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Integrated Watershed Management

“ problem definition and scoping”

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The Process of Problem Defining

1. The vision of what the watershed should be like in terms of:
   - The beneficial water users
   - The quality and quantity required for them
2. Evaluate the disparity between the existing and the ideal conditions
   - Conditions are less than ideal? What you should do? What restorative actions should begun
   - users and public authorities

1. Identify categories of water uses
2. Determine the desired water users
3. Develop targets for each water use, short-and long term

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1. Identifying Current Water Uses

Water uses categories

- Potable drinking
- Industrial water supply
- Agriculture
- Flood control
- Thermal and hydroelectric power generation
- Navigation
- Water-based recreation
- Fish and wildlife habitat
- Water quality management
- Others?
- Combinations of two or more of the above list
- ……?

Table 3.1 Water Use Categories Employed by the National Rivers Authority in Catchment Planning

Water Use Categories	Typical Uses
Potable (Drinking) Water Supply	Municipal water supply (surface or groundwater sources)
	Residential water supply (private wells)
Industrial Water Supply	Process water supply
	Cooling waters
Agriculture	Irrigation waters
	Livestock watering
	Milkhouse wash water
	Livestock housing wash water
Flood Control	Impoundment of high flows for delayed release
	Construction of dams, reservoirs, levees, and channel protection
Thermal Electric Power Generation	Cooling waters
	Settling pond waters
	Water for pipe flushing and maintenance
Hydroelectric Power Generation	Impoundment of water for power generation
	Construction of dams and reservoirs
	Pumping and drawdown of water levels
Navigation	Recreational boating (e.g., sailing, canoeing, motor boat traffic)
	Commercial shipping
	Commercial navigation for tourism purposes (e.g., sightseeing)
Water-based Recreation	Recreational fishing
	Recreational boating and windsurfing
	Swimming
	Hiking
	Picnicking
	Nature enjoyment activities (e.g., bird-watching)
	Aesthetic enjoyment
Fish and Wildlife Habitat	Aquatic and riparian habitats
	Protection of community structure
	Protection of rare and endangered species
Water Quality Management	Protection of minimum flows for water quality preservation
	Low-flow augmentation from reservoirs
	Assimilation of waste discharges from municipalities and industries
	Assimilation of storm- and combined-sewer discharges

(*Source:* NRA 1933a)

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1.1 estimating population size

- preliminary list of water users
  - Population size and growth
  - The population current and future demand for those uses
    - Water, electricity, manufacturing, agriculture, recreation, sewer systems, dams, etc..
  - Long term population forecasting

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1.2 estimating water demand

- *Water demand is expressed in two categories:*
  - Water withdrawals:
    - The volume of water removed from the natural system for human use and activities
  - Water consumption:
    - The volume of water removed and consumed and thus unavailable for return to the natural system
- *Water demand varies widely, depending on:*
  - *Geographic location*
  - *Activities*
  - *Climate (warm dry countries): uses according to climate?*
- *Water demand influenced by:*
  - Population size and density
  - Annual per capita income
  - Quality of supply and
  - Annual Rainfall

Most resources planning are based on assumptions of increasing per capita demand i.e. as growth increases in a watershed area; total water demand is expected to increase

- Water consumption varies widely in:
  - Industrial, commercial, and institutional settings see table:

Table 3.4 Typical Industrial Wastewater Discharge Rates for the United States and Canada

Brewery wastes	900–1,440 L/bbl
Apple canning wastes	110–174/case
Baked beans processing wastes	151 L/case
Fresh green beans processing wastes	540–800 L/case
Fresh lima beans processing wastes	216–1,110 L/case
Dried lima beans processing wastes	76–125 L/case
Milk processing wastes	900–4,180 L/100 kg
Cheese processing wastes	10,780–19,300 L/100 kg
Poultry processing wastes (conventional technology)	17,600 L/1,000 kg live weight
Poultry processing wastes (advanced technology)	9,200 L/1,000 kg live weight
Petroleum refining wastes	76–227 L/bbl
Pulp and paper (bleached kraft) processing wastes	120–220 cu m/tonne
Steel processing wastes	57 m^3/tonne
Textiles—wool processing wastes	516 m^3/tonne of finished cloth
Textiles—rayon processing wastes	25–58 m^3/tonne of finished cloth

(*Source*: Eckenfelder 1970; Metcalf and Eddy 1991)

- Estimation current water demand:

$$consumption = \frac{Average\ (Llday)}{(No\ \text{of households}) \times (no\ \text{of people / houshold})}$$

Increase in water demand VS available resources

  - Water supply crisis in watersheds reorients the publics and the institutions attentions on water demands
  - Possible mechanisms for water demand reduction

- Managers address the problem of water demand forecasting by including these assumptions:
  - Estimation of the population growth over the planning period
  - Estimation of the precipitation entering the area
  - Estimation of the volume of surface and groundwater available for future extraction
  - Nature of water using industries, commercial establishments and institutions in the watershed
  - Attitudes towards water use VS conservation

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2. Identifying current water users

Understanding water users, their attitudes, needs, activities and priorities for successful management. The entities are:

- Government agencies
  - who have roles on water supply, sanitation,
  - natural resources agencies,
- Industrial water users
- Commercials shipping and fishing interests
- Residential water users
- Public interest groups
  - NGOs, green groups, etc…
- Agricultural sector

3. Setting targets for future use

The purpose is to indicate areas of water uses that are impaired and require restoration, and set targets for current and future uses. Major water use targets are:

- Water quantity:
  - Reliable annual flow VS withdrawals
  - Withdrawals consumed VS returned to the system for reuse
  - Change of supply-demand ratio in response to population growth
- Water quality:
  - Standards and guidelines
- Fisheries
- Ecology and conservation:
  - Rare or endangered species
  - Valued historical or archeological remains
  - Areas of great natural beauty
  - Sensitive habitats
  - Park lands
  - Nature reserves
  - Scientific research stations
- Navigation
- Hydroelectric power generation
- Recreation
- Agriculture

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4. scoping

Scoping: to determine which uses and watersheds require management intervention and which do not. Successful scoping means:

- A clear definition of each problem to be solved. The following questions may be helpful in defining the problem (use impairments):
  1. What are the use impairments observed in the watershed or anticipated (prepare a list)
  2. Which use impairments are most important to the community (2-5 use impairments)
  3. What is the geographic extent of the use impairments
  4. Why each use is considered to be impaired
  5. What use parameters do communities use as criteria in deciding that the use is no longer viable
  6. Which use parameters can be measured easily
  7. What standards or objectives for the use are not currently met
  8. What specific numerical targets do you wish to meet,
  9. During what time period and area do you want these targets to apply
- Clear and specific problem definition in the community debate
- Community consensus on the relative importance of the various problems identified in the watershed

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The targets in section 3 sets the goals towards which the plan is directed, example:

- Problem: less water quantity, low water quality
- Goal: increase quantity , reduce pollution

Example of possible management action
Target : Water quality indicator

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Table 3.9 Management Actions and Water Quality Indicators for the Latrobe Catchment AEAM Study (adapted from Grayson et al. 1994)

Management Action	Water Variable Affected
1. *Management of point source pollution*, including review of existing discharges, treatment of urban wastewater, land disposal of wastes, ocean disposal of wastes, promotion of "best management practices" in industry, improved domestic sewage systems, and introduction of a "polluter pays" system or transferable discharge entitlements	Water quality variables of point source inputs and receiving waters
2. *Management of diffuse source pollution*, including land use controls, adoptions of sustainable agricultural practices, control of extractive industries, forestry controls, erosion controls for construction sites and roads, retention ponds for urban, industrial, and rural runoff, vegetation conservation and revegetation, regulation of dairy waste disposal, encouragement of recycling reuse of water, establishment of buffer zones (revegetation of riparian zones and stream banks, controlling grazing, controlling access), and policy on leases of streamside reserves	Water quality variables of surface runoff and in-stream habitat variables
3. *Management of river flows*, including storage operations (flow regimes, environmental allocations, rates of release, hydropower operation), diversions (within catchment and between catchments), controls on farm dams, water recycling, regulation of wastewater discharges, introduction of new pricing policies, groundwater use, desnagging, and meander reinstatement	Streamflow variables and in-stream habitat variables
4. *Management of the in-stream environment*, including streambed and bank stabilization, willow control, and establishment of macrophytes	River water quality and in-stream habitat variables