INDIAN INSTITUTE OF SCIENCE

Water Resources Systems:

Modeling Techniques and Analysis

Lecture - 1

Course Instructor : Prof. P. P. MUJUMDAR

Department of Civil Engg., IISc.

Course Contents

- Introduction
- Concepts of systems and systems analysis
- Optimization with methods using calculus
- Linear programming
- Dynamic programming
- Simulation
- Combination of simulation and optimization
- Multi-objective planning
- Reservoir sizing & operation
- Simulation and optimization of hydropower systems

Course Contents (contd.)

- Introduction to stochastic optimization
  - Review of probability theory
- Chance constrained linear programming
  - Reliability programming
- Stochastic dynamic programming
- Steady state and real-time reservoir operating policies
- Case studies
- Recent modeling tools
  - ANN
  - Fuzzy inference systems
  - Genetic algorithms

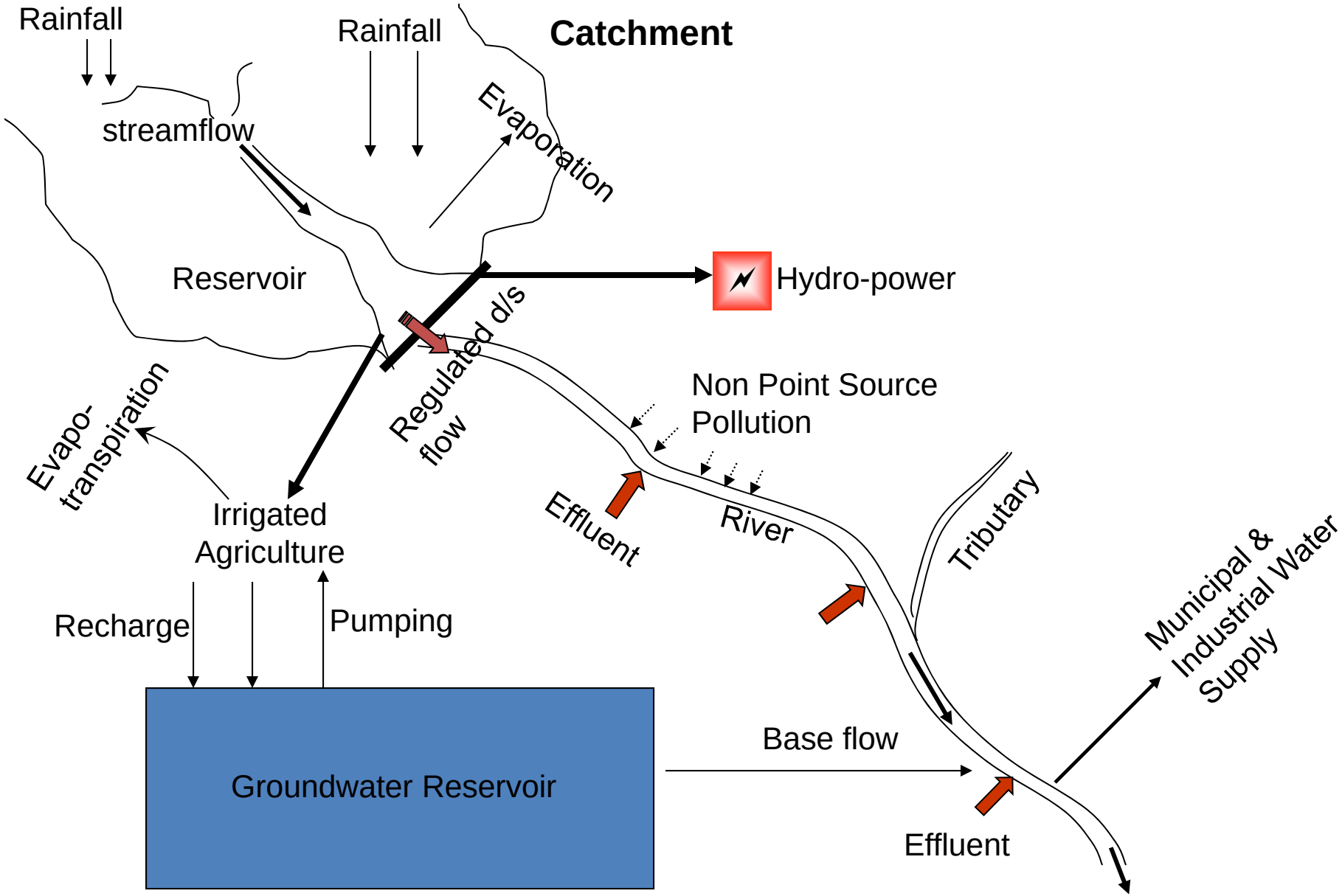
Reference books

- Loucks, D.P. and Eelco van Beek (2005). Water resources systems planning and management: An introduction to methods, models and applications., UNESCO.
- Vedula, S. and Mujumdar, P.P. (2005). Water resources systems: Modeling techniques and analysis., Tata McGraw Hill, New Delhi.
- Mays, L.W. and Tung, Y.K. (1992). Hydrosystems engineering and management., McGraw Hill, USA.
- Simonovic, S.P. (2009). Managing water resources: Methods and tools for a systems approach, UNESCO publishing, France.

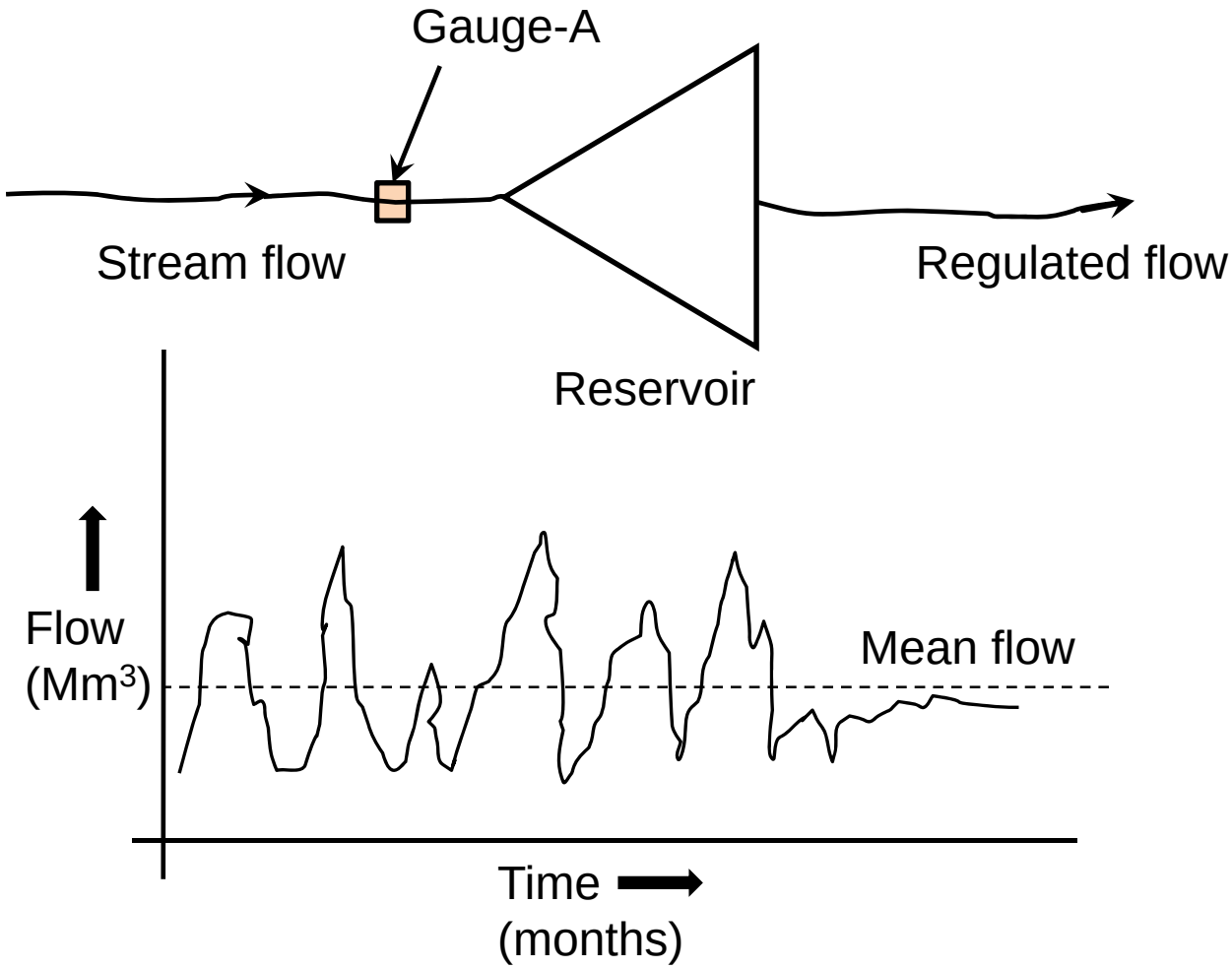
Reference books (Contd)

- Jain, S.K. and Singh V. P. (2003) Water Resources Systems Planning and Management, Elsevier.
- Chaturvedi M C (1987) Water Resources Systems Planning and Management, Tata McGraw Hill, New Delhi.
- Bhave, P. R., (2011) Water Resources Systems, Narosa Publishing House, New Delhi.
- Hiller, F.S. and Lieberman, G.J. (2005) Introduction to Operations Research, The McGraw Hill Companies, Inc., New York.

Introduction



A Typical Water Resource System



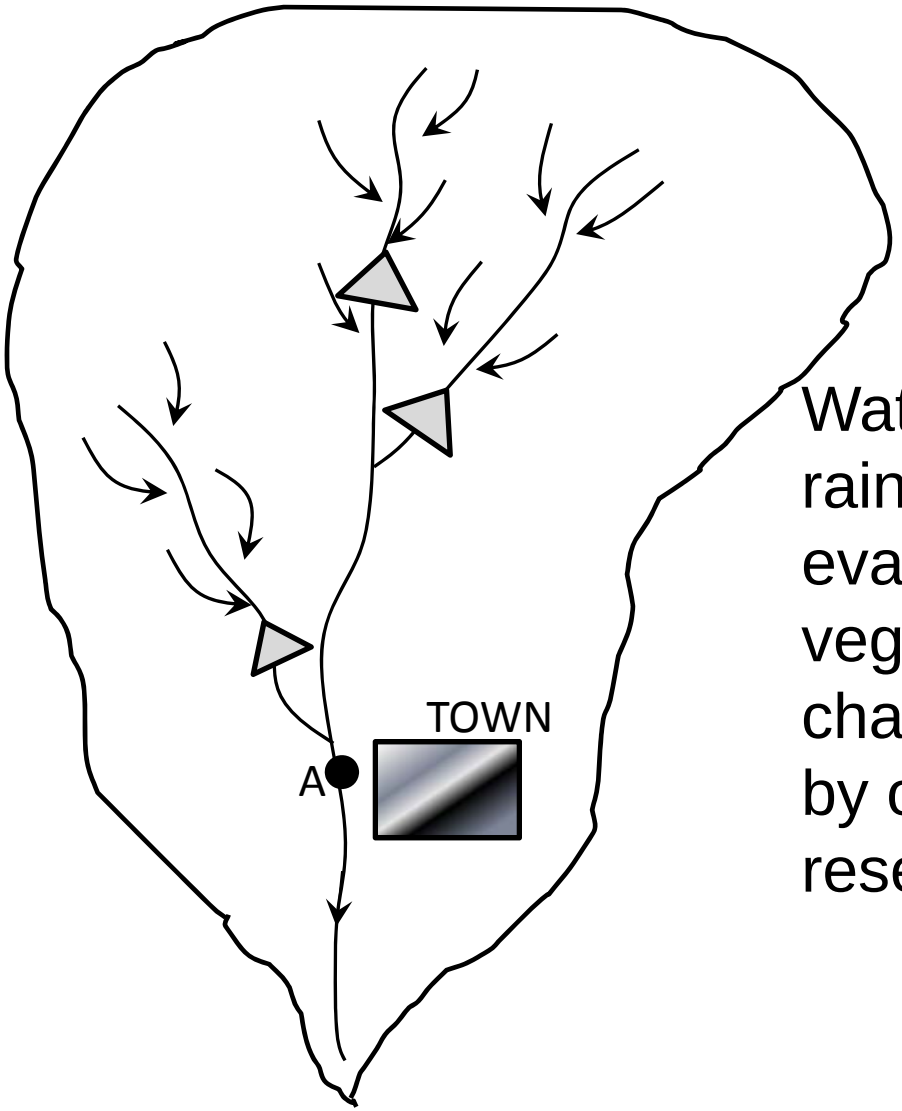
Observed (historical) flows at Gauge - A

History provides a valuable clue to the future

Reservoir Design and Operation

- What is the optimum size of the reservoir to meet a given demand
- How best can we operate the reservoir in the face of uncertainty of inflows

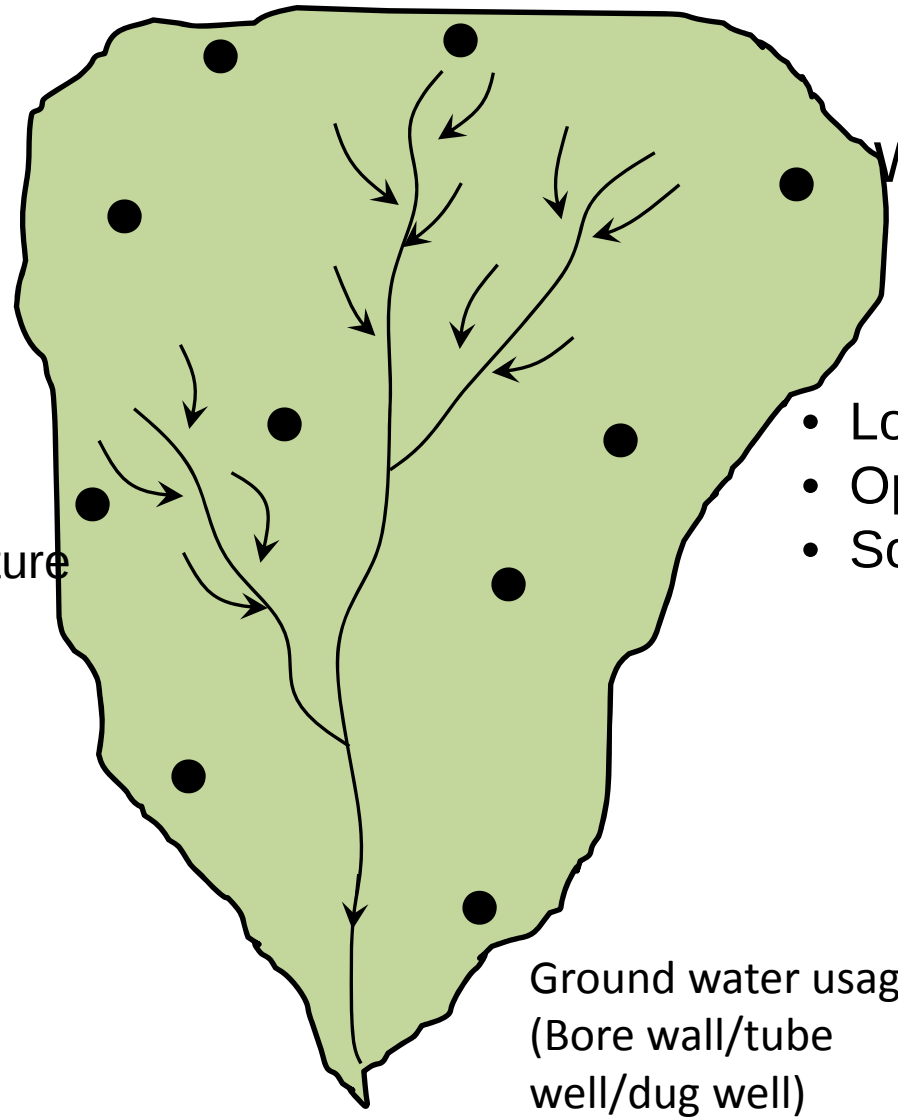
Introduction



Real-time Operation for Flood Control

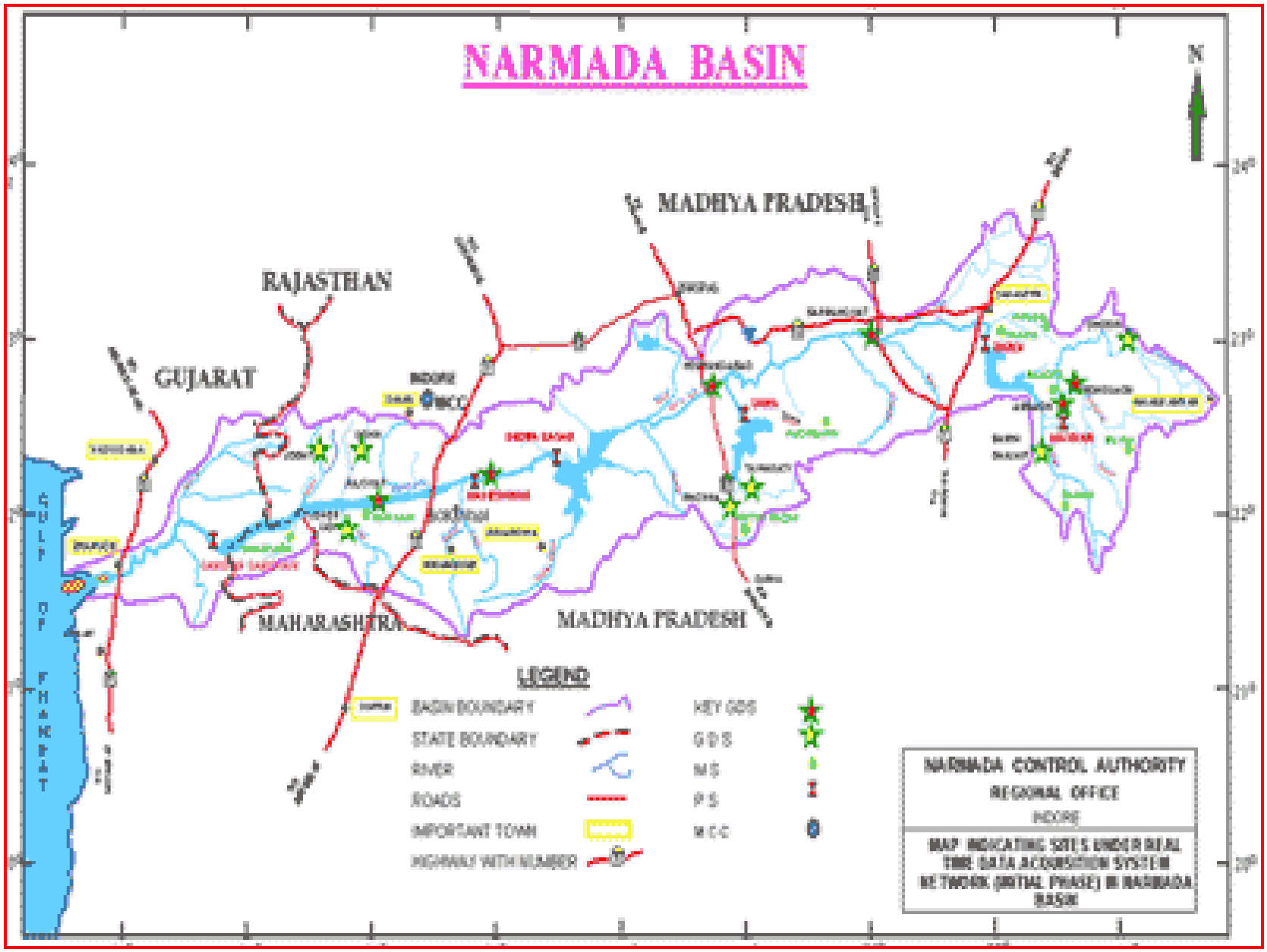
Water level at A: Function of rainfall in the catchment upstream, evaporation, infiltration, storage, vegetation and other catchment characteristics.; Can be controlled by operation of upstream reservoirs

Introduction



Optimal ground water development

- Location of wells
- Optimal pumping rates
- Solutions depend on
  - Agricultural demand
  - Aquifer characteristics
  - Energy costs
  - Socio-economic objectives

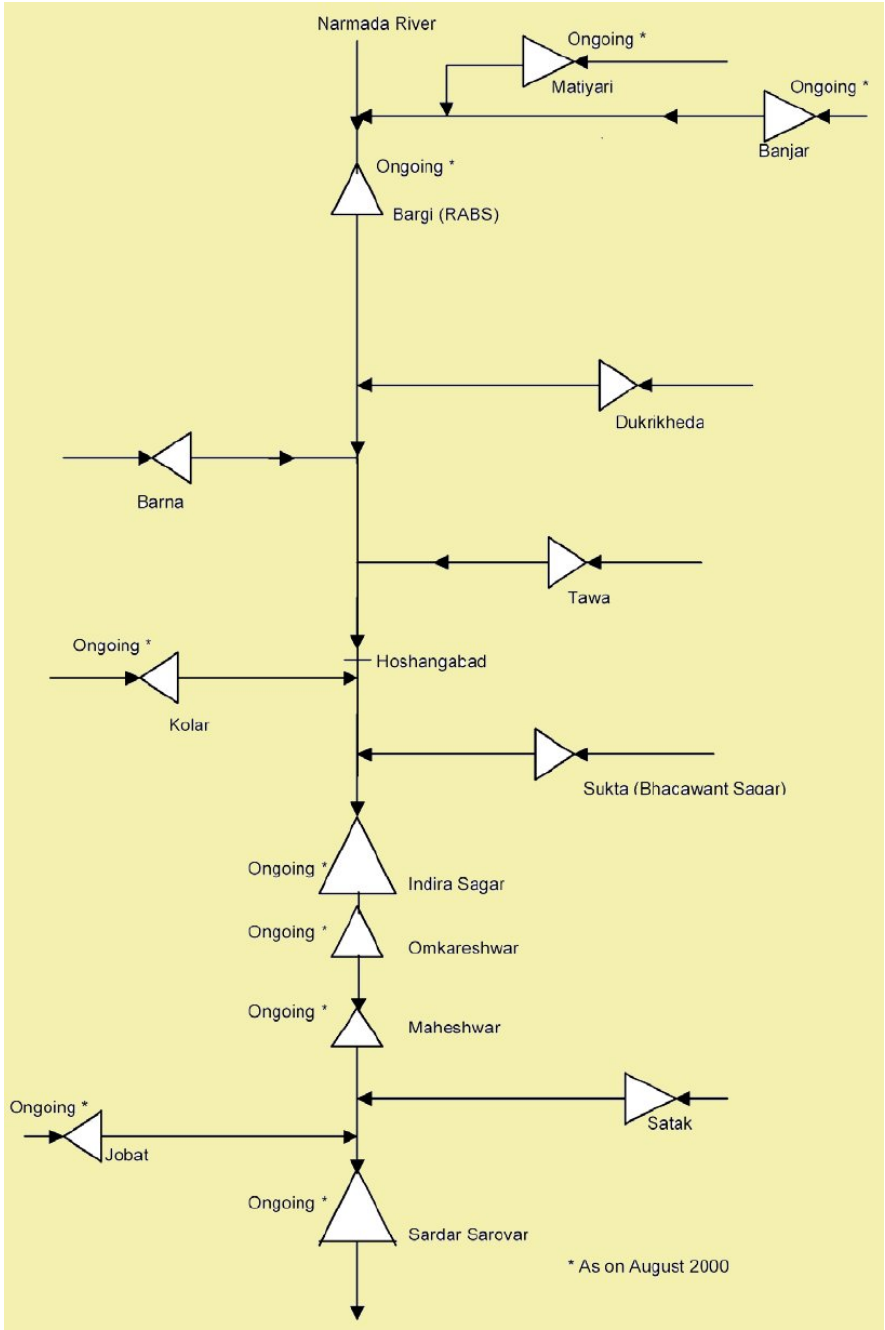


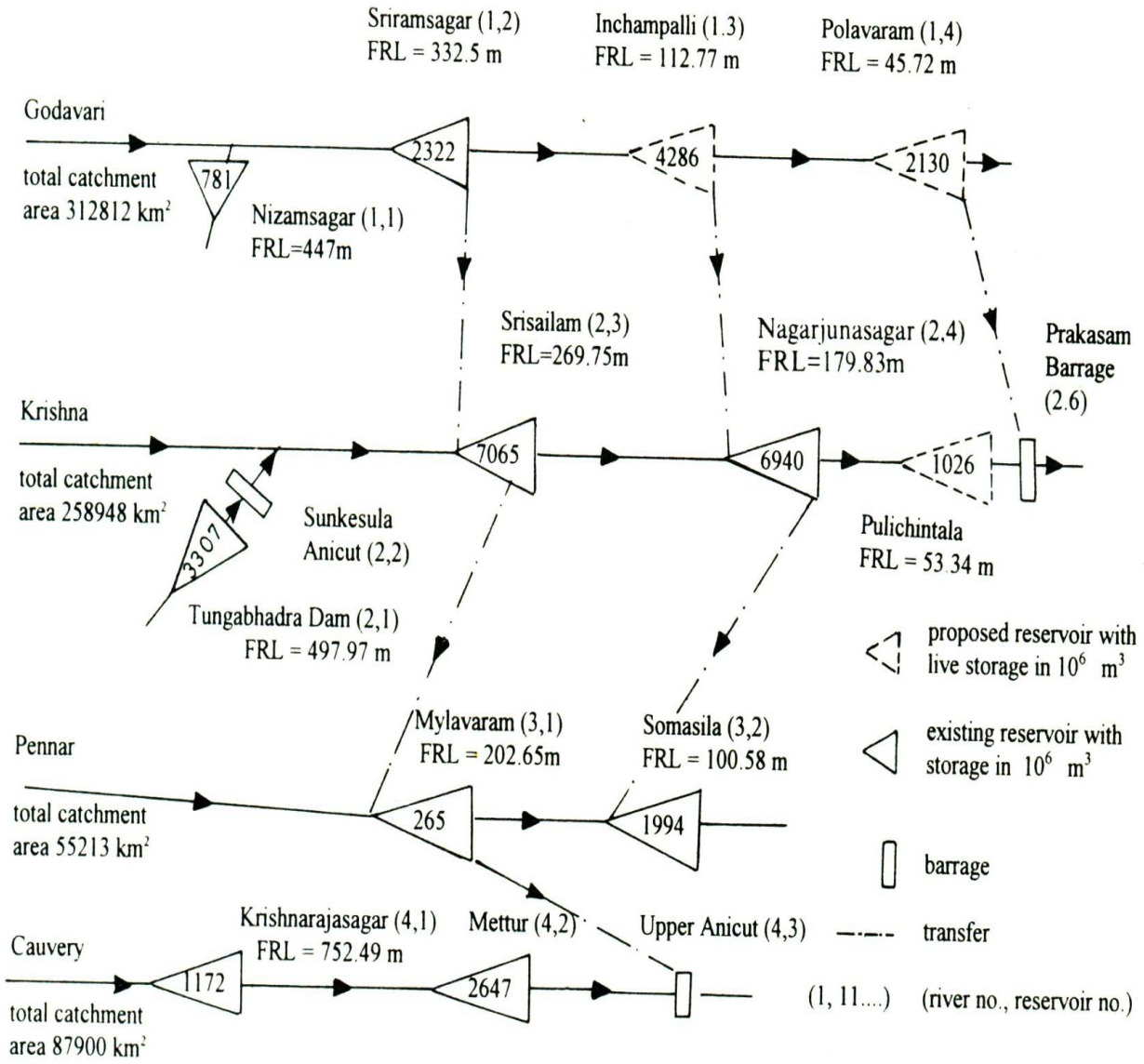
Source: Narmada Control Authority

Introduction

Multi-reservoir systems

- Flood control
- Meeting irrigation and M&I demands
- Hydropower generation
- Minimum environmental flows
- Conflicting objectives of stakeholders
- Long-term operation of the system

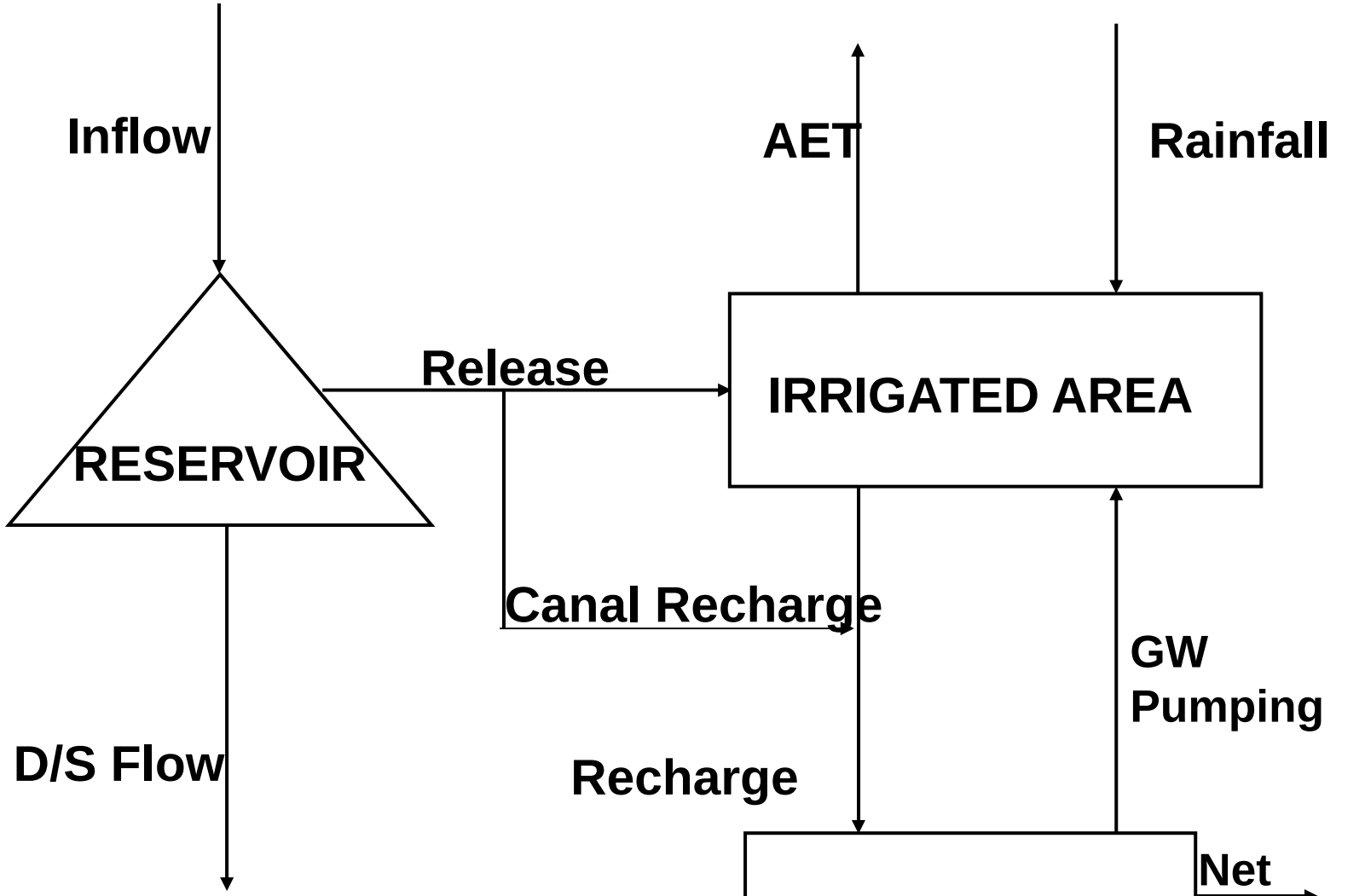




- Extent of water transfer possible in the proposed links
- Reliability of the transfers
- Intra-year operation of the reservoirs
- Maximization of irrigation potential
- Priorities of water allocations
- Environmental-ecological objectives

Interlinking of Rivers - Peninsular River System

Introduction



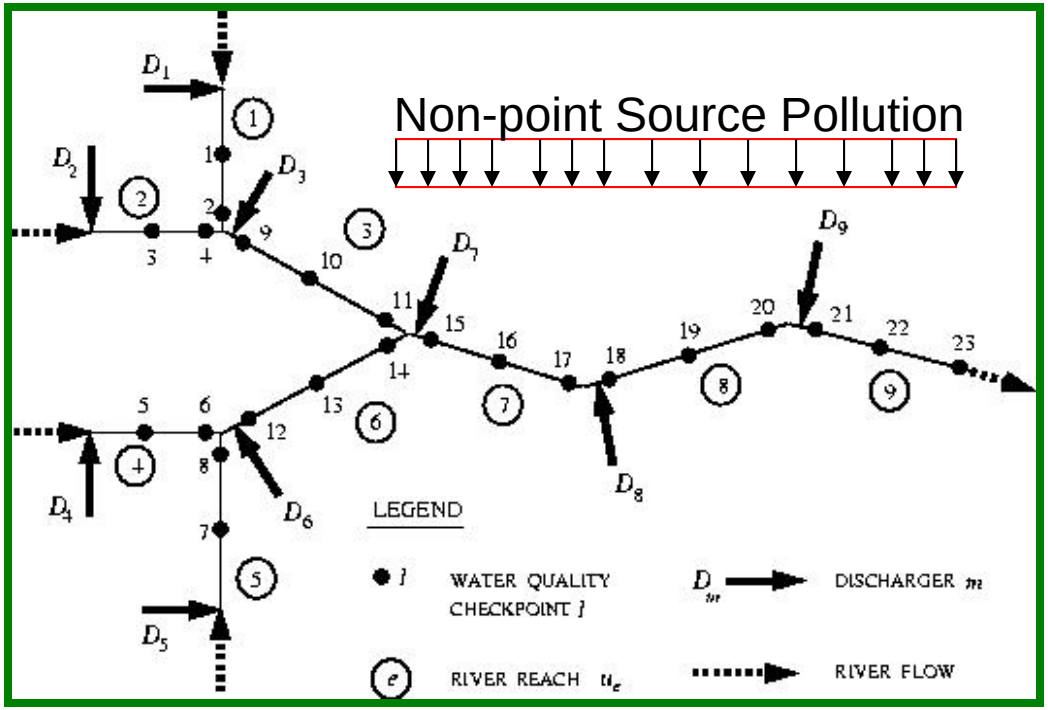
Conjunctive use of surface and ground water

Introduction

Water Quality in Streams

Governed by :

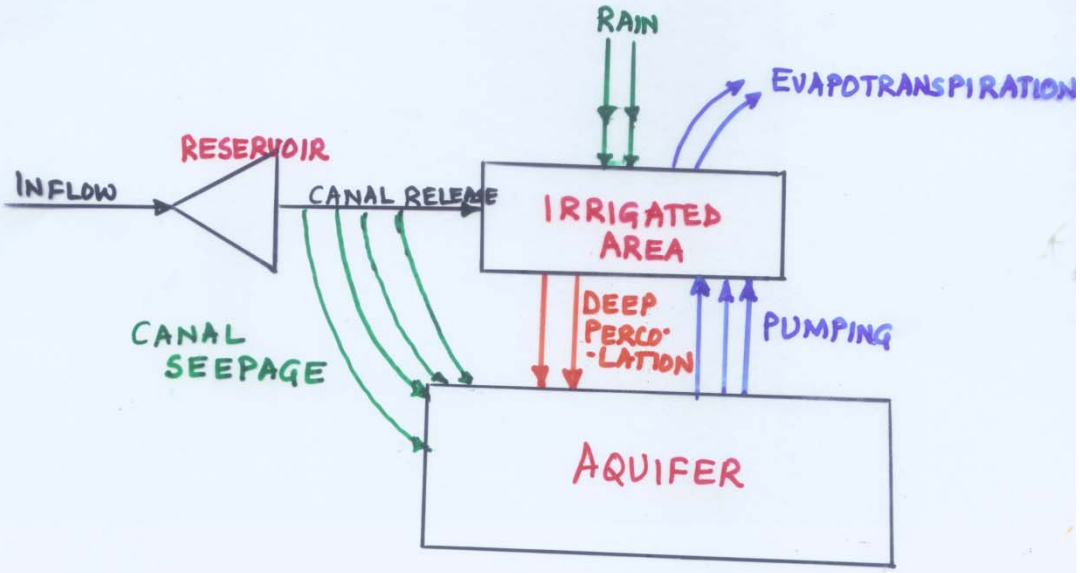
Streamflow, Temperature, Hydraulic properties, Effluent discharges, Non-point source pollution, Reaction rates …..



Optimal treatment levels to maintain water quality at various locations

Typical Problems In Water Resources Systems

- Conjunctive Use of Surface & Ground Water Resources.



- How Much To Pump From Aquifer
- How Much To Release From Reservoir
  - Aquifer Drawdown
  - Waterlogging
  - Irrigation Demands