

# Water Purification

---

## Sanitation & Implications on Malnutrition

Chelsea, Heather, Molly





# Wednesday Class Agenda

---

- Introduction (PowerPoint)
- Video
- BioSand Presentation
- Case study group discussions
- Share case study findings

# Water, Health & Malnutrition

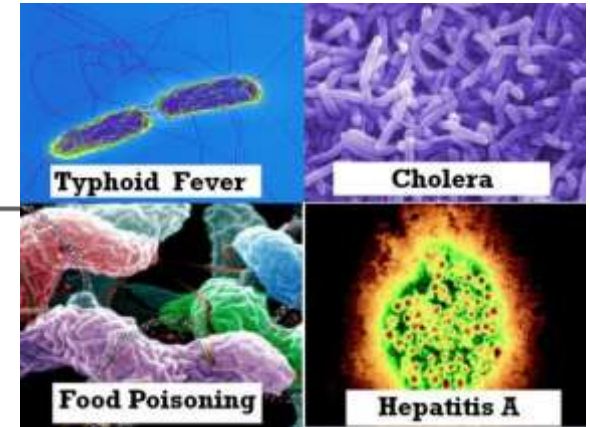
---

- Contaminated water causes 80% of health problems worldwide
- The water source in rural areas of developing countries is often unfit for consumption:
  - Polluted wells
  - Mud-hole shared by animals and humans
  - Streams & rivers contaminated with human/animal waste

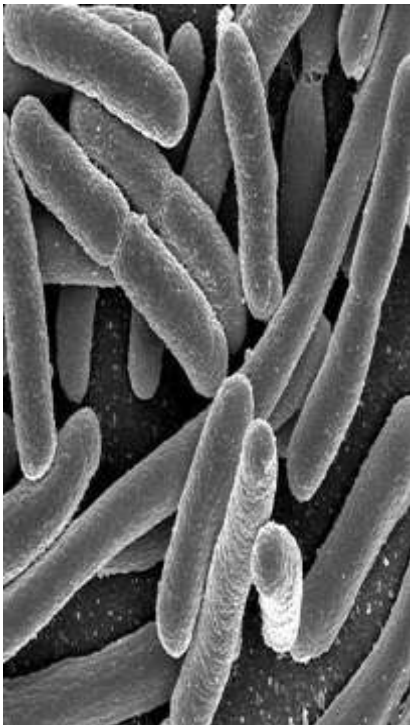


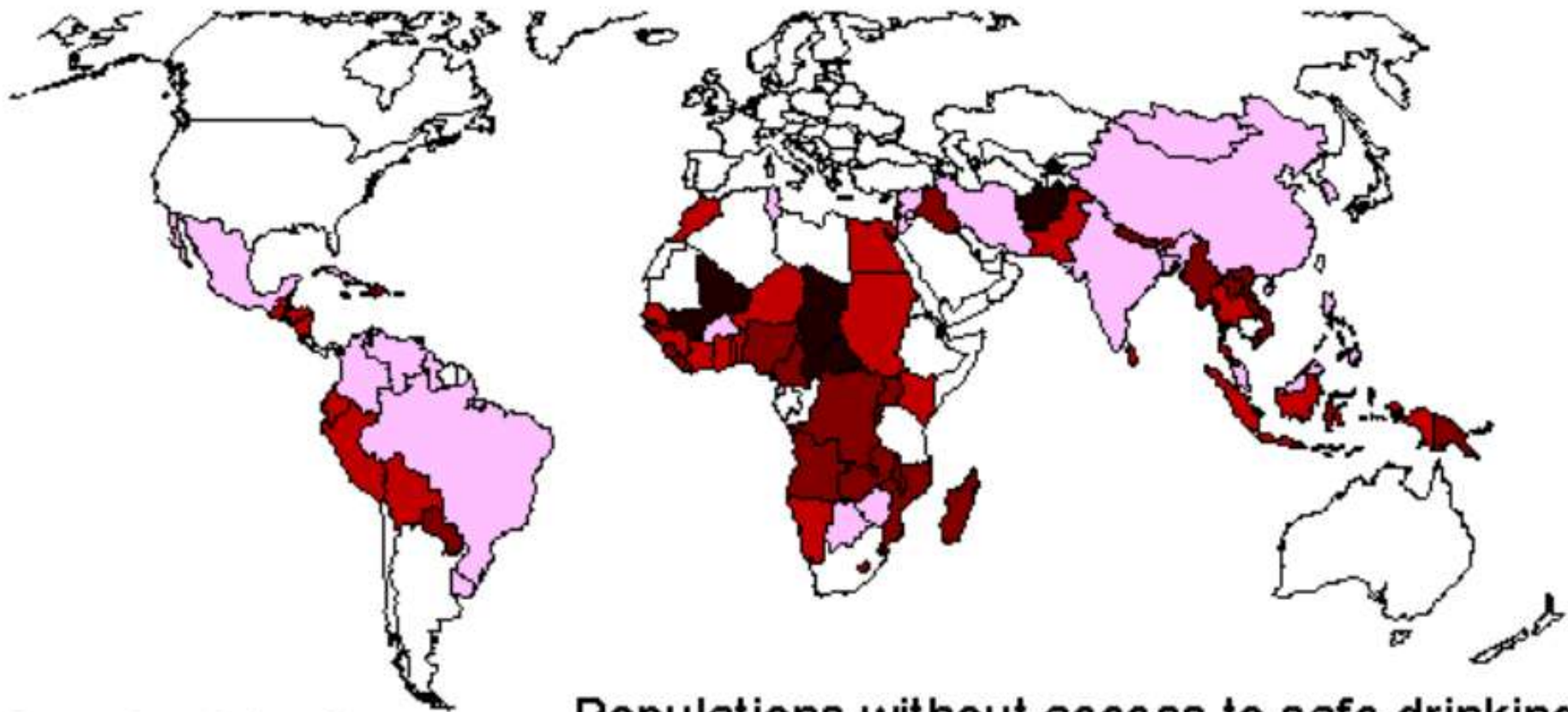
Image source: <http://arch1design.com/blog/wp-content/uploads/2010/09/DrinkingPollutedWater-300x248.jpg>

# Water, Health & Malnutrition

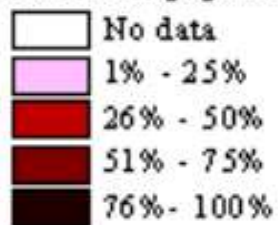


- Water-borne diseases
- 
- Diarrheal disease
  - ~1.8 million deaths each year=#2 cause of child death
  - Accounts for 4% of global burden of disease
    - 3.2% global deaths due unsafe water, sanitation and hygiene
    - 99.8% occur in developing countries





Percent of population without access



## Populations without access to safe drinking water

*from The World's Water  
The Biennial Report on Freshwater Resources  
(Gleick 1998)*



# Water Issues: Contributing Factors

---

- Most affected are extremely poor populations living in developing countries, often in rural areas
- Main problems include:
  - Low priority given to sector
  - Few financial resources
  - Unsustainable water supply and sanitation services
  - Poor hygiene behaviours
  - Inadequate sanitation in public places (hospitals, schools, & health centres)



# Sanitation and Personal Hygiene

---

- Community waste management
  - 90% sewage and 70% of industrial waste enter water sources without treatment
- Personal hygiene often taught at school
  - Resources must be available
  - These habits then taught to others

# Considerations

---

- Possible solutions must...
  - Be sustainable
    - Economically, culturally, environmentally
  - Be accessible
    - Gender, social status, disabilities
  - Involve education
    - Sanitation and personal hygiene
  - Address waste management & pollution issues



# Sources

---

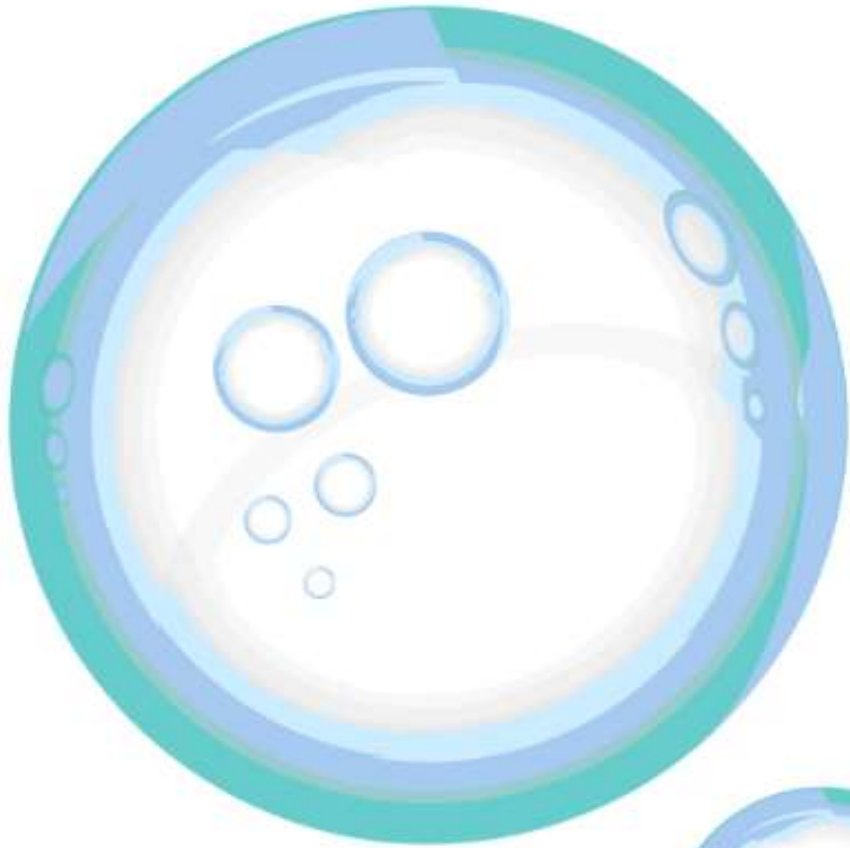
- UNICEF, World Health Organization & Water Supply and Sanitation Collaborative Council. (2008). *10 Things you need to know about sanitation*. Retrieved from <http://www.unwater.org/wwd08/docs/10Things.pdf> on 07 Feb 2011.
- United Nations. (n.d.). *International Decade for Action - Water for Life 2005 - 2015: Background*. Retrieved from <http://www.un.org/waterforlifedecade/background.html> on 07 Feb 2011.
- World Health Organization. (n.d.). *Water supply, sanitation and hygiene development*. Retrieved from [http://www.who.int/water\\_sanitation\\_health/hygiene/en/](http://www.who.int/water_sanitation_health/hygiene/en/) on 07 Feb 2011.
- World Health Organization. (2008). *Guidelines for drinking-water quality*. (Third edition). Geneva: World Health Organization.
- Adams, J., et al. (2009). *Water, sanitation and hygiene standards for schools in low-cost settings*. Geneva: World Health Organization.
- Stauber, C.E., et al. (2009). A randomized controlled trial of the concrete biosand filter and its impact on diarrheal disease in Bonao, Dominican Republic. *The American Journal of Tropical Medicine and Hygiene*, 80 (2), pp. 286-293



---

# BioSand Filter Video

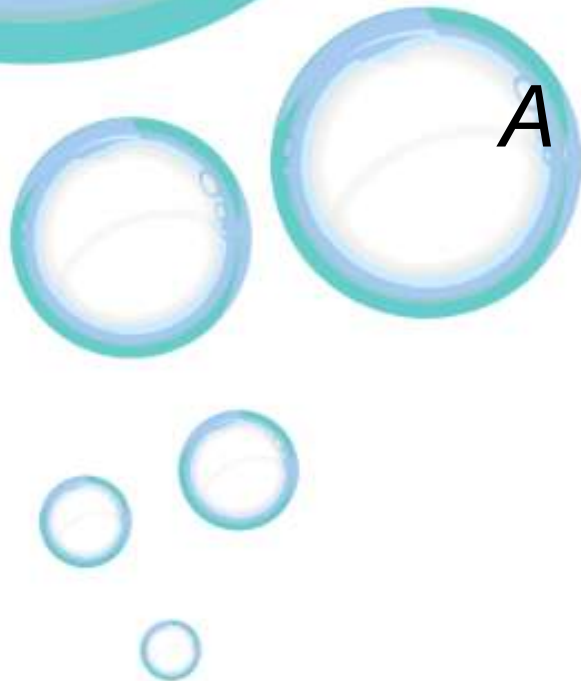
<http://www.youtube.com/watch?v=8LMWzb7DMS8>



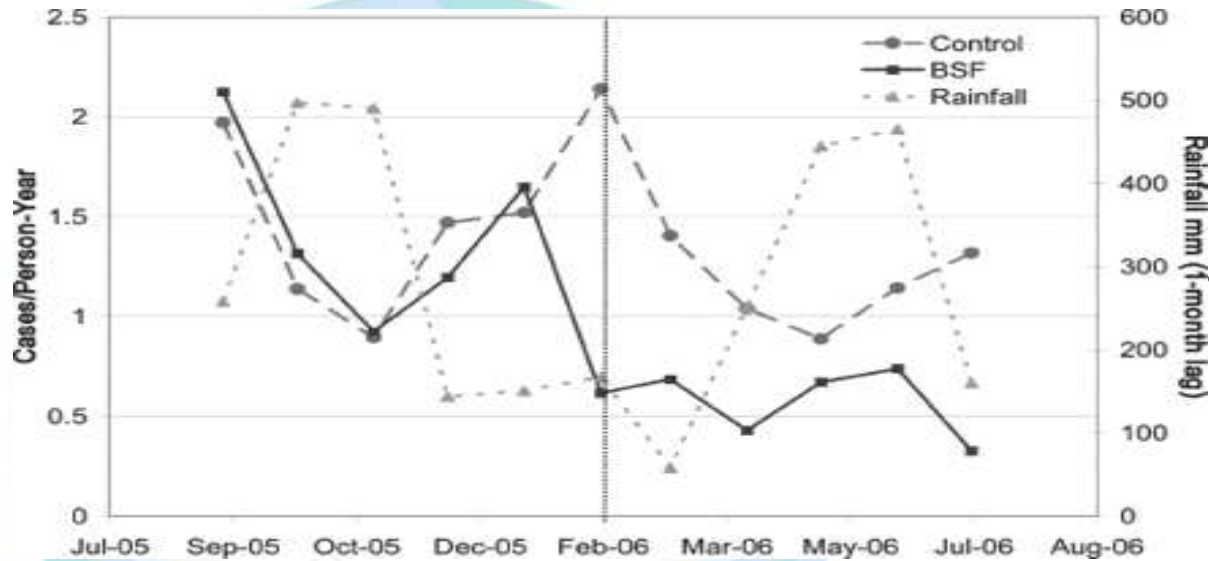
# BioSand Filters

---

*A slow sand filtration method*



# BioSand Filters



Graph: Dominican Republic

- BioSand filter (BSF) used by > 500,000 people globally
- Typical BSF=one-time cost of \$25–100 (country and implementer-dependent)
- Low rates of breakage/disuse over time

# Key features of a sustainable POU filter

---

1. Consistent --microbiologically safe
2. Effective--many different water sources/quality levels
3. Not labor-intensive
4. Low cost; relatively insensitive to income fluctuations
5. Reliable, accessible and affordable supply chain
6. Maintain high post-implementation use levels



# Cultural and Social Dimensions- General

---

- Will it displace exclusive breastfeeding?
  - Breast milk= major source of clean drinking water
  - Education must also play a partnering role
- **Behaviour change**-low, sources of H<sub>2</sub>O the same
- **Monitoring** use, acceptance, compliance, accurate reporting
  - Difficult

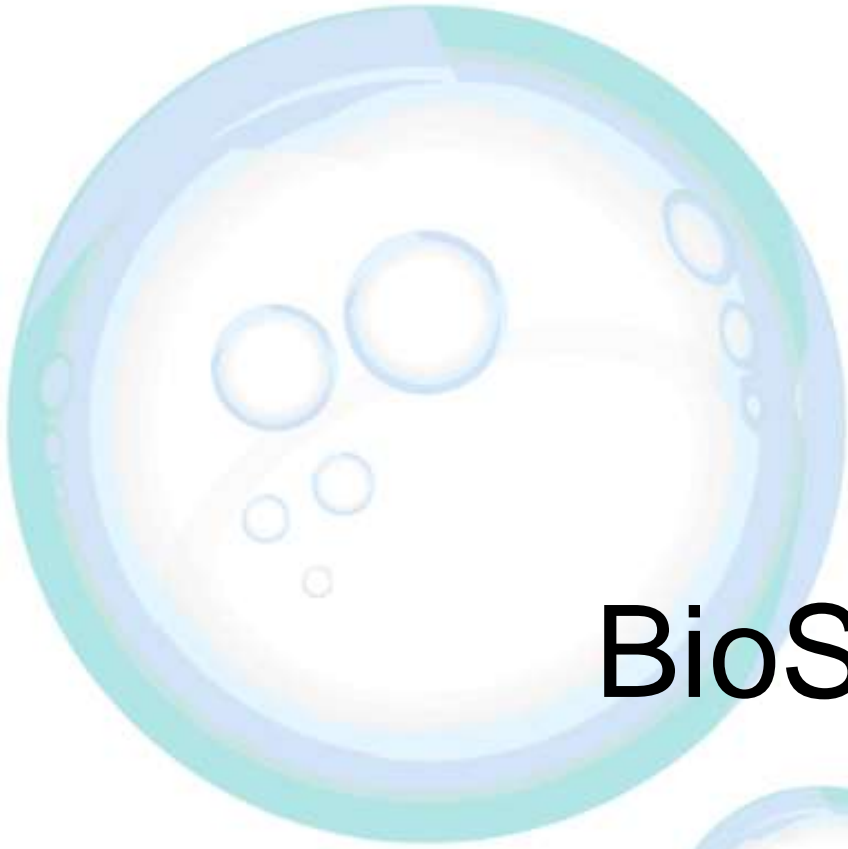


# Social and Cultural Dimensions

---

- Cameroon story





# BioSand Filters



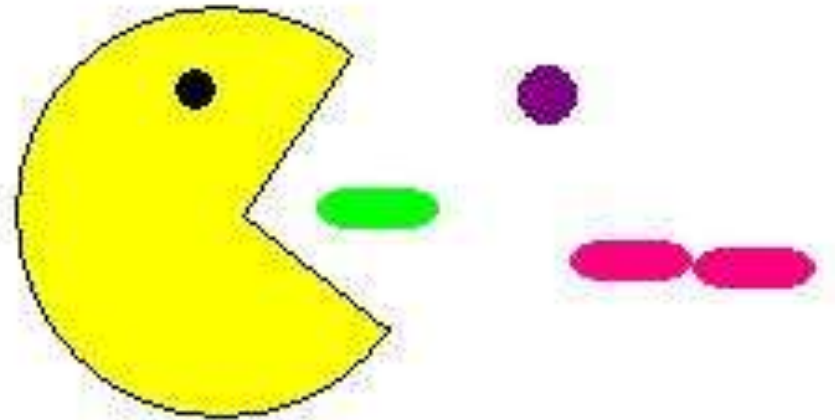
## Disinfection Mechanisms



# How does it work: Microbiology

---

- Four mechanisms
  - Mechanical trapping
  - Predation
  - Natural death
  - Adsorption





# How does it work: Microbiology

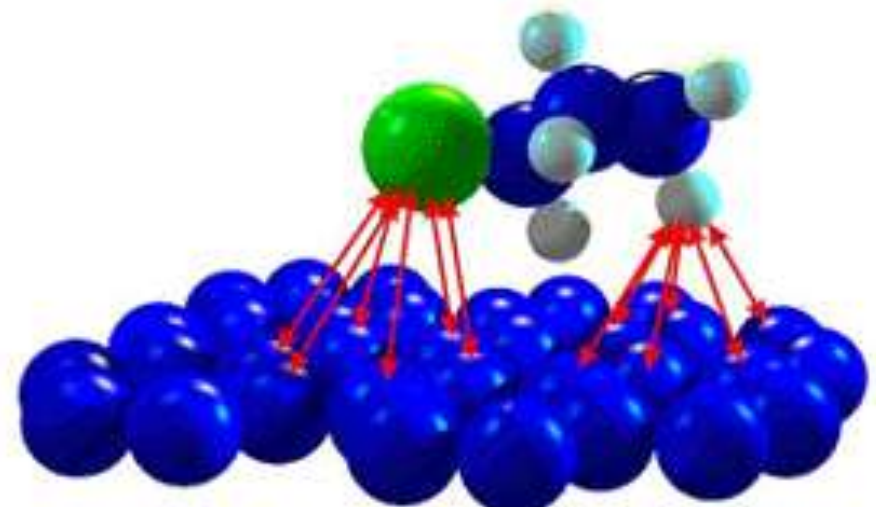
---

- Effectively removes bacteria, viruses, protozoans
  - Effectiveness & safety depend on quality of water originally
  - Can also disinfect water after filtration
- 30-40% reduction in diarrhea among all age groups

# How does it work: Chemistry

---

- Mechanism: adsorption
- Cannot remove dissolved substances
- Arsenic - 85-90% removal:
  - 0.01mg/L provisional guideline value
- Iron - 90-95% removal:
  - no guideline value, but 2mg/L considered safe





# Limitations

---

- Storage containers are a source of recontamination
- Does not remove dissolved substances, fertilizers, pesticides, colour
- Disinfection incomplete if water is heavily contaminated
- Needs to be used regularly with a consistent water source
- Difficult to move/transport



# Suggested Improvements

---

- Train people locally to ensure best practices
  - Maintenance
  - Consistent water source
- Community BioSand filter
- Improved chemical and microbiological disinfection
  - Combination of disinfection methods



---

# BioSand Filters



Political, Economical & Ethical  
Concerns



# Political Concerns

---

- Water and access distribution problems
- Demand for water driven by
  - Agriculture
  - Hydroelectric power
  - Fisheries
  - Recreation
- Unstable ecosystem, economy, political structure



# Economic Concerns

---

- **Effective, cheap**
- **Built from easily accessible materials**
  - Concrete
  - Plastic
- **Low operational costs**
  - rely on gravity
  - rely on biological layer (increases over time!)
- **Simple to use!**





# Economic Concerns

---

- **BioSand filter targeted at small communities**
  - with larger reservoirs, better able to withstand drought or famine
- **Water can be consumed by humans, livestock, or to irrigate fields**



# Ethical Concerns

---

- "Slow" - not the best solution for emergency relief (ie. drought, natural disasters)
- Need to eliminate ethical concerns related to control groups
  - Ensure treatment/control groups treated equally
  - How do you choose who gets filtered water?

## In Summary...

---

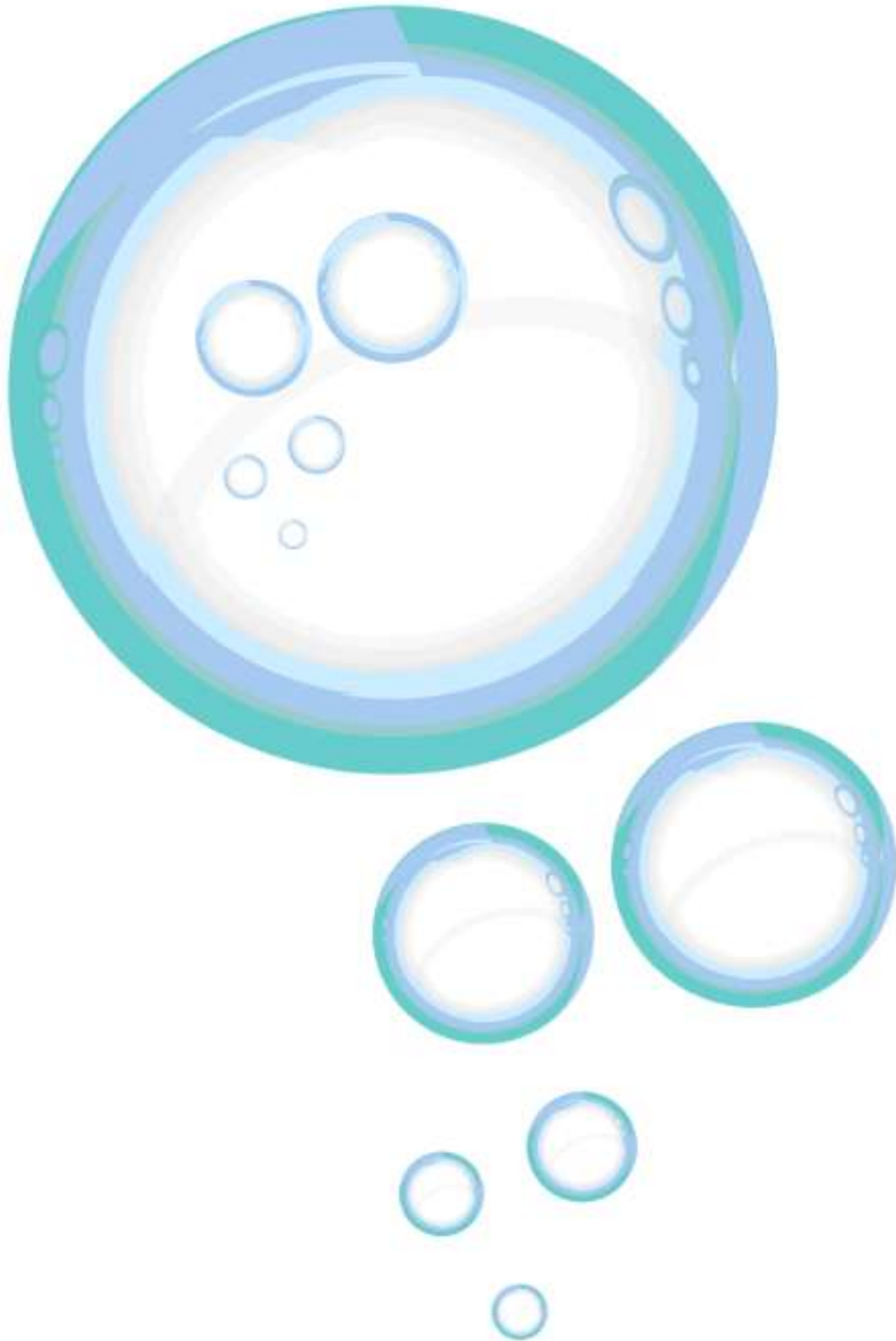
- Provision of clean water: More than simply providing access!
- 
- Need to introduce technology and political economy that fit socio-cultural needs



# Sources

---

- Centre for Affordable Water and Sanitation Technology. (2008). *BioSand filter manual*. Calgary: Centre for Affordable Water and Sanitation Technology.
- Stauber, C.E., *et al.* (2009). A randomized controlled trial of the concrete biosand filter and its impact on diarrheal disease in Bonao, Dominican Republic. *The American Journal of Tropical Medicine and Hygiene*, 80 (2), pp. 286-293.
- Tiwari, S.-S., *et al.* (2009). Intermittent slow sand filtration for preventing diarrhoea among children in Kenyan households using unimproved water sources: randomized controlled trial. *Tropical Medicine and International Health*, 14 (11), pp. 1374-1382.
- World Health Organization. (2008). *Guidelines for drinking-water quality*. (Third edition). Geneva: World Health Organization.



Any questions?

---

Thank you!



# Case Study Activity

---

- Split up into three groups
- Read over water purification method
- Within your group, discuss the method and its applicability
- Design a “poster” to share with the class

# Case Study Activity: Questions to Consider

---

- Where would this method work?
- Where would this method not work? Why not?
- Is this method sustainable?
  - Culturally
  - Economically
  - Environmentally
- How could this method be improved?

# Discussion Questions

---

- Which water disinfection strategies or methods do you think are most viable? Why?
- Are point-of-use water treatment methods a good long term strategy to address water quality issues in developing countries?