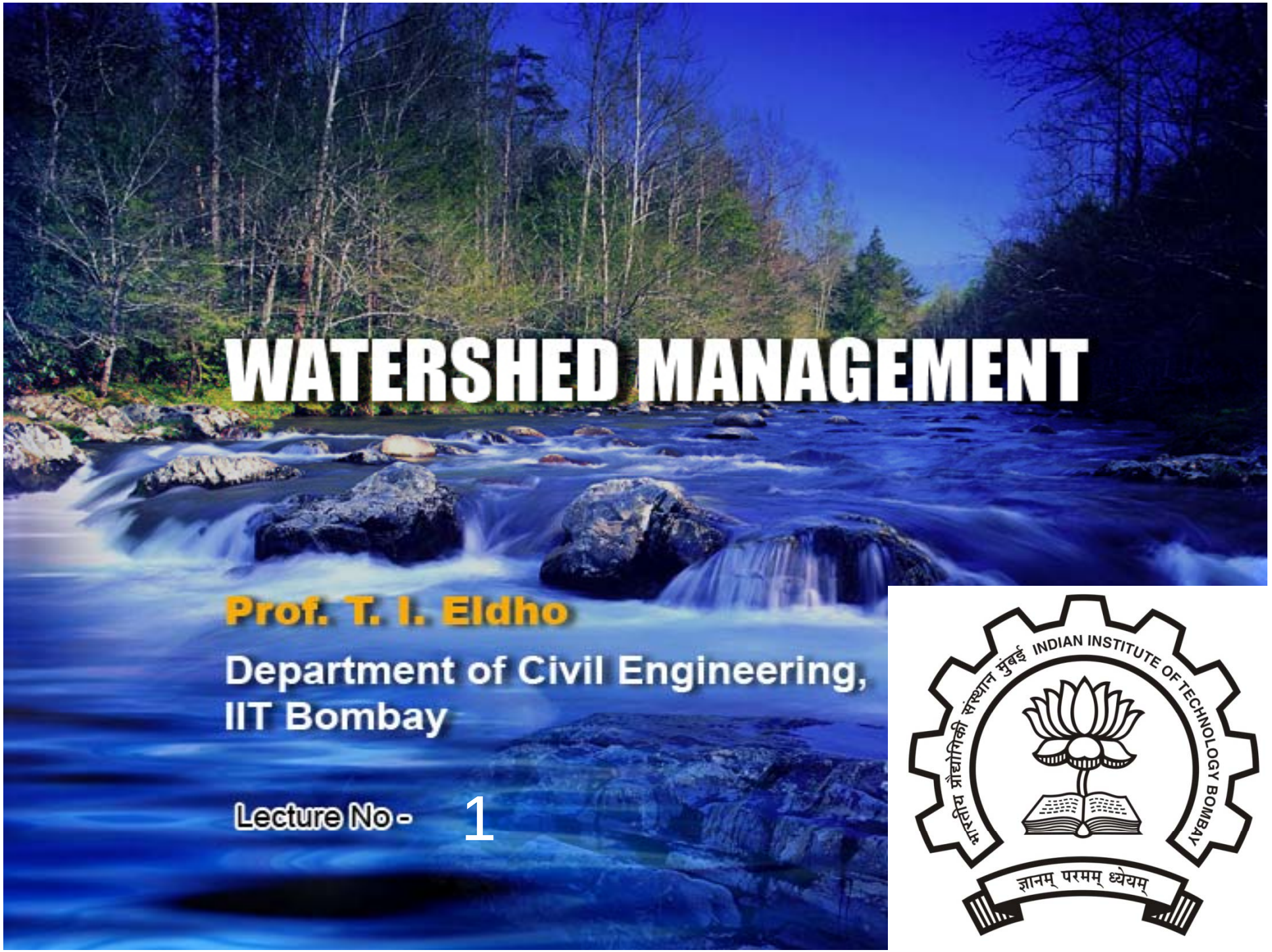
WATERSHED MANAGEMENT
Prof. T. I. Eldho
Department of Civil Engineering,
IIT Bombay
Lecture No - 1

Scope of the Course

- To discuss various aspects of watershed & its management – Integrated Watershed Management Approach.
- Watershed – ideal unit for multi-disciplinary planning & management of land & water resources – ensure continuous benefits – sustainable way
- Watershed Management (WM)–
  - Sustainable Management of entire land & resources.

Course Objectives

- To discuss various aspects of watershed development and management – resources: technological, social, ecological, environmental, sustainable issues.
- Focus - technical aspects of WM; perspectives on land & water management; analyze complex issues in water management and on specific knowledge on issues of WM.

Course Objectives..

- Course will be very useful to
  - Undergraduate & post-graduate students,
  - Teachers, NGO's, Field Engineers and Practitioners.
  - Number of field problems will be discussed to illustrate the concepts clearly.

Course Modules -10 (40L)

- 1) Introduction and Basic Concepts - 3
- 2) Sustainable Watershed Approach & Watershed Management Practices - 4
- 3) Integrated Watershed Management - 4
- 4) Watershed Modeling - 7
- 5) Social Aspects of Watershed Management - 3

Course Modules – 10 (40L)

- 6) Use of modern techniques in watershed management -5
- 7) Management of Water Quality -4
- 8) Storm Water and Flood Management -4
- 9) Drought Management -3
- 10) Water Conservation and Recycling -3

References

- 1) Allam, Gamal Ibrahim Y., *Decision Support System for Integrated Watershed Management*, Colorado State University, 1994.
- 2) Am. Soc. Of Agri. Engr., *Hydrologic Modeling of Small Watersheds*, Am. Soc. Agri. Eng., Michigan, 1982.
- 3) American Soc. of Civil Engr., *Watershed Management*, American Soc. of Civil Engineers, New York, 1975.
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- 5) Michael A.M., *Irrigation Engineering*, Vikas Pub. house, 1992.
- 6) Rajesh Rajora, *Integrated Watershed Management*, Rawat Publication, New Delhi, 1998.
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- 8) Murty, J.V.S. *Watershed Management*, New Age Intl., New Delhi 1998.
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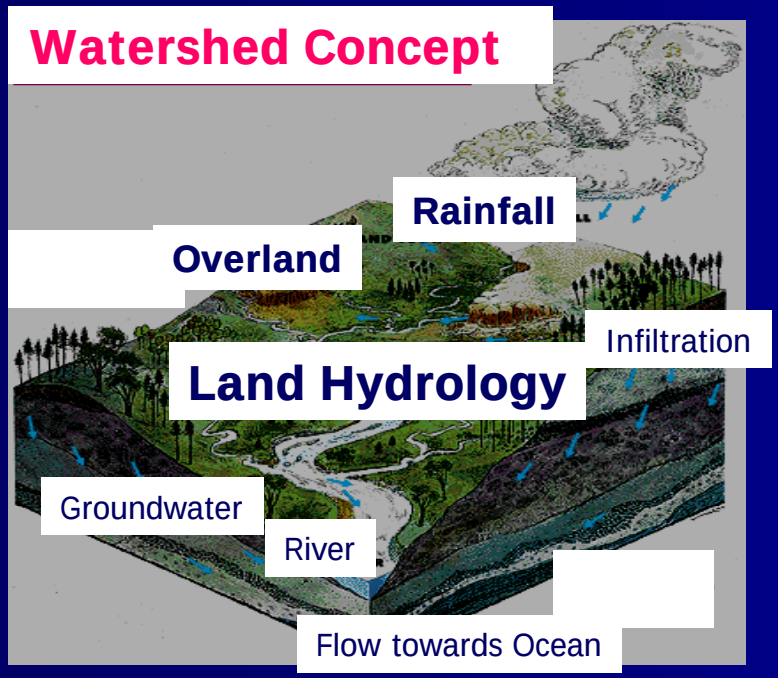
Module 1 – (L1-L3)

- **Introduction and Basic Concepts**
- Concept of watershed, introduction to watershed management, different stakeholders and their relative importance, watershed management policies and decision making.

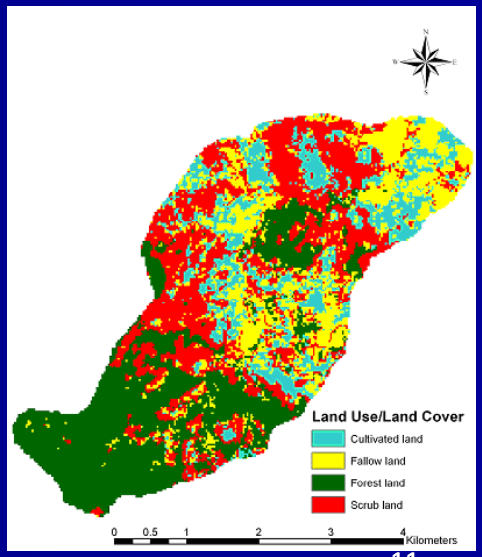
L1– Introduction to Watershed Management

- **Topics Covered**
- Concept of Watershed; Watershed Approach; Common watershed problems; Introduction to Watershed Management (WM)- WM necessity & principles; Case Study.
- Keywords: Watershed management, Concepts, Characteristics, Deterioration, Necessity, Principles.

Concept of Watershed



Reservoir in main channel



Hydrosphere & hydrological cycle – gives better concept about watershed

Concept of Watershed..

- Hydrosphere – in physical geography - describes combined mass of waters found on, under and above the surface of the planet .
- Hydrosphere consists waters of land (rivers and other water bodies, groundwater system etc.), oceans & atmosphere surrounding the land
- Hydrological Cycle - Change in phase of water in the hydrosphere.

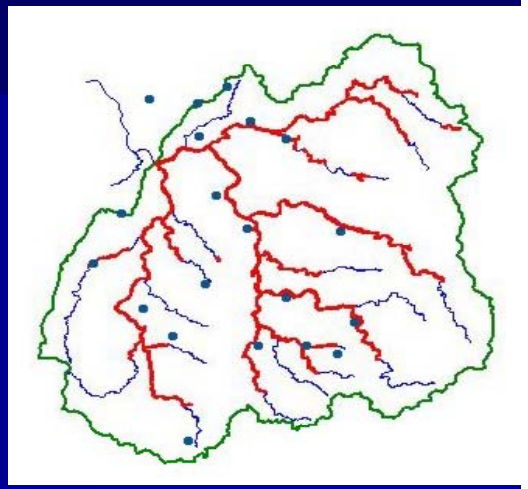
Concept of Watershed..

- Watershed: - topographically delineated area that is drained by a stream system
- An area from which runoff resulting from precipitation flows past a single point into a stream, river, lake or an ocean.
- Watershed - drains from surrounding ridges to the common point such as lake or stream
- Shares boundaries with neighboring watersheds.

Fig. modified from (www.fergusonfoundation.org/btw/watershed.html)

Watershed characteristics

- Size
- Shape
- Physiography
- Climate
- Drainage
- Land use
- Vegetation
- Geology and Soils
- Hydrology
- Hydrogeology
- Socioeconomics

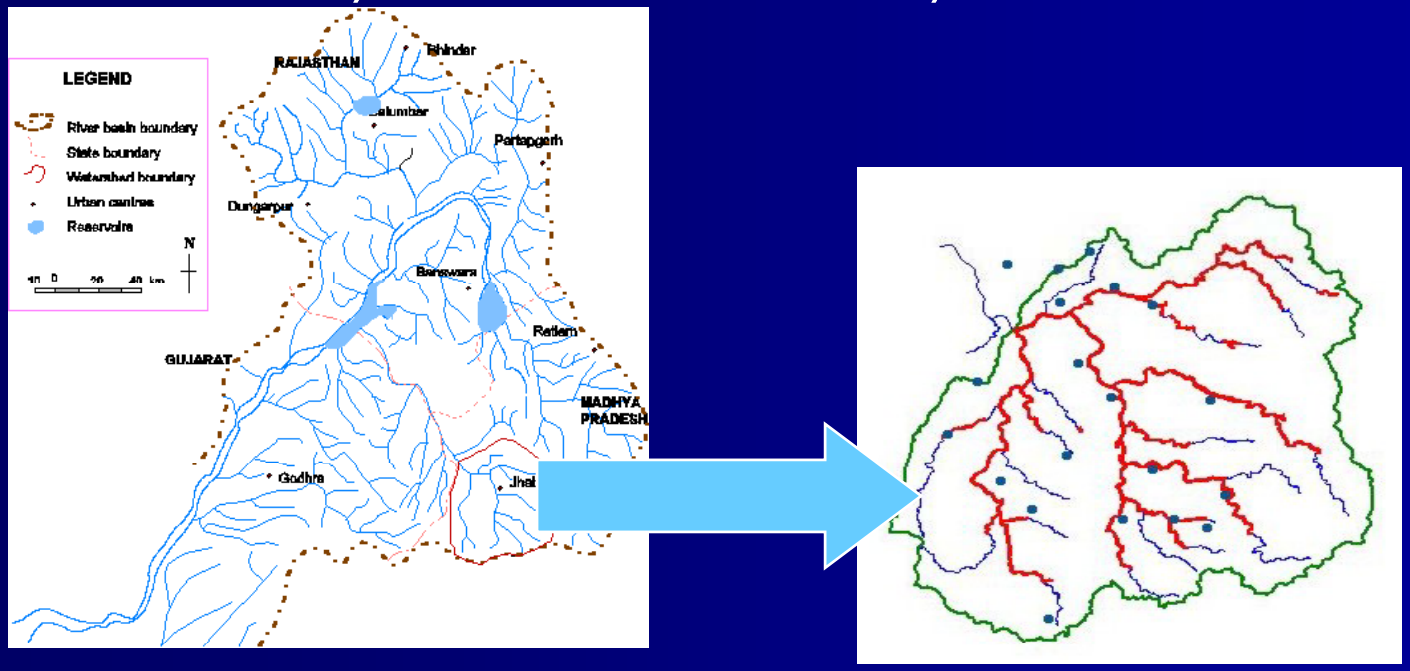


Photos: Singh, 07. 2001

Size of Watershed

Size – vary from few sq.m to thousands of Sq.km.

- Main watershed, Sub-watershed, Milli-watershed, Micro-watershed, Mini-watershed etc.



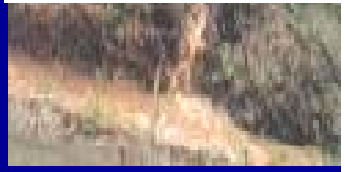
Watershed Approach

- Watershed approach - appropriate to solve various resources problems - for planning, implementation & management
- Managing Land & Water - watershed scale, appropriate- environmentally, financially & socially
  - Environmental scale - watershed defined by natural hydrology - Resources becomes a focal point in order to understand factors that contributes the problem.

Watershed Approach contd..

- **Financial and social benefits of watershed approach**
  - Core of watershed approach - better understanding of environmental factors.
  - Tasks such as modeling, monitoring & reporting under watershed framework - saves time and money.
  - People's participation -pillar of watershed approach - gives sense of ownership; greater public involvement & ensures sustainability of interventions planned.

Soil erosion



Watershed Deterioration

Uncontrolled, unplanned, unscientific land use

- Agricultural land:- faulty practices, erosion, shifting cultivation etc.
- Forest & grass lands:- tree felling, grazing, fire etc.
- Unscientific mining and quarrying
- Bad road alignment and construction
- Extension of industrial activities
- People apathy:- People participation

Watershed Deterioration- Consequences

- Low productivity - agriculture, grasslands, forests - reduction in biomass
- Declination of groundwater level- causing increase in cost of irrigation
- Siltation of reservoirs, lakes and channels
- Frequent floods and droughts
- Erosion and denudation
- Water quality & quantity problems
- Poverty – social problems

http://www.guardian.co.uk/world/gallery/2008/aug/28/india.india?picture=337042017

Typical Watershed Problems

- Physical problems
  - steep slope, bad lands, soil erosion…
- Resource use problems
  - shifting cultivation, fire, deforestation etc.
- End problems
  - reduced yield, flood, drought
- Socio-economic and other problems
  - poverty, migration etc.

Watershed Complications

Photos: Singh, 07. 2001

- Influence of human on watershed development

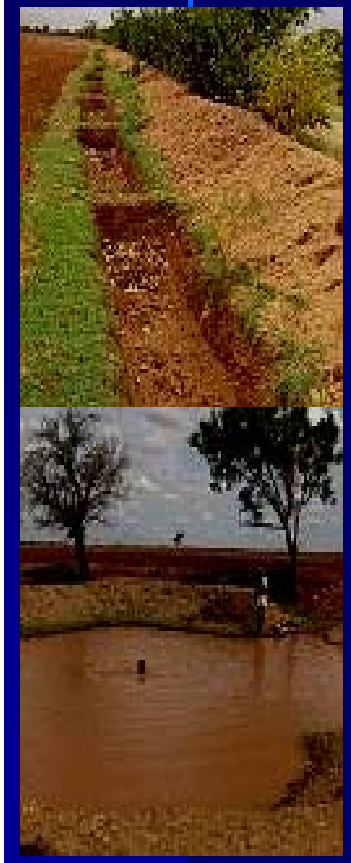
  Eg: Changing contour of land & use, pollution sources.

  Remedies: Land management, Stop pollution at source; waste management, Reduce - fertilizers.

- Water related issues: Surface & groundwater quantity & quality.

  Remedies: change in cropping pattern, agricultural water management , rainwater harvesting, stopping point and non-point sources of pollution

Necessity of Watershed Management



http://watershed.kar.nic.in/Photo Gallery

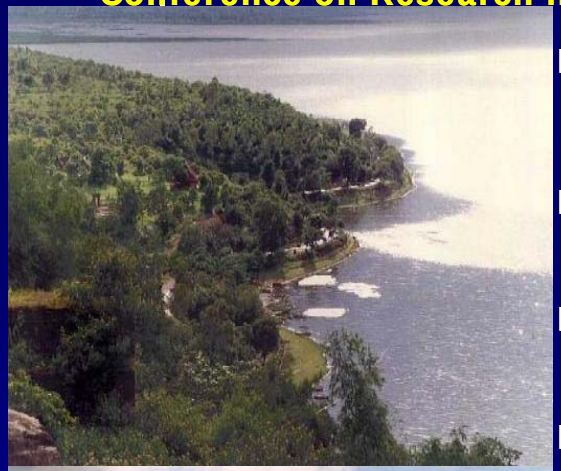
- For better water & land management
- For stability of land use in lower areas
- For arresting soil erosion, improving soil moisture, reducing floods & droughts
- For developing water, land and biomass resources with a focus on social and environmental aspects
- For judicious use of natural resources - active participation of stake holders, in harmony with the ecosystem

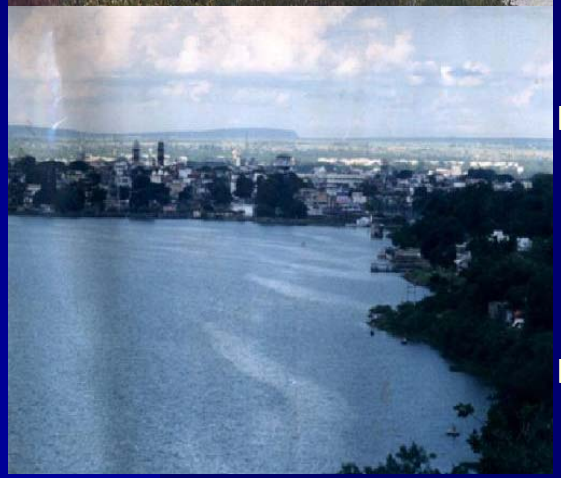
Principles of Watershed Management

- Utilizes land according to capability
- Maintain adequate vegetative cover for control of soil erosion
- Conserve maximum possible rainwater at places where it falls - Contour farming
- Drain out excess water with a safe velocity to avoid soil erosion and store it for future use
- Preventing erosion & to increase groundwater recharge
- Overall management of the available resources in a sustainable way

Case study: Upper Lake WM

(Ref: Nandi P.K. *Management of Upper Lake Watershed.* First Interagency Conference on Research in the Watersheds, October 27-30, 2003, Benson, Arizona)





- Upper Lake of Bhopal, MP, India
- Watershed Area - 361 km^2
- Water spread area – 31km^2
- Created in the 11th century AD
- By obstructing natural flow of Kolans, a rain-fed tributary of Betwa river by constructing an earthen dam
- Location:Lat.23º12' to 23º16'N & Long. 77º18' to 77º23' E

Ref: www.ramsar.org

Upper Lake Watershed –Land Use

(2003) - approximate

Built Up Area	21.0 km2
Crop Land	219.3 km2
Open Forest	5.4 km2
Land with Scrub or Without Scrub	90.4 km2
Barren Rocky/Stony	8.6 km2
Other Lakes/Ponds	16.3 km2
Total Watershed Area	361.00 km2

Some information on Upper Lake

Importance:

- Lifeline for farmers and fishermen - about 500 families
- Principal source of potable water to the city of Bhopal –more than 1.5 million people

Environmental Concerns affecting Upper lake:

- Deterioration of water quality
- Reduction of storage capacity of the lake
- Obstruction to smooth flow through the spill channel of the lake
- Growth of invasive aquatic plants

Some Problems - Upper Lake Area

Flow of Sewage and Siltation in Upper Lake from the Adjoining Colonies

Ref:
www.ramsar.org

Weed Growth in Upper Lake

Interventions -Upper Lake conservation

- Initiation - Ministry of Envi. & Forests, Gov. India & State Gov.
- Designated as Bhoj Wetland along with Lower lake- located d/s of Upper Lake

Interventions:

- 50 m wide strip of land all along the FTL of the lake was demarcated for avoiding encroachment
- Buffer Zone between lake and human settlements

FTL- Full Tank Level

Interventions

- Intensive plantation in buffer zone
  (1.7 million plants/ 10 km^2)
- Construction of 73 Check dams
  across 28 inlet channels

- Development of sewerage
  system for managing 35 MLD domestic sewage
- Solid waste management Practices
- Organic farming instead of inorganic fertilizers

Stakeholder Participation

- Well Coordinated awareness programs
- Reforestation of watershed area through participation of farmers
- Participation of political, religious leaders, district/city administration, local people, NGOs, schools / colleges
- Promotion of organic farming in the watershed through participation of farmers

Results of Implementations

- Reduced sedimentation due to construction of silt traps and plantation
- General ambience of the area improved due to buffer zone
- Ample job opportunities for the local people
- No significant deterioration of the water quality

WM Case Study– Lessons Learned

- Necessity of Integrated Watershed Approach
- Importance of conservation practices – necessity of buffer zone
- Overall environmental management
- Necessity of legal framework to control anthropogenic activities
- Necessity of long term management plans
- People's participation- success of the project.

Tutorial – Questions?.

- A) Discuss watershed concept within the perspective of holistic development of an area.
- B) Illustrate important watershed characteristics.
- C) Describe watershed deterioration and its consequences.
- D) What are the important water related problems in a watershed?.

Self Evaluation – Questions?.

- A) What is a watershed?. What is the importance of watershed based approach in water management?.
- B) Discuss watershed approach – planning, implementation & management.
- C) What are the important principles of watershed management?.
- D) Discuss watershed management as a part of sustainable development.

Assignment – Questions?.

- A) Discuss the water management in a watershed as a part of hydrologic cycle?.
- B) What are the typical watershed related problems?.
- C) Discuss the necessity of watershed management by considering various problems in an arid zone watershed?.
- D) With the help of a case study, show the importance of people participation in Watershed Management?.

Unsolved Problem!.

- In your locality, identify your watershed area. List out the sources of water for the area.
- Identify the nature of your watershed.
- List out the water problems of your area.
- Develop a plan presenting how will you apply the principles of watershed management to your area?.
- List out both short term and long term benefits from the interventions of your plan.

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