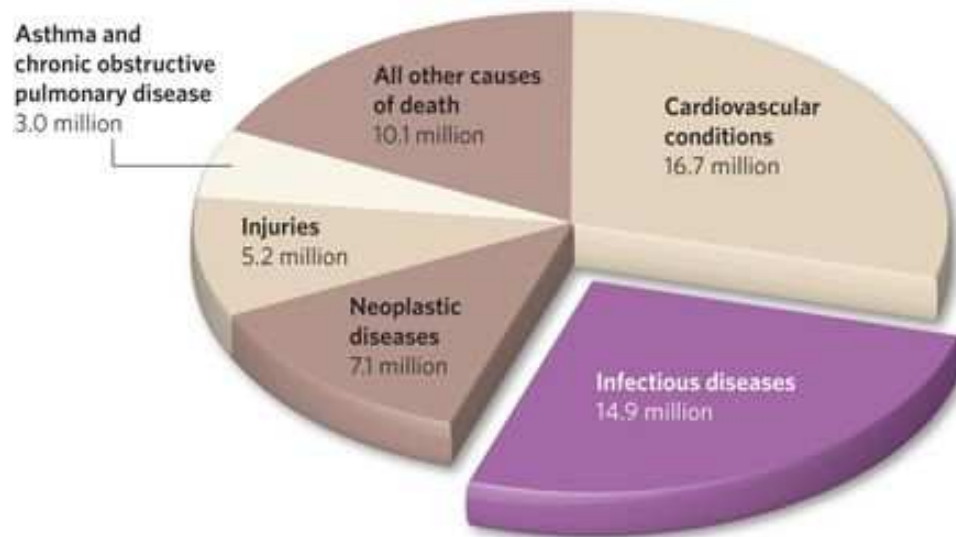


Water quality problem – case study

Today's class

- Cholera: effect to humans
- Bangladesh case study
 - Cholera endemic: how it occurred
 - How people reacted with the endemic
 - Thoughts

Infectious diseases and pathogens



Infectious diseases	Annual deaths (millions)
Respiratory infections	3.96
HIV/AIDS	2.77
Diarrhoeal diseases	1.80
Tuberculosis	1.56
Vaccine-preventable childhood diseases	1.12
Malaria	1.27
STDs (other than HIV)	0.18
Meningitis	0.17
Hepatitis B and C	0.16
Tropical parasitic diseases	0.13
Dengue	0.02
Other infectious diseases	1.76

- Types of disease-causing organisms (pathogens): (viruses), bacteria, protozoa, helminthes

How cholera affects the body

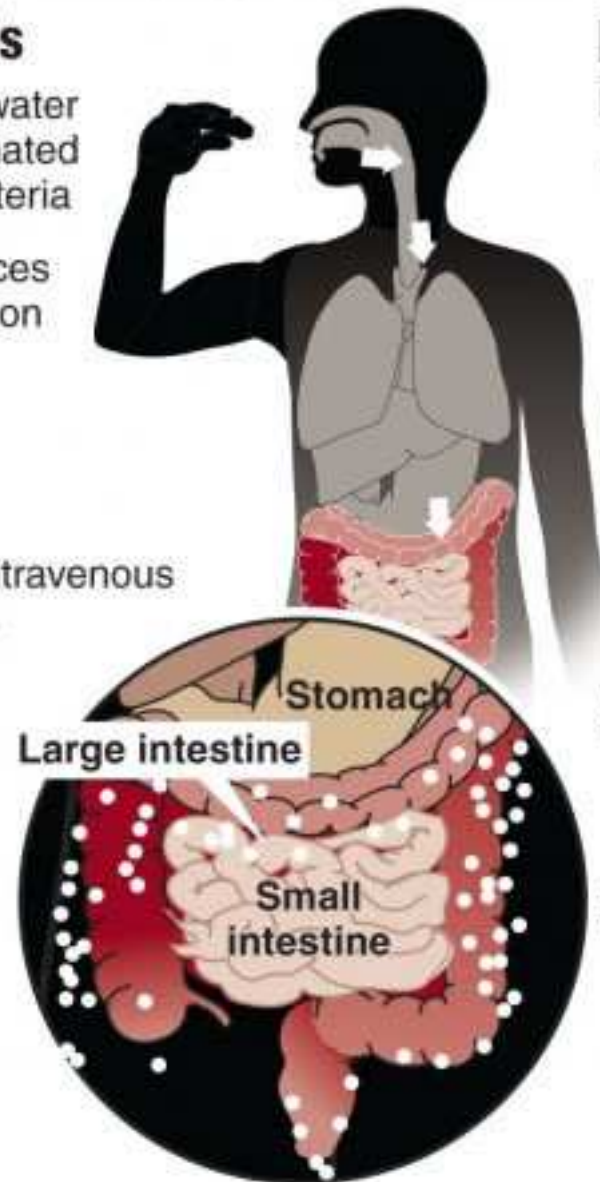
Cholera is an acute intestinal infection that causes severe diarrhea, dehydration and, if not treated promptly, death.

How it spreads

- People ingest water or food contaminated with cholera bacteria
- In epidemic, feces of diseased person is source of contamination

Treatment

- Salt solution, intravenous fluids, antibiotics
- In unprepared communities, death rates can be as high as 50 percent



In the large intestine

- 1** Bacteria multiply rapidly



- 2** Toxin from bacteria penetrates cells of intestinal wall

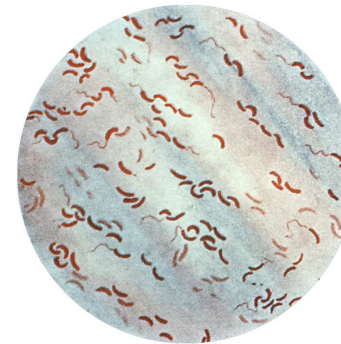
- 3** Toxin prevents intestine from absorbing water from digested food; diarrhea, dehydration result

Cholera - effect of human infection

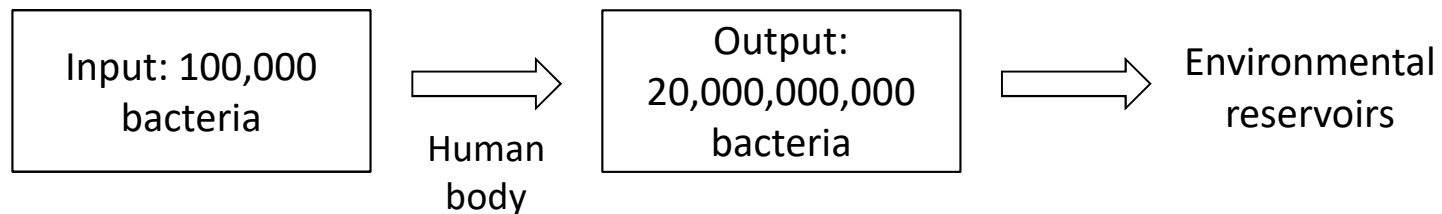
- The cholera cot



- *V. cholerae* in “rice water stool”

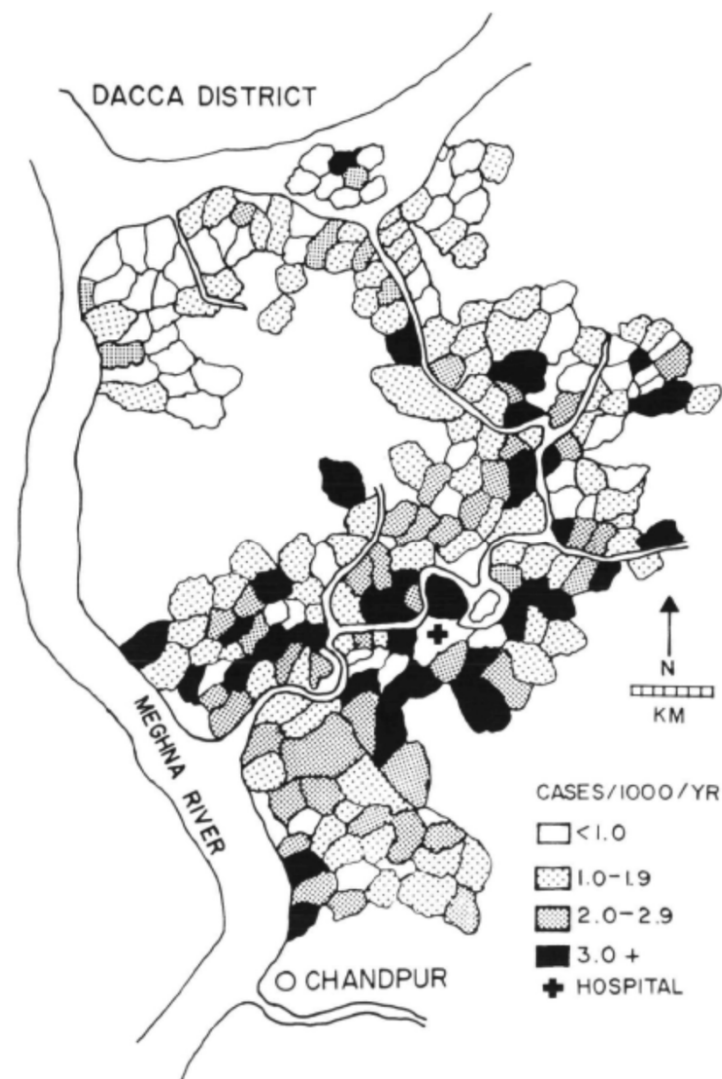


- Benefit that *V. cholerae* gets from humans



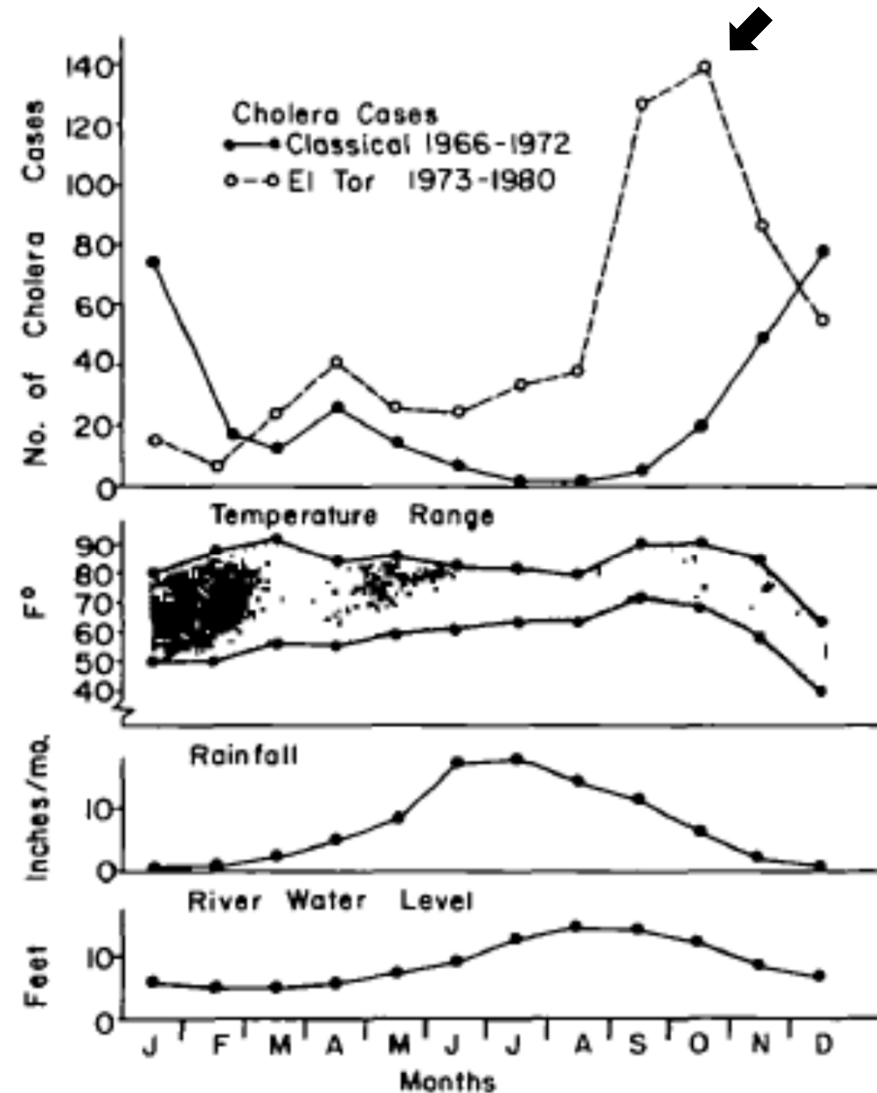
Cholera endemic in Bangladesh

Hospitalization rate for cholera,
Matlab, Bangladesh, 1968-
1977



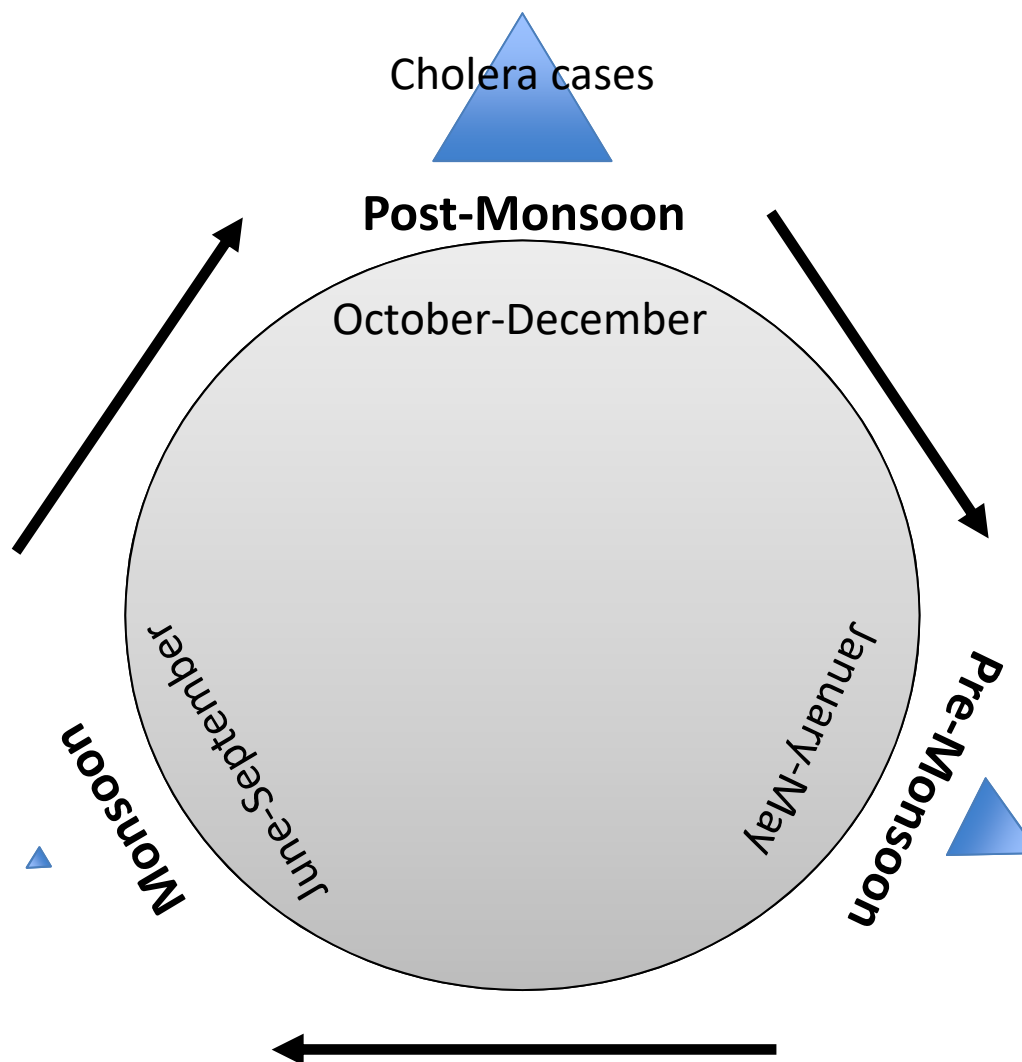
Cholera endemic in Bangladesh

Relationship of season to cholera outbreaks (Matlab, Bangladesh)



Cholera endemic in Bangladesh

Relationship of season to cholera outbreaks



Cholera endemic in Bangladesh

N fertilizers in runoff + sunlight in post-monsoon

→ Algal bloom



Cholera endemic in Bangladesh

Algal heterocyst

N₂ fixation – attracts microbes,
provides nitrogen



Blue-green algae,
Anabaena variabilis

<Algal bloom>



Copepod
(small crustacean)

V. cholerae attaches to chitin
surface and feeds on it

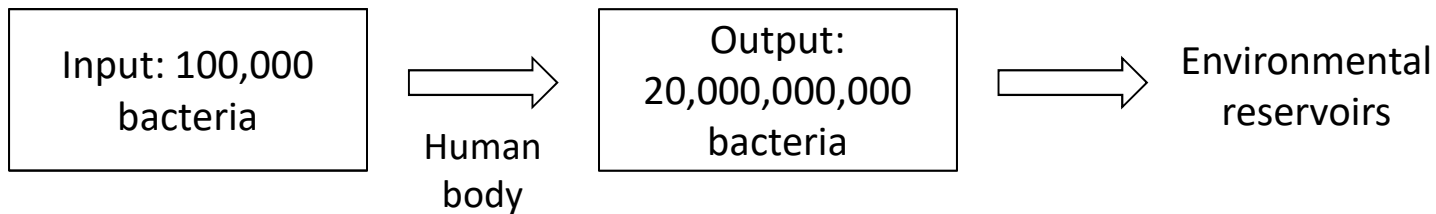


<Copepod bloom>



Cholera endemic in Bangladesh

- Once humans are infected...



The “hanging latrine”
of Bangladesh



Cholera solutions?

- Removal of hanging latrine
- Drill wells
 - 1985-2000, millions of tube-wells drilled in Bangladesh
 - By 2000, tube-wells supplied water to 97% population



Cholera solutions?

- 50% of groundwater wells:
>10 $\mu\text{g}/\text{L}$ (46 million persons)
- 28% of groundwater wells:
>50 $\mu\text{g}/\text{L}$ (28 million persons)
- Arsenic poisoning:
 - Hyperpigmentation (1,200,000 cases/yr)
 - Keratosis (600,000 cases/yr)
 - Skin cancer (125,000 cases/yr)
 - Fatalities (3,000 cases/yr)

“Largest mass poisoning of a population in history”



Solutions -- Your turn

Next class

- Wastewater management: collection and masterplan
 - Wastewater collection
 - Wastewater flow: components and variation
 - Loading and concentration of wastewater constituents
 - Wastewater flow equalization
 - How we set up a masterplan for wastewater infrastructure in Korea