CATAPULT DESIGN WORKSHOP SERIES

WORKSHOP

Water Assessment

"For drinking water to be wholesome it should not present a risk of infection, or contain unacceptable concentrations of chemicals hazardous to health and should be aesthetically acceptable to the consumer. The infectious risks associated with drinking water are primarily those posed by faecal pollution, and their control depends on being able to assess the risks from any water source and to apply suitable treatment to eliminate the identified risks."

P. Payment, M. Waite and A. Dufour - Chapter 2 : INTRODUCING PARAMETERS FOR THE ASSESSMENT OF DRINKING WATER QUALITY

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The majority of our world's population lacks access to life's basic needs. We develop and implement human-centered products to help them thrive.

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CATAPULTDESIGN

WORKSHOP

WATER ASSESSMENT

Community water sources and storage systems are often the the source of infectious diseases. Solutions to this problem can be quite simple and a community's water should be checked for and protected from water-borne viruses, bacteria, and microorganisms.

In this workshop, we'll discuss what contaminates water, what kind of information to collect when assessing water, and the possibility of crowd sourcing data to broaden our knowledge base.

MATERIALS NEEDED:
Water Assessment Kit
Chlorine/Iodine Examples
Carbon/Charcoal Filter
Ceramic Filter
Sand Filter
UV Light Bulb

WHY DO A WATER ASSESSMENT?

- To determine if there's opportunity for improvement (ie filtering water)
- To determine if there are any areas of community concern (ie water borne illness)
- To determine what is working and what is not.

CLASSIFYING WATER CONTAMINANTS

There are 3 Types of Contaminants No single purification method is 100% effective at removing all categories of contaminants.

1) Particulates

Fine particles of solid or liquid matter suspended in water

2) Chemicals (man-made and natural)

Minerals (salts)
VOCs (Volatile Organic Chemicals)
Chlorine
Heavy Metals
Sewage treatment
Air pollution
Fuel

3) Microorganisms

Protozoa (largest organism and most prevalent in Africa)
Giardia
Cryptosporidium
Bacteria
E.Coli
Cholera
Salmonella
Viruses (the smallest organism)
Hepatitis A
Poliovirus
Echovirus

MEASURING WATER POLLUTION

Physical testing

Temperature: Information often already available online

Solids concentration like total suspended solids (TSS)
TSS of a water sample is determined by pouring a carefully measured volume of water (typically one liter; but less if the particulate density is high, or as much as two or three liters for very clean water) through a pre-weighed filter of a specified pore size, then weighing the filter again after drying to remove all water. The gain in weight is a dry weight measure of the particulates present in the water sample expressed in units derived or calculated from the volume of water filtered (typically milligrams per liter or mg/l).

Turbidity

Turbidity is the measure of water clarity. The more suspended solids in the water, the murkier it becomes. The increased turbidity of water can reduce the diversity of life in three ways:

Suspended particles absorb heat from sunlight and warm the water. Warmer water holds less oxygen and organisms begin to suffer. Also, some organisms can not live in the warmer water.

Particles also block sunlight. Plants and algae grow less and release less oxygen from photosynthesis. Particles also settle on the bottom and can cover and suffocate fish eggs and insect larvae

Turbidity is often tested by dropping a Secchi disk into the water and measuring at what depth it disappears. If this test is not practical, consider a kit such as the La Motte turbidity test, which involves observing a dot at the bottom of a column of water.

Chemical testing

Many published test methods are available for both organic and inorganic compounds.

Frequently-used methods include pH, biochemical oxygen demand (BOD), chemical oxygen demand (COD), nutrients (nitrate and phosphorus compounds), metals (including copper, zinc, cadmium, lead and mercury), oil and grease, total petroleum hydrocarbons (TPH), and pesticides.
Bacteriological Testing

Bacteriological water analysis is a method of analyzing water to estimate the numbers of bacteria present and, if needed, to find out what sort of bacteria they are.

Environmental Testing Kits: http://www.forestry-suppliers.com/product_pages/View_Catalog_Page.asp?mi=3327

CURRENT METHODS OF SANITIZING WATER

CHEMICAL

Adding chemicals, such as Chlorine and Iodine, to the water supply will kill viruses, bacteria, and protozoa (depending on the concentration and time). Chemical additives are not filters and cannot remove particles in the water. Chemical solutions are low-cost and becoming more and more readily available in developing countries. Proctor & Gamble's PUR packets program is a widespread effort in Africa.

Drawbacks:

- Many stories of lack of acceptance of chemical solutions.
- Iodine leaves a bad taste and does not produce clarity in water like chlorine does.
- Pregnant women should not drink water purified with iodine.
- Too high a dosage of chlorine causes illness or death.
- All chemical solutions need to be used with a filter to remove particles.

DISTILLATION

Applying heat to water can purify through boiling or solar distillation. Solar distillers capture condensation from evaporated water, therefore it's affective against all micro-organisms, particles, and most chemicals (depending on the contaminant).

Solar stills can typically be generated from local materials for fairly low-cost.

Drawbacks:

- The distilling process is extremely slow.
- Generally, only small amounts of liquid are produced daily.
- Would require a material change or a completely separate compartment from the Hippo Roller.

FILTERS

Carbon/Charcoal

Carbon is seldom used as a sole filter. It's typically part of bigger filtration system. Carbon filters remove chemicals by attracting them on a molecular level. When all the surfaces are covered, the filter must be replaced.

Carbon filters are rated in microns, or the measurement of their pore size. The smaller the pore size, the larger the surface area and the more affective the filter is. One micron is the maximum pore size recommended to effectively filter out contaminants and pathogens.

Carbon filters can improve taste and odor.

Drawbacks:

- Typically used in conjunction withe another purification method.
- Filters must be replaced regularly and be made available to the end user.
- Carbon filters are not able to remove viruses because the pore size is too large.

Ceramic

Ceramic filters are similar to carbon filters in terms of operation. Ceramic elements have the smallest pore size and are highly effective when used in conjunction with nanosilver coating.

Drawbacks:

- Most Ceramic filters require nanosilver, or silver colloid, for maximum efficacy. Silver colloid is not local to all regions.
- Ceramic filters do not remove chemicals (heavy metals and VOCs), bad tastes, or pollutants from water.
- Delicate and difficult to integrate into other technology.

Sand

Sand filters are classified as either Rapid Sand Filters or Slow Sand Filters (aka Bio-sand Filters).

Rapid sand filtration uses larger particle sizes for expedited filtration, but is typically used in conjunction with another purification method.

Slow sand filters use much finer particles and rely upon a natural buildup of biological mass on the top layer to remove viruses. Sand filters can be readily produced locally if the right sand is present.

Drawbacks:

- Bio build up on the surface of biosand filter is sometimes counter intuitive to "clean."
- A constant flow of water must pass through a slow sand filter to achieve efficacy, otherwise the bio buildup dies.
- Many parts of Africa don't have proper sand for filtration; shipping in sand is expensive.

ULTRAVIOLET LIGHT

Ultraviolet light emitted from UV bulbs or UV LEDs kills microorganisms. UV light can sterilize a container of water (static), or sterilize a continuously flowing stream of water (dynamic). In either case, UV sterilization hinges on the "dwell time", or the amount of time water is exposed to the UV light source.

A UV bulb's power and wavelength is specified based on the amount of water that needs to be purified. Smaller, less powerful bulbs mean longer exposure times; larger, more powerful bulbs mean less exposure time. Exposure time can be shortened by agitating the water.

Drawbacks:

- UV requires electricity.
- UV bulb has to "warm up" before working.
- "Instant-start" UV bulbs are more expensive.
- Instant-start bulbs have a shorter lifetime than slow-start bulbs.
- Mixture of water and electrical circuitry requires good design/engineering practices.
- Bulb must be kept dry.
- UV systems require a secondary filtration process to get rid of particles.
- High voltages required to power UV bulbs
- Need at least a kilovolt to strike a lamp.
- UV bulb requires replacement every 6-12 months.
- High up-front development costs
- UV bulbs are delicate.

CONDUCTING A WATER ASSESSMENT

STEP 1: Establish your Requirements

People:
What skills will the project staff and community need?
What training will the project staff and community need?
Who will be the liason between the project staff and community? Who will manage this project?

Finances:
What amount of funding will this project require?
What can the community and partners contribute?
Will additional funds be needed to complete the project?
Are there any other sources of funding available?
Who will be responsible for budgeting and tracing funds?

Materials:
What tools, construction materials, books, and job-related equipment are required?
What local materials can be used?
How will the materials be transported to the site?
If production is required, can it be done locally?
If materials are not available, what is the alternative plan?

Services:
Who will provide food, housing and transportation for the project staff?
Who will provide food, housing and transportation for community members during training events?

STEP 2: Determine what affects the water supply

Talk to people. See how they use the water and what - if any - side effects there are. Determine if there are any other factors that might come into play.

Visit and observe the water source and how people use it. Observe if there are any unsanitary habits such as...

Conduct both physical and chemical tests of the water source. If dirty, conduct an assessment of which sanitation treatment (chemical, distillation, filtering and/or UV treatment) will work best.

Work with the community to analyse/install the treatment system. Establish who will maintain the system. Establish a maintenance schedule.

Educate the community on how the treatment system works and why it is needed

STEP 3: Research Possible Systems

What is the water being used for currently?
What are possible water sources?
What types of systems are available?
  Municipal: Like the energy grid, but for water
  Provided by Government
  Wells
  Aqueduct
  Pulling from surface: Rivers/Lakes
  Rainwater or Surface Water Harvesting
How much does each system cost?
Is a community-based or individually-owned system better? Why? (Individually-owned systems are more likely to be maintained.)
What technology has been used in the past?
What challenges have you come up against?
What are the biggest areas of opportunity?

CASE STUDY: THE RIPPLE EFFECT

Acumen Fund & IDEO, with backing from the Bill & Melinda Gates Foundation.

The Ripple Effect project aims to improve access to safe drinking water for over 500,000 of the world's poorest and most underserved people; to stimulate innovation among local water providers; and to build the capacity for future development in the water sector as a whole. Acumen Fund, a nonprofit global venture fund that uses entrepreneurial approaches to solve large-scale problems, brings experience in the water sector and a deep understanding of what brings success to social enterprise. IDEO offers a human-centered approach to designing products, services, and interactions.

To date, our work in India has contributed to new distribution models, automated water vending machines, and better vessels for existing businesses. These small-scale pilots provide the awardees with opportunities for learning and experimentation, developing new business innovations before taking them to scale. We plan to follow a similar model in Africa.

Video: http://vimeo.com/7329159
Blog: https://client.ideo.com/rippleeffect/

STEP 4: Gather Data

[Use worksheet Cata101: Community Info]

Community

* *Interviews with community members*
  Community Name (staff defined)
  Years the community has been in existence (using scale)
  Geographic Boundaries of the community (defined using google maps)
  Leaders in the community* (RO/Sidebar)
  Demographics: Racial/ethnic makeup, male/female ratio, economic standing, educational level
  Expenses and Income
  Community Issues* (multiple option or RO)
  Community History* (RO)
  Moral & Involvement levels*(multiple options/heat map)
  Health & nutritional status (multiple options/heat map)
  Family Size (Scale)
  Who cooks food (icon)
  Electricity access/frequency/cost

Water Gathering and Storage

  Who collects water (icon)
  % of water for cooking
  % of water for cleaning
  % of water for agriculture
  Where is water stored (icon)
  Cleanliness of drinking containers (scale)
  Opportunity for water contaminants (multi-option)
  Distance traveled to obtain drinking water (google maps)
  Location of clean drinking water (google maps)

Health Clinics

  Do people wash their hands (RO)
  #/amount of water contaminants
  % of water-borne disease
  % of mothers with HIV
  Do people get sick from the water?

QUESTIONS: Interviews with Community Members

How long have you been a member of the community?
How do you feel about the community?
What do you feel are the community's strengths?
How do you feel the community could improve?
What makes you proud of the community?
What can you tell me about the history of this community?
What do you think lies in the future for this community?
What access do you have to electricity? How often? Cost?
Would you pay an extra ____ to have clean water?
Would you spend an extra ____ min. to have clean water?
How long do you store clean water?
How do you make money?
Any health problems in your family?
Where does your water come from?
How do you clean your water?

ACTIVITY: CROWD-SOURCED MAPPING OF WATER

Proposal: Using the list of universal questions above, create a web-based program for mapping world water quality. Allow for layers of information to be turned on and off.

Existing world water maps:
http://www.waterwebster.com/maps_framebottom.htm

Crowd sourced data:
"Emergency in Haiti"
"Open Street Map" using the CloudMade platform

Examples of Data Visualization:
http://infosthetics.com/
http://site.layar.com/catalog/

WORKSHEET : Cata101 : PIE GRAPHS

Let's discuss what we can do to make the water assessment information we've gathered most useful.