Training on Modern Irrigation Technology

Experience of Small-scale Water Resources Development in Thailand

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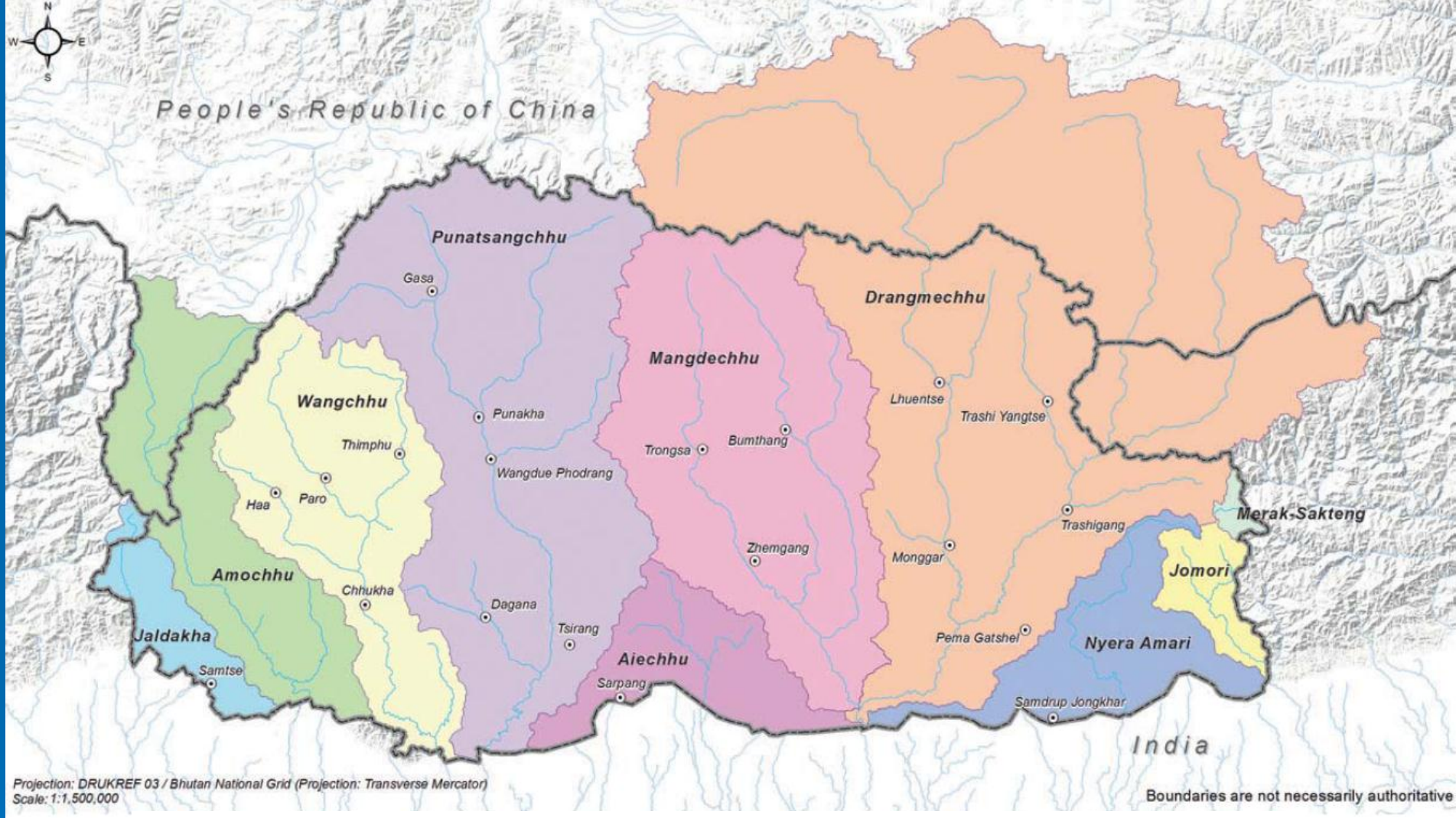
24 May 2018

Topics to be discussed

1. Integrated Water Resources Management (IWRM)
2. Small Scale Water Resources Project
3. Case study on Small Scale Water Resources Project



Water is the most important natural, economic and life-sustaining resource and we must ensure that it is available in abundance to meet the increasing demands. Present and future generations will have assured access to adequate, safe and affordable water to maintain and enhance the quality of their lives and the integrity of natural ecosystems.

There is increase in fluctuation between lean season and monsoon season flows leading to sub-optimal utilization of generating capacity of hydropower plants. The increasing sediment load in rivers is decreasing the expected output and economic life of hydropower plants. The uneven distribution of precipitation over the fragile mountainous environment makes the country highly vulnerable to landslides, floods, droughts and impacts of climate change.

The predicted climate change is likely to induce the following changes in climatic and hydrological variables:

- Precipitation will increase
- Precipitation will take the form of rainfall rather than snowfall
- Rainfall will be more erratic and intense
- Snowmelt will start earlier
- Winter seasons will be shorter
- Wet season flood flows and transportation of sediment and debris will increase
- Dry season flows, in contrast, are expected to decrease

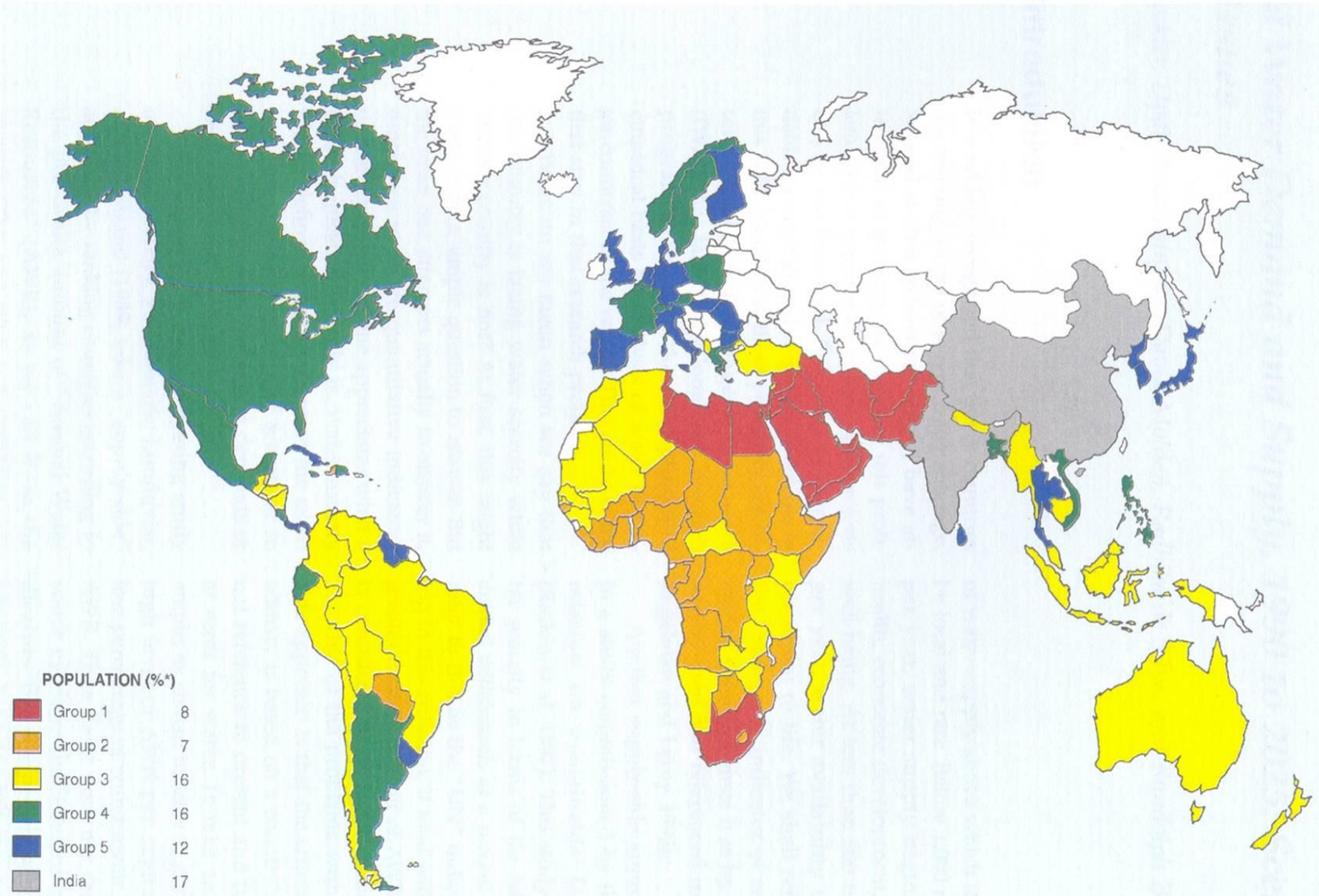
MANAGEMENT BASIN		HYDROLOGICAL BASIN		AREA (km²)	ANNUAL FLOW (million cubic meters)
1	Amochhu	1	Amochhu	2,310	9,375
		2	Jaldakha	942	
2	Wangchhu	3	Wangchhu	4,596	5,209
3	Punatsangchhu	4	Punatsangchhu	9,645	19,129
		5	Aiechhu	1,937	6,989
4	Mangdechhu	6	Mangdechhu	7,380	11,797
5	Drangmechhu	7	Drangmechhu	8,457	13,569
		8	Nyera amari	2,348	4,506
		9	Jomori/ Dhansiri	642	
		10	Merak-Sakteng	137	
			TOTAL	**38,394**	**70,576**
			FLOW (m³/s)		**2,238**

Water demand projection for different types (in MCM/Year) for 2015 and 2030

Demand Type	2015	2030	Percentage
Drinking Water	36.09	77.68	53.54
Industry & Others	74.39	218.35	65.93
Irrigation	666.9	9111.8	92.68

World Water Situation (IWMI indicator of water scarcity)

IWMI indicator of relative water scarcity.



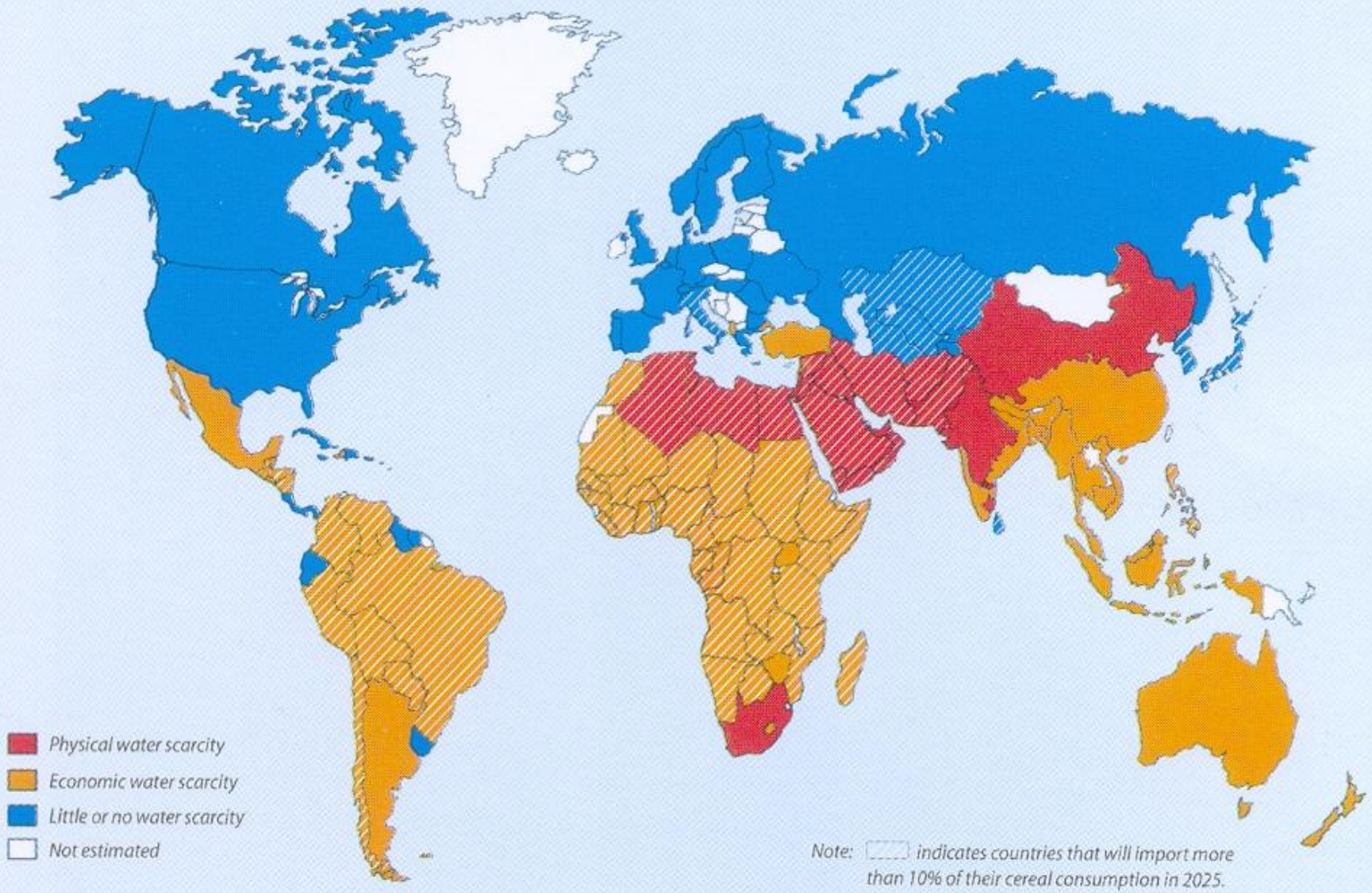
World Water Demand & Supply
(IWMI indicator of water scarcity)

Criteria

1) The percentage increase in water "withdrawal" over the 1990 to 2025
2) Water withdrawal in 2025 as a percent of the "Annual Water Resources" of the country

Group 1:	Water-scare by both criteria (West Asia and North Africa)
Group 2-5:	Sufficient water resources but more water resources projects should be developed.
Group 2:	Develop more than twice of current use (Sub-Sahara Africa)
Group 3:	Increase withdrawal by 25-100 %
Group 4:	Increase withdrawal by less than 25%
Group 5:	No additional withdrawal or even less water

Projected Water Scarcity in 2025



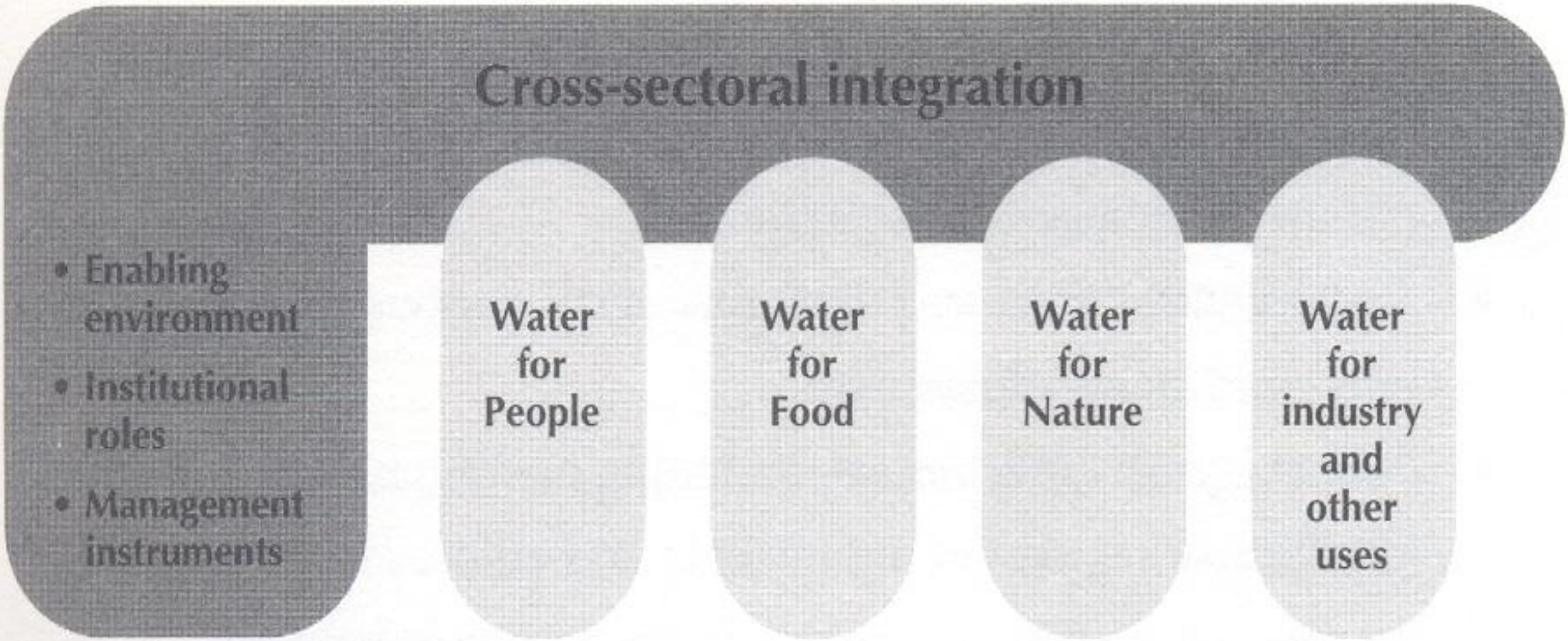
I. IWRM

- process for better management of water resources

- encompasses governance, stakeholder participation, and balancing development for resource sustainability

IWRM Principles (The four Dublin principles)

1. Water as a finite and vulnerable resource
2. Participatory approach
3. The important role of woman
4. Water as an economic good



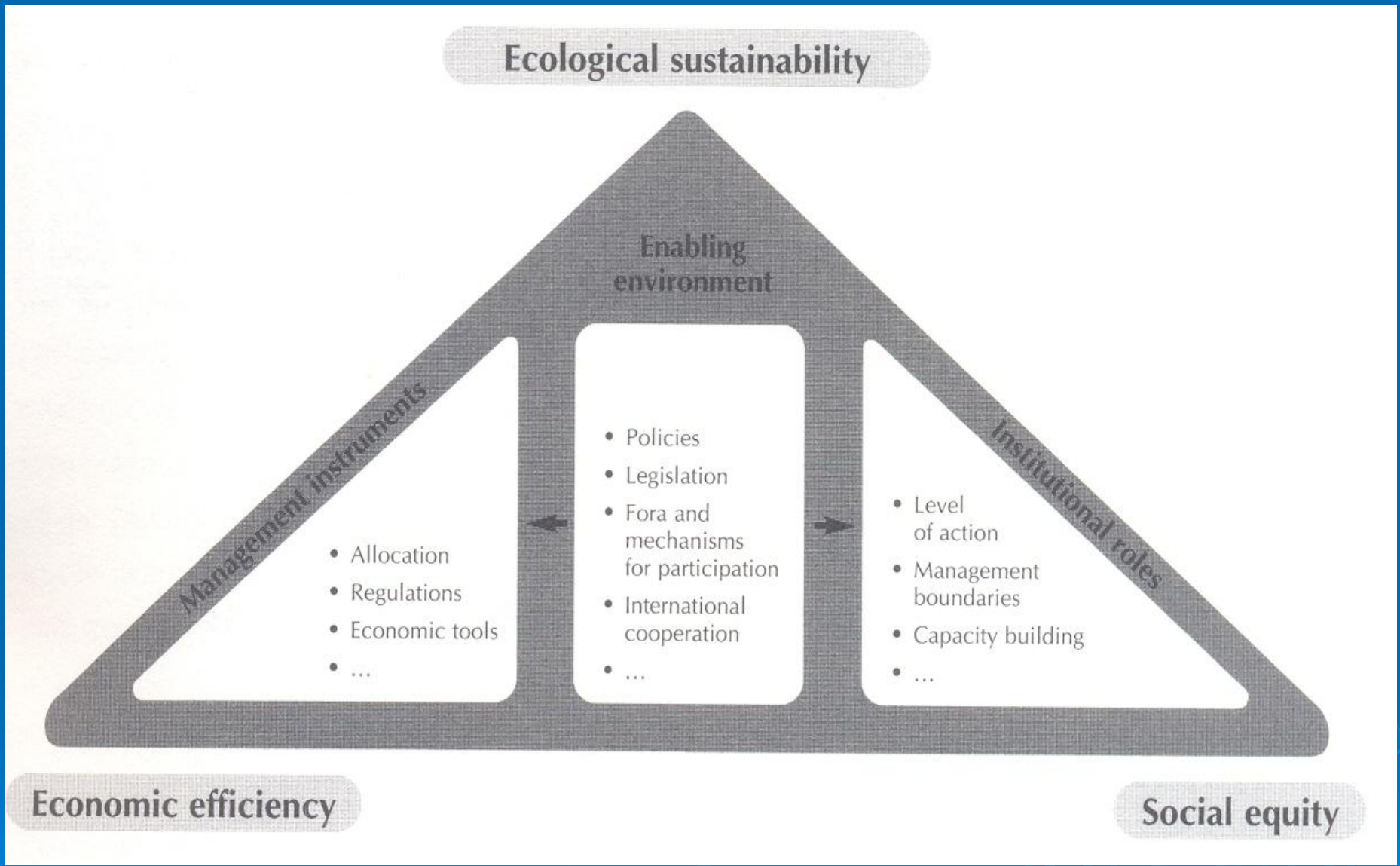
IWRM and its relations to sub-sectors

IWRM Background

- No general blueprint suitable for each and every country
- The IWRM process has to be adjusted according to the socio-economic, political and cultural conditions of each particular country
- An IWRM plan can therefore be interpreted as preparing a road-map or action program to put IWRM into practice

Initiating the Implementation Process

- **Recognizing the three basic components of IWRM**
  - **Enabling environment**
  - **Institutional roles**
  - **Management tools**



General framework for IWRM

Summary of IWRM

- A road-map or action program to put IWRM into practice takes time
- There is a need for a group of key players who can act as catalysts for changes and who should be motivated and influential enough to obtain government endorsement of the road map and/or action program
- Critical factor is to be consistent in pursuing the IWRM objectives and have patience in pursuing the same

Summary of IWRM

- **IWRM can be implemented or institutionalized through a step-by-step process**
- **In the preparation of river basin plans, the application of IWRM process is far more important than having a plan *per se***
- **Public awareness and multi-stakeholder participation is a must to ensure acceptance by public and the government**

Participatory Water Management

PIM is an important process in water management

Tell me, I'll forget

Show me, I might remember

Involve me, I will learn

Participatory Process

- people are at the heart of development - ultimate beneficiaries and agents
- participation - a process that enables stakeholders to influence or share control over development initiatives and over decisions and resources that affect themselves.

Participatory Process

- Involves four main phases: initiating, preparing, implementing, and sustaining
- No single answers and blueprints
- Progress depends on social, economic, political and cultural conditions

Need for Participation

- improve performance and sustainability of policies, programs, and projects
- enhance stakeholder capacity and skills
- empower stakeholders
- foster a sense of local ownership
- facilitate conscientious monitoring of activities
- motivate sustained commitment

Need for Participation

- smoothen transitions: from activity conceptualization → assessment → design → capacity building → implementation → monitoring and evaluation.
- enhance the social capital and promote sound governance.
- minimize external criticism.
- build consensus.
- improve conflict management.

Modes of Participation

- Information sharing – one way communication
- Consultation – limited two-way communication

- Collaboration – work alongside
- Empowerment – accept responsibility

Comment on PIM

- The merit from the PIM must be existed for both the office and the farmer.
- The PIM must be part of the water allocation such that the farmer should satisfy the water delivery.
- Water fee may be collected in order to assist in the operation and maintenance of the system by the water user group.
- The contract between water user groups and the irrigation agency is another approach in order to achieve equity and conflict resolution.

Comment on PIM (cont)

- Farmers must participate on both operation and maintenance of the irrigation system.
- Participation may start from the ditch level and advance to higher level of the distribution system.
- If the condition is allow, PIM should be a voluntary system. The progress may increase step by step.

II. Small Scale Water Resource Project

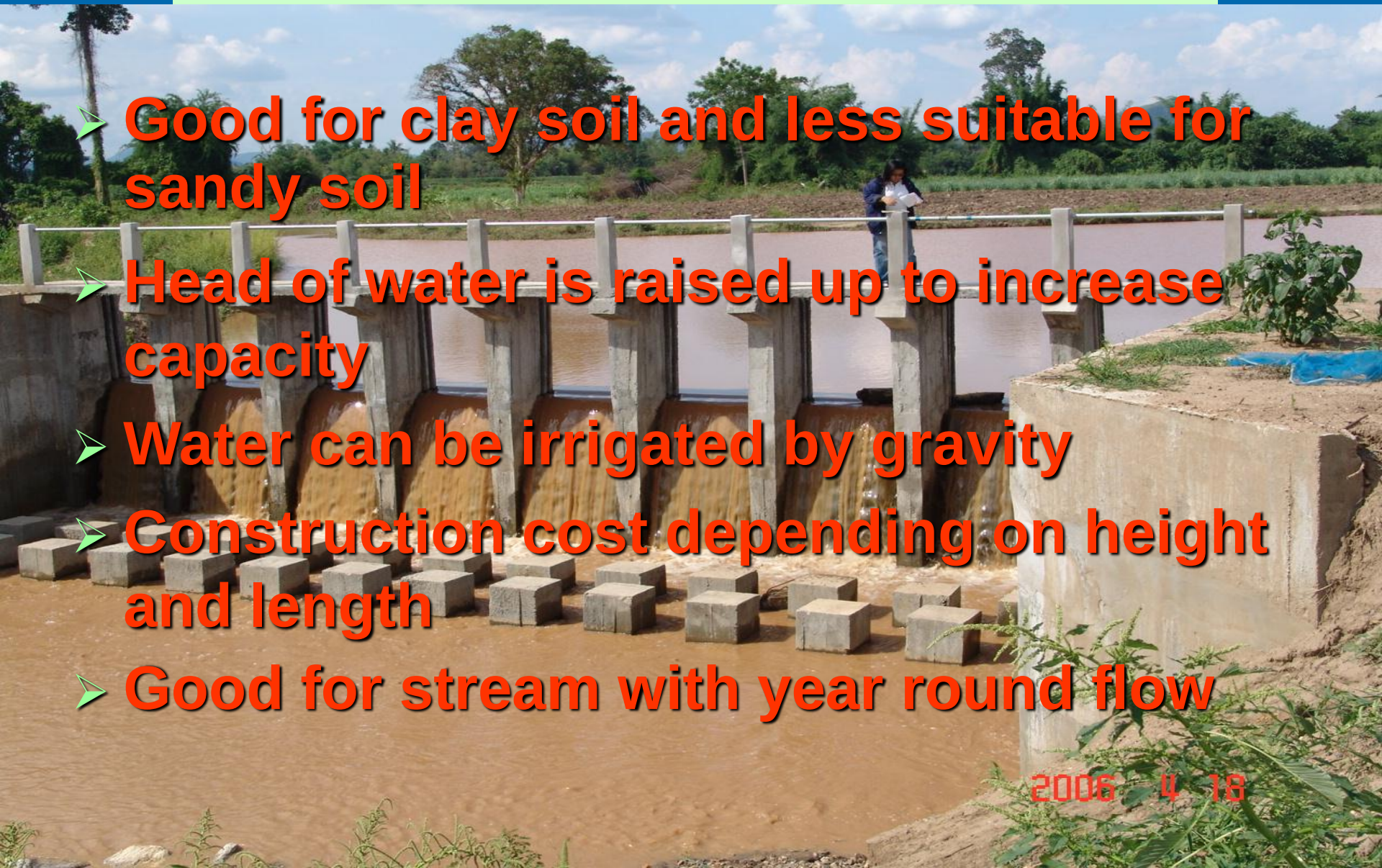
- Type of Small Water Resources Project
- Participatory Irrigation Management (PIM)
- Some issues in SSWRP

II.1 Small Scale Water Resources Project

1. Natural stream with irrigation canal

2. River weir

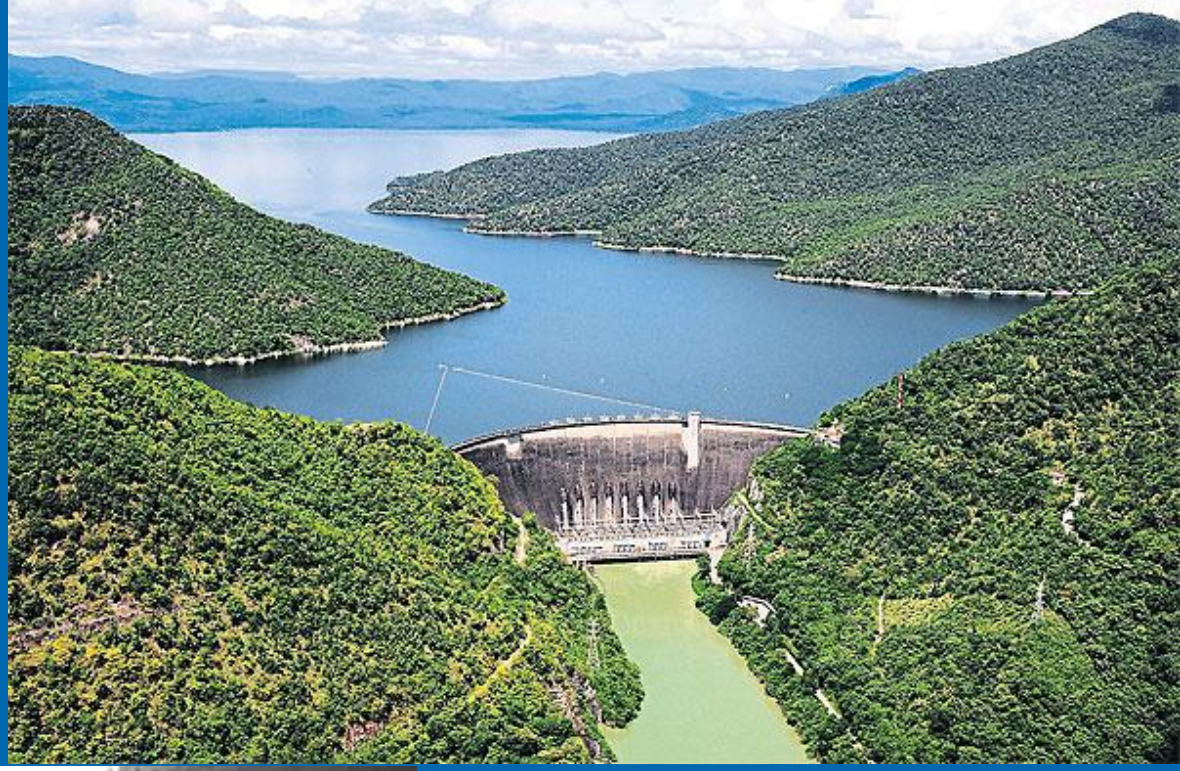
Weir Construction



- Good for clay soil and less suitable for sandy soil
- Head of water is raised up to increase capacity
- Water can be irrigated by gravity
- Construction cost depending on height and length
- Good for stream with year round flow

3. Reservoir

Bhumibol Dam

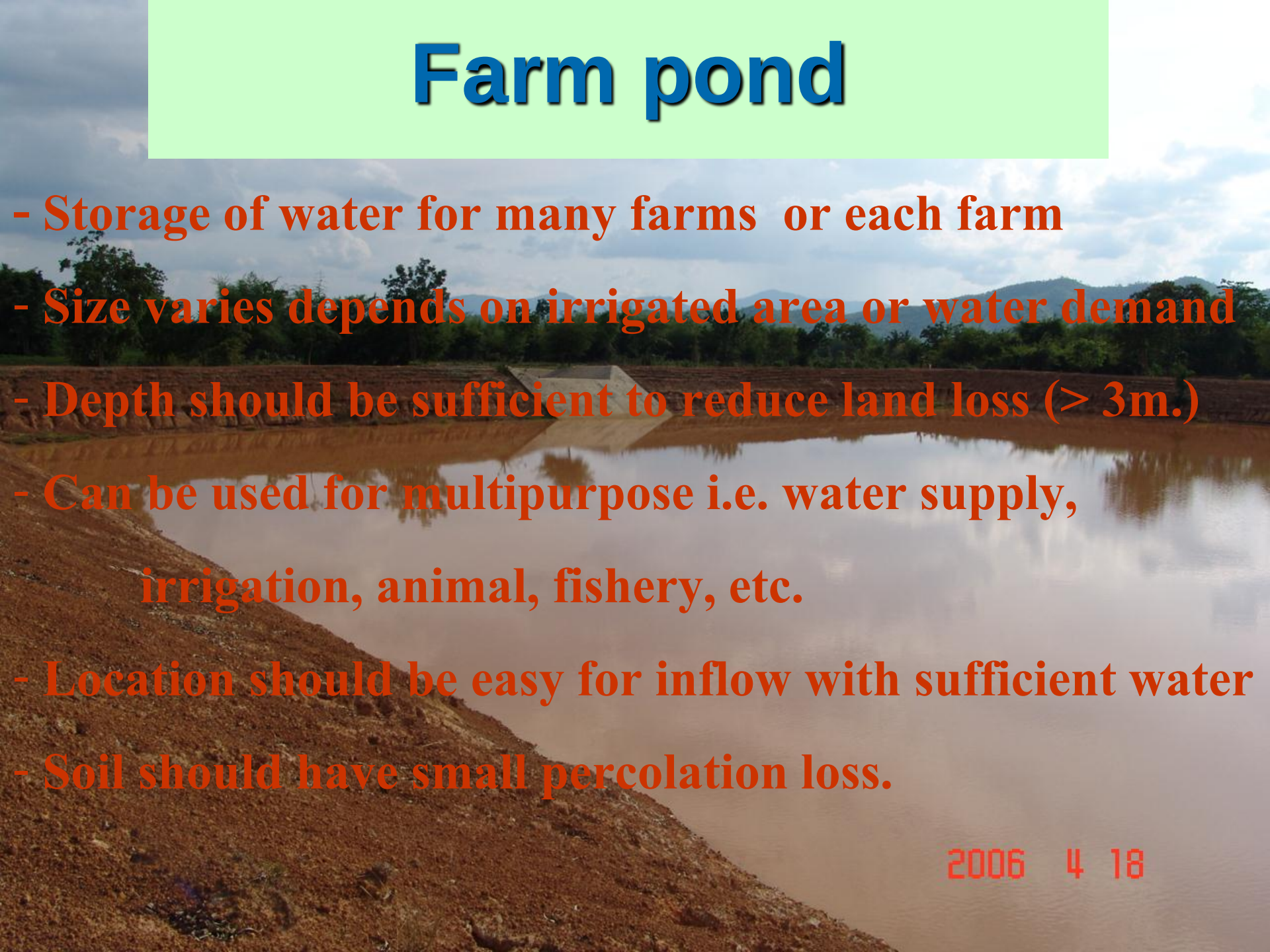


Chukha HEP

4. Farm pond

Farm pond

- Storage of water for many farms or each farm
- Size varies depends on irrigated area or water demand
- Depth should be sufficient to reduce land loss (> 3m.)
- Can be used for multipurpose i.e. water supply, irrigation, animal, fishery, etc.
- Location should be easy for inflow with sufficient water
- Soil should have small percolation loss.



Type of farm pond

- Receiving water from ground surface or stream
- Receiving water from rainfall
- Receiving water from groundwater

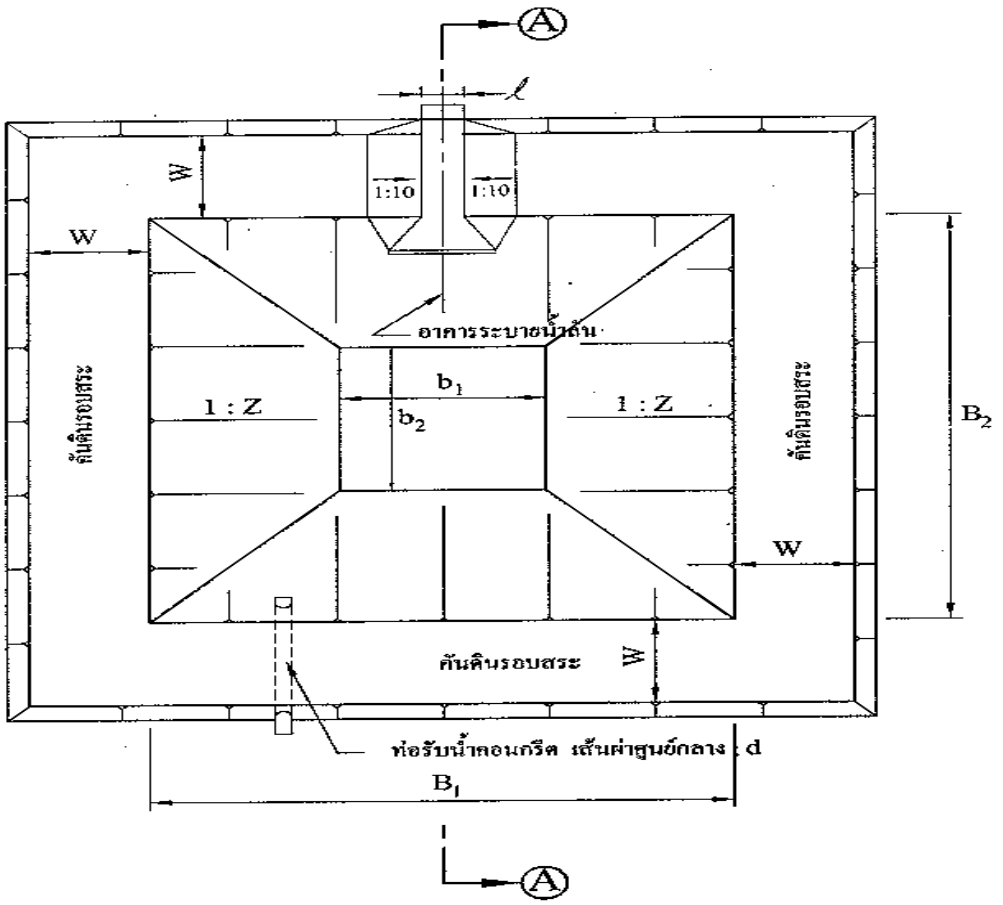
a) Good location of pond receiving water from ground surface

- Location with small stream path at lowland
- Close to natural stream or river for easy diversion
- Soil with good water holding capacity such as clay (may observe from nearby pond)
- Easy access for excavation by hand or machinery

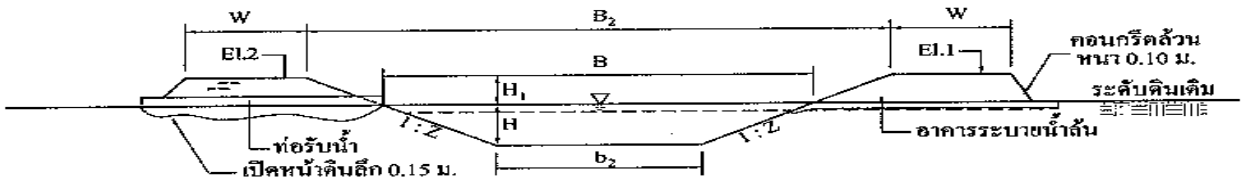
b) Good location of pond receiving water from rainfall

- Location is flexible
- Area with good rainfall
- Top of pond should be big enough
- Soil with good water holding capacity

Typical of farm pond



รูปที่ 7.3 แปลนมาตรฐานสระเก็บน้ำ



รูปที่ 7.4 รูปตัดสระเก็บน้ำ A-A

Inlet to farm pond

Source of power

Diesel

Electricity

Size of farm pond

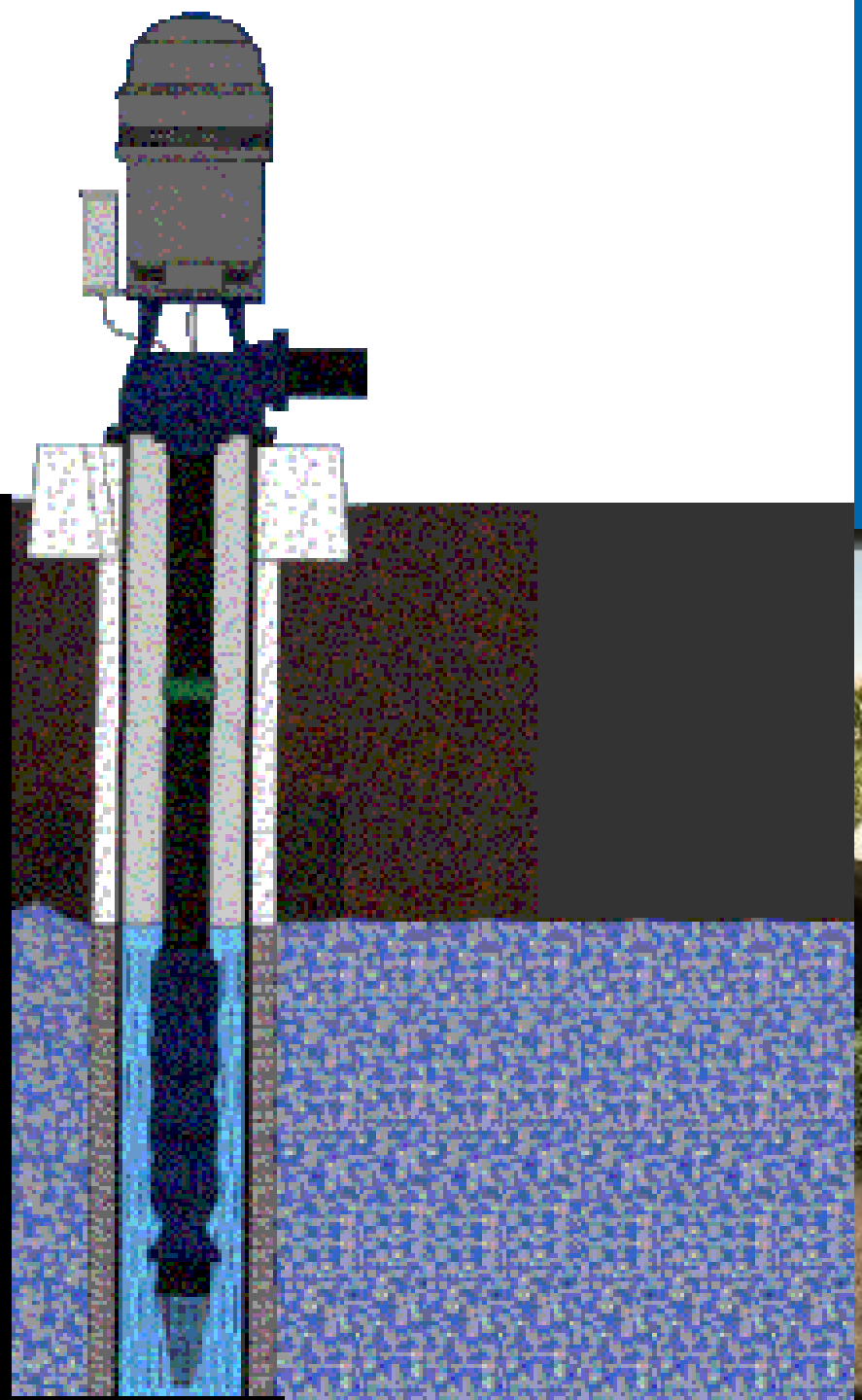
- Depth should be at least 3-5 m.
- The size should be large enough i.e. 10 % of land
- Side slope depending on soil type

  1:1 for clay soil

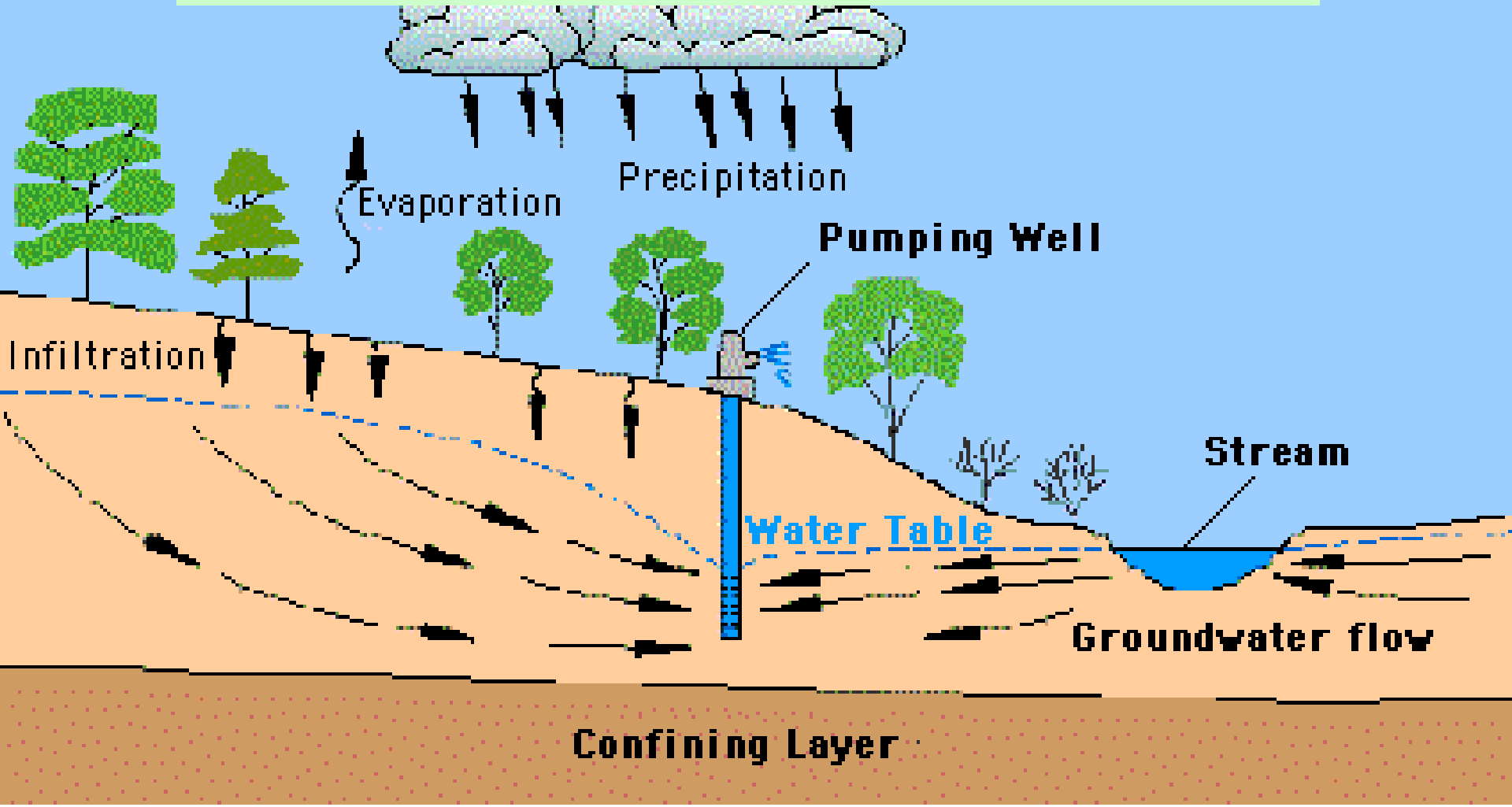
  1:1.5 to 1:2 for sandy soil
- Evaporation loss and seepage should be taken into consideration

5. Pumping station

6. Groundwater



Groundwater well



(Adapted from USGS)

Groundwater well

- Major water resource for many countries in Asia
- Long term annual pumping must be limited to prevent permanent drawdown.
- Pumping cost varies with groundwater level.
- Water quality depends on type of rock in the aquifer.

Groundwater Layer

Groundwater may have many layers but it should be classified into 2 types :

- shallow well 30-50 meters
- tube well or deep well 30-800 meters

- **Observation of potential site for groundwater**

  - A lot of large tree in dry season (with green color)
  - Lowland such as valley
  - Area with groundwater wells in adjacent area
  - Excavation to investigate soil moisture in dry season
  - Other observation such as termite

- **Effect on overuse of groundwater (Over Pumping)**
  - **Lower of GW elevation**
  - **Pumping cost is higher**
  - **Land subsidence**
  - **Saltwater intrusion near by the sea.**

Problems on groundwater quality

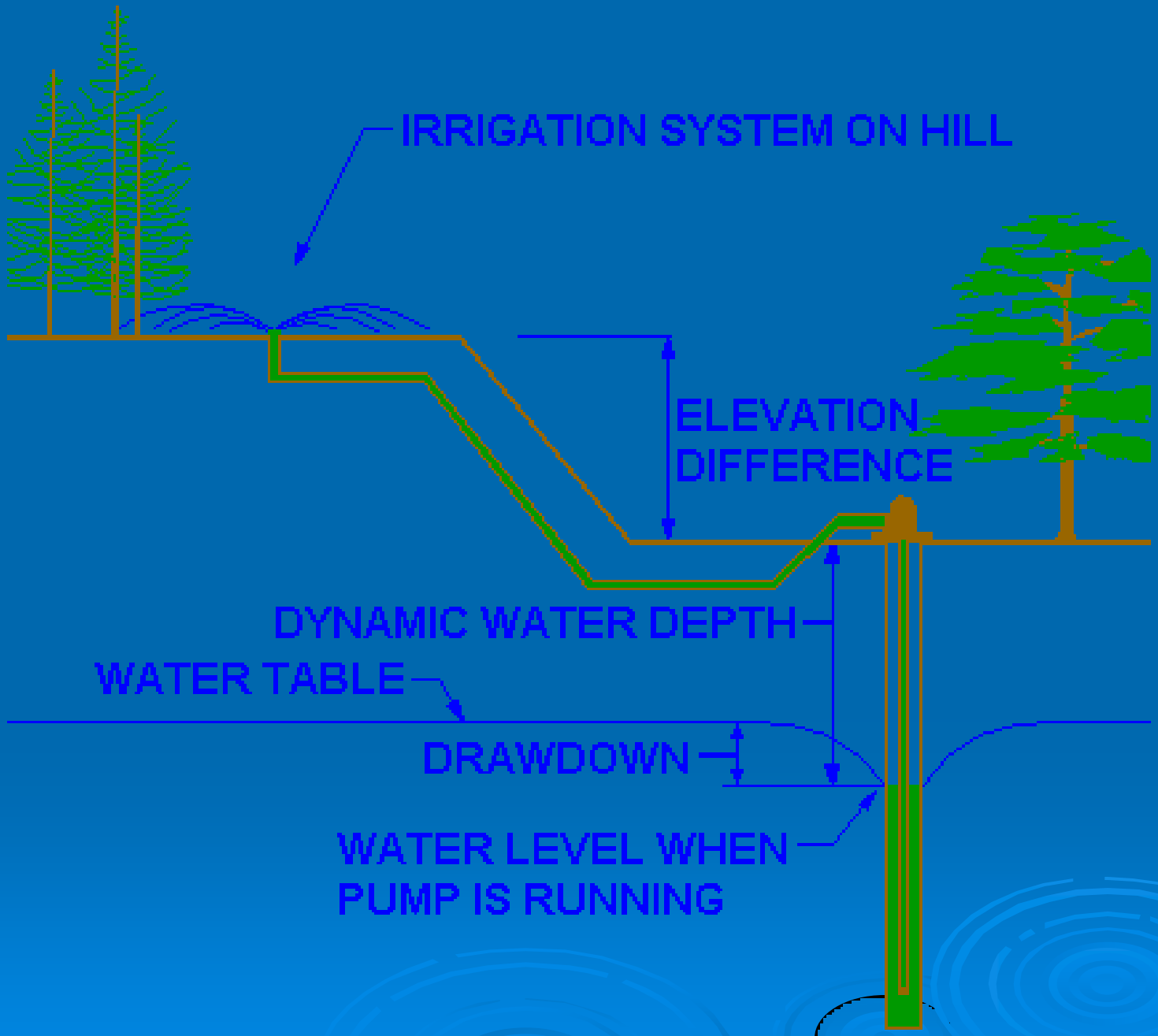
- Ferrous oxide (Iron oxide)
- High dissolved solid especially from limestone
- Salty water
- Bad smell or other unsuitable characteristics
- Arsenic contamination (Bangladesh)

Types of Pump

a) Groundwater pump with handheld

b) Groundwater pump with windmill

c) Groundwater with pump



TYPICAL WELL & PUMP WATER SYSTEM

Specific characteristics of groundwater use

- Energy cost for pumping such as fuel or electricity
- Water may be distributed by pipe system

  (smaller losses)
- Limited yield or annual pumping to avoid side effect

Cost for groundwater development

1. Borehole excavation
2. Pump and pipe
3. Motor or engine
4. Operation cost such as fuel
5. Maintenance

II.2 Some issues in SSWRP

1. The small scale irrigation project should have the following objectives:

   - Crop cultivation to support the local need.
   - Wet season should be the prime target, and the residual water may be use for the dry season.
   - The technology for operation and water application should be fit with local condition.
   - Capacity building on both irrigation and agriculture is important to both officer and farmer.
   - Farmer user group must be strengthen for the future operation.

2. The duty and responsibility for water user must be clearly defined:

- **Before irrigation season**
  - Survey of water demand
  - Acknowledge the water supply
  - Arrange the meeting to plan the water use
- **During irrigation season**
  - Check the water delivery according to water allocation plan
- **End of irrigation season**
  - Check the water source and the residual volume
  - Implementation of maintenance plan
  - Meeting for future improvement in planning

3. For pumping irrigation, the activities related to estimation and collection of water fee for electricity or fuel must be implemented.

- Calculation on cost of energy
- Technique to save the energy cost or energy consumption
- Operation plan and methodology for fee collection
- Water user group must be initiated and all farmers should be the member
- The maintenance and its cost on pumping station

4. Monitoring and Evaluation is important for the success of the project.

- Understanding the need for project evaluation
- Information and data requirement
- Estimation on total cost of operation
- Evaluation for future improvement based on
  - Evaluation indexes (efficiency and effectiveness)
  - Analyses after an improvement

III. Case study on Small Scale Water Resources Project

1. An evaluation of surface and subsurface with emphasize on tube well for domestic water supply by bureau of budget

The success of the project on tube well construction (total of 190,000 ponds) for water supply was evaluated for 4 objectives

1. To evaluate the effectiveness and efficiency of system management
2. Side effect of the project such as water level, salinity and system damage
3. To evaluate the suitability of existing law
4. To evaluate the achievement of various agencies
5. Recommendation on the future management

Small water supply from GW

Large water supply for GW


Handheld shallow well


New design of the system

Results

1. Effectiveness

- About 80-85 percent of handheld groundwater pumping systems are functioning.
- About 95 percent of domestic water supply systems are functioning.
-The water fee per unit of water is different for each location.

2. Groundwater use for agriculture

- Groundwater use for irrigation is only limited to some regions.
- About 10 percent of the population use groundwater for agriculture.

3. Implementation

- About 80 percent of the village has a good potential of groundwater use for domestic water supply.
-The new settlement is far from the original village such that the new development must be carefully analyzed.
-There is some duplication of the system by the construction of different agencies.

4. Construction Organization

- There are many standard of water supply system since four agencies are responsible for the job. This should be reduced in the future.
- The role and responsibility of organizations should be changed and the number of agencies should be reduced.

5. Recommendation

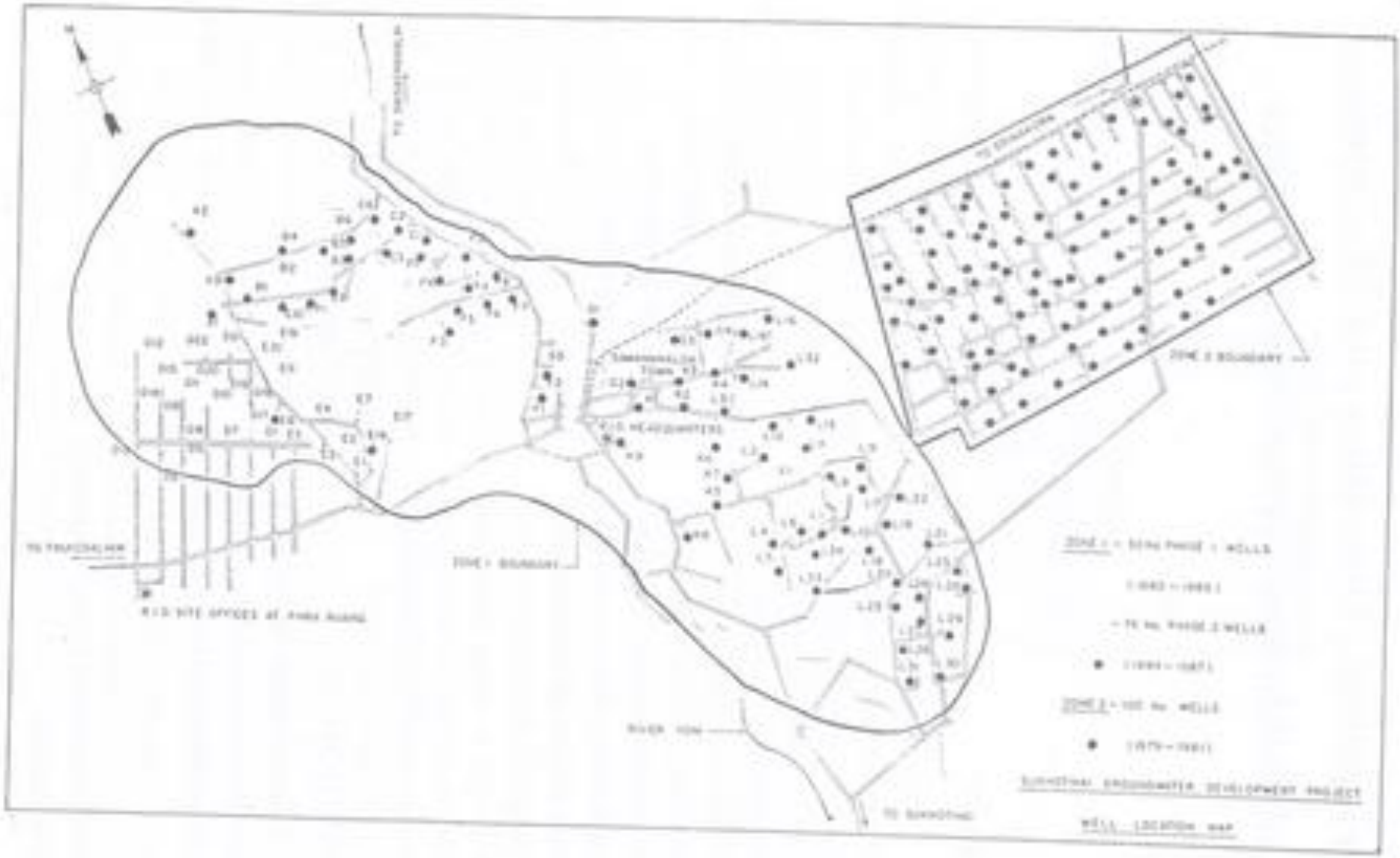
- The construction of water supply system should be the responsible of local administration organization.
-The restriction of groundwater use should be tighten to prevent the negative effect especially the lowland near by the sea.
- Bangkok and suburban area has the most impact from excessive of groundwater use.

2. Groundwater project for irrigation

The Sukhothai groundwater project were a large groundwater irrigation project comprised of more than 200 wells and each well had an irrigation about 50-60 ha therefore it is more like many small pumping projects.

There are some problems arise after few years of operation as follows:

1. **Water charge and water allocation**
2. **Need of on farm work (undulate land)**
3. **Institutions to support the project**
4. **Coordination and communication**
5. **Operation and maintenance**



Analysis and recommendation

1. Groundwater protection by limited the amount of pumping
2. Increase step of water charge by time
3. On farm development
4. Operation policy regarding season and water shortage
5. Research and development
6. Capacity building for both staffs and farmers
7. Participatory process in project management

3. Water resources planning, development and management by local administration organization

According to the constitution of 1997 , the LAOs will be initiated and large amount of budget will be allocated to them. There responsibility regarding small scale water resources covers the whole process from planning, design, construction, operation, and evaluation.

However LAOs has a lot of limitation in design and operation of the system such that there are numbers of incident for improper design, operation and maintenance of water resource structure.

Most LAOs are unable to operate and maintain small reservoir properly

Weir can be operated by the beneficial farmers

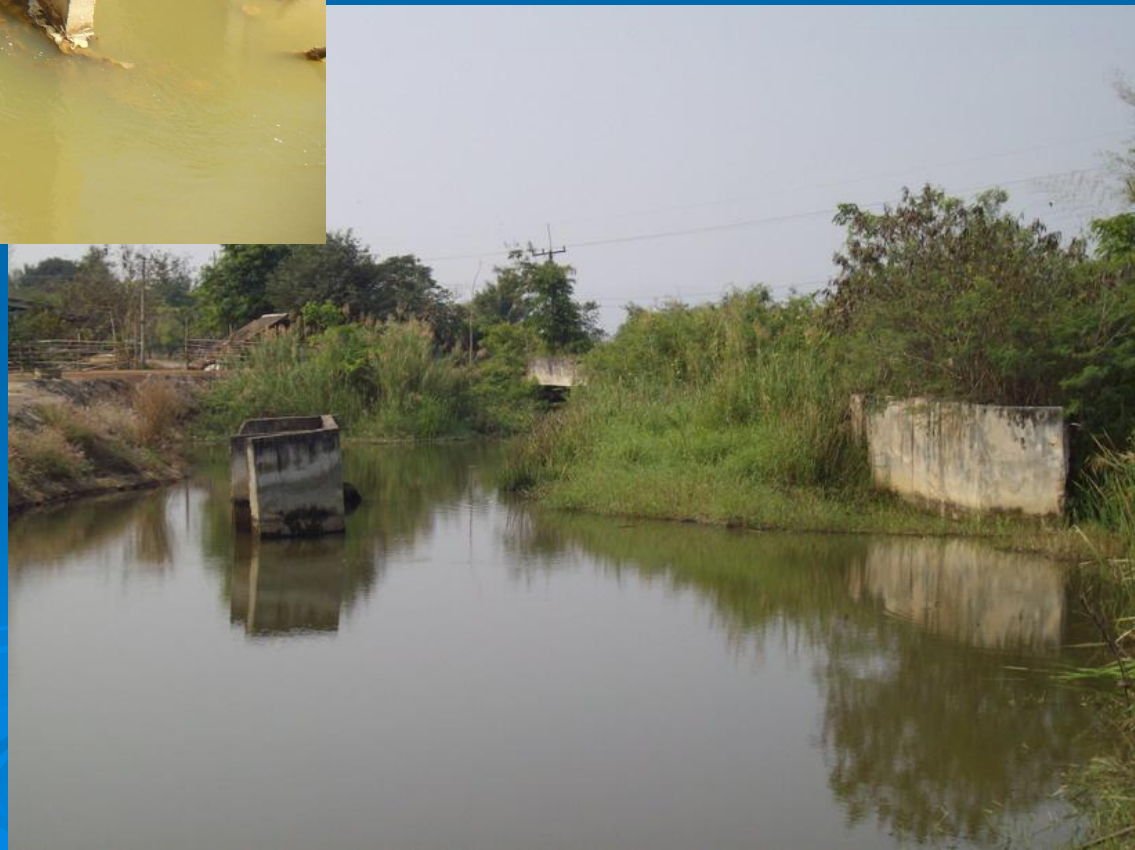
Various types of weir are constructed by TAOs

Problems and damages

Weir without rip-rap protection at upstream

Damage at the side of structure

Weir is too small comparing to the flow



Sediment in the weir due to soil erosion

Damage due to high flow

Damage by people

Irrigation canal and control structures

Lined canal

Earth canal

Weed control by farmers

Sediment removal by farmers

Removal of sediment from stream

Maintenance issue of SSWRP

1. The objectives of maintenance

   - to maintain the system in good condition at all time,

   - to extend the life of the project at high efficiency by adequate maintenance,

   - to achieve the prior objectives with a minimum cost.

2. Types of Maintenance

- Routine maintenance
- Periodical maintenance
- Annual maintenance
- Emergency maintenance
- Deferred maintenance

Cycle of Project Maintenance

3. Method of Maintenance

- Manual
- Machinery
- A combination of both

The selection of maintenance method must consider:

- Cost and level of technology
- Labour or machinery
- Amount of work
- Duration of work
- Quality of work

4. Problems, Causes, and Solutions in Maintenance

4.1 Results

An irrigation system with insufficient maintenance may deteriorate until it is not possible to repair. It may affect on water allocation to be:

- Uncertain
- Unreliable
- Inadequate
- Lack of control

4.2 Causes

The causes to damage irrigation system (by human, animal and nature) can be summarized as follows:

- Rainfall
- Wind
- Runoff and flow in the canal and drainage systems
- Grass and weed
- Invasion of canal and drainage systems
- Crack on canal and structure caused by heat
- Rust or deterioration

Causes by Human

The major cause for system deterioration is **lack of budget** for maintenance. The other causes are:

- Improper maintenance
- Lack of training for maintenance staff
- Misallocation of budget
- Lack of control and supervision in maintenance
- Poor design or construction

4.3 Solutions

Sufficient budget will enhance the maintenance capability of both equipment and maintenance staff.

Other factors are

- Staff training (i.e. maintenance procedure)
- Job identification
- Report and analyses of situation
- Priority of work
- Monitoring and evaluation
- Participation on maintenance

Participation on maintenance of Irrigation system

The maintenance may cover the followings:

- **Reservoir**
- **Weir**
- **Maintenance of wood and steel structure**
- **Water quality control and environment**

*** The detail in the maintenance procedures will not be discussed here.**

The requirement of maintenance may be reduced by the followings:

- Optimal design (i.e. no silt accumulation and erosion)

- Proper operation (i.e. the opening and closing of gate)

- Other measures (i.e. soil conservation, chemical and biological control)

Thank you for your attention!