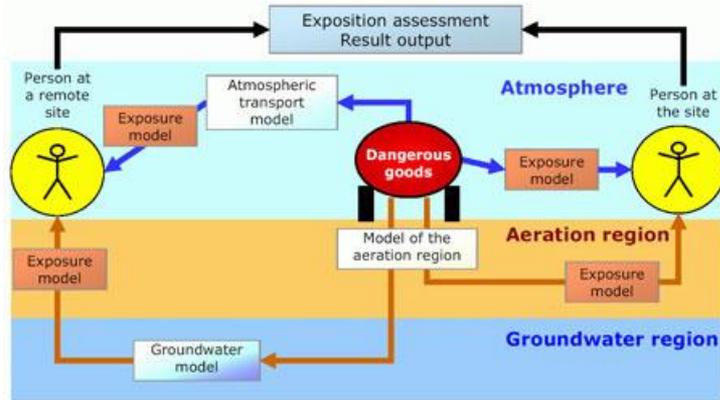


Special Issues in Energy Financing & Risk Management

# Environmental Impact Assessment & Environmental Risk Assessment



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PROFESSOR

October 2023

Conceptual model for the environment:

**1. Atmosphere**

- air pollution

**2. Hydrosphere**

- water pollution

**3. Lithosphere or geosphere**

- soil and subsoil
- erosion

**4. Biosphere**

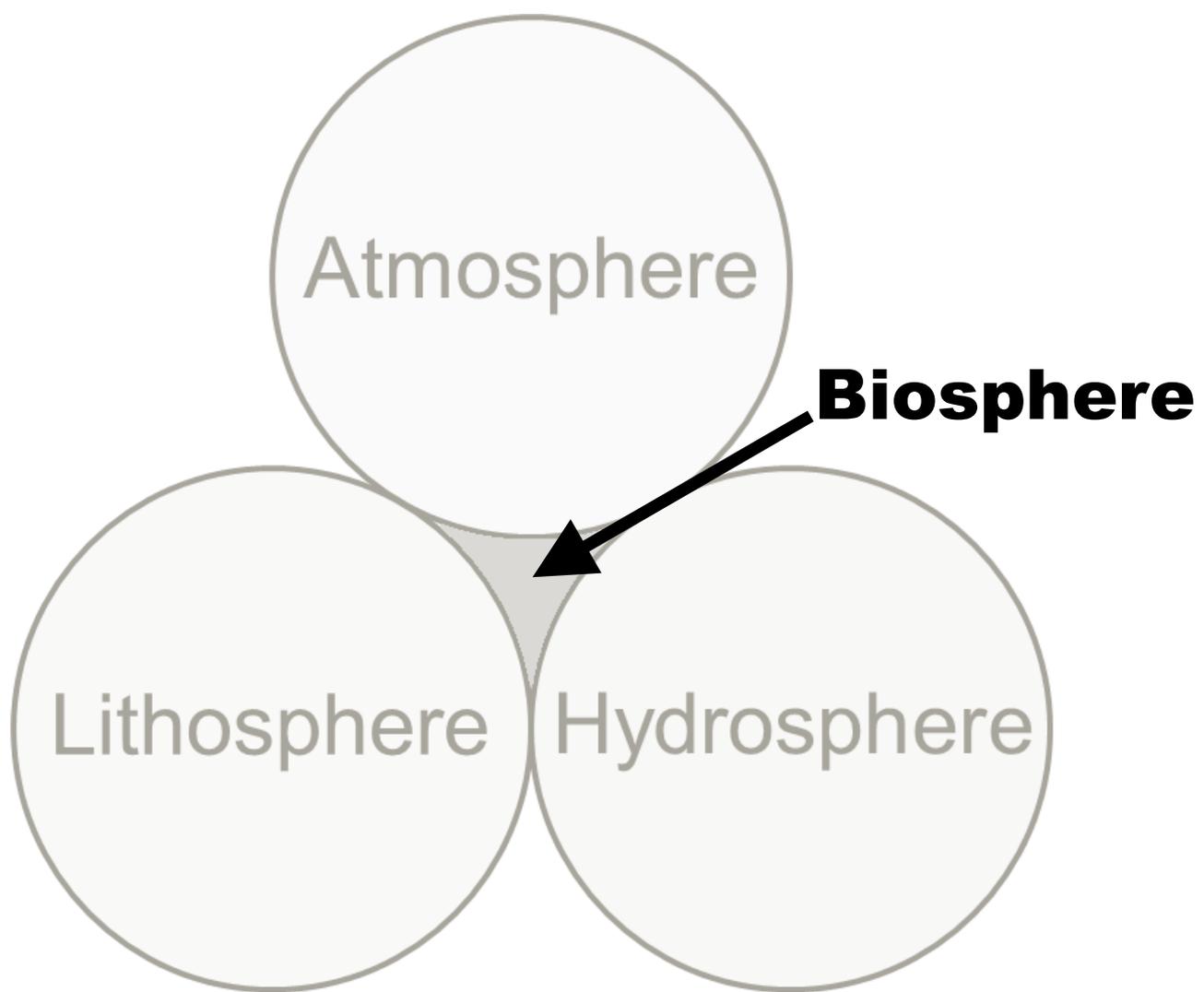
- fauna and flora
- ecosystems

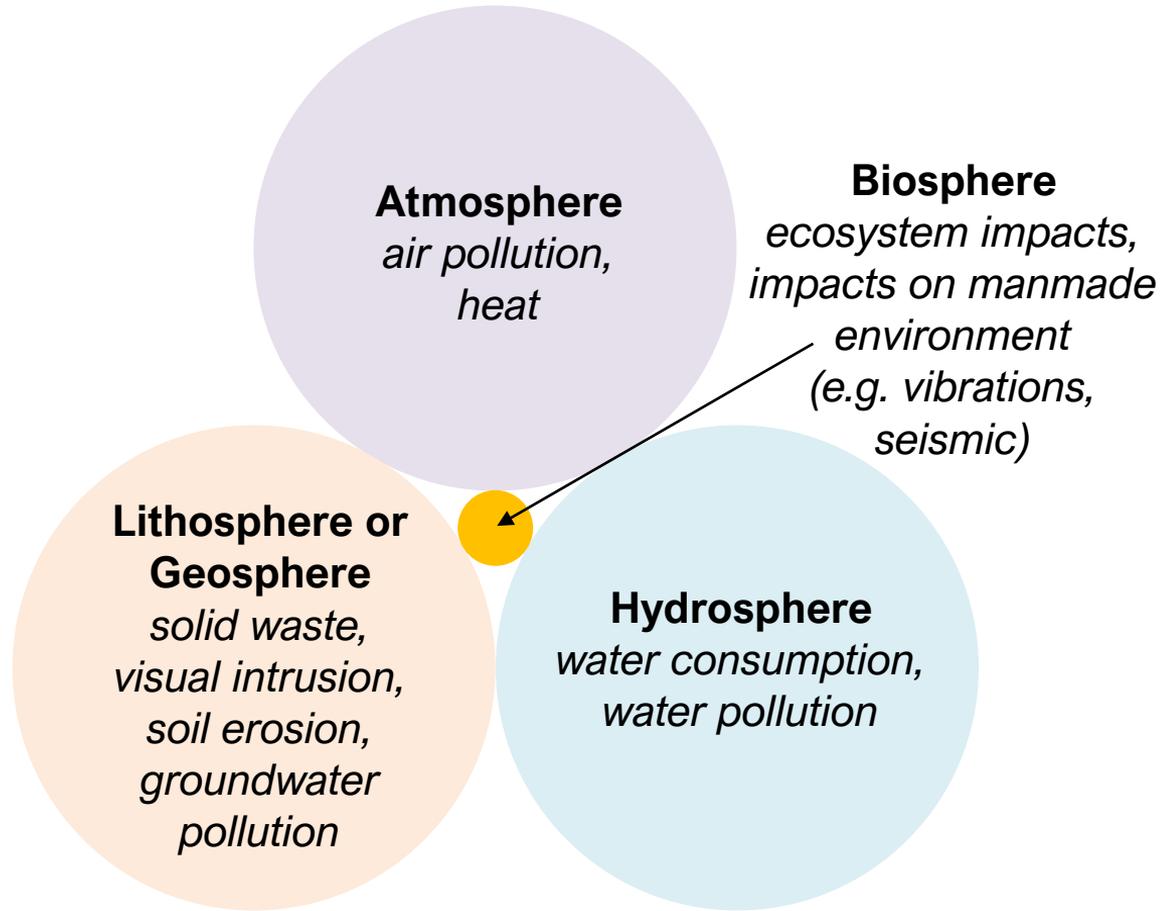


Atmosphere

Lithosphere

Hydrosphere





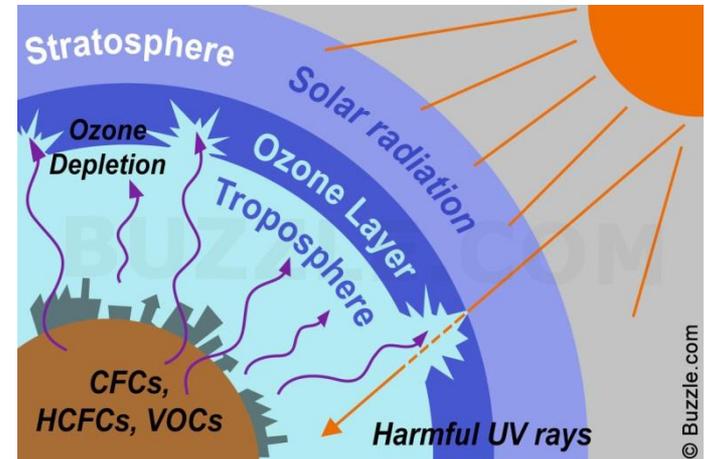
In the **atmosphere** we encounter local and global problems.

**Global** problems:

- global climate change/global warming (and the greenhouse effect)
- ozone (layer) depletion

**Local** problems:

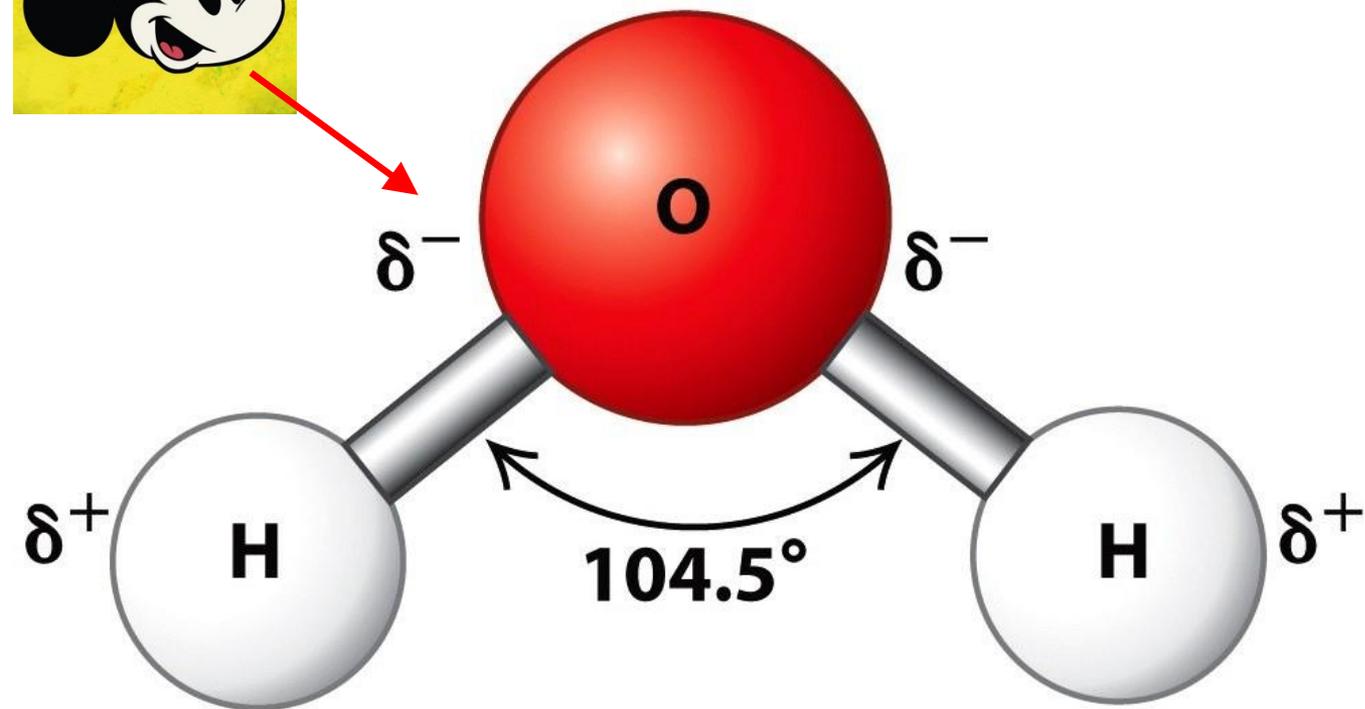
- traffic pollution (cars).



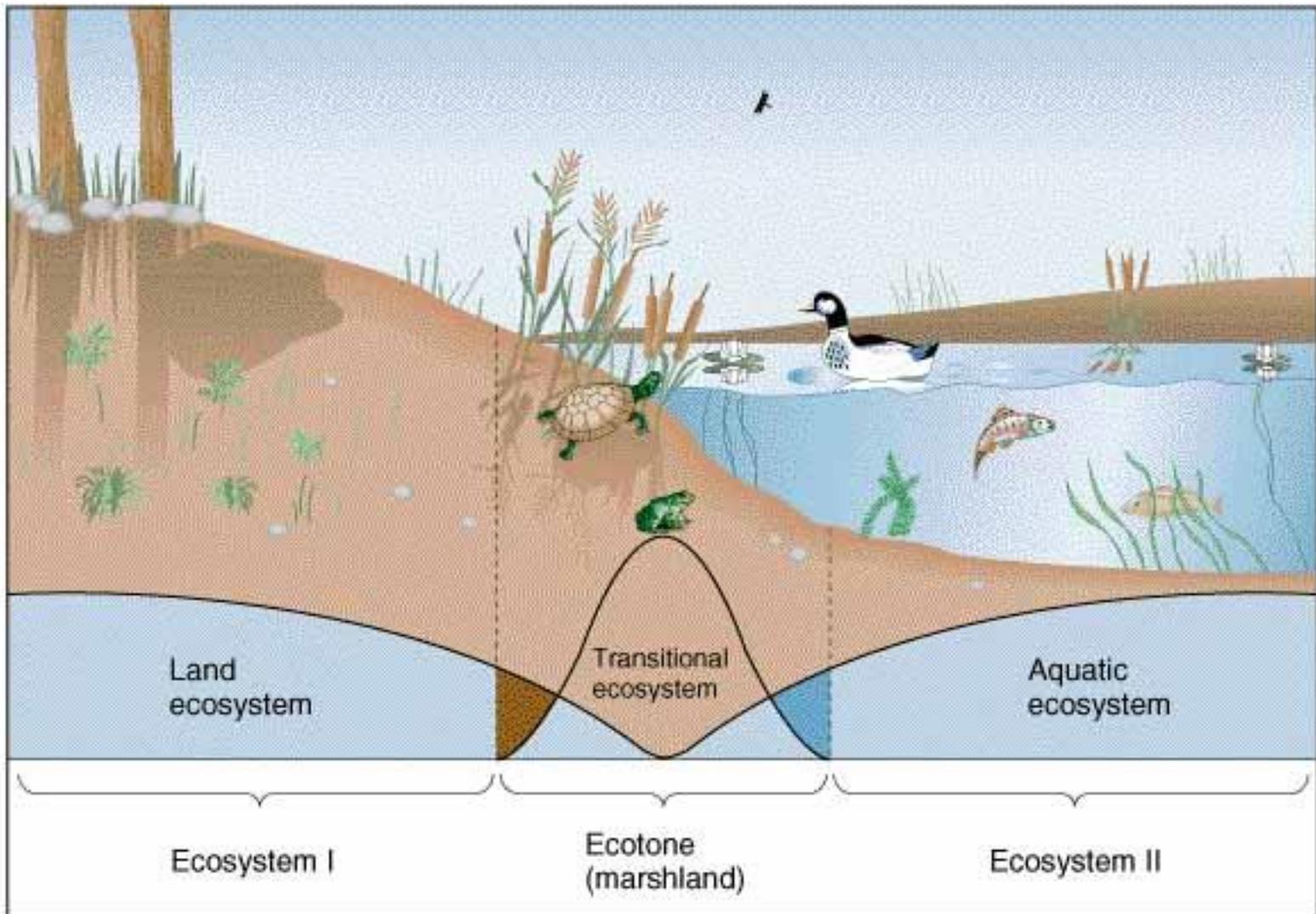
The **hydrosphere** contains saltwater (oceans, seas) and freshwater (lakes, rivers, wetlands, groundwater).

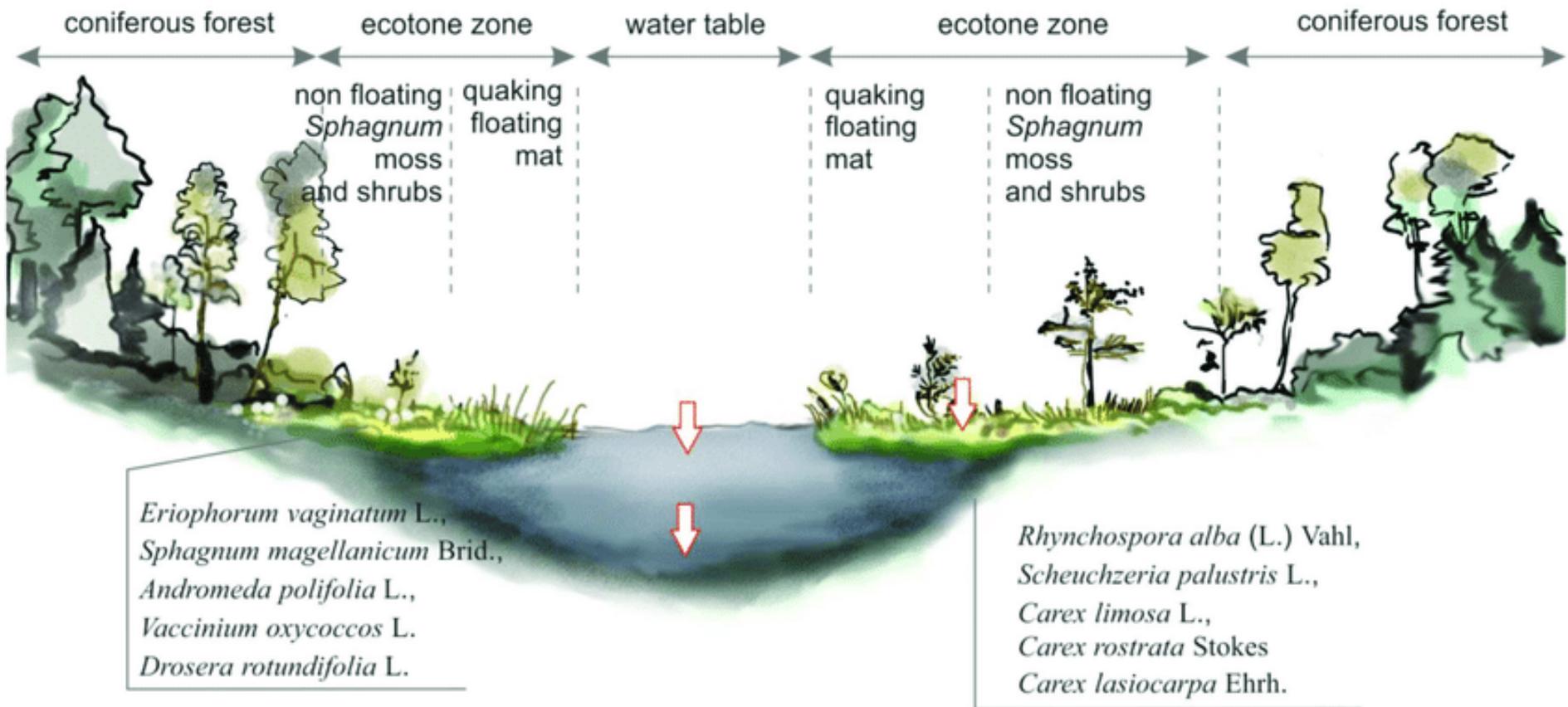
An **ecotone** is the transition area between two biomes, e.g. freshwater and saltwater in wetlands.

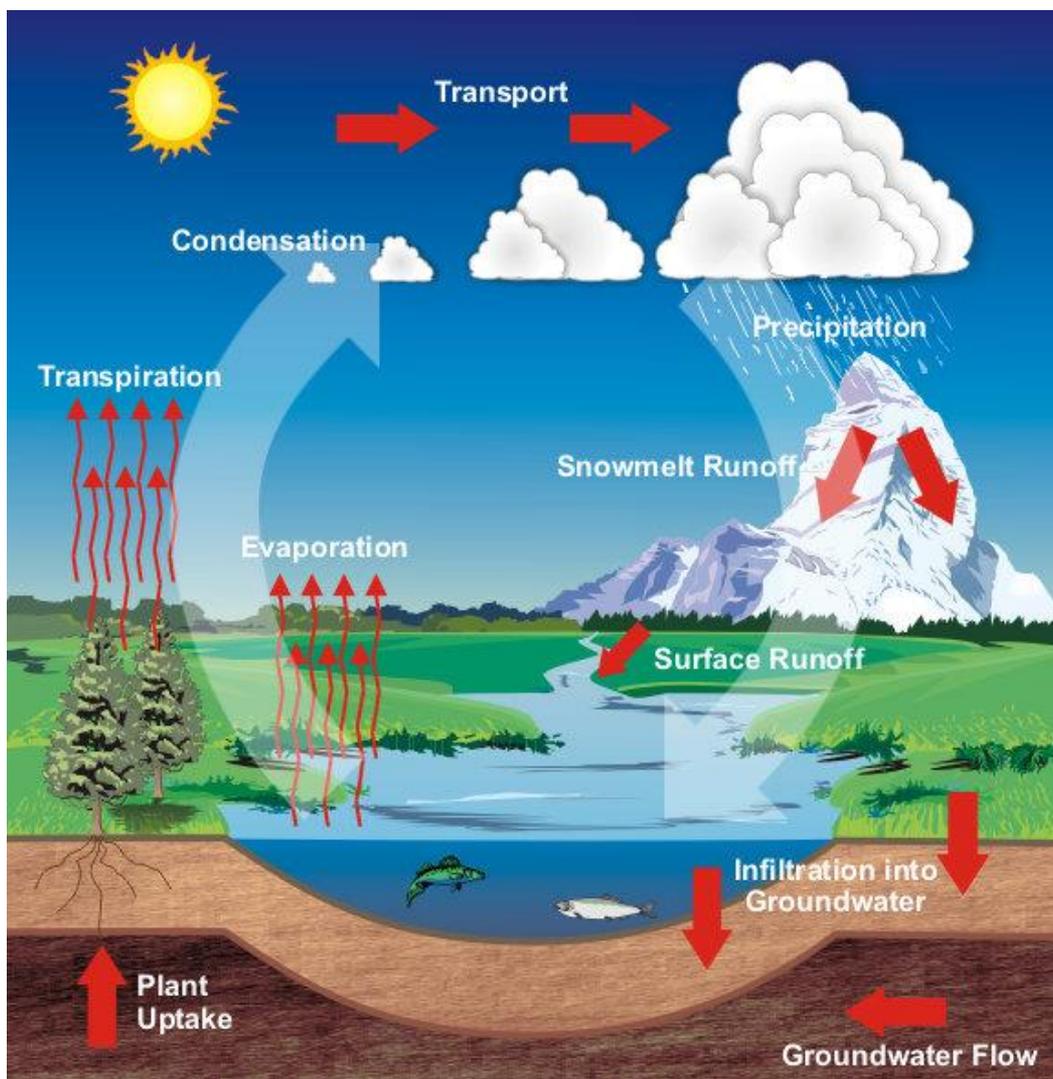
Water circulates via the **hydrologic cycle**.



A vertical double-headed arrow with a minus sign ( $-$ ) at the top and a plus sign ( $+$ ) at the bottom. To the right of the arrow, the text "Dipole moment" is written in bold black font.







The **lithosphere** (or geosphere) contains the soil:

Soil = Dirt + Water + Air + Life

Problems of the lithosphere include soil erosion and groundwater pollution.

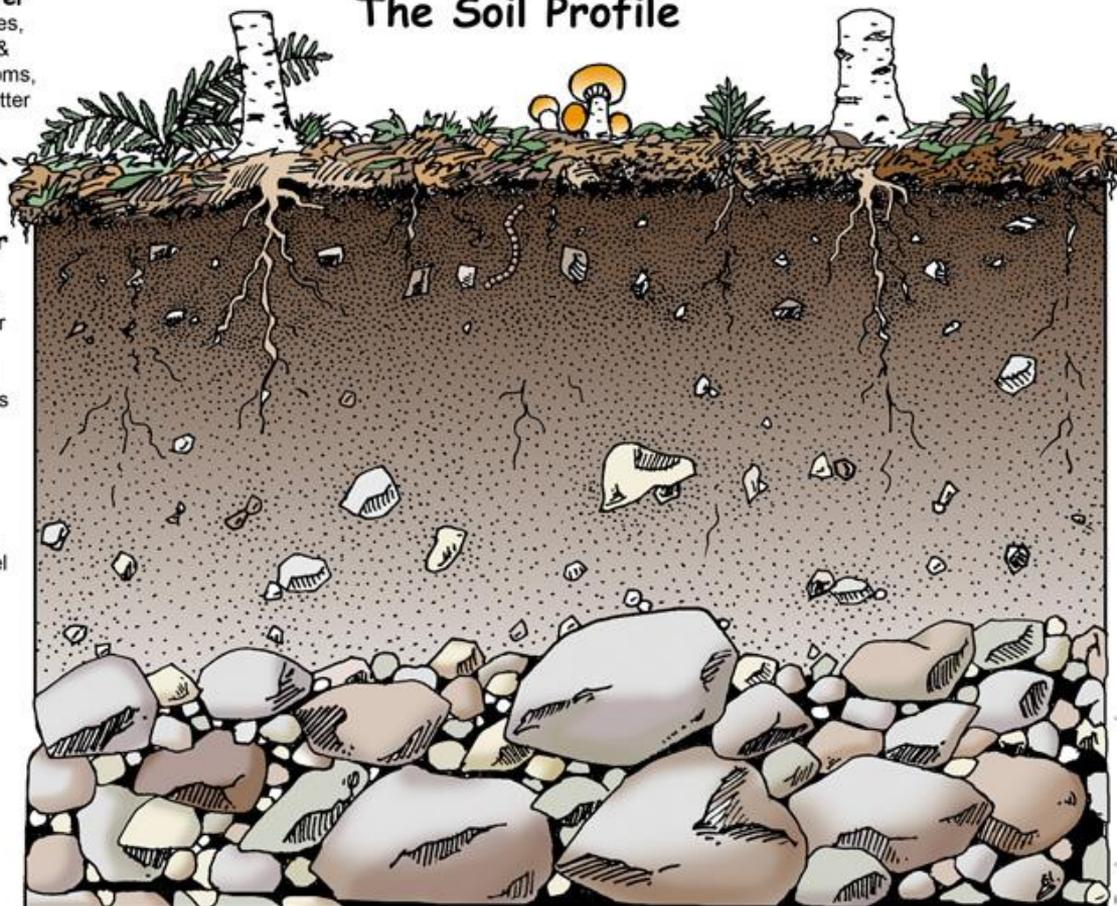
# The Soil Profile

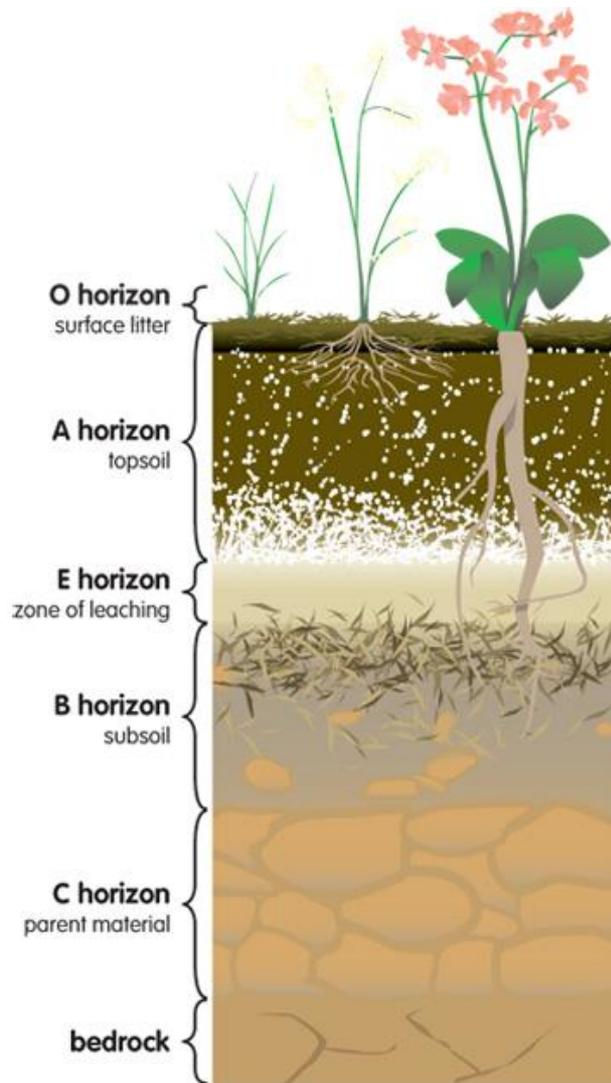
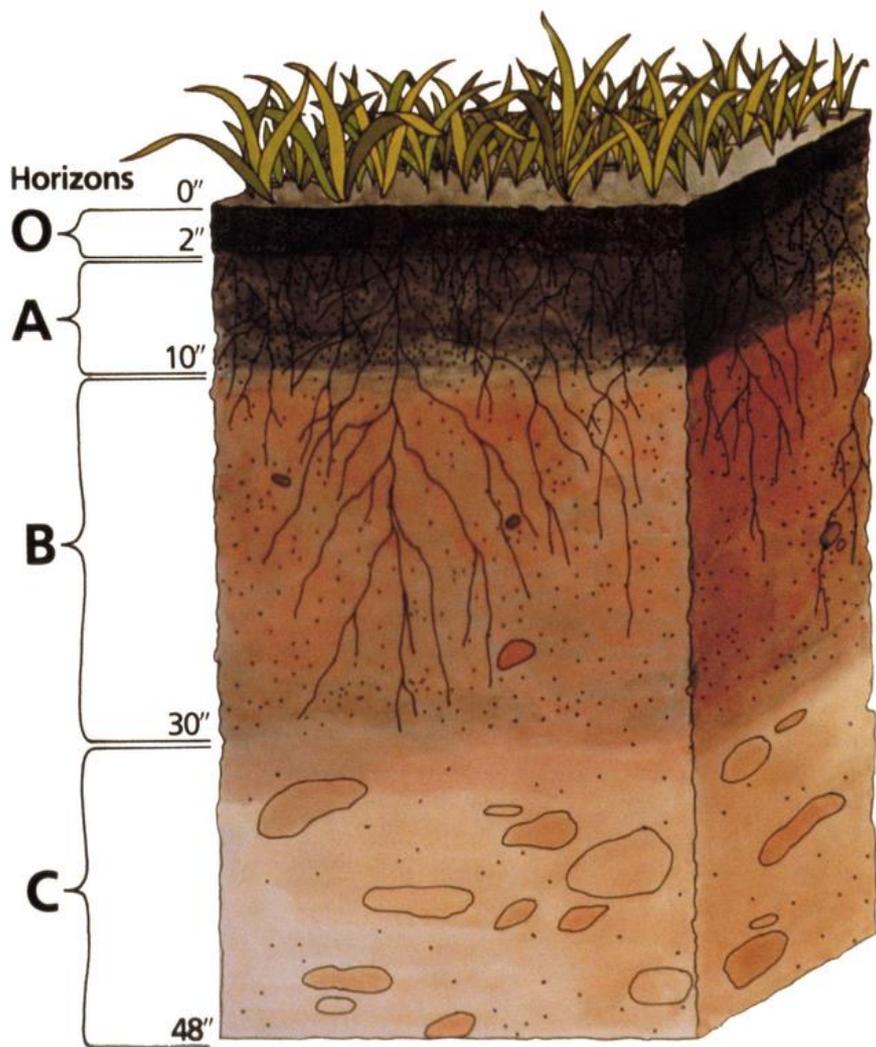
**Surface Litter**  
leaves, branches,  
animal scats &  
bodies, mushrooms,  
other rotting matter

**Topsoil Layer  
(or humus)**  
rotting organic  
matter from litter  
layer and  
minerals from  
weathering rocks

**Subsoil**  
crumbling rock,  
sand, clay, gravel  
and silt

**Parent  
Material**  
actual bedrock  
underlying the  
soil layers

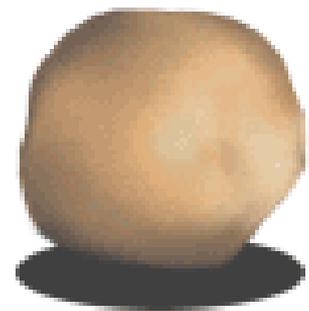




GRAVEL



SAND



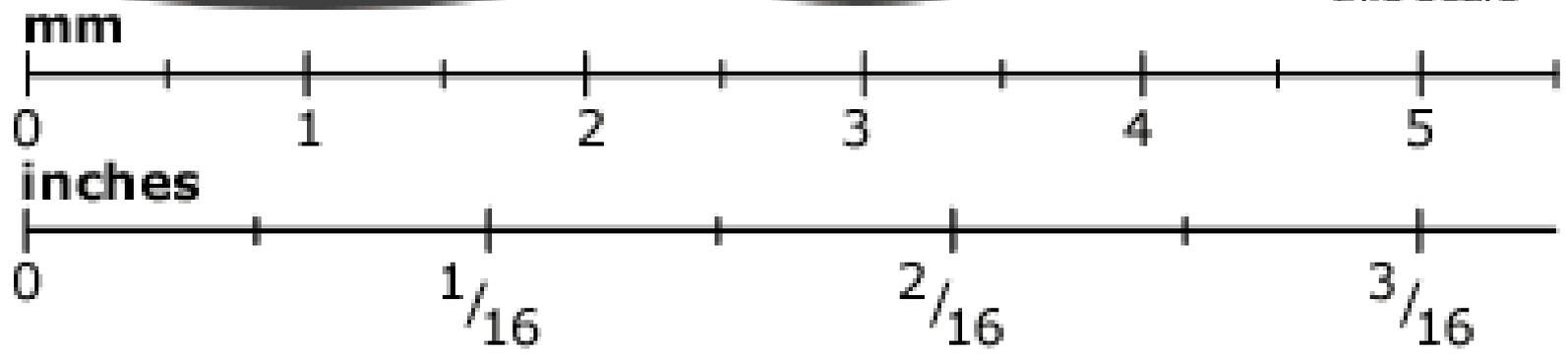
SILT



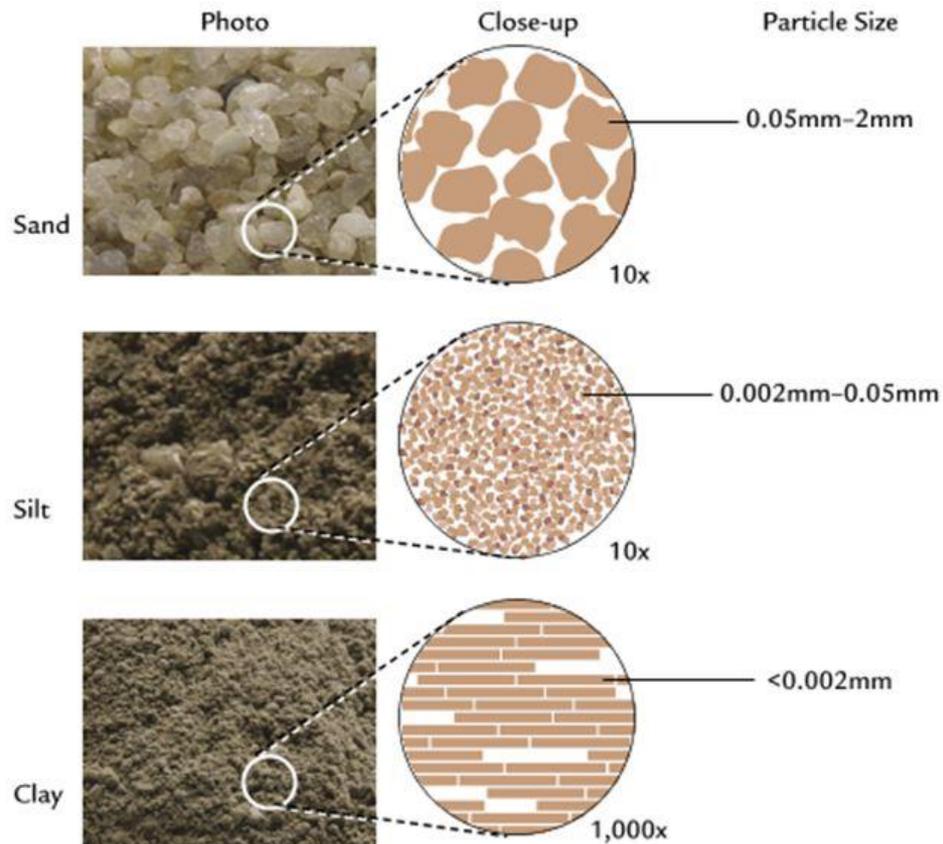
CLAY



invisible at this scale



# Sand, Silt, and Clay

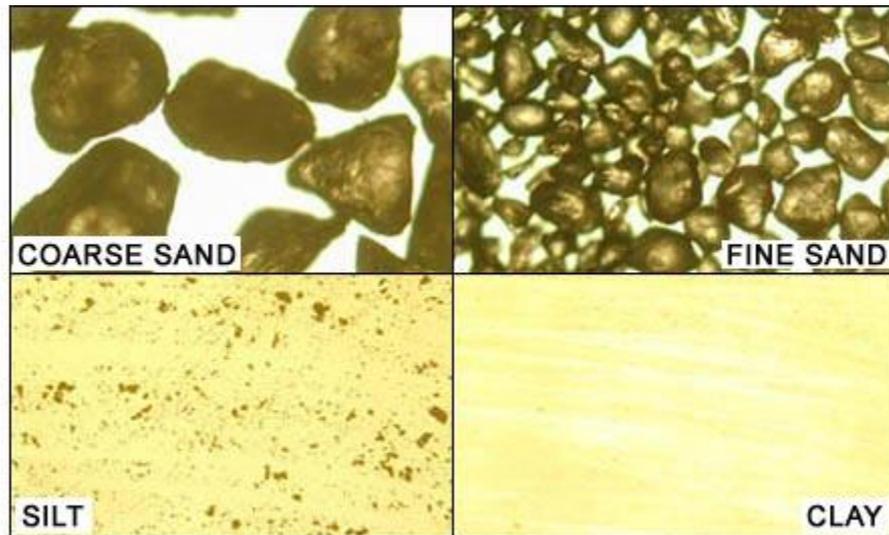




**Sand**

**Silt**

**Clay**



**COARSE SAND**

**FINE SAND**

**SILT**

**CLAY**

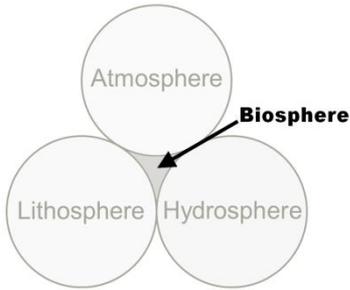
PHOTO CREDIT: VAHE PEROOMIAN

**TYPES OF ROCK GRAINS**

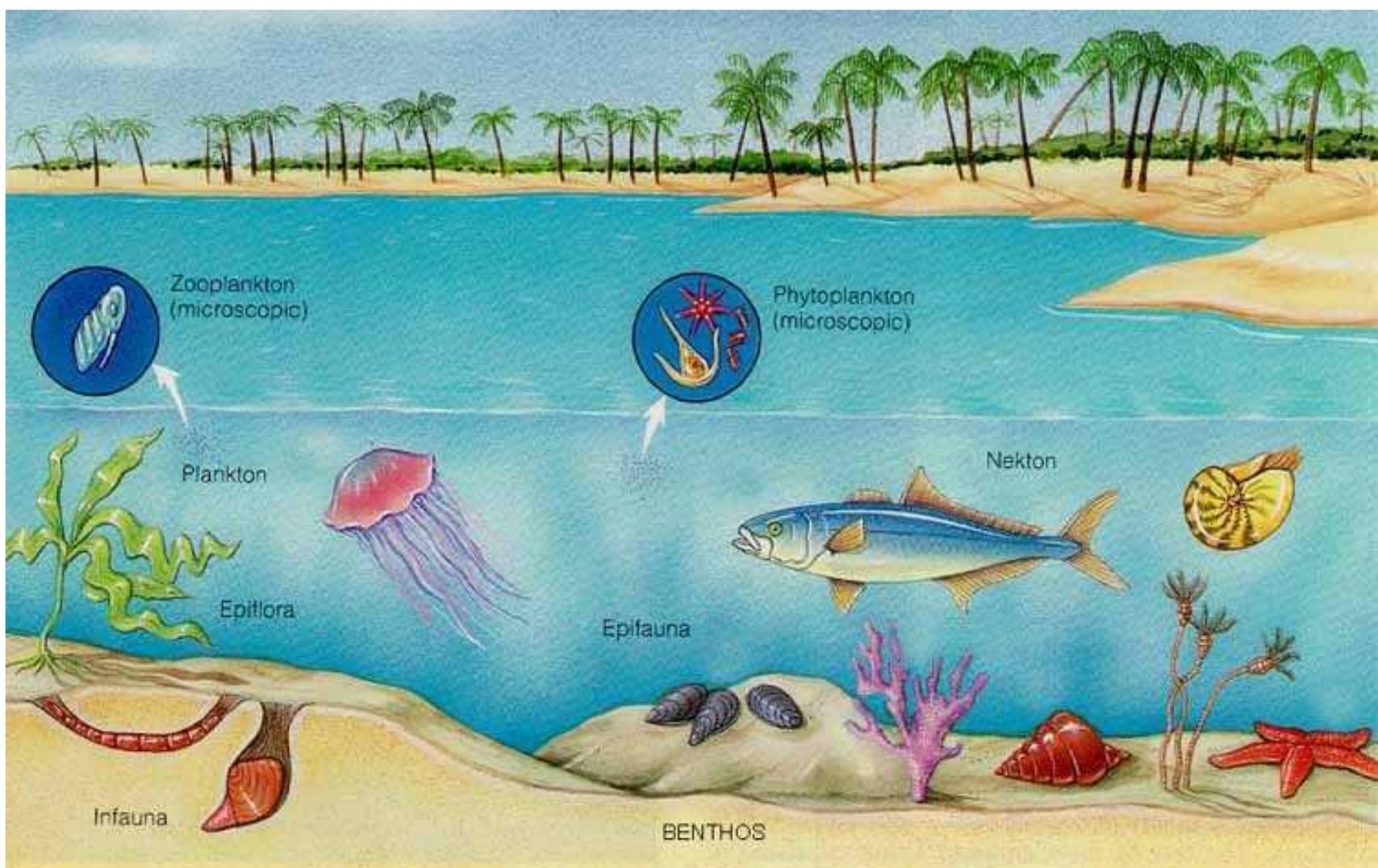
Ability of  
Sand, Silt, and Clay Particles  
to Conduct Water

<https://youtu.be/cC7SPH2KEY4?t=19>

The **biosphere** lives at the intersection of the other spheres:

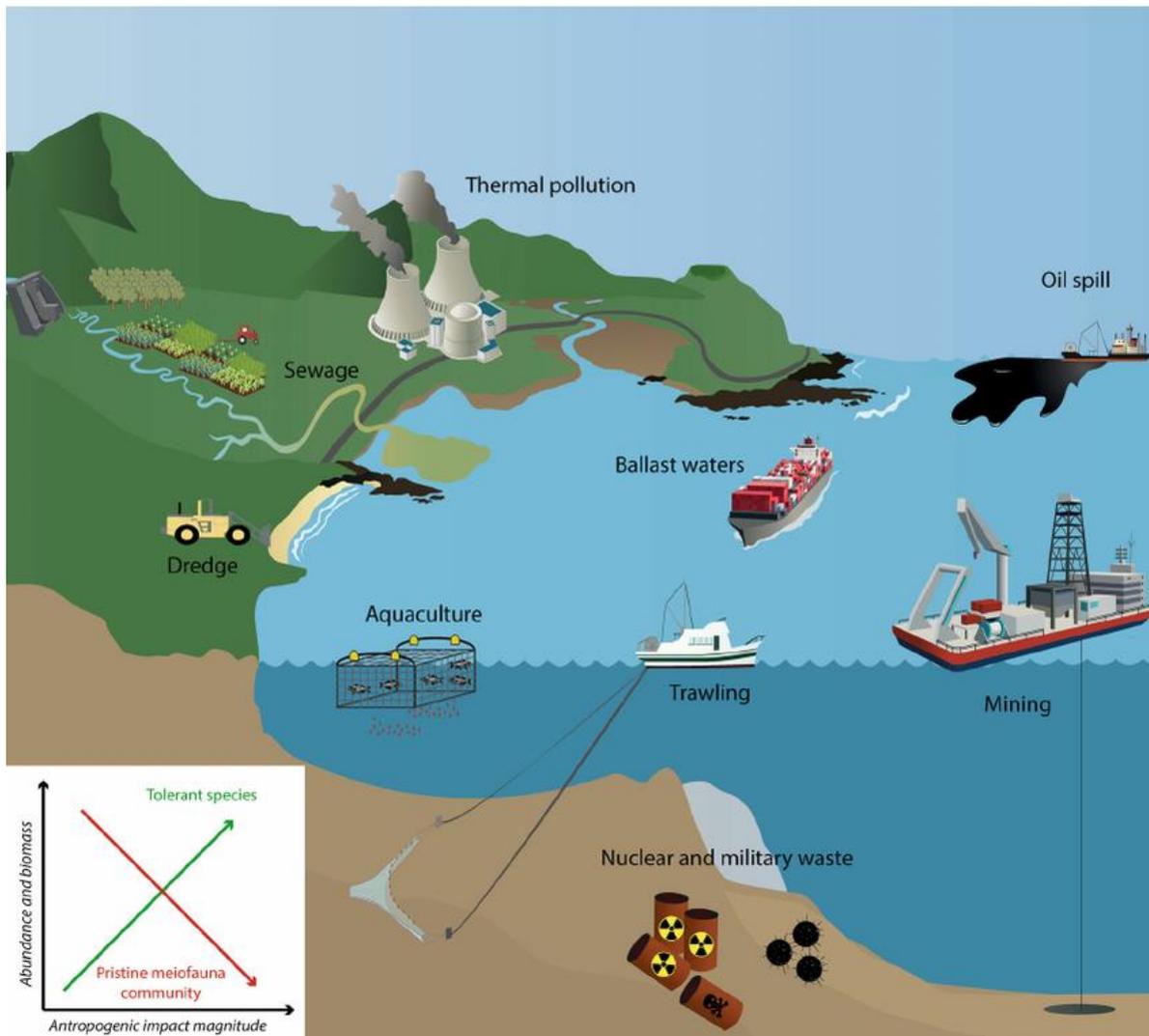


- Between atmosphere and lithosphere  
✓ surface of earth
- Between hydrosphere and lithosphere  
✓ bottom of sea (benthos)
- Between atmosphere and hydrosphere  
✓ surface of sea



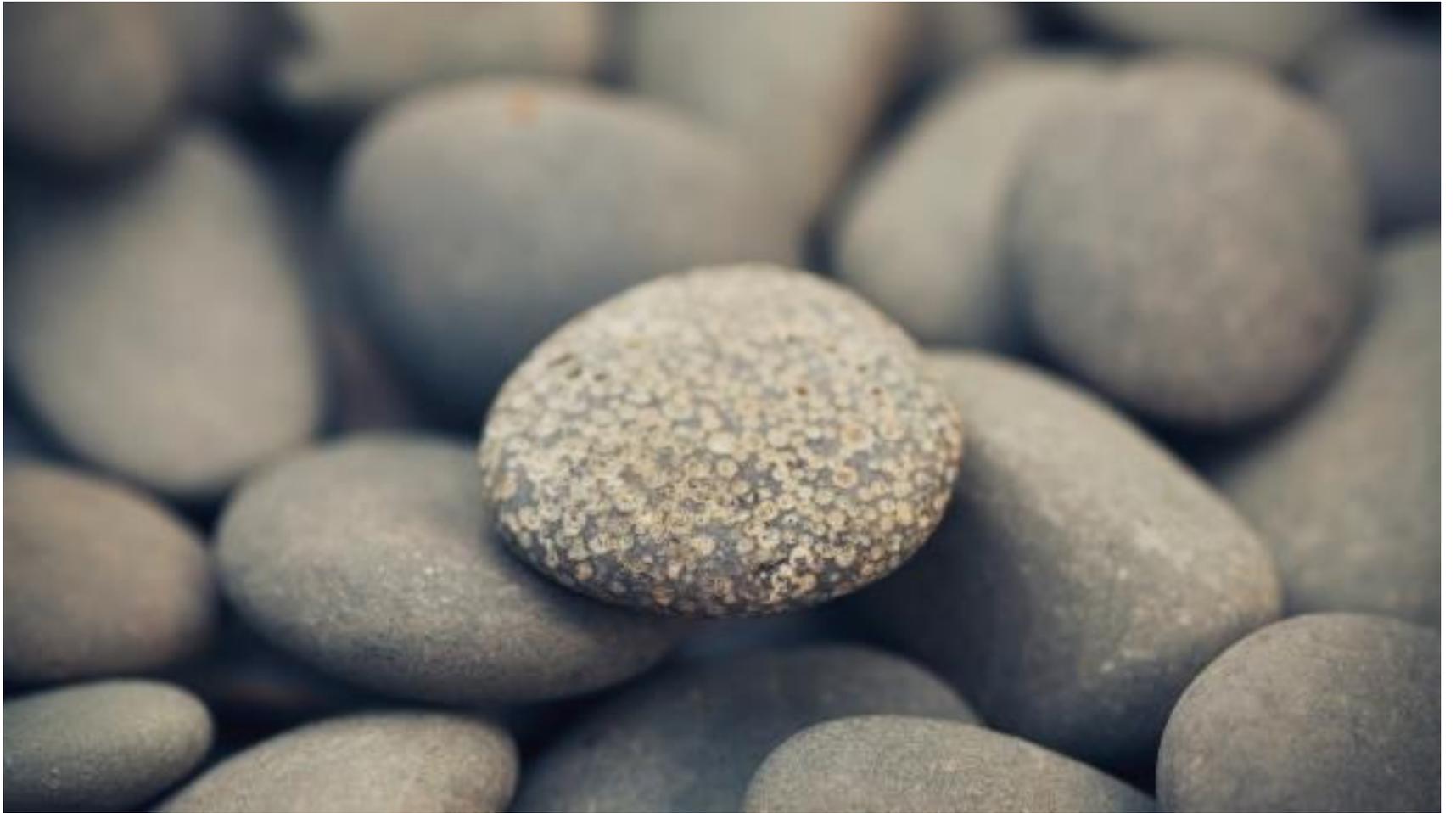
## **Natural** and **anthropogenic** environment:

- natural environment contains animals (fauna) and plants (flora)
- anthropogenic environment contains men, cities, transportation infrastructure, industries, mining, agriculture, shipping etc.



## Biotic and abiotic components of the environment:

- Biotic components include the biosphere (flora and fauna)
- Abiotic components include the other three spheres, i.e. atmosphere, lithosphere and hydrosphere
  - ✓ rock (*but not all rocks are just rocks*)
  - ✓ stream
  - ✓ cloud.







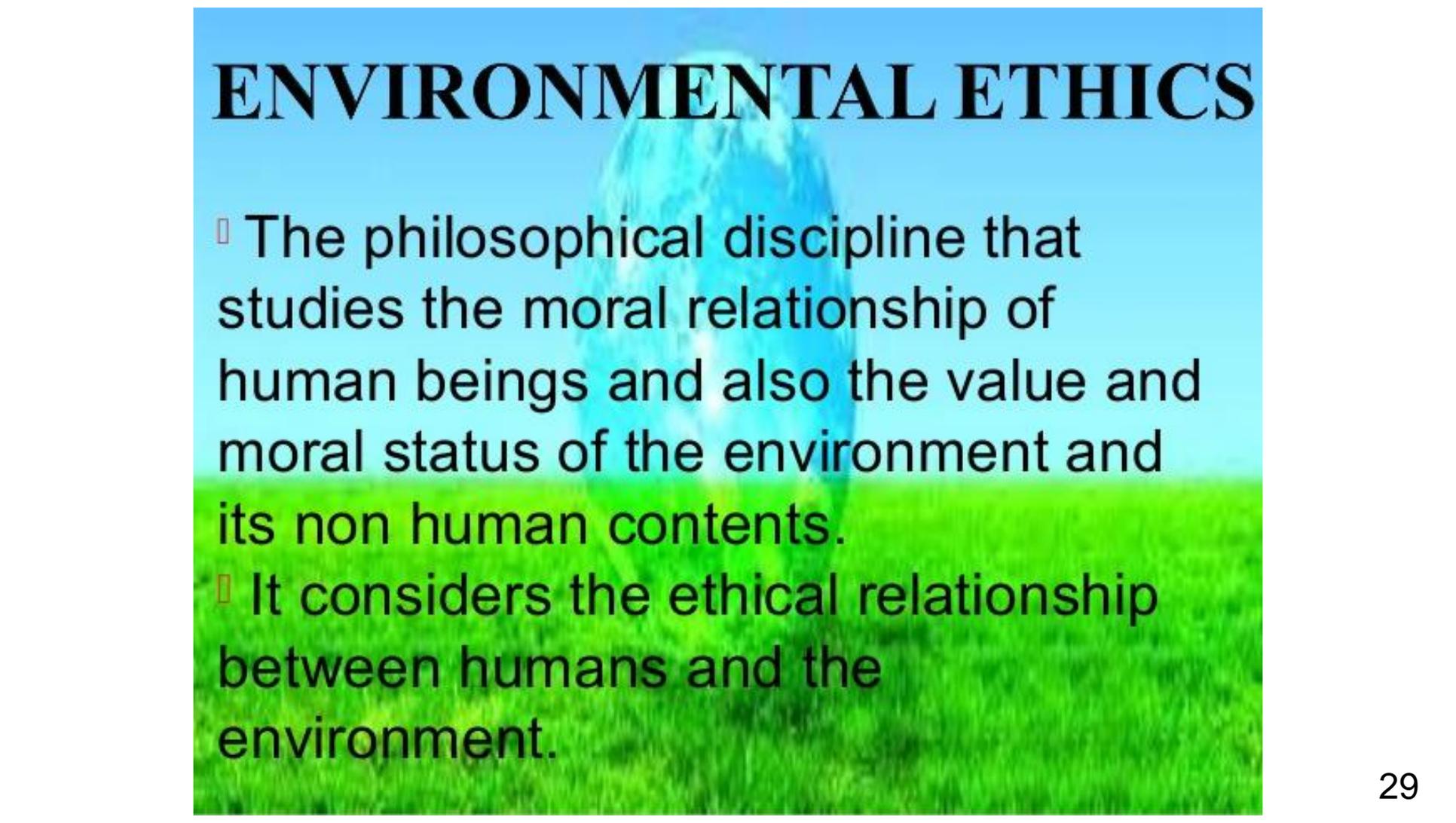
# Stonehenge



# Acropolis (Athens)



# ENVIRONMENTAL ETHICS



- ▮ The philosophical discipline that studies the moral relationship of human beings and also the value and moral status of the environment and its non human contents.
- ▮ It considers the ethical relationship between humans and the environment.



# Environmental Ethics

- Anthropocentrism
- Non-Anthropocentrism
- Biocentrism
- Ecocentrism

# ARE ANIMALS MORAL AGENTS?

- Moral agent
  - Responsible for own actions
  - Deciding whether an action is right or wrong
  - Altruism and protection of the vulnerable



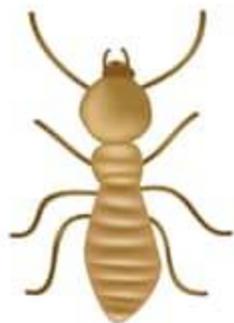




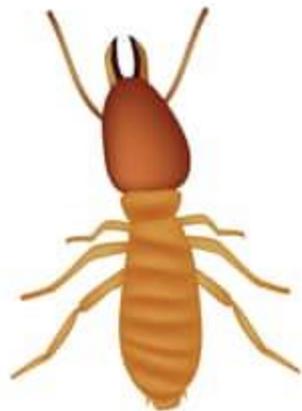




# Termites



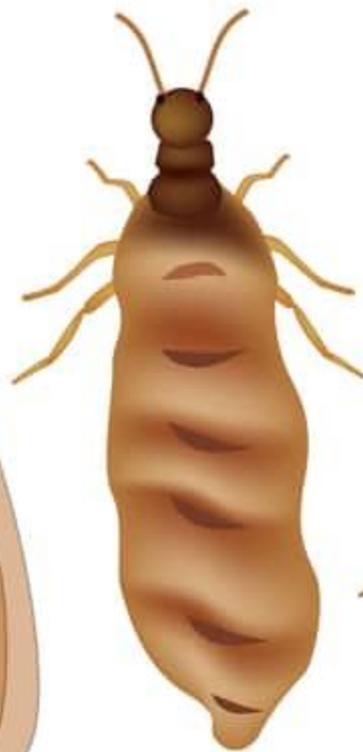
Worker



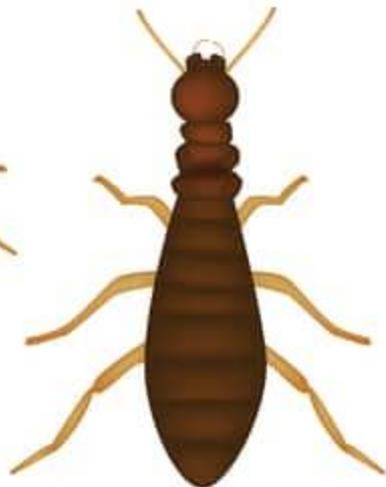
Soldier



Winged  
reproductive



Queen



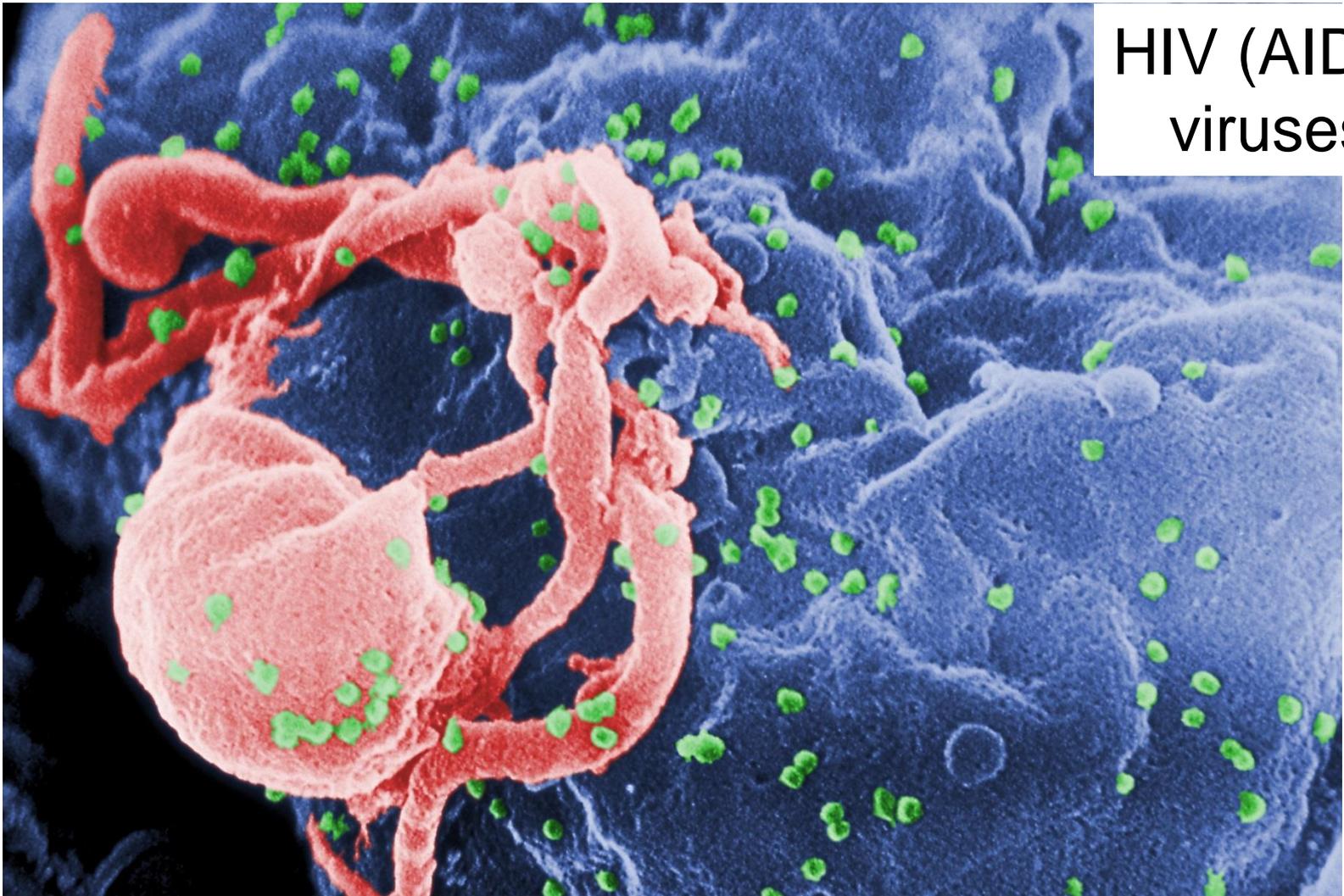
King



Enteric parasites  
of soldier who escaped  
North Korea (2017)



# HIV (AIDS) viruses



## Fauna, flora and vegetation:

- Fauna refers to animals
- Flora includes plants and trees
  - ✓ (Predominant) vegetation refers to the prevailing grasses, plants and trees.

Pollution («ρύπανση») and contamination («μόλυνση»):

- pollution refers to physical, chemical or biological pollutants
- contamination usually refers to biological agents and implies health effects.

## Environmental Impacts

- are studied via Environmental Impact Assessment (EIA)
- are reported in **Environmental Impact Statements** (EISs, «Μελέτες Περιβαλλοντικών Επιπτώσεων»)

# The Environmental Impact Assessment Process

Major steps in the EIA process are:

- Screening
- Initial Environmental Examination (IEE)
- Scoping
- Full-Scale Assessment
- EIA Review and Decision Making
- Monitoring and Follow-Up





MULTIFUNCTIONAL  
DEEP-WATER  
TERMINAL

**BEAU  
PORT  
2020**

**ENVIRONMENTAL  
IMPACT  
STATEMENT**

Amended version

September 2016



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## Types of impacts:

- unfavorable or favorable
- direct or indirect
- long term or short term
- reversible or irreversible

Qualitative Criteria	Choice	Description
NATURE	<ul style="list-style-type: none"> <li>• Direct</li> <li>• Indirect</li> </ul>	Refers to the origin/source of an impact – does the SOURCE activity DIRECTLY or INDIRECTLY act on the environmental target (species or natural communities).
TYPE	<ul style="list-style-type: none"> <li>• Positive</li> <li>• Negative</li> </ul>	Positive impacts imply species or natural communities will have a higher likelihood of persistence and increase in viability, Negative impacts imply the opposite.
LIKELIHOOD	<ul style="list-style-type: none"> <li>• Not Likely</li> <li>• Potential</li> <li>• Certainty</li> </ul>	<i>Not likely</i> means there is roughly a 10% chance of an impact occurring, <i>Potential</i> means 10 to 70% and <i>Certainty</i> means that in impact has a greater than 70% chance of occurring.
SCALE	<ul style="list-style-type: none"> <li>• Specific habitats</li> <li>• Island environs</li> <li>• Regional</li> <li>• National or International</li> </ul>	Scale of the impact will be defined as restricted to specific habitats, impacts that impact the entire island environment

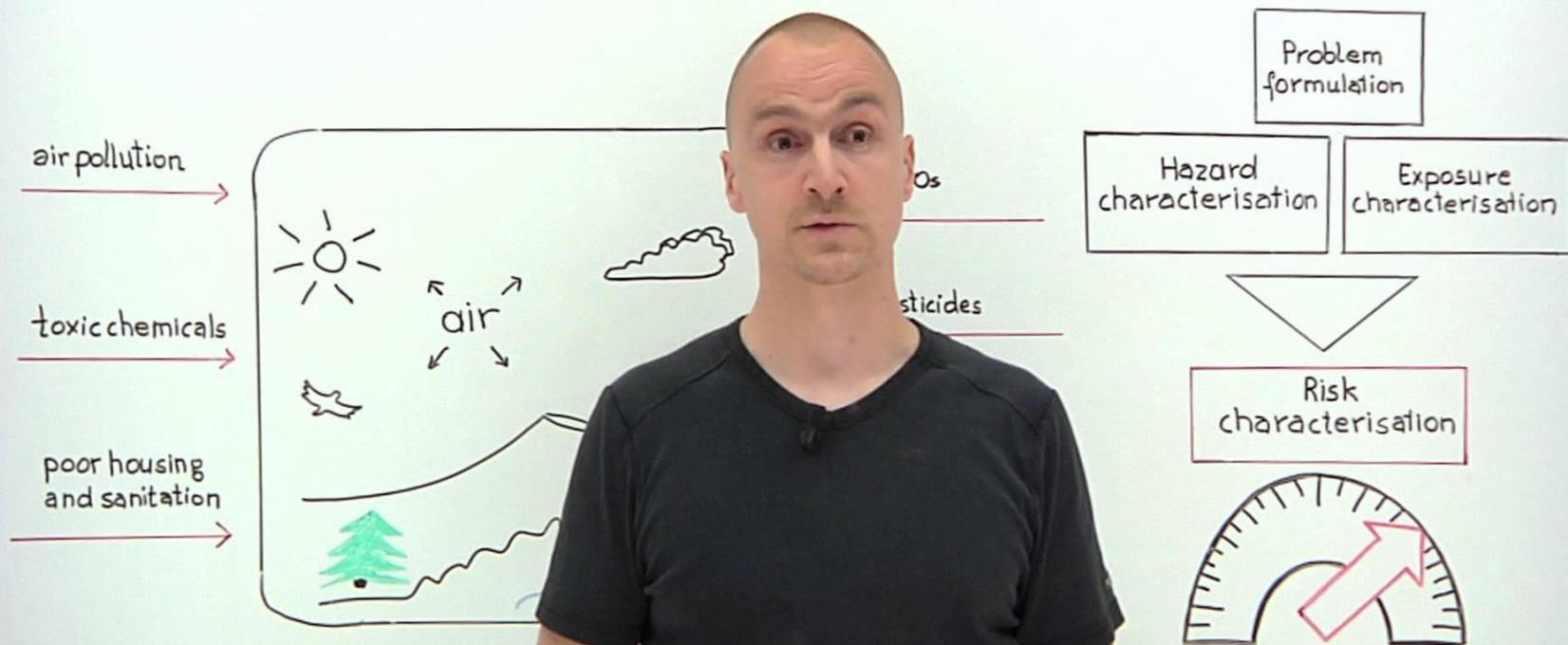
DURATION	<ul style="list-style-type: none"> <li>• Temporary</li> <li>• Long-term</li> </ul>	Temporary refers to impacts that last less than 3 years, meaning species recover to
		pre-impact levels, or natural communities recover to no noticeable impacts. Long term refer to more than 3 years
REVERSIBILITY	<ul style="list-style-type: none"> <li>• Reversible</li> <li>or</li> <li>• Irreversible</li> </ul>	Reversible implies that the impacted species or natural community will recover, Irreversible impacts mean that the species or natural community is lost to the project site, and impact should be mitigated

Table 4.1. Environmental impact characterization

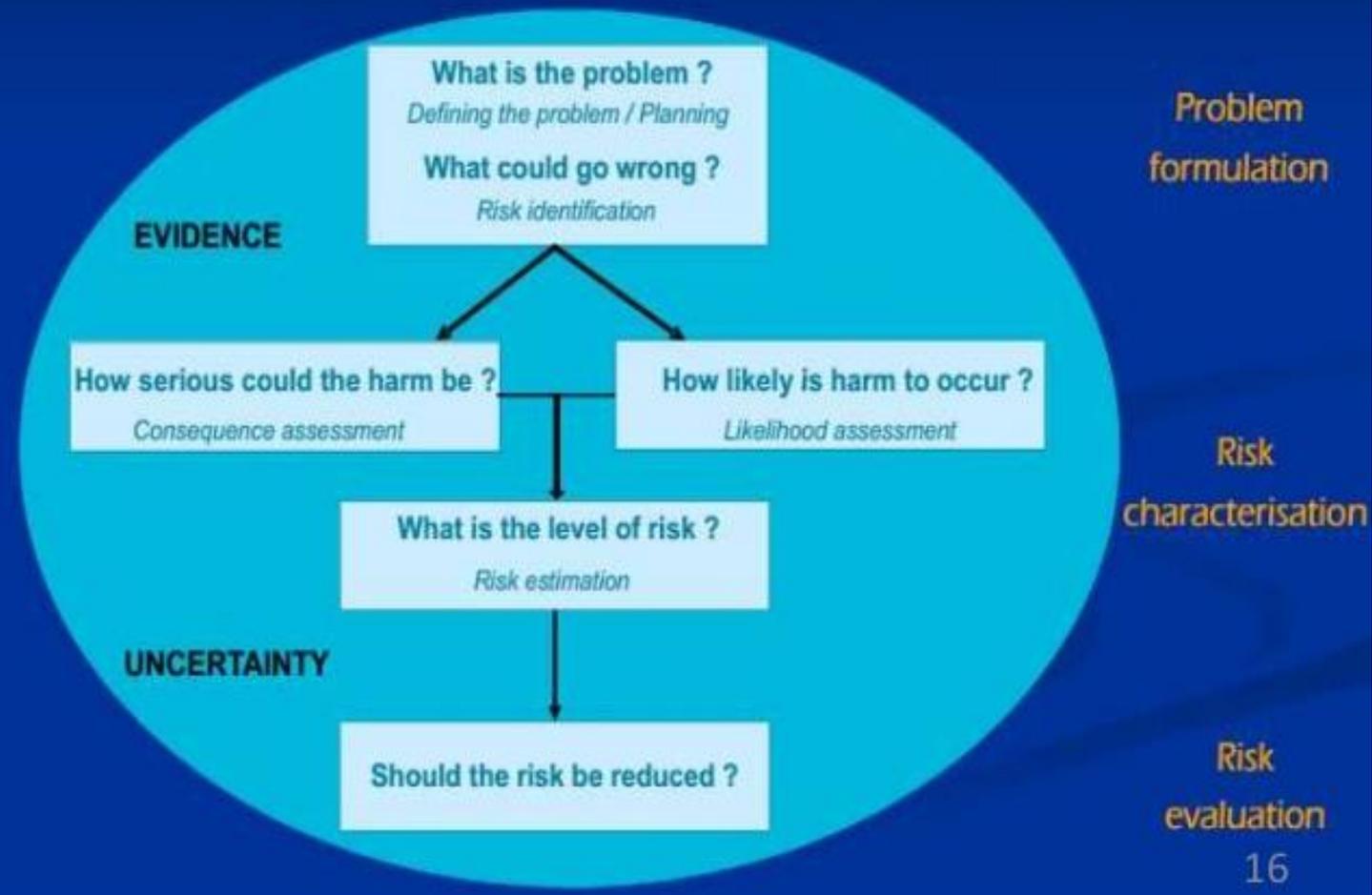
Impact	Positive (P)	Not likely (NL)	Temporary (T)	Reversible (R)	Direct (D)	Local (L)
	Negative (N)	Potential (P) Certain (C)	Long term (LT)	Irreversible (I)	Indirect (I)	Regional (R) International (I)
Soil subsistence	N	P	T	R	D	L
Induced seismicity	N	P	T	I	D & I	R
Soil erosion	N	P	LT	I	I	L
Groundwater contamination	N	NL	LT	I	D	L
Generation of solid wastes	N	C	T	I	D	R
Land use changes	N	P	LT	I	D	L
Visual intrusion	N	P	T	R	D	L
Water consumption	N	C	LT	I	D	R
Surface runoff	N	P	LT	R	I	L
Thermal pollution	N	P	T	R	D	L
Eutrophication of surface waters	N	P	LT	I	D	L
Water pollution	N	P	T	R	D	L
Greenhouse gas emissions	N	C	LT	I	D	R
Air pollution (from rig, traffic, etc.)	N	C	T	R	D	L
Odors	N	C	T	R	D	L
Noise	N	C	T	R	D	L

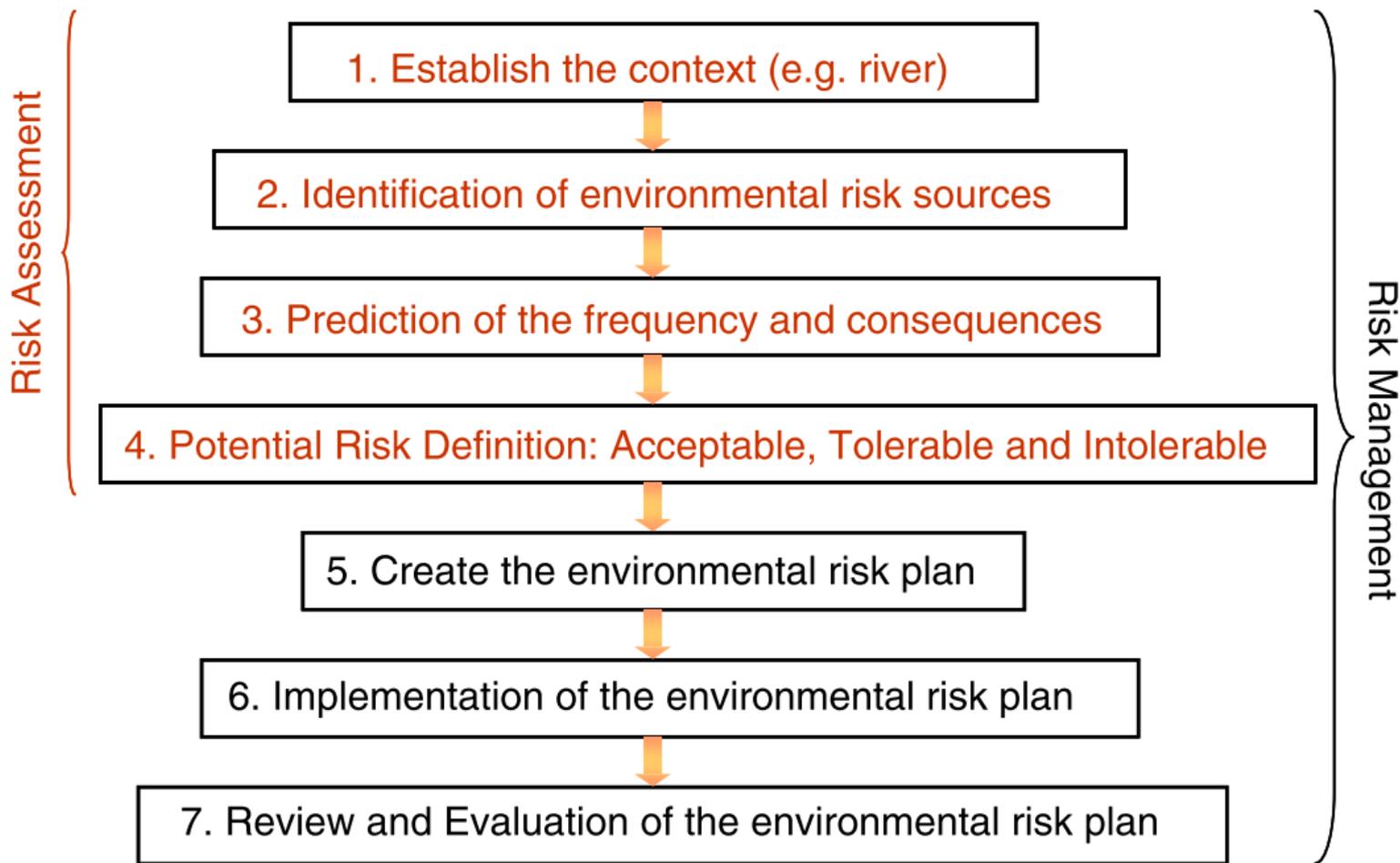
Impact	Positive (P) Negative (N)	Not likely (NL) Potential (P) Certain (C)	Temporary (T) Long term (LT)	Reversible (R) Irreversible (I)	Direct (D) Indirect (I)	Local (L) Regional (R) International (I)
Ecosystem disturbance	N	P	T	I	I	L
Vegetation changes	N	P	LT	I	D	L
Biodiversity	N	P	LT	I	I	R
Effects on paleontological resources	N	P	LT	I	D	L
Effects on wildlife	N	P	LT	I	I	L
Public health (including toxicity)	N	NL	LT	R	I	L
Radiation risk from radioactive deposits	N	NL	LT	I	I	L
Effects on employment	P	C	LT	R	D	R
Effects on markets	P	C	LT	R	D	R
Effects on farming	N	P	LT	I	D	L
Resettlement	N	P	LT	I	I	R
Effects on infrastructure	N	P	LT	R	D	L
Effects on tourism	N	NL	LT	I	I	R
Effects on cultural resources	N	NL	LT	I	I	R
Environmental injustice	N	NL	LT	I	I	I
Energy consumption	N	C	LT	I	D	R
Use of materials	N	C	LT	I	D	R

# ENVIRONMENTAL RISK ASSESSMENT



# ENVIRONMENTAL RISK ASSESSMENT – Framework





**Figure 1.** Steps in environmental risk management.

# Severity - Amount of damage or harm a hazard could create

**Catastrophic 4.** Operating conditions are such that human error, environment, design deficiencies, element, subsystem or component failure, or procedural deficiencies may commonly cause death or major system loss, thereby requiring immediate cessation of the unsafe activity or operation.

**Critical 3.** Operating conditions are such that human error, environment, design deficiencies, element, subsystem or component failure or procedural deficiencies may commonly cause severe injury or illness or major system damage thereby requiring immediate corrective action.

**Marginal 2.** Operating conditions may commonly cause minor injury or illness or minor systems damage such that human error, environment, design deficiencies, subsystem or component failure or procedural deficiencies can be counteracted or controlled without severe injury, illness or major system damage.

**Negligible 1.** Operating conditions are such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies will result in no, or less than minor illness, injury or system damage.

# Probability -the likelihood of the hazard occurring

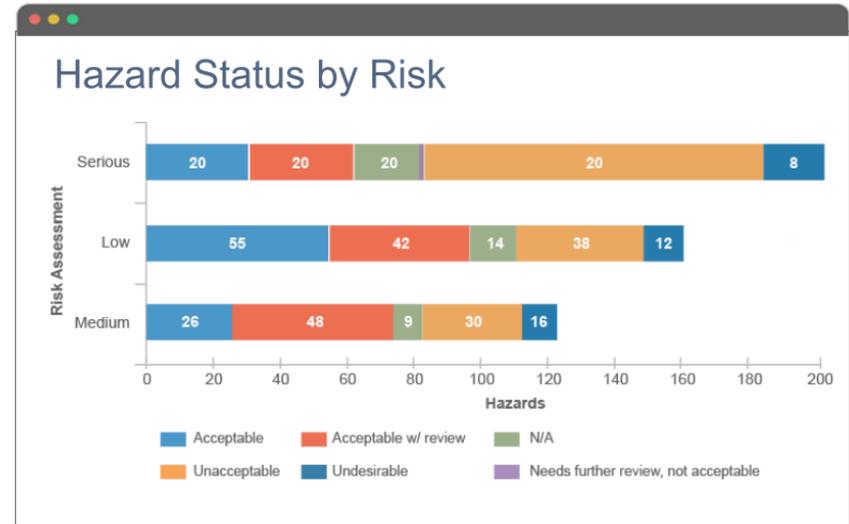
**Frequency 5.** Likely to occur often in the life of an item.

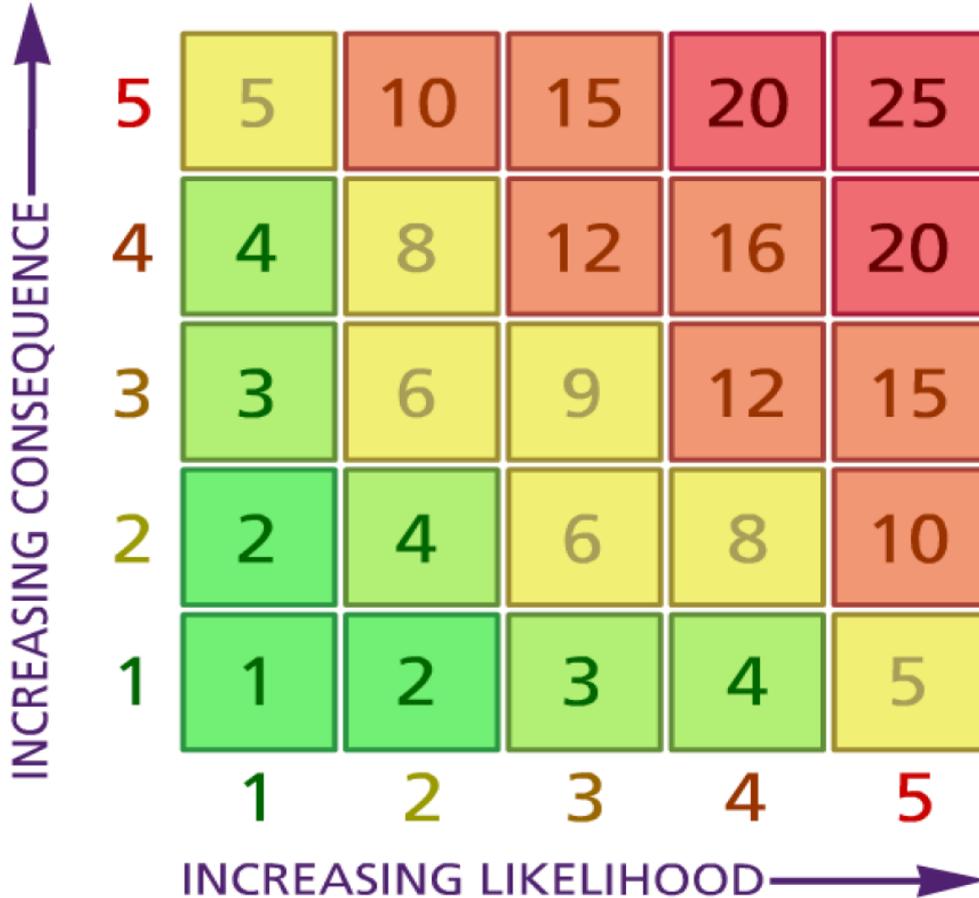
**Probable 4.** Will occur several times in the life of an item.

**Occasional 3.** Likely to occur some time in the life of an item.

**Remote 2.** Unlikely but possible to occur in the life of an item.

**Improbable 1.** So unlikely, it can be assumed occurrence may not be experienced.





**17-25 Unacceptable**

Stop activity and make immediate improvements

**10-16 Tolerable**

Look to improve within specified timescale

**5-9 Adequate**

Look to improve at next review

**1-4 Acceptable**

No further action, but ensure controls are maintained

# Risk Assessment

Multiply the scores of probability and severity together

Probability	Severity			
	Catastrophic- 4	Critical - 3	Marginal - 2	Negligible- 1
Frequent - 5	High - 20	High - 15	High - 10	Medium- 5
Probable - 4	High - 16	High - 12	Serious- 8	Medium- 4
Occasional - 3	High - 12	Serious- 9	Medium- 6	Low- 3
Remote - 2	Serious- 8	Medium- 6	Medium- 4	Low- 2
Improbable- 1	Medium- 4	Low- 3	Low- 2	Low- 1

Consistent with AS/NZS ISO 31000:2009, the approach to risk assessment involved:

- 1 Establishment of context;
- 2 Risk identification;
- 3 Risk analysis;
- 4 Risk evaluation;
- 5 Risk treatment;
- 6 Monitoring and review; and
- 7 Communication and consultation.

**Table 4-1 Environmental Setting**

<b>FEATURE OF ENVIRONMENT</b>	<b>EIS VOLUME 1 REFERENCE</b>	<b>EIS SPECIALIST REPORT REFERENCE</b>
■ Overview of Setting	Section 3 – Project Description	-
■ Terrestrial Ecology	Section 7 – Terrestrial Ecology	Appendix C – <i>Terrestrial Ecology Report</i>
■ Aquatic Ecology	Section 8 – Aquatic Ecology	Appendix D – <i>Aquatic Ecology Report</i>
■ Groundwater	Section 9 – Groundwater	Appendix F – <i>Groundwater Report</i>
■ Surface Water	Section 10 – Surface Water	Appendix H – <i>Baseline Surface Water Monitoring Report</i>
■ Social environment, including:		
– Air Quality	Section 12 – Air Quality	Appendix I – <i>Air Quality Report</i>
– Acoustic (Noise) Environment	Section 13 – Noise and Vibration	Appendix J – <i>Noise and Vibration Report</i>
– Visual Amenity	Section 14 – Visual Amenity	-
– Socio-economics	Section 15 – Socio-economics	Appendix K – <i>Socio-economics Report</i>
– Cultural Heritage	Section 16 – Archaeology	Appendix L – <i>Archaeology Report</i>



Risks were systematically identified taking into consideration the full range of project activities in relation to individual aspects of the existing environment. The following aspects of the environment were considered as part of the risk assessment:

- Groundwater;
- Surface water;
- Ecology (including biodiversity issues relating to air quality and noise); and
- Social (including social issues relating to air quality, noise, visual amenity, socio-economics and cultural heritage).

**Table 4-2 Ratings for the Assessment of Consequence Levels**

CONSEQUENCE LEVEL	ENVIRONMENT	COMMUNITY
1	Low level impact/s to land, biodiversity, ecosystem services, water resources or air	Low-level social impacts. Low-level infringement of cultural heritage or minimal disturbance to heritage structures. Minimal impact on human rights.
2	Minor impact/s to land, biodiversity, ecosystem services, water resources or air	Minor medium-term social impacts on small number of people. Repairable damage or disturbance to property, structures or items. Minor infringement of cultural heritage. Minor, temporary human rights impacts.
3	Moderate impact/s land, biodiversity, ecosystem services, water resources or air	Moderate medium-term social impacts or frequent social issues. Moderate damage to structures/items of local cultural heritage significance/sacred locations. Moderate, temporary human rights impacts.
4	Significant impact/s (>20 years) land, biodiversity, ecosystem services, water resources or air	A breakdown of social order. Widespread damage to items of global cultural significance. Highly offensive infringements of cultural heritage. Company directly responsible or complicit in severe, long-term impacts on human rights.
5	Permanent, severe impact/s to land, biodiversity, ecosystem services, water resources or air	Complete breakdown of social order. Widespread desecration of items of global cultural significance. Company directly responsible or complicit in severe and widespread long-term impacts on human rights.

**Table 4-3 Ratings for the Assessment of Likelihood**

<b>LIKELIHOOD</b>	<b>ENVIRONMENT</b>
<b>Almost Certain</b>	Could be incurred more than <b>once in a year</b>
<b>Likely</b>	Could be incurred over a <b>1-2 year timeframe</b>
<b>Possible</b>	Could be incurred within a <b>5 year timeframe</b>
<b>Unlikely</b>	Could be incurred in a <b>5-20 year timeframe</b>
<b>Rare</b>	Less than once in <b>20 years</b>



Table 4-4 Risk Assessment Matrix

LIKELIHOOD	CONSEQUENCE				
	Level 1 Low level impact	Level 2 Minor impact	Level 3 Moderate impact	Level 4 Significant impact	Level 5 Severe impact
Almost Certain	High (11)	High (16)	Extreme (20)	Extreme (23)	Extreme (25)
Likely	Moderate (7)	High (12)	High (17)	Extreme (21)	Extreme (24)
Possible	Low (4)	Moderate (8)	High (13)	Extreme (18)	Extreme (22)
Unlikely	Low (2)	Low (5)	Moderate (9)	High (14)	Extreme (19)
Rare	Low (1)	Low (3)	Moderate (6)	High (10)	High (15)