Steps in Water and Sanitation Planning

- Problem Identification
- Organize Community Participation & Support
- Set Objectives
- Collect Data
- Formulate Alternatives
- Choose Best Method
- Develop Detailed Plan
- Build the System
- Operate and Maintain
- Monitor and Evaluate
Problem Identification

• Current water source is unacceptable, if:
  – **Water Quality** is bad;
  – **Water Quantity** is insufficient;
  – **Inaccessible Water Source**
  – **Unreliable Water Source**

• Water Quality is measured by laboratory or field testing, but oftentimes, this is difficult, so…

• Surveys…
Types of Surveys

- “Sanitary” Surveys (water/sanitation/hygiene)
- Infrastructure Survey
- Epidemiological Surveys
  - Prospective and Retrospective Cohort Surveys
  - Cross-Sectional Surveys (snapshot in time);
  - Longitudinal ecologic surveys (on-going surveillance over many years)
- Willingness-to-Pay Surveys (aka “Contingent Valuation”)
- Focus Groups
- Example: Batey1, Dominican Republic
Batey – Dominican Republic
Batey, DR
Batey 1 Water Tower

Aquaduct
Community Participation and Support

• A successful program must include a plan for community support
• 3 ways to gain community support:
  – Promotion
  – Community involvement (community appraisal, user groups, mapping)
  – Training in O&M

Can you think of other ways?
Data Collection

- Population statistics
- Rainfall
- Environmental data
- Mapping
  - Community Mapping / Community Appraisal
  - GIS Mapping
- Community’s development history
- Community resources
- Culture and customs

GIS & Data Mapping – Diarrhea in Northern Region Ghana

Villages and Water Sources Within the Pure Home Water Operating Area

(Map: Jenny VanCalcor, 2006)
Types of Water Sources Used by Households

- Pipe Inside the Home
- Pipe Outside the Home
- Tanker
- Well
- Borehole
- Spring or Rain Water
- Stream
- Dugout
- Other

Locations:
- Savelugu-Nanton
- Tolon-Kumbungu
- Tamale

Image credits: Statistical Service Ghana, 2006
1 million out of 1.8 million people in the Northern Region are currently using an unimproved source.
Types of Sanitation Facilities Used by Households

Latrine is the process of being built

Data: Ghana Statistical Service, 2003
Map: J. VanColaar, 2006
Ghana Guinea Worm Eradication Program
Villages Reporting Endemic and Imported Cases in 2005

Legend:
- Endemic Village
- Imported Cases
- Villages
- Districts

Figure by MIT OpenCourseWare.
Set Alternatives

OR

OR

OR

OR...?
Choose the Best Alternative

• Question: What are some considerations (decision criteria) you might use to choose the best alternative?
Choose the Best Alternative

- Water supply characteristics (will it meet demand now? In 10 years?)
- Social acceptability – community’s needs
- Health factors
- Economic factors- willingness to pay
- Institutional context
- Accessibility
- Other… What do you think…?
Develop the Plan

• Question: What should be in the plan?
What’s in the Plan?

- Proposed System
- Costs
- Sources of Finance
- Implementation Schedule
- Plan for Construction and Sources of Materials
- Energy Requirements
- Environmental Impacts
- Social Impacts
- Operation and Maintenance Requirements
- Other?
Monitor and Evaluate the System

- User Acceptance
- Water Quality
- Water Quantity
- Accessibility
- Reliability
- Proper Operation and Maintenance
- Financial sustainability
- Sustainable Yield
- Systems Thinking: Relationship to:
  - Sanitation
  - Hygiene interventions
  - Other?
Some Factors Affecting Planning

- Geographic Location, Environment & Climate
- Urban vs. Rural – Population Growth and Density
- Settlement Patterns
- Domestic Water Use, Agriculture Water Use
- Culture
Geographic Location, Environment and Climate
Tropical Climates Hinder:

• Agricultural development
  – Year-long insect problems
  – Locusts are endemic in many regions
  – Tsetses flies prevent use of animals for plowing

• Mineral resource development
  – Deep, highly weathered soils
  – Extraction is expensive, special equipment

• Human productivity
  – Disease and malnutrition
  – High temperature and humidity
Tropical Land Degradation

• Commodity crops
• Change from shifting cultivation
• Progressive problems
  • Poor agricultural practices reduce nutrients and organic matter
  • Vegetation and organic material are removed for fuel and fodder
  • Lack of vegetative cover causes erosion
  • Irrigation increases salinity content of soils
  • People abandon degraded land and move to other areas
Environmental Factors - Rainfall

- Not uniformly distributed throughout the year
- Distinct wet and dry seasons
- Excessive precipitation and storms during the wet season often destroy crops
- Droughts common
Annual Rainfall Distribution

Average Monthly Precipitation
Washington, DC

Total Average Annual Precipitation = 1036 mm

Map removed due to copyright restrictions.
Annual Rainfall Distribution

Average Monthly Precipitation
Coban, Guatemala

Map removed due to copyright restrictions.

Total Average Annual Precipitation = 2517 mm
Annual Rainfall Distribution

Total Average Annual Precipitation = 2858 mm

Map removed due to copyright restrictions.
Annual Rainfall Distribution

Total Average Annual Precipitation = 578 mm

Map removed due to copyright restrictions.
Environmental Factors - Heat

• No freezing temperatures in the tropics
  – Plant and animal pests and diseases reproduce throughout the year
  – Intense ecological competition
  – Quick turnover of soil organic matter
• UV radiation destroys plastics, rubber, and synthetics
• Heat and humidity cause corrosion of machinery
Environmental Factors - Soils

- Tropical soils are highly weathered
  - Low organic matter
  - Low nutrient contents
- Laterites (high iron clays)
  - Harden when exposed to sun and air
  - Used to build roads
- Alluvial and volcanic soils are the exception – rich and fertile
Community and Cultural Factors
Communities in Northern Region Ghana

Traditional

Non-Traditional

(Photos: Rachel Peletz, 2006)
Patterns of Domestic Water Use

- Volume of water used depends on income
- Only the wealthy have large amounts of safe water
- In rural areas, water is often carried from a source outside the home
  - Performed by women and children
  - Requires time and energy
  - Opportunity cost for agriculture and other productive activities
- People may use different sources for different uses
Patterns of Domestic Water Use

• Domestic water uses
  – Bathing
  – Cooking
  – Dishwashing
  – Drinking

• Other water uses
  – Clothes washing (often done at water source)
  – Gardening
  – Livestock
Patterns of Domestic Water Use

![Bar graph showing range of daily consumption by different types of water sources]

- **Multiple Tap**: Highest range of daily consumption (up to 300 lpcd)
- **Single Tap**: Lower range compared to multiple taps
- **Standpipe**: Lower than single tap, but higher than rural
- **Rural**: Lowest range of daily consumption
# Patterns of Domestic Water Use

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Consumption (lpcd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural springs, streams, etc.</td>
<td>2-25</td>
</tr>
<tr>
<td>Standpipes in cities/villages</td>
<td>10-50</td>
</tr>
<tr>
<td>Single tap in the home</td>
<td>15-90</td>
</tr>
<tr>
<td>Multiple taps in the home</td>
<td>30-300</td>
</tr>
<tr>
<td>United States</td>
<td>375-600</td>
</tr>
</tbody>
</table>
Patterns of Domestic Water Use

- Factors influencing water use and consumption
  - Cost – money, time, and energy
    - How much women and children can carry
    - Distance to source
    - Time spent in line
    - Effort to pump or haul water from well
  - Woman’s perception of quality – based on aesthetics
  - Family size and family power structure
    - The larger the family, the lower the amount available per person
    - How much water the husband uses for bathing
  - Social norms
    - Is clothes washing usually done at source?
    - Socializing
Patterns of Domestic Water Use

• Factors influencing water use and consumption
  – Technology – are pumps functional?
  – Reliability of the water source
  – Time of year (rainy or dry season)
  – Competing uses

• Other considerations
  – Women do most of the carrying, but men make most of the decisions
    • Location of house
    • Community improvements
    • How income is spent
  – Women are the ones most affected by community water projects, but they have little public voice
Patterns of Domestic Water Use

Figure by MIT OpenCourseWare.
Domestic Water Use

• 20 m$^3$/person/year represents a global average.

• But water consumption varies widely
  • Oman = 7 m$^3$/person/year
  • Japan = 90 m$^3$/person/year
  • USA = 200 m$^3$/person/year
<table>
<thead>
<tr>
<th>Sector</th>
<th>m3/person/yr</th>
<th>km3/yr</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic*</td>
<td>20</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>Industrial</td>
<td>200</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Cooling</td>
<td>225</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Livestock</td>
<td>40</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Sub-Total</td>
<td>565</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Agriculture</td>
<td>3,300</td>
<td></td>
<td>85</td>
</tr>
<tr>
<td>Total</td>
<td>3,865</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

(Clarke, R, 1993 and Vovich, M.I. 1977)
Global Water Use

- Irrigation = 70%
- Industry/Commercial = 20%
- Domestic = 10%

(Brown, L. 2003)

- Today, 2B people (1/3 human population) depend on groundwater for their water needs.
Water Systems Planning

• Case studies
  – Tanzania
    • Increased number of standpipes (increased access)
    • Consumption increased only 2 lpcd
    • Access was apparently reasonable prior to the project
  – Thailand
    • Designed system assuming 50-80 lpcd
    • Actual consumption
      – Standpipes: 9.6-36.8 lpcd
      – House connections: 24.4-65 lpcd
    • System was over designed, scarce resources were wasted
    • Could have provided water to more people for same cost
Water Systems Planning

• Recommended design figures
  – Standpipes: 25 lpcd
  – House connections: 50 lpcd

• Plan for losses – leakage, illegal connections

• Planning for future growth
  – Should consider future growth and increased demand
  – Overestimating demand will waste limited capital funds
  – Try to make projects expandable, extendable, improveable
Water Systems Planning

• Planning for future growth
  – Providing excess capacity now may be more economical than adding it in the future – economies of scale
  – Industrialized countries – design to meet demand for next 20 years
  – Developing countries
    • Design for next 5-10 years
    • Funds may not be available for longer periods
    • Do not want to tie up valuable resources that could be used elsewhere
Settlement Patterns

- Urban peripheries
- Rural clustered
- Rural scattered
Settlement Patterns – Urban Peripheries

- Usually unplanned housing layouts
- Includes both rural poor and urban poor (different views)
- High unemployment
- Water supply and sanitation is inadequate
- Public health is usually precarious
- Urban dwellers generally use more water than rural people
- Places for washing clothes and dishes or bathing may not be available
- Disposal of sullage (graywater) may be a significant problem
Settlement Patterns – Urban Peripheries

• Standpipes
  – May require a guard to prevent wastage, vandalism, and contamination by wastewater
  – Single standpipes often serve 500-3000 families – long lines
  – Better figures are 50-100 families per pump
  – Overuse of hand pumps cause frequent pump failures
  – Inconvenience and unreliability may result in people using less desirable sources
  – Need to consider demand and maintenance during planning process
Shantytown outside Rio de Janeiro
Settlement Patterns – Urban Peripheries

• Vendors
  – Sell water from tank with a hose, or from tins from a cart
  – Women may not want to be out on urban streets
  – May be of dubious quality
  – Costly
Public Vendors - Cameroon
Public Water Vendor

Kibera, Kenya
## Settlement Patterns – Urban Peripheries

<table>
<thead>
<tr>
<th>Source</th>
<th>Health Hazard</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taps</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Standpipes</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Vendors</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Surface</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Underground</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Rain-barrels</td>
<td>High</td>
<td>Low</td>
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</table>
Settlement Patterns – Rural Clustered

- Villages ranging from 50 to 5000 people
- Develop around a reliable source
- Have reasonable access to water
- Consumption does not change much until water is piped to homes
India
Nigeria
## Settlement Patterns – Rural Clustered

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Settlement Patterns – Rural Scattered

• Considering women’s role
  – Time spent carrying water is time lost from other activities
  – 80% of women participate in agriculture
  – In Africa, women produce approximately 80% of the food consumed by their families
  – Women collect and gather 80% of fuel supplies
  – Women perform 50% of house repairs
  – Women participate in 33% of house construction
  – Women do 100% of the cooking, cleaning, washing, and child care
  – Women receive a disproportionately smaller share of food, leisure time, and health care than men
Settlement Patterns – Rural Scattered

- Hauling water consumes a considerable portion of women’s time
- Women may carry up to 40 liters (40 kg – 88 lbs) per trip and may make several trips per day
- Men use more water for bathing since they don’t carry the water
- Water stored in the home in 200-300 liter containers – not much storage
- Sullage often used for watering animals or irrigation – reduces water to be hauled
## Settlement Patterns – Rural Scattered

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Carrying Water, Northern Region, Ghana
Kenya – Waiting for water
Kenya – Women-run water vending
References and More Info


