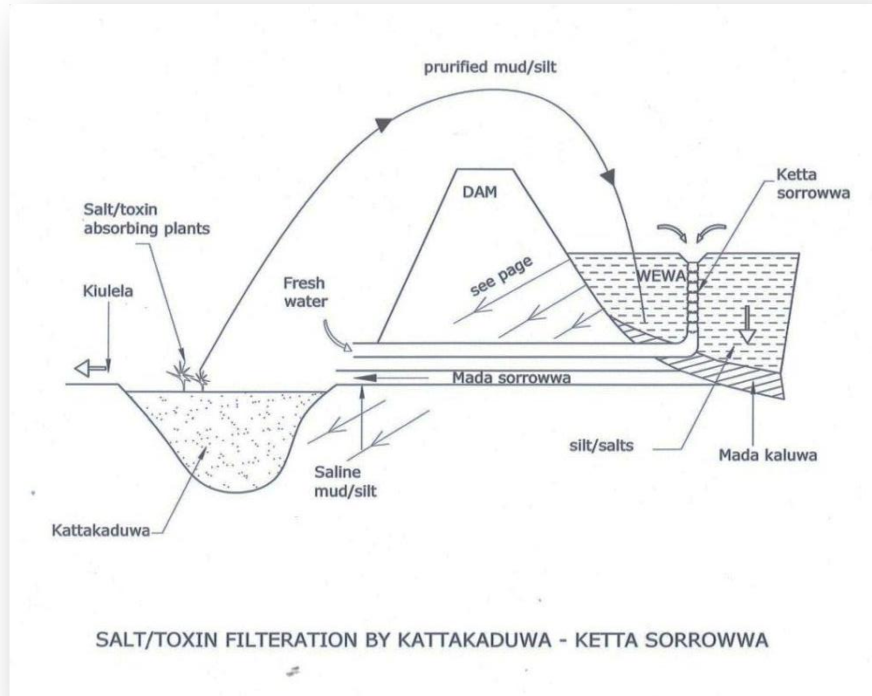
Salinity & silt control in ancient system

Due to ancient soil-water system, the soil was maintained almost close to field capacity and under saturated condition, where ever possible. Therefore the concentration of salt is low and infiltration of salt towards the bottom of soil strata was high. Also the 'Katta kaduwa – kiul ela' system has functioned as a salt filter.

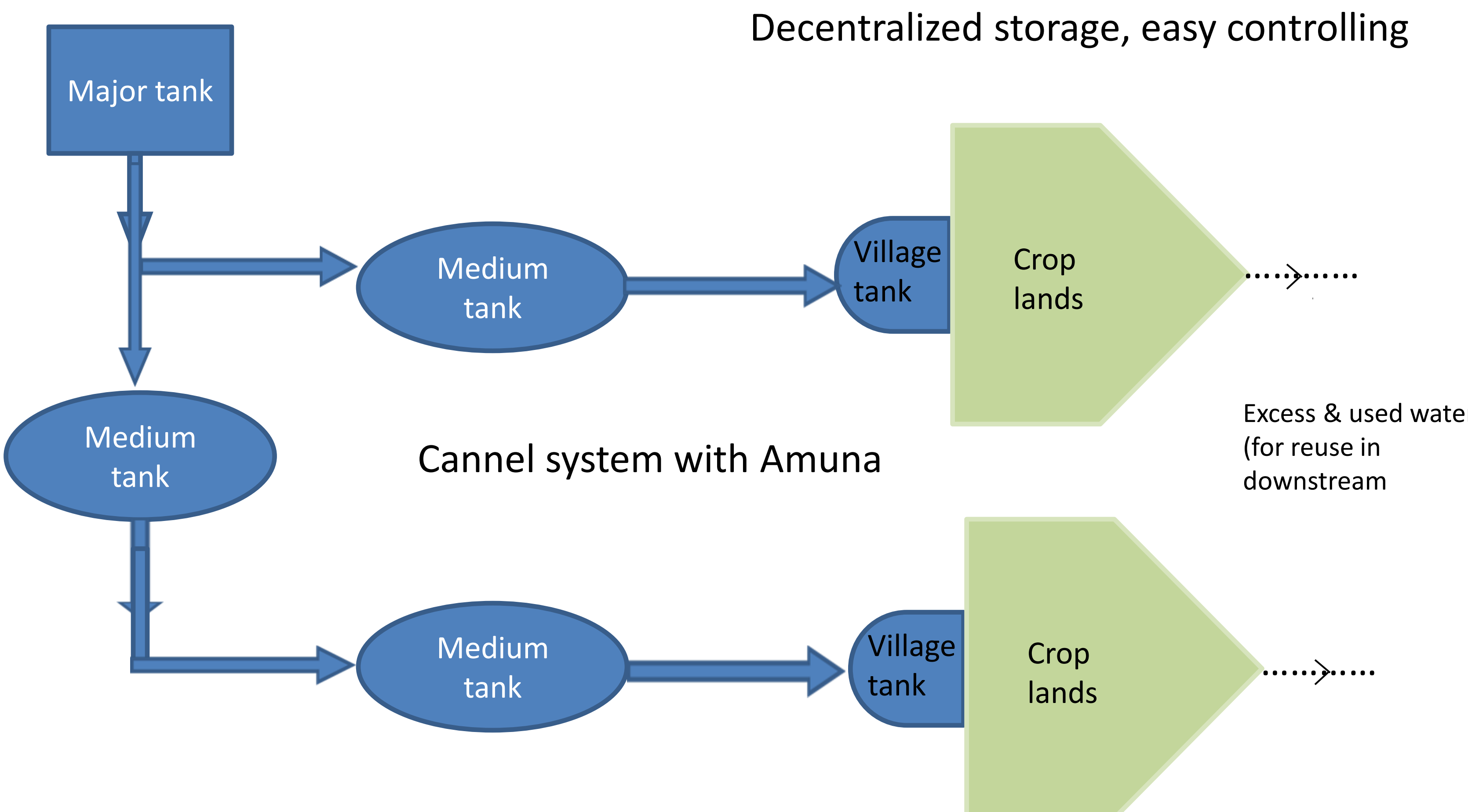
Also the function of amuna has restrained the spreading of salinity by always letting the top most water to flow downwards.

Function of Katta Kaduwa, kata sorowwa and mada sorowwa



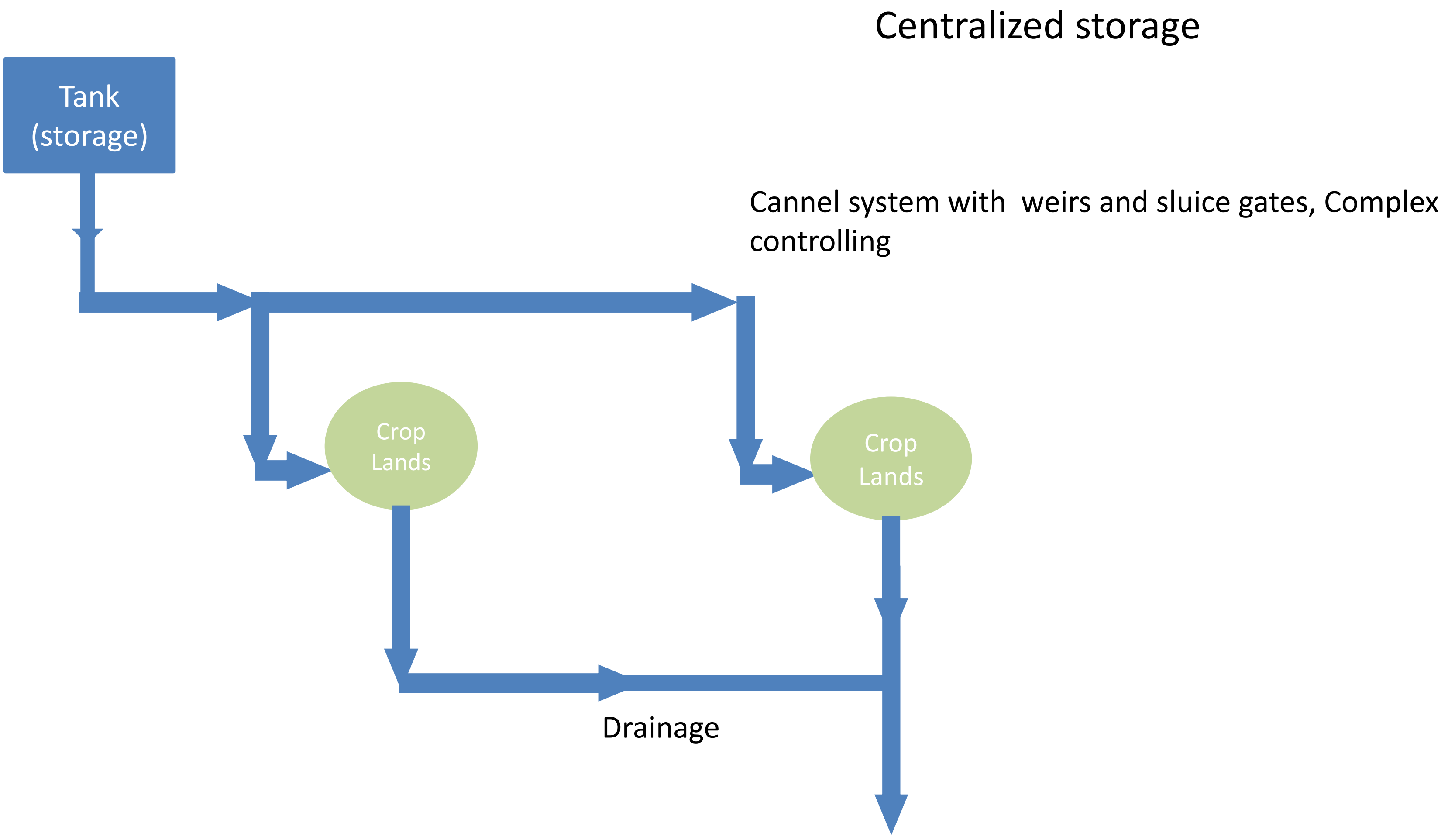


Ancient water system



- Water is stored in local vicinities. Water requirement of crop lands are easily satisfied by the local storages. The excess water and some amount of reuse water is sent to down stream enhancing reuse of water.
- No complex controlling system
- Eco-system is enriched with water, soil fertility is increased.

Modern Water Distribution



- Water is stored almost only in major tanks.
- Very difficult to distribute to satisfy timely requirement of water to crop lands, through cannels and sluice gates which allow water to flow underneath.
- Echo-system is lack of water. Soil is degrading.

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Water Policy in Sri Lanka

- Though Sri Lanka had an excellent Water Management system, no water policy exists in the country.
- There have been many interventions in the past two and a half decades in developing a water policy, due to many socio political barriers many draft policies are still confined to drafts though some parts of policies are made into either institutional mandates or norms.
- Swings and Roundabouts: A Narrative on Water Policy Development in Sri Lanka by Rajindra Ariyabandu in November 2008 amply describes the failure of adopting a unified water policy which is a crying need given the many challenges faced by water sector, for irrigation, industry, recreational, management of eco-systems., hydro power requirements, or drinking.
- The main failure seem to be that of political in nature, spurred by the common understanding that " Water is God's Gift to mankind and should not be paid for" given the fact that water was issued free of charge for millennia and even potable pipe borne water was not paid for until mid nineteen eighties.
- One other draw back had been the perception that water once regulated by policy water would be made into a commercial commodity and these are alien concepts being imposed by capitalist countries and finding agencies.
- However at village level local agricultural and community organstions regulate water according to age old traditions and common understandings but the durability of such systems are at times challenged by local water shortages especially during droughts etc.

Draft National Drinking Water Policy in Sri Lanka due to dire need is being pursued at present

Goal

The Government of Sri Lanka, while recognizing that access to safe drinking water is a basic right of every citizen, is committed to the provision of adequate quantity of safe drinking water to the entire population at an affordable cost and in an equitable, efficient and sustainable manner.

Policy Principles

a. Access to safe drinking water is a basic right with commensurate responsibilities on the recipients.

b. Planning and development of water supply will follow people centered, participatory and demand responsive approaches.

c. Abstraction of water from rivers and streams for domestic purposes will be carried out in recognition of (without prejudice to) downstream needs.

d The Government will act as the custodian of the water resources and manage such resources on behalf of the people in an effective efficient and equitable manner, consistent with the social, economic and environmental needs of present and future generations.

e. Water for domestic purposes will receive priority over other uses, subject to implementation of any previous agreement for other uses.

f. Investment in drinking water supply development will be based on priority needs regardless of social standing or geographical location.

g. Pipe-borne water supply option will only be considered when all other cost effective options are not feasible.

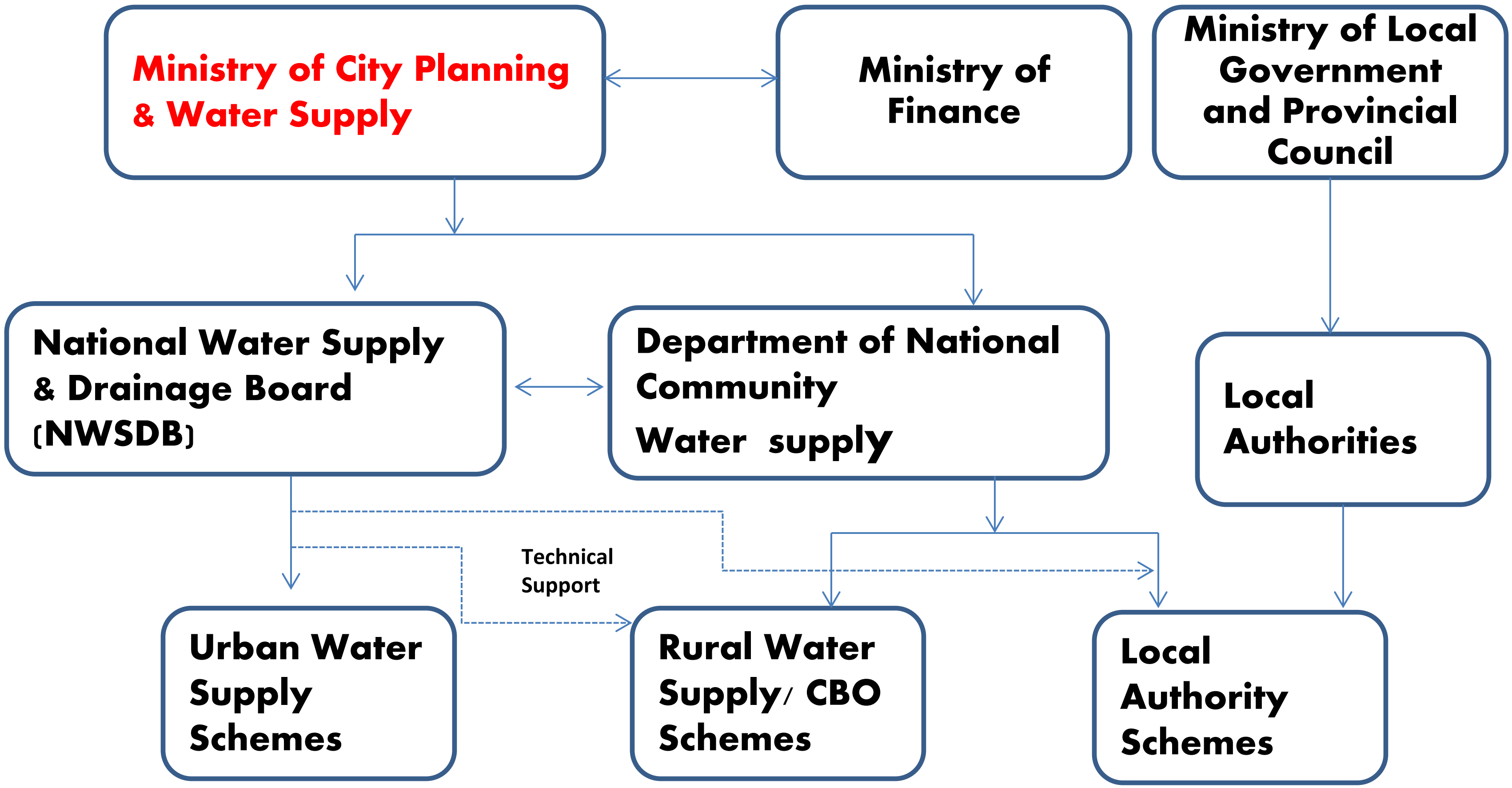
h. The operational responsibilities will be decentralized to the lowest appropriate level with due consideration to management capacity.

i. Safety of drinking Water supplied to the people need to be ensured at all times by all water service agencies through adoption of appropriate instruments.

The National Water Supply & Drainage Board (NWSDB)

The principle agency responsible for development, operation and maintenance of drinking water supplies is the National Water Supply and Drainage Board (NWSDB), which functions under the ministry in charge of drinking water. The NWSDB, established under an act of parliament in 1975 is mandated to engage in development, service provision and regulate quality standards of designs and water supplied to the public.

Institutional Arrangement



Current Status of Institutionalised Water Supply in The Country

- The National Water Supply & Drainage Board formed by Act of Parliament in 1975 is the lead organization responsible for Water Supply in the country.
- Total No. of Water Supply Schemes maintained by the NWSDB is 329.

  31 schemes cover major cities and 298 schemes cover townships and villages.
  - Current total water production per month is around 50 million m^3
  - % of Non Revenue Water (Island wide) around 28%
  - Total water supply connections by NWSDB – 1,857,000

    Domestic – 1,716,000

    Non Domestic – 139,100

    Public stand posts – 1,725
- CBO managed Rural Water Supply Schemes

  Total connections – 550,000

Present Status of Water Supply

-	NWSDB	- 37%
-	LA	- 1%
-	CBO	- 13 %
-	Protected Dug wells	- 32%
-	Hand Pumps	- 7%
-	Safe WS coverage	- 90%

These CBO schemes have been constructed over the period of more than four decades. NWSDB and LA WSS are run through government body but RWS Systerms run by individual organizations CBOs without national level structure.

Rural Water Supply CBO Based Schemes

Innovative Strategies And Institutional Arrangements For Ensuring Of Sustainability Of Rural Water Supply Programme In Sri Lanka Through CBOs

Rural Water Supply CBO Based Schemes

- Provision of WSS would be people centred and demand driven.
- The role of the Government would be to regulate and facilitate 80% of infrastructure cost borne by the Government
- Community involvement 20% contribution either cash or kind
  - CBO, Private Sector and NGOs are providers of services.
  - Users should manage the facilities
  - Women should play a central role in decision making process .

- LA s play either a catalyst or direct indolent role

Initial Discussions to identify needs sources and key players facilitated by the Government

Field Surveys

Typical discussion at village level under the heavens.

Typical discussion at village level under the heavens.

Facilities Provided to the Community

Typical Ferrocement Rainwater domestic tank in SL. Another varient of RWS

Typical RWS/CBO Scheme with Treatment facility consisting of Aerator, Roughing filter, ground storage tank, Elevated storage for Distribution

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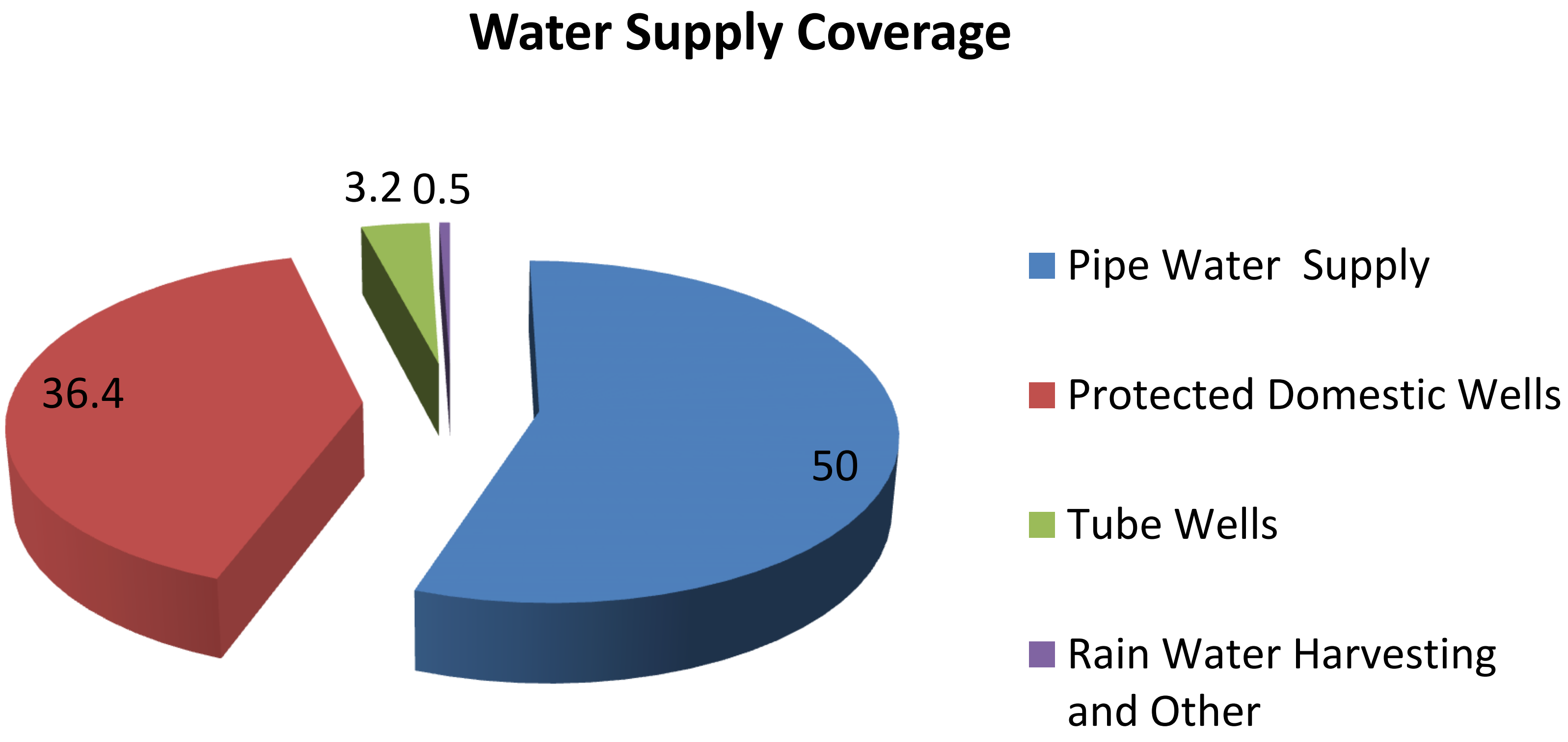
Technological and Institutional interventions for sustainable and safe drinking Water

- Organisational Reforms
- Regulatory Reforms
- Policy Targets
- Standardisation of appurtenances and supply technologies and Schemes
- Changes in procurement and project implementation structures
- Focused attention of problematic areas such as CKDu prevalance.

Current Water Sector Performance



Target of the safe drinking water and sanitation by 2020

Provide safe drinking water and adequate sanitation facilities	to all
Increase pipe borne water supply coverage	from the present 50% to 60%
Provide safe drinking water	to the CKDu vulnerable areas
Reduce non-revenue water supply in Colombo City	from 46.1% to 18%
Reduce non-revenue water supply in National level safe drinking water	from 27.2% to 25.0%
Increase Urban piped sewerage facilities	from the present 2% to 3.3%

Challenges In the Sector

- Depletion of Water resource and effective management
- Competing on different demands for water
- Catchments/Watersheds protection
- Water conservation and re-use
- Limitations in funds for investments
- Introducing legislation & regulations
- Emerging water related chronic diseases. (eg. CKDu)
- Difficulties in laying pipes in urban areas.
- Climate change impact and mitigation

Water Resources, Intervention of Policy/Program/Projects with Technology

Depletion of ground water could be managed with mapping and monitoring of ground water table using Island-wide network of data loggers. This information is also necessary for formulation and enforcement of regulations.

As Catchment protection is vital, protection and monitoring could be strengthen with affordable technology e.g. Arial photography.

Strengthening of Environmental Protection License process of Central Environmental Authority and Maintaining Pollution Source Inventory, CEA is in the process of preparing it. Online access and minoring relevant parameters and the status of EPL will be maintained.

Regulation and management of Water resources and users is a challenge at the moment. Certain structural arrangement in the different users is necessary. E.g. installation gauging stations in the rivers, careful production planning and monitoring in the case of Power and water Supply (available planning tools any gap), efficient management of Water In the case of Irrigation.

Water Resources,
Intervention of Policy/Program/Projects with Technology

Ground Water Monitoring and Management

Catchment Protection

EPL and PSI

Regulation, sharing, and Management

Water Treatment (Production),
Intervention of Policy/Program/Projects with Technology

Installation of Quality Instruments in the Plant/Life cycle Cost for intended purpose

Blend of Right water treatment process design considering raw water, RO plant for desalination in critical areas.

Treatment Plant Automation considering affordable technology

Integration of water treatment plant with storage system and distribution networks for effective remote monitoring and controlling.

Objective of introduction of Technology

- Affordable
- Energy saving
- Life cycle cost
- Reduction of Non Revenue Water, leak etc.
- Facilitate regulatory monitoring , competition regulation etc.
- Maintain water quality

Water Storage
Intervention of Policy/Program/Projects with Technology

- Water supply system with VSDs (Variable Speed Drive), construction of water towers can be avoided and direct pumping to distribution system based on water demand.
- Testing of Water storage tanks such as PC tanks (Pre-stressed concrete tanks). These tanks need small land plot than conventional tanks. (acquiring of enough land at right place is always challenge and project experience delays.)
- Ground sump for multi-story buildings

Water Transmission and Distribution Intervention of Policy/Program/Projects with Technology

- Pre-qualification of of pipe manufactures and preparation of list manufactures for pipes and fittings, valves, couplings and flange adapters. (to ensure good quality products) Some are already standardised
- Installation of bulk meters for measuring inflow and outflow and minimize the NRW by taking action with remote monitoring
- Procurement of good quality water meters which ensure billing.
- Old pipe replacement in Colombo, establishment of DMA(district metering areas) for auditing water and taking action on NRW.
- Regulatory strengthening for controlling poor water fittings import to the country

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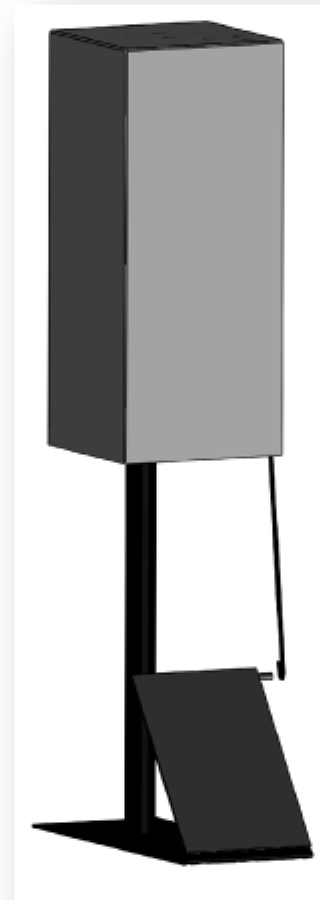
New Technological Legislative interventions

- New Interventions in Water Resources mapping, Extraction, treatment, transmission, distribution.
- Implementation of regulatory and organisational mechanisms.
- Introduction of new devices and appurtenances for water conservation and minimise waste.etc
- Registration of plumbers under the recently enacted legislations to regulate the engineering practitioners

Foot operated water valve developed by NERDC – An Example of a new introduction of a simple device



Foot operated water valve to be adopted in all public installations

- New generation water valve use for wash basins which is operated by foot
- Water valve contains a complete unit fixed to the floor where the wash basin is fixed meanwhile the water lines of the tap wants to connect through this unit.

Advantages

- Save water by 58% compared to the hand operated water valve.
- User friendly design with easy operation.
- Both hands are fee for cleaning while operating the tap.
- No requirement of alternative power sources to operate.
- Easy to install and no need heavy modifications for fixing location.
- Can easily control the water flow rate as operator required.
- There are no effects for the human health.
- Higher durability.
- Less maintenance.
- Ergonomical design.

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Way Forward

- **Technology- Supply and Demand Side**

- New technologies may be costly; therefore parameters such as efficiency, long term sustainability and reduced O&M expenditure have to be *marketed* to promote the adaptation of new technologies

- Slow sand filters, Upward flow roughing filters , Household level filtration units, bio sand filters.

- Rainwater harvesting with recharge into existing wells.

- Study and improve ancient water management techniques: ***Basic science was understood*** by our forefathers we have only theorised them now we have the analytical tools to analyse and use technology to re do what they did to ensure sustainability

Way Forward

- **Institutional Reforms:**

  - Challenges- To build up the synergy of centralized and decentralized water supply schemes so that one could help the other in case of disasters not yet emerged as a problem .

  - Regulatory mechanism to be introduced under the PUCSL.

  - New technology may require lesser number of staff to handle these, therefore action should be taken to educate and make trade unions stakeholders in the technological transformation process

  - Ex: smart metering which enable automated meter reading may awaken meter readers on a threat to their role in NWSDB – engage them in a much more sophisticated technologically superior area of work such as in IT systems related to billing - they can carry mobile meters that collect data and let them get involved in some kind of bill processing data uploading etc.

  - Get the private sector participation to operate and maintain the assets

Way Forward

- Public Participation :

  - Attitude changes so that less water is used.
  - Creating Public Awareness

- Other interventions

- use of different qualities of water for different purposes Two supply lines?, In house water re-cycling for appropriate use – widely practiced in industry can we extend this to domestic and commercial sectors? .
- Eco-sanitation practices where re-cycling is inbuilt.
- Make use of market competitions, promote procurement strategies to procure innovative technologies for sustainable water use.
- Introduce asset management as a tool for better water management and minimise wastage.
- Introduce smart metering and smart water transmission and distribution practices. A buzz word not for the sake of a fancy concept but for real time costing of water and to encourage DSM.

Thank you

Effect of a Domestic Leakage

Tiny drop wise leak make a BIG LOSS at last.!

If 10% of the taps in our country have such leakages, the wastage would be around 21 million of liters per day....

This amount is sufficient to provide water for 30,000 new families...

How many of these have you noticed at home ???

Kata Sorrowwva

Keta Sorrowwa (bottomless pots kept one over the other and connected to the sorowwa (sluice) passing through the dam with flexibility to either increase or decrease the water level of the tank)

Water is released from the surface of the wewa. Salinity of the outlet water is reduced.

Soil-Water Ecosystem – Godavana (Some kind of spill way mostly natural)

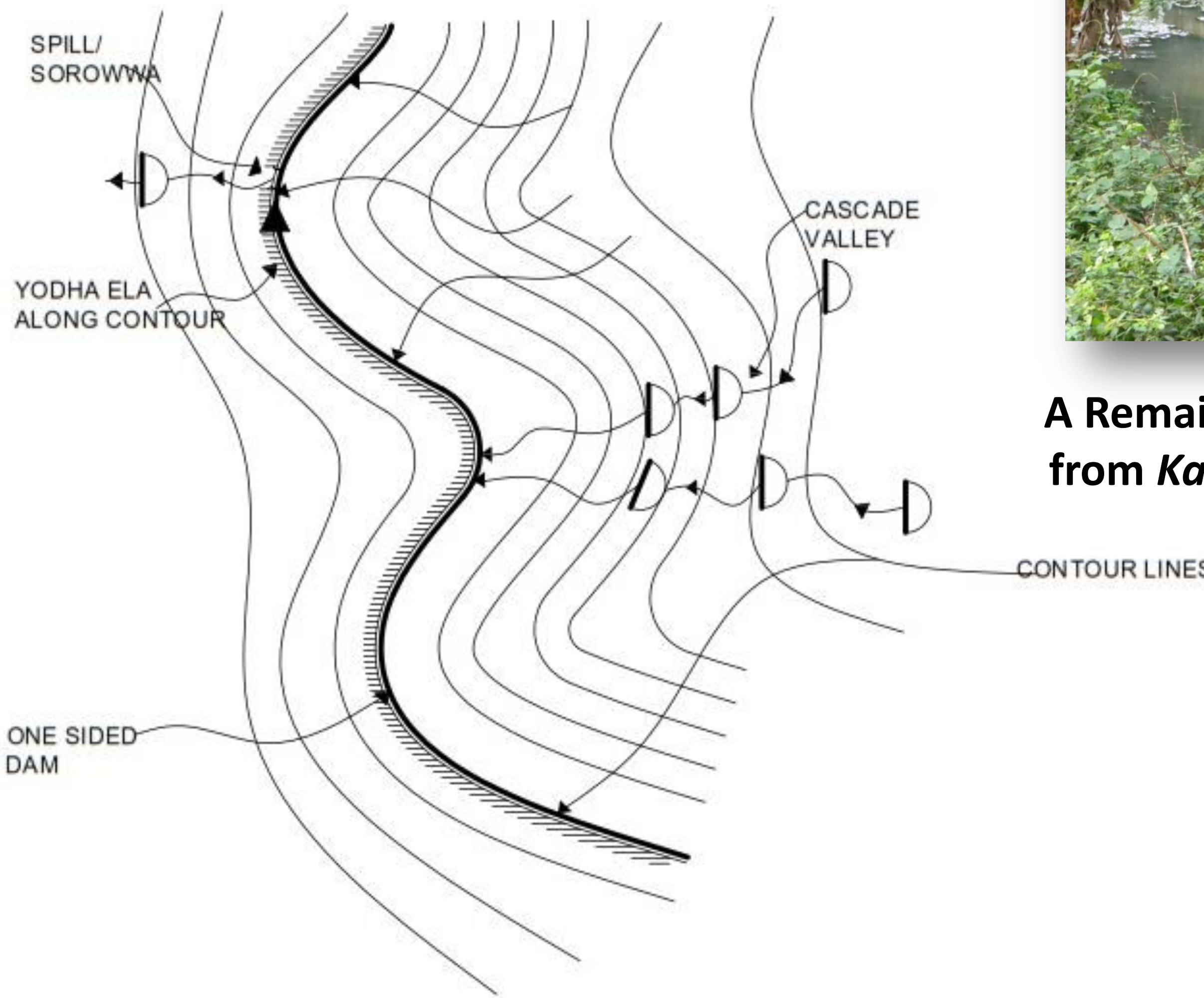
Goda Vana – Maintains the level of the water in the weva (tank) at an acceptable level so as not to disturb existing eco-system and releases the excess water to the downstream.

Soil-Water Ecosystem – Amuna (Diversion Weir)

Ammuna in *Malwatthu Oya (Thekkama) – diverts water to Yodha Weva*

Ammuna in *Ridi Bedi Ella*

Function of *Yodha Ela*



A Remaining part of *Yoda Ela* stretched from *Kala Wewa* to *Tissa Wewa 80 km*

Yodha Ela is a 'non flowing canal which is constructed almost on contour lines (one inch to one mile)connecting water in different vallyes.

Soil-Water Ecosystem

The system mainly consisted of Village level small to middle sized *wewas (Tanks) cascading from a Main Storage Tank through a network of canals*

Small tanks

Middle level tanks

large tanks

Bisokotuwa Sorowwa

Both *Bisokotuwa* and sluice tunnels were covered on the outer side with burnt bricks and a puddle of tempered clay to prevent seepage of water into the dam

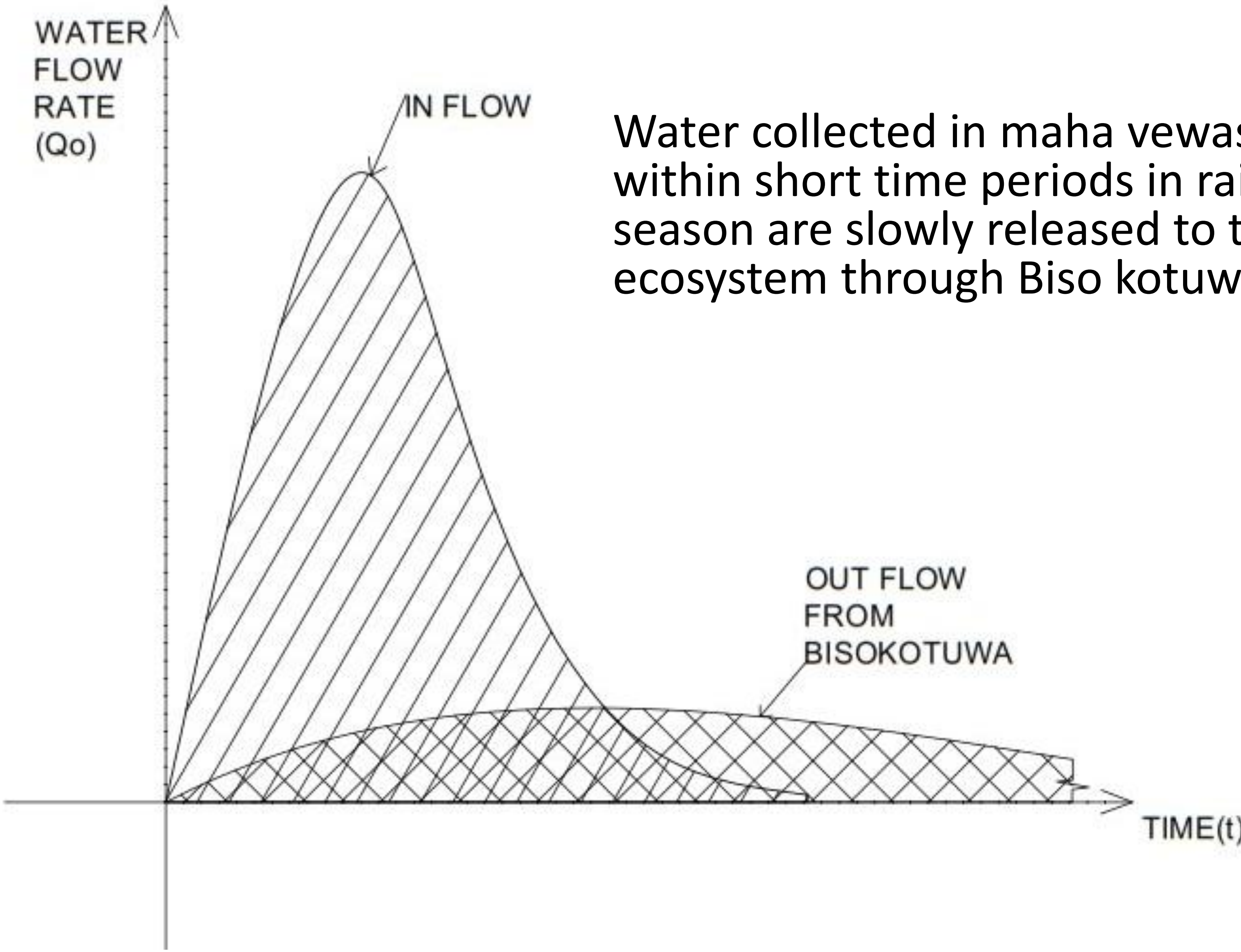
Soil-Water Ecosystem - Bisokotuwa

Bisokotuwa at Kuda Willachchiya Wewa

Bisokotuwa Sorrowwa* at *Parakrama Samudraya

Bisokotuwa Sorrowwa* at *Eru Wewa

Hydrograph of ***Maha Wewa with Biso kotuwa***



Water collected in maha vewas within short time periods in rainy season are slowly released to the ecosystem through Biso kotuwa

Soil-Water Ecosystem- Kattakaduwa - Kiulela

Kattakaduwa

Kattakaduwa *– Marshy Land situated parallel to the dam in the immediate down stream. Plants which absorbs salinity are grown in this land.*

Kiul Ela *which drains the excess water in the paddy lands starts on this marshy land. This will lower the see page lines in the dam and the stability of the dam will be increased.*

Kiul Ela

Way Forward

- Technology- Supply Side

- New technologies may be costly; therefore parameters such as efficiency, long term sustainability and reduced O&M expenditure have to be promptly marketed to promote the adaptation of new technologies

- Slow sand filters, Upward flow roughing filters , Household level filtration units, bio sand filters.

- Rainwater harvesting with recharge into existing wells.

- Institutional Reforms:
  - Challenges- To build up the synergy of centralized and decentralized water supply schemes so that one could help the other in case of disasters not yet emerged as a problem .

- New technologies may be costly; therefore parameters such as efficiency, long term sustainability and reduced O&M expenditure have to be promptly marketed to promote the adaptation of new technologies
- New technology may require lesser number of staff to handle these, therefore actions should be taken to educate and make trade unions stakeholders in the technological transformation process
- Ex: smart metering which enable automated meter reading may awaken meter readers on a threat to their role in NWSDB – engage them in a much more sophisticated technologically superior area of work such as in IT systems related to billing - they can carry mobile meters that collect data and let them get involved in some kind of bill processing data uploading etc.
- It will be efficient to get the private sector participation to operate and maintain the assets

Public Participation :

- Attitude changes so that less water is use.
- Better appurtenances so that same comfort level is obtained from using less water .
- Creating Public Awareness

- use of different qualities for different purposes Two supply lines, In house water re-cycling for appropriate use – widely practiced in industry can we extend this to domestic and commercial sectors? .
- understanding and reducing the 'Watergy
- Eco-sanitation practices where re-cycling is inbuilt.

- - Due to huge market competitions, innovative procurement strategies to procure innovative technologies
- - Obtaining end user certificates (ie. Comments on the product from those who already use it) will not be available for the new technologies. This is a challenge for the engineer and subject expertise as standards are also not developed very often.
- - Launching the implementation at pilot project scale will be the best approach
- - There is a great need to establish the databases on asset management of the current assets to make the procurements decisions to shift to innovative technologies
- Ex: life cycle cost of existing water meters is the key parameter to consider when shifting to smart metering. A smart meter costs about 80-100 US$ (without cost of accompanied software etc.) per unit and this will be much higher than a conventional meter unit. However the life cycle cost hopefully be lower.

Effect of a Domestic Leakage

Tiny drop wise leak make a BIG LOSS at last.!

If 10% of the taps in our country have such leakages, the wastage would be around 21 million of liters per day....

This amount is sufficient to provide water for 30,000 new families...

How many of these have you noticed at home ???