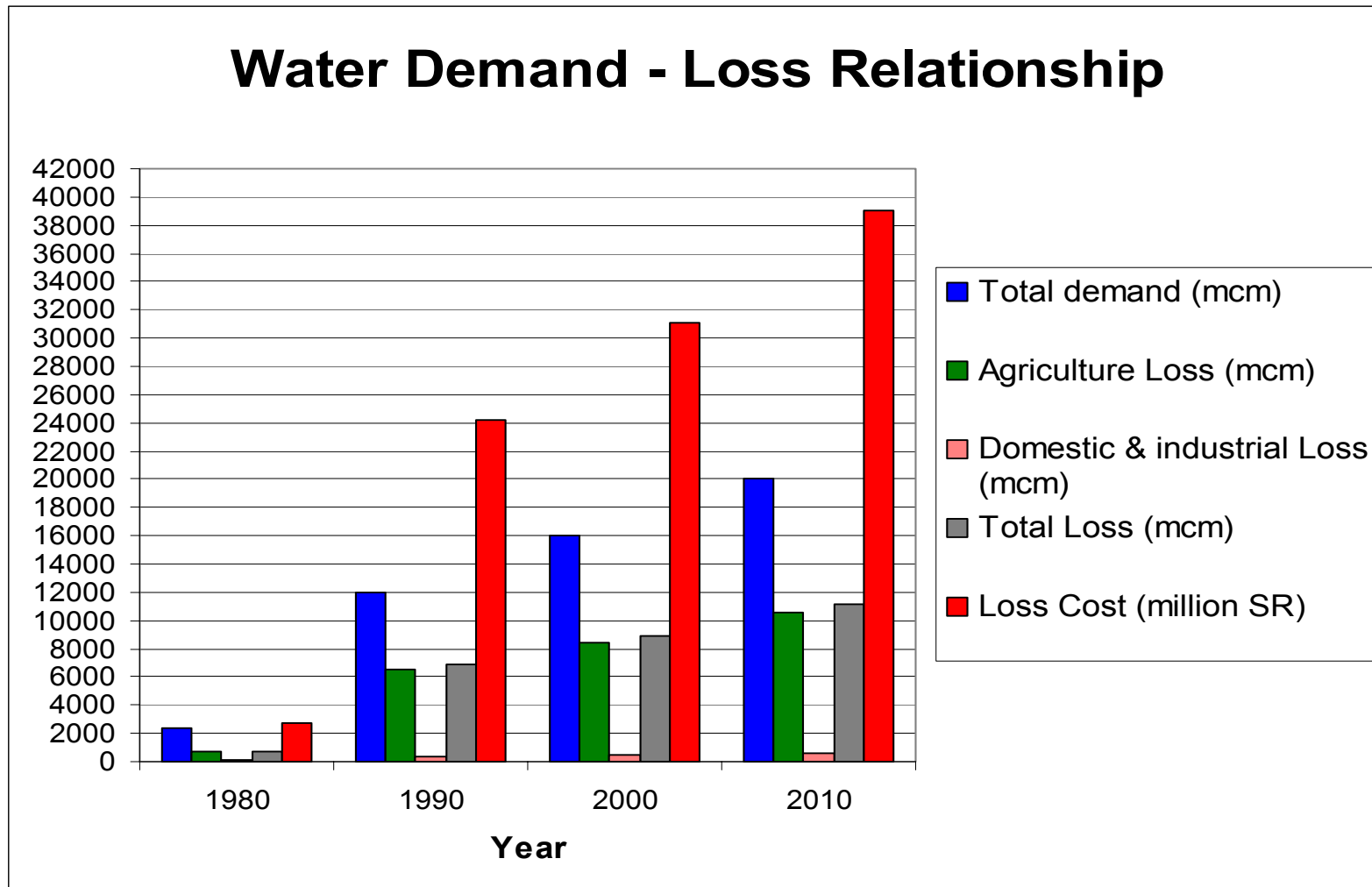




# **Planning & Development of Groundwater Resources**

ENVS 524 - Module 4, Planning &  
Development of Groundwater  
Resources

# Is planning & management needed?



Cost calculation is based on a SR 3.5/cubic meter, 62% loss of agricultural demand, and 20% loss due to water distribution system leakage.  
ENVS 524 - Module 4, Planning &  
Development of Groundwater  
Resources

# Planning

- Defined as the orderly consideration of a project from the original statement of purpose through the evaluation of alternatives to the final decision on a course of action.
  - Includes all the work associated with the project
  - Each project is unique by itself!
  - A planning method should be supported by quantitative analysis
  - Consider assumptions regarding future in your plans and update plans periodically
  - Consider technological, economic, social, political, and environmental aspects when planning a project

## Sequence of Planning Activities



# Identification of the Problem

- Lowering water level
- Land subsidence
- Sea water intrusion
- Water quality degradation & pollution
  - Chemical
  - Bacteriological
  - Hydrocarbons
  - Change of salt balance due to overpumping
- Percolation of waste water
  - Landfills
  - Waste ponds

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# Formulate Alternative Planning Objectives

## ■ Develop a water resources for:

- Serving the public (e.g. domestic, agricultural, industrial uses)
- Facing emergency (e.g. shortage of water supply)
- Protecting the environment & remediation of the aquifer

## ■ Consider:

- Basin vs. regional flow systems
- Social impacts (e.g. water prices ... etc.)
- Economic, legal, and political constraints
- Financial costs of the project
- Aquifer management as a part of a water supply or disposal system

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# Define Elements of Planning

- Pumping locations
- Pumping schedule
- Artificial recharge locations and schedule
- Boundary conditions of the groundwater system
  - Structures (bridges, dams, airports ... etc.)
  - Mountains
  - Valleys
- Monitoring system
  - Manual
  - Telemetry
- Organizational and financial aspects

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# Obtain Official Authorization

- Resolve problems before starting to plan (e.g. owned lands)
- Note policy & governmental decisions (e.g. reserving location for another purpose like airport area)
- Identify sites for water storage and distribution
- Know the impacts of legal and environmental constraints (consult with environmental authorities)
- Be ready with different alternatives to receive **authorization and budget!!** That's the role of planners!!

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# Develop Goals for Investigation

- Prepare a report that discusses alternative plans
- **Recommend a plan**
- Discuss justifications for selecting a plan and answer the questions:
  - Why?
  - How much? (Budgets and its limits!)
  - When?
  - How long?

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# Select Scope for Investigation

- **Determine study area**
- **Prepare a plan schedule**
- **Identify the level of the project. Is it a:**
  - **Preliminary examination**
    - Experience & knowledge about a specific area
      - Eliminate actions that are infeasible (e.g. looking for groundwater in impermeable parts of the field)
      - Identify actions that deserve further study (e.g. searching for groundwater in an alluvium deposits)
    - Does it satisfy the needs of the project?
    - Any other alternative areas?
  - **Reconnaissance investigation**
    - Use of old available data (maps, ariel photographs, data banks ... etc.)
    - Consideration of alternative plans to meet the needs
    - Estimates of benefits & costs
  - **Feasibility study**
    - Reduce planning and implementation costs
    - Provide accurate cost estimates

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# Develop Work Program for Investigation

- Identify what must be accomplished to achieve the planning goals
  - A new well field
  - An environmental solution (e.g. remediation of an aquifer)
- Prepare a work schedule that includes:
  - Tasks
  - Subtasks
  - Duration
- Collect the available old data
- Start a new data collection campaign

# Form a Working Team

- Engineers
- Hydrogeologists
- Geologists
- Geophysicists
- Economists
- Legal advisors and others

## Elements of Feasibility Study

Projecting future water demands

Exploration

Assessment of water resources

**Capability of extraction & recharge facilities**

Aquifer boundary conditions

Legal & organizational considerations

Alternative plans

Report on investigations

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# Projecting Future Water Demands

- Projection of planning (forecast future conditions)
  - For how long will the project serve the community?
  - What are the expected (true not fictitious) water demands?
  - What are the risks (economic, environmental, ... etc.)?
  - What are the alternatives?
  - Water price function.
- Consider uses:
  - Domestic
  - Industrial
  - Agricultural

# Surface & Subsurface Exploration

- Geological & hydrogeological investigations
  - Topography & geology of the area
  - Types of rocks & deposits
  - Other investigations
- Geophysical investigations
  - Seismic methods
  - Gravity methods
  - GPR ... etc.
- Test wells

# Assessment of Water Resources

- Aquifer properties (porosity, hydraulic conductivity ... etc.)
- Aquifer type
- Aquifer extent
- Aquifer yield and storage
- Water budget
- Alternatives (e.g. desalination, importation ... etc.)



# Aquifer Boundary Conditions

- Impermeable rocks
- Quantity of inflow and outflow
- Quality of inflow and outflow

# Legal and Organizational Considerations

- Water rights
- Rights to use storage
  - Pumping
  - Recharging
- Damages of groundwater aquifer
  - Lowering water level
  - Aquifer degradation
- Following official regulations
  - Ministry of Water and Electricity
  - Presidency of Meteorology and Environment
- Costs optimization

# Alternative Plans

## ■ Physical Alternatives

- Change pumping and recharge schedules
- Control groundwater levels
- Control water quality degradation
- Control saline water intrusion
- Control land subsidence

## ■ Economic Alternatives

- Costs & benefits
- Economic feasibility

# Report on Investigations

## ■ Present:

- Study results
- Alternative plans

## ■ Recommend:

- Most economical alternative
- Best physical implementation plan