

Introduction & diseases related to environmental health & hazard

Objectives

- To understand the definition of environmental health and components of the environment.
- To describe the interaction between humans and the environment
- To understand common concepts in environmental health; exposome, environmental risk transition, sensitive populations
- To understand the framework for disease prevention in environmental health
- To identify global environmental health priorities
- To describe environmental health situation globally
- To identify air pollutants, their sources and effects
- To describe water sources and the hydrological cycle
- To identify water pollutants, their sources and effects
- To describe methods for prevention of air and water pollution
- To identify diseases attributed to environmental pollution

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- Extra



Environmental Health

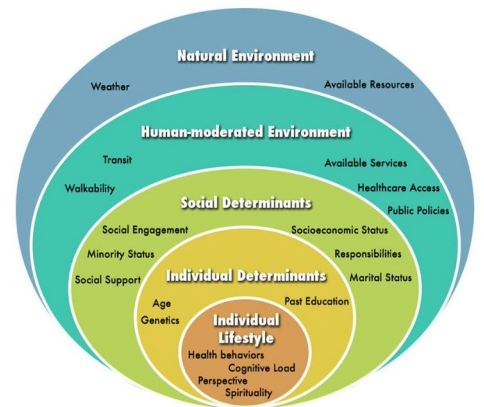
Environmental health is the branch of public health that focuses on preventing human injury and illness and promoting health and well-being by:

- Identifying and evaluating environmental sources
- implementing policies and programs to reduce chemical and other environmental exposures in air, water, soil and food

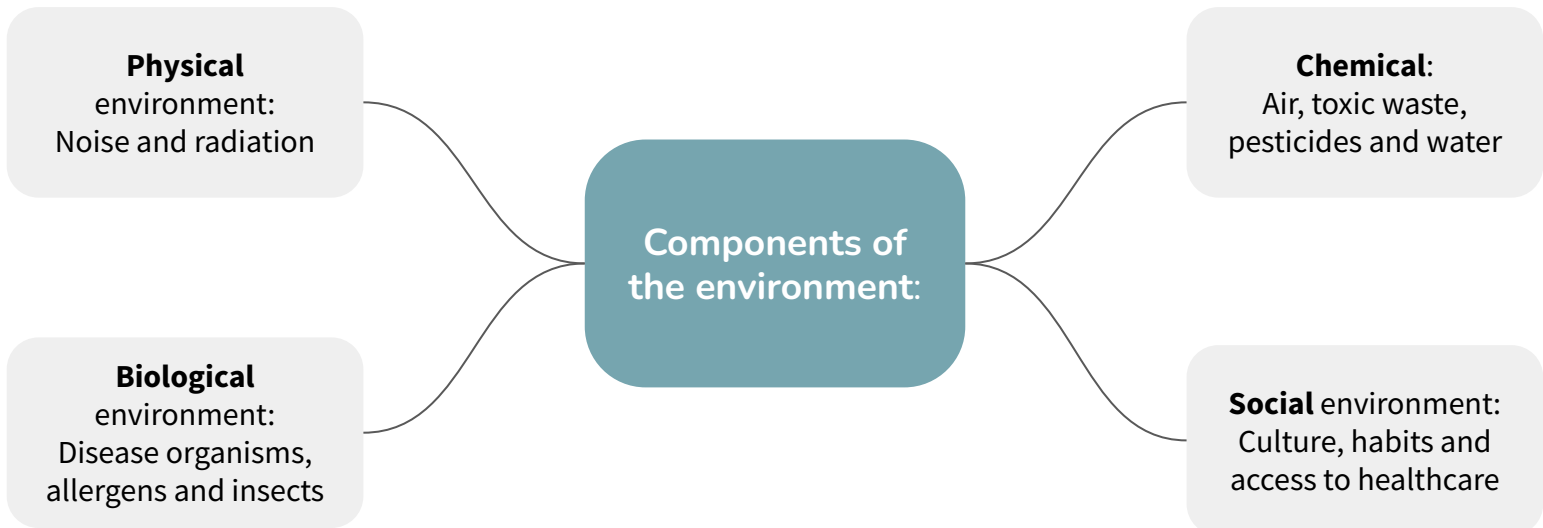


Common Terminology in Environmental Health

- **Environment:**
The complex of physical, chemical, and biotic factors that act upon an organism or an ecological community and ultimately determine its form and survival.
- **Ecological system (ecosystem):**
Dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit.
- **Ecological model:**
Proposesthatthedeterminantsofhealthinteractandare interlinked over the life course of individuals.
- **Exposome:**
The measure of all the exposures of an individual in a lifetime and how those exposures relate to health. Similar to the genome. We're exposed to the environment from utero, and this exposure can result in illnesseses, disease. This cumulative exposure is referred to as the exposome.



Components of the Environment





Environmental Exposures that Impact Human Health

- **Air**
- **Water**
- Food
- Soil
- Land cover (forests, buildings)
- Other living creatures Weather
- Waste
- The built environment
- Radiation



Sensitive Populations

Generally, when we regulate a contaminant, we are not regulating it for the general population. We are doing it for the sensitive subpopulation. Ex: In covid, the vulnerable people were the elderly and undocumented workers working in crowded areas. These individuals were provided free access to testing without having to fear being deported.

Intrinsic Factors	Acquired Factors
Age	Chronic medical conditions
Sex	Health care access
Genetics	Nutrition/Fitness
Race/Ethnicity	Social Factors (poverty, employment status, language)



Human Factors that Impact the Environment

We impact the environment and the environment impacts us. How do we impact the environment?

- Population Industry
- Mining
- Land use e.g. clearing wildlife habitats so we can live there
- Waste e.g. the garbage island in the pacific
- Recreation sunscreen used kills the coral reef when u go scuba diving
- Animal resource
- Agriculture a lot of our agricultural practices are damaging to the soil, we use up ground water
- Transportation Transportation produces a lot of greenhouse gasses which leads to climate change
- Construction clearing land, producing emissions, creating a lot of waste

HOW MANY EARTHS ARE NEEDED IF EVERYONE LIVED LIKE YOU? →

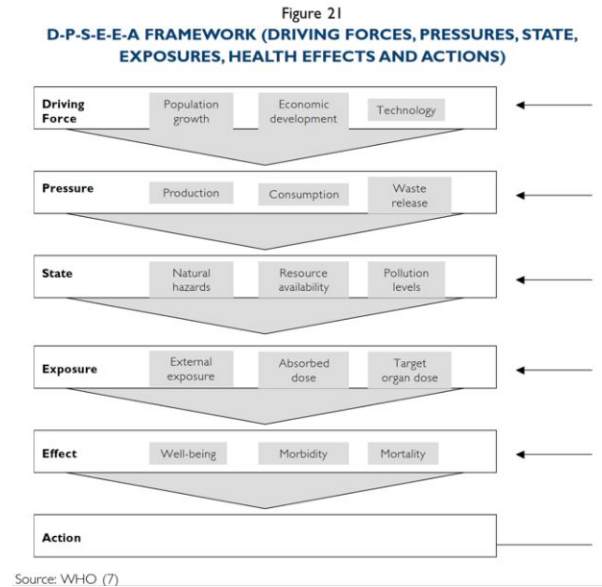
Most of us would need 5-7 earths





D-P-S-E-E-A Framework

Where do we take action? We can take action at any of these stages. It's kind of like primary/secondary/tertiary prevention.



Global Environmental Health Priorities

Environmental health issues in developing countries resulting in significant mortality: There's many more but these cause the most morbidity and mortality world-wide.

- Unsafe water, poor sanitation, and hygiene
- Indoor smoke (cookstoves)
- Vector-borne disease
- Urban air pollution
- Road traffic accidents
- Lead exposure
- Unintentional poisonings
- Climate change



Environmental Risk Transition

Less developed	More developed (industrialized)
poor water/sanitation/hygiene → Diarrheal diseases	long-term and long-range pollutant such as acid rain precursors
indoor air pollution → Respiratory diseases	ozone-depleting chemicals
poor housing quality → Infectious diseases	Nutrition/Fitness

Air Pollution Diseases & Prevention

Criteria

The US has National Ambient Air Quality Standards, and from it they developed the 7 criteria air pollutants. Basically, they set up clear standards and regulations and see if these specific pollutants are meeting the standards or not.

We're gonna talk about all of them except for lead because we've made huge advances in that area since we stopped the use of leaded gasoline.

Carbon Monoxide (CO)

- **Odorless, tasteless, colorless gas**
- **By product of combustion**

Sources:

- Primary sources are motor vehicles and anything with a combustion engine.
- Other sources: gas-powered stoves, space heaters, water heaters, generators, fireplaces, tobacco smoke, volcanoes, and forest fires.

Health effects:

- Absorbed in the blood and displaces oxygen from hemoglobin
- Fatigue, headaches, nausea, dizziness, disorientation, and visual and coordination impairment, angina, cognitive impairment and death.
- In movies when someone is sitting in a car with the exhaust plugged and they're trying to kill themselves, they're doing it via CO poisoning. The only way to detect it in homes is by using CO detectors since it is colorless and tasteless. Usually CO poisoning happens in the winter because that's when we use (faulty) heaters.

Particulate Matter (PM)

- Solid or liquid particles suspended in air
- Can be primary or secondary

Types:

- PM 10
- PM 2.5
- Nanoparticles (<0.1)

Sources:

- **Manmade:** Burning of fuels, driving unpaved roads, industrial activity, combustion process
- **Natural:** dust, mold, pollen, salt spray (in Saudi, the main one is dust.)

Health effects:

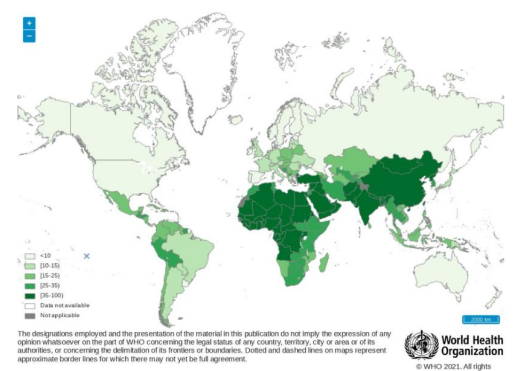
- Larger particles deposit in mucous membranes
- Smaller particles can be inhaled and penetrate into the lung and even blood stream (e.g. diesel exhaust)
- Irritation of mucous membranes (eyes, throat, nose)
- Respiratory symptoms
- Exacerbation of chronic pulmonary and cardiac conditions
- Increased ER visits, hospitalizations, and mortality

Criteria Air Pollutants

TABLE 10.2 National Ambient Air Quality Standards for Criteria Air Pollutants

Pollutant	Primary/Secondary	Averaging Time	Level	Form	
Carbon monoxide (CO)	Primary	8 hours	9 ppm	Not to be exceeded more than once per year	
	Secondary	1 hour	35 ppm		
Lead (Pb)	Primary and secondary	Rolling 3-month average	0.15 µg/m ³	Not to be exceeded	
	Primary	1 hour	100 ppb	98 th percentile of 1-hour daily maximum concentrations, averaged over 3 years	
Nitrogen dioxide (NO ₂)	Primary and secondary	1 year	53 ppb	Annual mean	
	Primary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years	
Particulate pollution (PM)	PM _{2.5}	Primary	1 year	12 µg/m ³	Annual mean, averaged over 3 years
		Secondary	1 year	15.0 µg/m ³	Annual mean, averaged over 3 years
	PM ₁₀	Primary and secondary	24 hours	35 µg/m ³	98 th percentile, averaged over 3 years
		Primary and secondary	24 hours	150 µg/m ³	Not to be exceeded more than once per year on average over 3 years
Sulfur dioxide (SO ₂)	Primary	1 hour	75 ppb	99 th percentile of 1-hour daily maximum concentrations, averaged over 3 years	
	Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year	

Modified and reproduced from US Environmental Protection Agency. Criteria air pollutants. National Ambient Air Quality Standards (NAAQS) table. Available at: <http://www.epa.gov/criteria-air-pollutants/naaqst-table>. Accessed June 18, 2017.



Global Concentrations Of Fine Particulate Matter Pm 2.5.

Saudi Arabia is not doing great in terms of fine particulate matter and that's mainly due to the environment and industry. Most other countries with high levels are developing countries.



Sulfur Dioxide (SO₂)

- Water soluble gas
- Can be converted to sulfuric acid and contributes to acid rain formation
- **Sources:**
 - Primarily produced by power plants
 - Produced from burning sulfur containing fuels; e.g. coal
 - Natural sources are volcanoes
- **Health effects:**
 - Respiratory symptoms
 - Hospitalizations from cardiovascular and respiratory causes
 - Eye irritation
 - Adverse pregnancy outcomes
 - Mortality

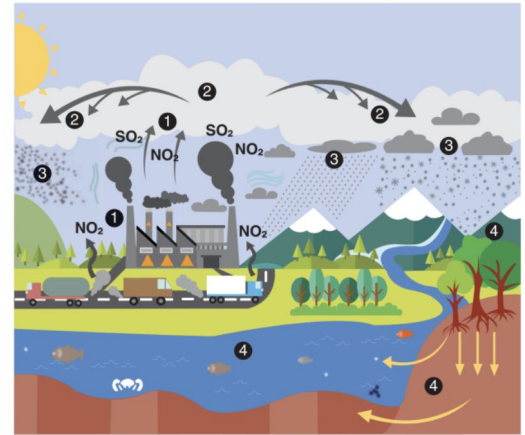


FIGURE 10.11 Acid rain pathway.

* Numbers shown in figure refer to the pathway for acid rain in our environment.

¹ Emissions of SO₂ and NO_x are released into the air.

² The pollutants are transformed into acid particles that may be transported long distances.

³ These acid particles then fall on earth as dust, rain, snow, and other materials.

⁴ The acid rain particles may cause harmful effects on soil, forests, streams, and lakes.

Reproduced from US Environmental Protection Agency. What is acid rain? Available at: <https://www.epa.gov/acidrain/what-acid-rain>. Accessed June 6, 2017.



Nitrogen Dioxide (NO_x)

- Category of gases containing nitrogen and oxygen
- Produced through combustion (احتراق) when nitrogen in air is oxidized
- Precursors of tropospheric ozone and particulate matter
- NO is a greenhouse gas (a gas that absorbs and emits radiant energy within the thermal infrared range, causing the greenhouse effect)
- NO₂ is a criteria pollutant
- **Sources:**
 - Motor vehicles, and power plants
 - Indoor kerosene heaters, non-vented gas stoves and heaters, and tobacco smoke.
 - Processes in soil, forest fires, and lightning



Volatile Organic Compounds (VOCS)

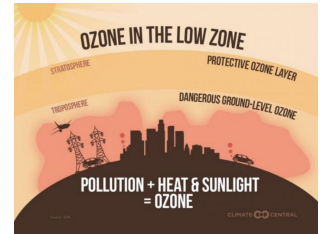
- Not a criteria but important to mention bc of their health effects and because they are a precursor of a criteria.
- Group of chemicals that readily evaporate at normal temperature and pressure
- Include benzene, chloroform, formaldehyde
- Precursors of ozone
- **Source:**
 - Produced from transportation, industrial processes
 - Half of VOCs are from transportation, particularly old poorly maintained vehicles That's why in some countries, including Saudi Arabia, cars past a certain age on the road have specific regulations.
 - Naturally from vegetation; (an assemblage of plant species and the ground cover they provide)
- **Health effects:**
 - Irritation of respiratory tract
 - Headaches,
 - **Cancer**



OZONE

Most of you know ozone as the ozone layer. That is called stratospheric ozone. The criteria ozone is tropospheric or ground-level ozone. On particularly hot days, ground ozone increases. They generally recommend that you check the weather on hot days, and it'll tell you the weather "ozone red day" or "ozone orange day", tell you the the level ozone so that particularly sensitive people do go outside or postpone it.

- Gas in the troposphere (ground-level ozone) and in the stratosphere (ozone layer)
- **Ground level ozone is harmful, but the ozone layer is protective** (GOOD UP HIGH...BAD NEARBY)
- **Source:**
 - Tropospheric ozone is formed from VOCs and Nox with sunlight
 - Concentrations are seasonal increasing during hotter months
- **Health effects:**
 - Respiratory symptoms
 - Decreased lung function
 - Increased ER visits and hospitalizations
 - Children and asthmatics are particularly sensitive



Urban Air Pollution

- Composed of PM10 and PM2.5 include pollutants such as sulfate, nitrates and black carbon
- **Source:**
 - Residential energy for cooking and heating
 - Vehicles
 - Power generation
 - Agriculture/waste incineration
 - Industry.
- **Health effects:**
 - 91% of premature deaths occurred in low and middle-income countries
 - Contributes to the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma.

4.2 million deaths every year occur as a result of exposure to ambient (outdoor) air pollution

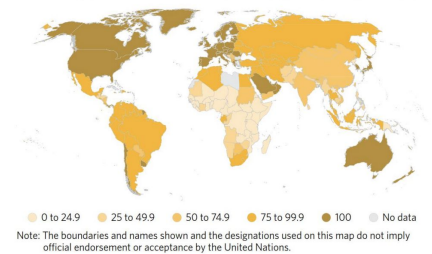
9 out of 10 people worldwide live in places where air quality exceeds WHO guideline limits



Indoor Air Pollution

- Disproportionately affects poor in low- and middle-income countries **cooking in unventilated huts**
- Rate of access to clean cooking fuels and technologies is 0.1% per year one of the SDGs (access to clean cooking fuels and technologies)
- **Source:**
 - 2.6 billion people use open fires and simple stoves fueled by kerosene, biomass, or coal for cooking
- **Health effects:** 3.8 million deaths:
 - 27% from pneumonia
 - 18% from stroke
 - 27% from ischaemic heart disease
 - 20% from COPD
 - 8% from lung cancer

Share of the population with access to clean cooking systems, 2019 (percentage)



3.8 million deaths every year as a result of household exposure to smoke from dirty cookstoves and fuels



Dust and Sandstorms

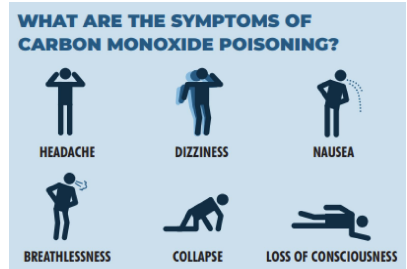
- Common weather events in arid and semi-arid regions
- **Source:**
 - Winds lift large amounts of sand and dust from bare, dry soils
 - Transport 1000s of km
 - Dust particles can contain various hazardous materials
- **Health effects:**
 - Respiratory conditions
 - CVD
 - Increased ER visits
 - Increased mortality



Air Pollution Prevention

- **Standards and regulations:**
 - National Ambient Air Quality Standards (NAAQS)
 - Removal of lead from gasoline
 - Regulating Co2 emission from vehicles
 - Cap and trade approach very popular in capitalist countries.
Basically there is a limit set for the total CO2 that can be produced by ALL industry, then factories that have reached their limit can buy credits for emissions from other factories.
 - Regulations targeting environmental change (e.g. desertification)
 -
- **Education and awareness**
 - Ozone action days
 - Carbon monoxide awareness month

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
<i>When the AQI is in this range:</i>	<i>...Air quality conditions are:</i>	<i>...As symbolized by this color:</i>
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for sensitive groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very unhealthy	Purple
301 to 500	Hazardous	Maroon



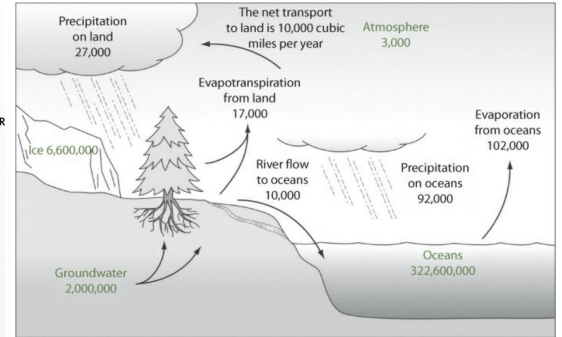
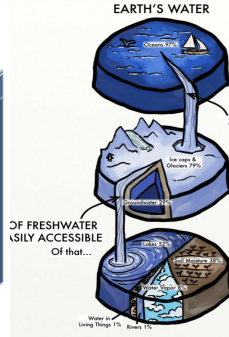
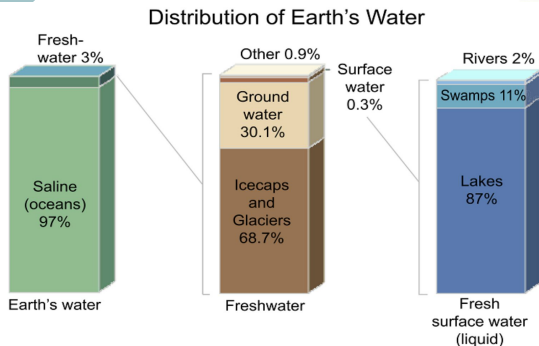
Air Quality in Saudi Arabia

- In 2012 the Kingdom of Saudi Arabia's Presidency of Meteorology and Environment produced a new national environmental Standards for 3 different air quality standards:
 - Ambient Air Quality
 - Mobile Source Emissions
 - Emissions from Stationary Sources
- What's the air quality in [Riyadh now?](#)

Water Pollution Diseases & Prevention

Where Do Humans Get Water From?

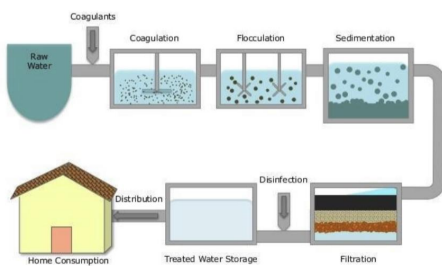
Even though the earth is covered in a lot of water its not that easy to access.



The Hydrological Cycle

Water Treatment

Water Treatment Process



- Processing of water takes place in water treatment plants
- There are four stages of water treatment : coagulation, sedimentation, filtration, and disinfection.
- In Saudi Arabia we mainly use desalinated water.
- Disinfection: Chlorine but it produces a chlorine by-product which is bad for our health so we're developing new technologies using UV, OZONE that have less of an effect.

Microbial Water pollution

Table 16.7 The Indicator Approach to Monitoring Water Quality

Indicator	What does it indicate	Limitations
Coliforms	Presence of the coliform group of bacteria, many of which are present in human or animal fecal material.	Certain coliforms grow naturally in drinking-water biofilms, particularly at warmer temperatures. Not indicative of protozoa or viruses.
<i>E. coli</i>	Presence of <i>E. coli</i> ; strong indication of fecal contamination.	Inactivated more rapidly than other pathogens. Not indicative of protozoa or viruses.
Coliphages	Indicative of the presence of viruses specific to <i>E. coli</i> .	May or may not be indicative of viral pathogens. Not indicative of protozoa or bacteria.
Enterococci	May be indicative of presence of animal wastes as well as human waste.	Not indicative of protozoa or viruses.
<i>Clostridium</i>	Spore-forming bacteria; anaerobes; protozoa.	Not indicative of viruses.
<i>Pseudomonas</i>	Survives in drinking-water biofilms; may indicate presence of bacterial pathogens that are more persistent than coliforms.	Not indicative of protozoa or viruses.
Aeromonads	Survive in drinking-water biofilms; may indicate presence of bacterial pathogens that are more persistent than the coliforms.	Not indicative of protozoa or viruses.
Human-specific <i>Bacteroides fragilis</i>	Indicative of the presence of viruses specific to <i>B. fragilis</i> ; may be present when coliphages are absent.	May or may not be indicative of viral pathogens. Not indicative of protozoa or bacteria.
Turbidity	May indicate that the water exceeds turbidity regulations. Some studies show increased risk for waterborne disease at high turbidity (pathogens adhere to particles).	Measures only turbidity; cannot be directly correlated to pathogen loading.
Residual chlorine	Measures the disinfectant residual at the tap. Absence of residual chlorine has been shown in some studies to be consistent with waterborne disease.	Measures only residual chlorine; cannot be directly correlated to pathogen loading.

- Water can be contaminated with various organisms including bacteria, viruses, helminths, protozoa
- Surface and groundwater contamination due to poor sanitation primarily
- Human health effects occur due to ingestion or other contact with polluted water
- Examples: Cholera, schistosomiasis (bilharzia) very common in Egypt, cryptosporidiosis resulted in the biggest water-borne outbreak in US history in 1993, affecting 400K people, cercariasis (swimmers itch) just from contact with your skin, legionellosis (respiratory) from hot tubs or spas, there was also a big outbreak in the US at a conference bc it was in the ventilation systems
- Technically the water in Saudi Arabia is drinkable, the problem is with the جراباب، so install a water filter if you can., and avoid plastic bottles.

Chemical Water pollution

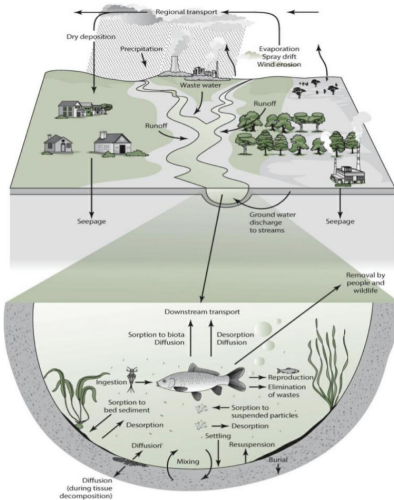


Figure 16.3 Pesticide Movement in the Hydrological Cycle, Including Movement to and from Sediment and Aquatic Biota in a Stream

Anthropogenic

- Point source: a stationary location or fixed (one location) facility from which pollutants are discharged. E.g. a pipe, industrial plant, ship
- Example: in Minamata Japan, there was a chemical plant that discharged mercury into the bay that the local population relied on fully for fishing and resulted in widespread poisoning and minamata disease (mercury poisoning at very high levels)
- Nonpoint sources are diffuse pollution sources without a single point of origin. E.g. runoff rainwater washes all the dirt (agriculture, factories) and goes somewhere. In the US, they close down the beaches after it rains bc the sewers overflow into nearby oceans and rivers.
- Other examples: leaching of wastes into groundwater, lead leaching from old drinking-water pipes, and pharmaceuticals and personal care products (PPCPs) that are released into water from human sewage.

Water Sanitation and Hygiene WASH

What is clean water?

Water that is free from:

- disease-causing microbes including bacteria, viruses, protozoa, and worms
- High concentrations of anthropogenic chemical contaminants (e.g. pesticides, nitrates, microplastics, other industrial pollutants)
- High concentrations of naturally occurring contaminants such as arsenic and fluoride

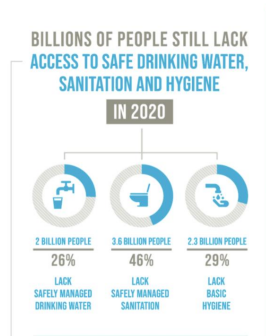
What is basic sanitation?

Sanitation facilities that are effective in separation of excreta from human contact and prevention of human fecal pollution of the environment.

Examples:

- Flush or pour-flush toilets
- Latrine connected to a pipe sewer Septic tank
- Pit latrine
- Composting toilet

Global wash sanitation



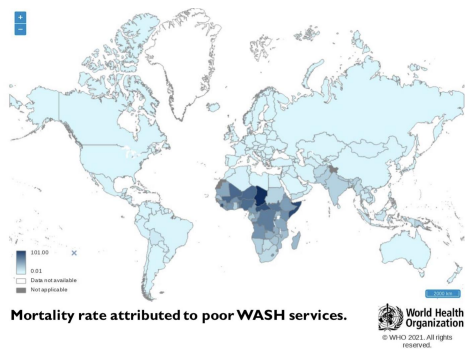
- 771 million people lack even basic drinking water
- 1.7 billion people without basic sanitation
- 494 million practice open defecation
- 1 in 3 people lacked basic handwashing at home and 670 million had no handwashing facility at all

Wash associated health effects

- Diarrheal diseases
- Schistosomiasis
- Soil transmitted helminth and trachoma infections
- Respiratory tract infections
- Malnutrition
- Vector-borne diseases (e.g. Malaria)

Table 1. | Disease burden from inadequate WASH, 2016*

DISEASE	DEATHS	DALY'S (THOUSANDS)	POPULATION-ATTRIBUTABLE FRACTION
Diarrhoeal diseases	828 651	49 774	0.60
Soil-transmitted helminth infections	6 248	3 431	1
Acute respiratory infections	370 370	17 308	0.13
Malnutrition ^a	28 194	2 995	0.16
Trachoma	<10	244	1
Schistosomiasis	10 405	1 096	0.43
Lymphatic filariasis	<10	782	0.67
SUBTOTAL: drinking-water, sanitation and hygiene	1 243 869	75 630	NA
Malaria	354 924	29 708	0.80
Dengue	38 315	2 936	0.95
Onchocerciasis	<10	96	0.10
SUBTOTAL: water resource management	393 239	32 740	NA
Drownings	233 890	14 723	0.73 ^b
SUBTOTAL: safety of water environments	233 890	14 723	NA
TOTAL: inadequate water, sanitation and hygiene	1 870 998	123 093	NA



Other wash associated effects



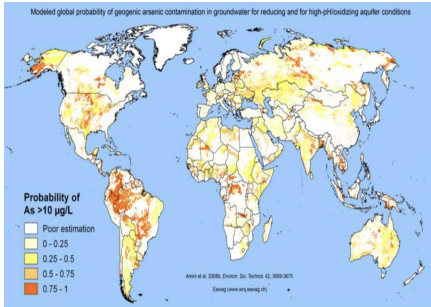
HARMFUL CHEMICALS FROM HUMAN ACTIVITIES AND INDUSTRIAL WASTES SUCH AS PESTICIDES AND FERTILISERS.



CHEMICALS AND MINERALS FROM THE NATURAL ENVIRONMENT, SUCH AS ARSENIC, COMMON SALTS AND FLUORIDES.



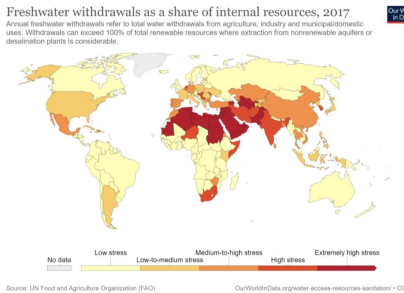
Arsenic contamination in water



- Arsenic is naturally-occurring contaminant in groundwater affecting 140 million people in 50 countries.
- Long term exposure can cause skin lesions (arsenicosis) and cancer.
- Exposure has also been associated with cardiovascular disease and diabetes
- In utero and early childhood exposure is linked to negative cognitive development
- In Bangladesh 1.4 million tube wells have high levels of naturally occurring arsenic
- Has nothing to do with whether or not the country is developed



Water scarcity



- When a resource is extracted faster than it is renewed.
- More developed countries consume more water.
- Less developed consume a larger proportion for agriculture.
- Temporary disruptions of water affect those is less developed countries.



Water and health in Saudi Arabia



- Extremely water scarce area
- Consume 4 times the renewal rate
- Ranked third in consumption after the US and Canada
- Relies heavily on water desalination
- The majority of wastewater is not reused
- Water conservation is one of the goals of Vision 2030
- Qatrah is a program by the National Water Company that aims to decrease Saudi Arabia's consumption of water

Quiz

MCQ438

1- What is the most serious environmental effect posed by hazardous wastes?

- A. Air pollution
- B. Contamination of groundwater
- C. Increased use of land for landfills
- D. Destruction of habitat

2- A company would do an outdoor concert in June, they brought a contractor to build a temporary stage, and the concert was informal. Which of the following hazards could happen?

- A) Hypothermia, trauma injury, food poisoning
- B) Hyperthermia, trauma injury, food-borne diseases
- C) Hypothermia, poor airway circulation, air pollution
- D) Heat stroke, poor airway circulation, food-borne diseases

3- Exposure to which of the following hazardous materials results in instantaneous reactions?

- A. Aerosolized zinc
- B. Ammonia gas
- C. Asbestos
- D. Lead

4- What is the first stage of risk assessment?

- A. Exposure assessment
- B. Issue identification
- C. Toxicity study
- D. Risk characterization

5- What is the main objective of risk characterisation?

- A. Estimation of the potential for adverse health or ecological effects to occur from exposure to a stressor
- B. Determination of pathways
- C. Estimation of exposure
- D. Collection of data

Answers

Q1	Q2	Q3	Q4	Q5
A	B	B	B	A

Dr Quiz439

Q1: What is an ozone red day?

Q2: The primary contributor to particulate matter in Riyadh is:

- A) Dust
- B) Combustion products from vesicles
- C) By products from cement industry
- D) By products of oil refineries

Answer: A

Thank You and
Good Luck

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Wish you all
the best!