Opportunities for citizen science in reducing exposure to environmental hazards: Lead in soil and arsenic in well-water”

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Earth2Class Workshops at Lamont-Doherty Earth Observatory

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Areas of interest -- Bangladesh

https://www.lonelyplanet.com/maps/asia/bangladesh/
Peru

https://www.lonelyplanet.com/maps/south-america/
Climates around the World

http://www.soils4teachers.org/around-the-world
Soil types around the world

http://www.soils4teachers.org/around-the-world
Soil horizons

• O – surface/ humus, organic matter
• A – topsoil – minerals and organic matter; best for organisms
• B – subsoil – rich in leached minerals; not very good for organisms
• C -- fragmented parent material
• R – solid bedrock

http://soils4teachers.org/soil-horizons
Life in the Soil

- Bacteria
- Earthworms
- Nematodes (roundworms)
- Arthropods (insects)
- Plant roots
- Air spaces
- Water

http://www.soils4teachers.org/biology-life-soil
Ground-water characteristics

- Supplies 51% of US population/99% of rural population
- 64% used for irrigation to grow food
- Major source of recharge for rivers and wetlands

http://www.groundwater.org/get-informed/basics/groundwater.html
- Zone of aeration
- Zone of saturation
- Water table
- Porous, porosity
- Permeable, impermeable
- Aquifer
- Aquiclude
Wells – tapping into groundwater

Aquifers and wells

[Diagram showing different types of wells and aquifers]

Source: Environment Canada

https://water.usgs.gov/edu/earthgwwells.html
Types of wells

https://water.usgs.gov/edu/earthgwwells.html
The Water Cycle

- Atmosphere
  - Condensation
  - Sublimation
  - Deposition
  - Evaporation
  - Evapotranspiration

- Precipitation
  - Snowmelt runoff
  - Streamflow
  - Seepage
  - Spring
  - Groundwater flow

- Groundwater storage

- Ice and snow

- Oceans
  - Ocean currents

- Volcanic steam

- Sun

U.S. Dept. of the Interior
U.S. Geological Survey
Howard Perlman, USGS, John Evans
https://water.usgs.gov/edu/watercycle.html
Water – more than H₂O!

- Polar molecule
- Rarely pure (pH = 7.0)
- “Universal Solvent”
- Able to dissolve thousands of molecules and ions
- Many are beneficial
- Some are harmful---pollutants/contaminants

http://www.biology.arizona.edu/biochemistry/tutorials/chemistry/page3.html
Groundwater Contaminants

- Contaminants may occur naturally, inadvertently, or intentionally
- Road salt, motor oils, septic tanks, urban runoff
- Fertilizers, pesticides, farm wastes
- Pharmaceuticals and personal products
- Toxic chemicals, hazardous wastes, landfill leakage
- Airborne compounds
- Other

http://www.groundwater.org/get-informed/groundwater/contamination.html
“Heavy Metals” – especially Pb and As

**Lead (Pb)**
- Found in air, soil, water, our bodies
- Fossil fuels (leaded gasoline), lead-based paints, industrial uses (plumbing, cosmetics, etc.)
- May travel long distances from source in air or water
- Many type of compounds

**Arsenic (As)**
- Naturally found in rocks, soils, water, plants, animals
- From volcanic activity, erosion, forest fires
- Wood preservative and other industrial uses
- Agriculture, mining, smelting

https://www.epa.gov/lead/learn-about-lead

Pb

- Cumulative toxicant that affects multiple body systems; particularly harmful to young children.
- Distributed to the brain, liver, kidney and bones; stored in the teeth and bones, where it accumulates over time.
- Usually assessed through the measurement of lead in blood.
- Lead in bone is released into blood during pregnancy and becomes a source of exposure to the developing fetus.
- No known level of lead exposure that is considered safe.
- Lead exposure is preventable.

As

• Naturally present at high levels in groundwater of a number of countries.
• Highly toxic in its inorganic form.
• Contaminated water used for drinking, food preparation and irrigation of food crops poses greatest threat to public health
• Long-term exposure to arsenic can cause cancer and skin lesions; associated with cardiovascular disease, diabetes.
• In utero and early childhood exposure linked to negative impacts on cognitive development and increased deaths in young
• Most important action in affected communities is prevention of further exposure by provision of a safe water supply.

http://www.who.int/mediacentre/factsheets/fs372/en/
Differences in Addressing Problems between “1st World” and “3rd World” Communities

• Federal, state, local, and private resources highly developed and based on decades of engineering/science
• Survival- and local resource-dominated strategies
• Laws and regulations, enforcement codes
• Awareness levels in populations
• Resources that can be brought to bear to solve problems
Even so, problems can arise locally

• Trace metal contaminants in NYC urban garden soils
• Lead in home gardens and urban soils – MN Extension Service
• Ambient levels of metals in NJ soils
• So how can you and your students find out whether problems exist “in your backyard”?  
• What techniques must be used by “experts” so decisions makers have necessary data?  
• What then should be done to address these concerns locally and internationally?