

Toxic effects of climate change

Lecture 19.09.18

Climate change management, HVL

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A grayscale microscopic image of biological cells, showing various cellular structures and membranes. The image is used as a background for the slide.

Toxicology

The study of the adverse effects of chemical compounds or physical agents on living organisms

Toxic compounds

- **Naturally occurring**

- toxins (i.e. animal toxins/venoms, plant toxins microtoxins, mycotoxins)
- inorganic compounds (metals, nutrients, salts)

"Natural is not safe"

- **Xenobiotics (foreign/artificial substances)**

- drugs, pharmaceuticals, medicine
- Poisons, pesticides, herbicides pollutants and toxicants

Exposure to a toxic compound

Dose = The actual amount of a chemical an organism are exposed to over a period of time.

“The dose makes the poison”

Acute exposure = short-term exposure

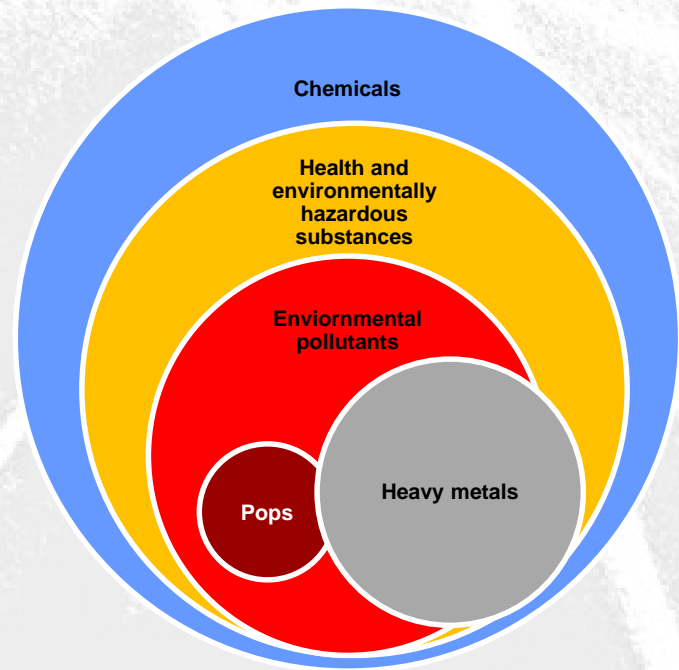
Chronic exposure = long-term exposure

Environmental pollutants = PBT/vPvB

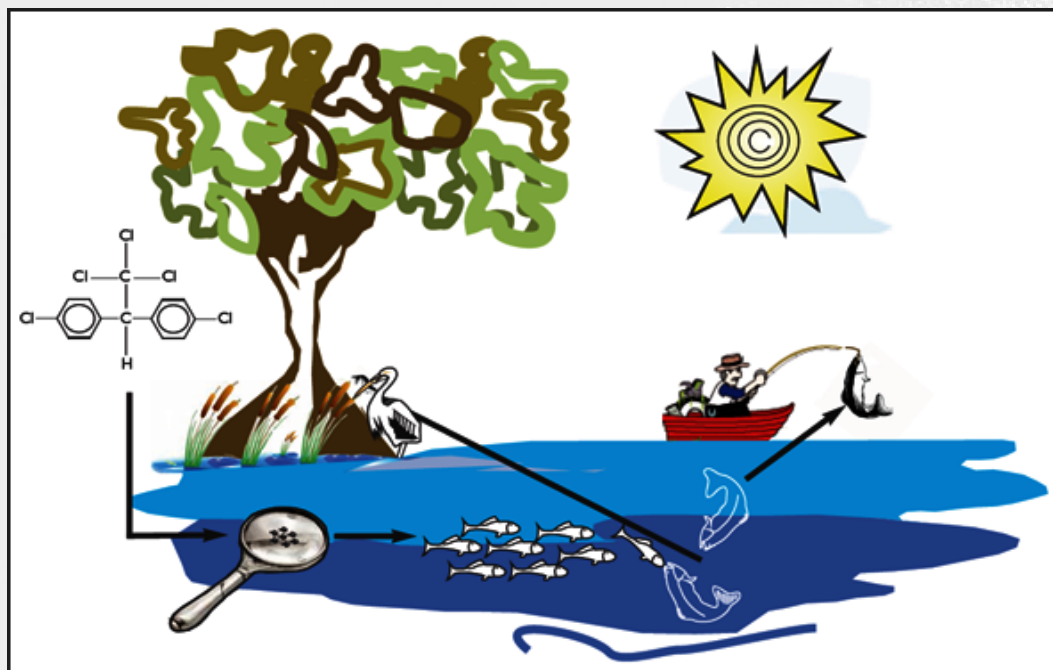
Substances that is persistent (P), bioaccumuate in food chains (B), and toxic (T). They may be spread over large distances.

PBT= persistent, bioaccumulative, toxic vPvB= very persistent, very bioaccumulative

- Bisphenol A
 - Phtalates
 - PFOS/PFOA
 - Siloxans
 - Bromated flame retardents
 - PCB
 - Dioxin
 - PAH
 - Mercury, lead
- «New» pollutants
- Historical pollutants



PBT – accumulates in organisms



[DDT] increase of 10 million times

[DDT] in fish-eating birds= 25 ppm

[DDT] in large fish= 2 ppm

[DDT] in small fish= 0.5 ppm

[DDT] in zooplankton=0.04 ppm

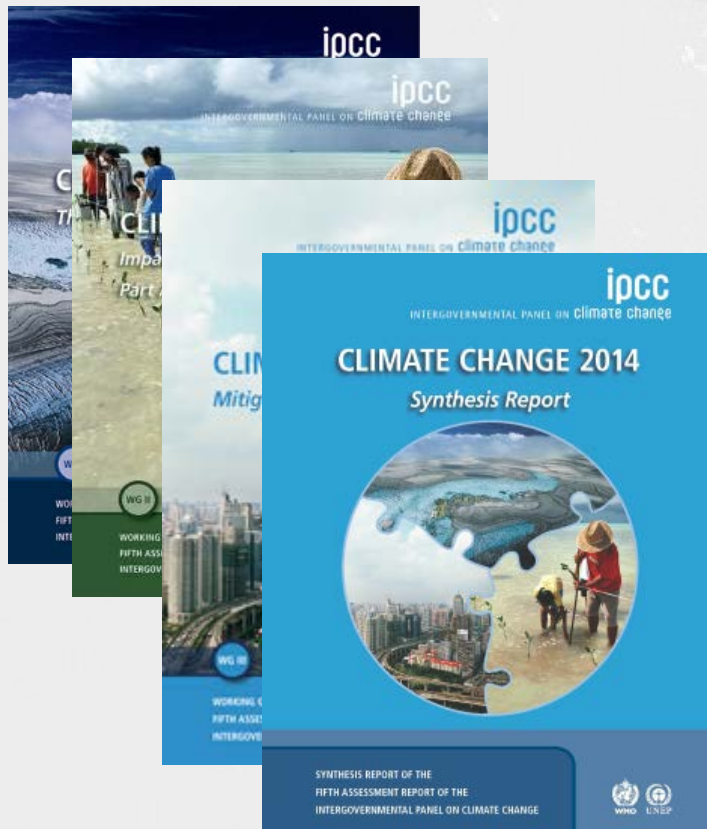
[DDT] in water= 0.000003 ppm

PBT substances are persistent, bioaccumulative and toxic

Goals for environmental pollutant levels in Norway/EU

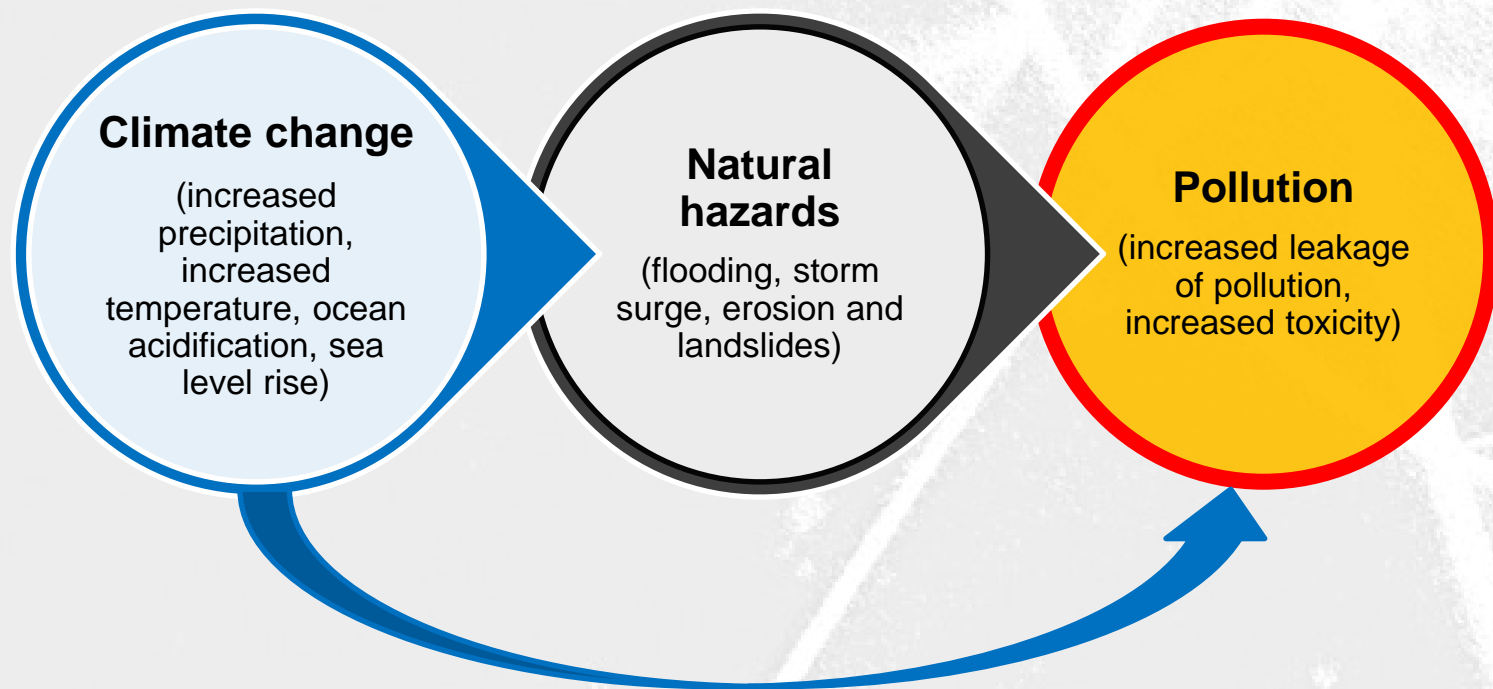
- **Reduce or stop the emissions of prioritized environmental pollutants by 2020** (St.melding nr. 14, 2006-2007 *Sammen for et giftfritt miljø*, NOU 2010:9 *Et Norge uten miljøgifter*, *Et miljø uten miljøgifter*, handlingsplan 2015)
- **All surface waters should have at least good ecological and chemical conditions by 2021** (EU's water frame directive)

IPCC assessment reports



AR5 **doesn't address the possibility that climate change could magnify the problem of long-lasting and pervasive toxic chemicals in the environment.**

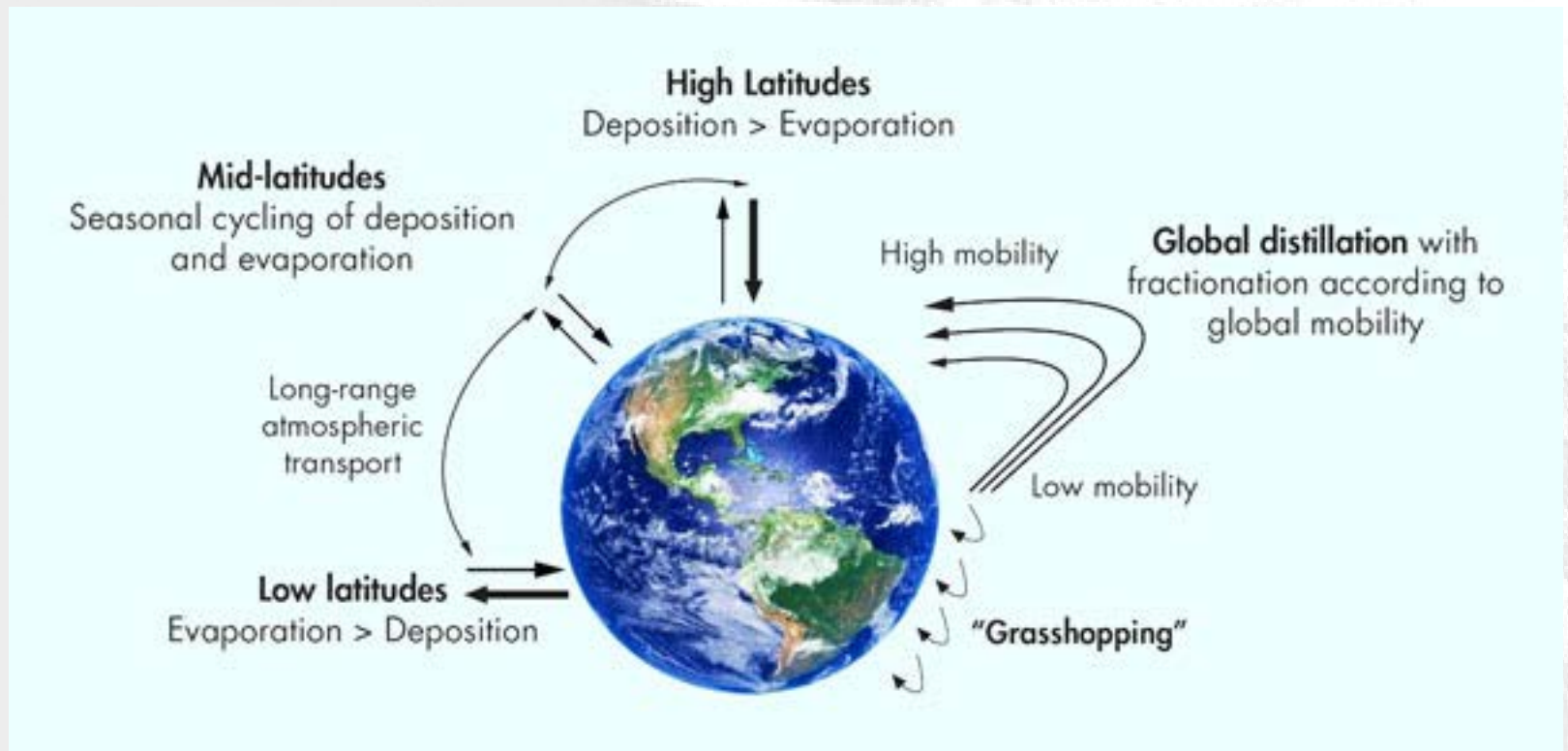
Direct and indirect effects of climate change on environmental pollution



Some impacts of climate change on toxicity

- 1. Increased distribution of pollutants**
- 2. Altering toxicity of compounds**
- 3. Altering air pollution – air quality (ozone, PM 2.5s)**
- 4. More production of natural toxins**
- 5. More infectious diseases – more use of pesticides?**
- 6. Increased exposure to toxic pollutants**
- 7. Increased toxicity due to rising temperatures**
- 8. Changes in salinity and pH**

1. Increased distribution of pollutants

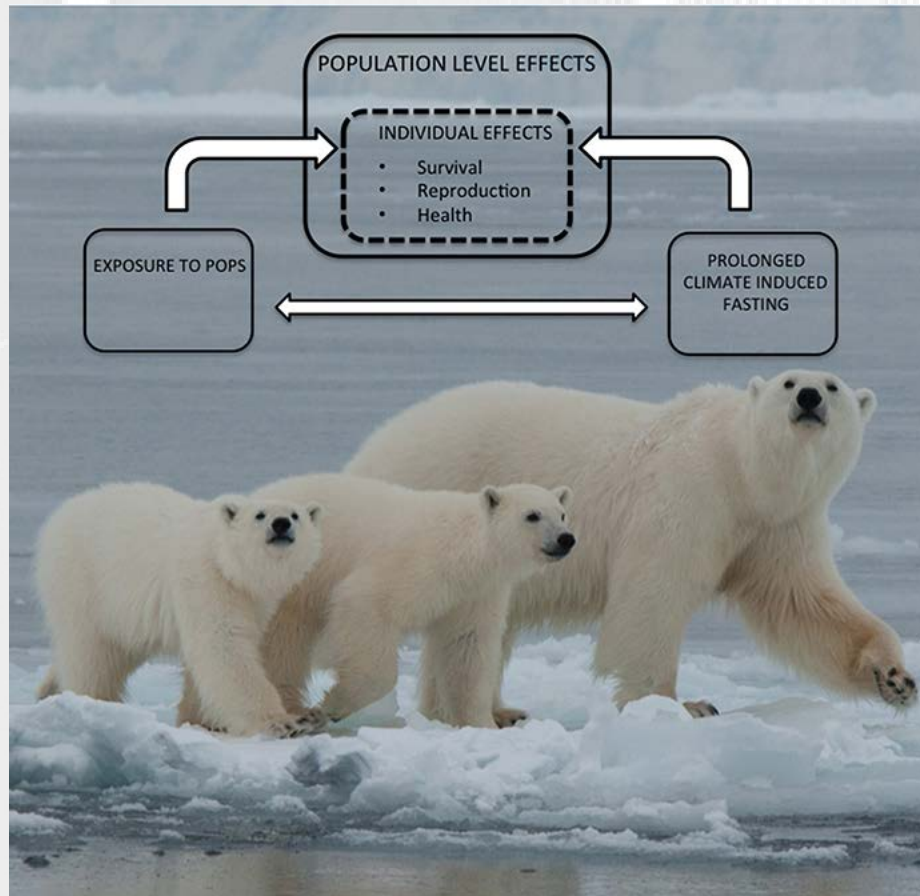


<http://www.eusem.com>

2. Altered toxicity caused by GCC

2.1. POPs

- **Increase uptake into algae due to increased temperature and decline in snow covers**
- **Increased metabolism of PCBs in organisms – the good and the bad news**

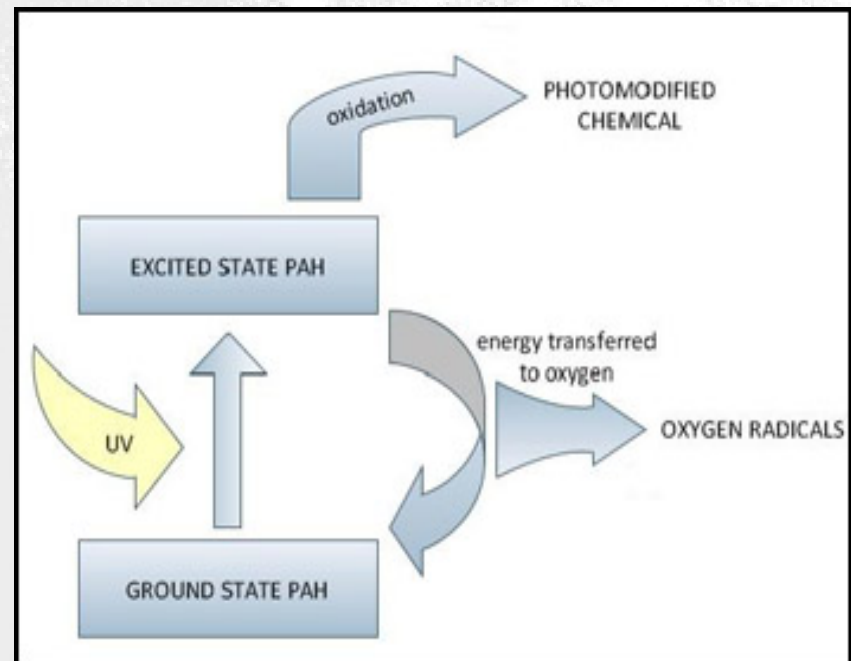


Source: Munro Jenssen et. al, Front. Ecol. Evol., 24 February 2015

2. Altered toxicity caused by GCC

2.2. Photoactivation of PAH

- **Photosensitisation**
- **Photomodification**



<http://aps.group.shef.ac.uk/level-4-web-sites/l4-students-08/harrison-jesse/background.html>

3. Air pollution – air quality

- **Ground level ozone production**
- **Smog formation**
- **PM = particular matter may increase**

"GOOD" VS. "BAD" OZONE

"Good" ozone is present at high altitudes in the atmosphere and is beneficial because it shields the earth from excessive ultraviolet radiation.

But "bad," or ground-level, ozone is the primary component of smog and is harmful to health.

Human activities, such as driving cars and generating electricity, are a major source of the pollutants that form ozone.



http://www.ucsf.edu/global_warming/science_and_impacts/impacts/climate-change-and-ozone-pollution.html

4. More natural occurring toxins

- **Toxic algal blooms**

- ASP-toxins (amnesic shellfish poisoning)
- DSP-toxins (diarrhoeic shellfish poisoning)
- PSP- toxins (paralytic shellfish poisoning)

- **More pathogenic microorganisms**

- *Aspergillus*: Aflatoxins (carcinogenic)
- *Fusarium*: DON (genotoxic, teratogenic)
- *Fusarium*: ochratoxin (carcinogenic)
- *Fusarium*: Fumonisin (carcinogenic)

5. More pests and parasites

- **Vector-borne disease are expected to increase associated with climate change, e.g. malaria, dengue fever**
- **may lead to enhanced demand for DDT or other pesticides in the future**
- **Pesticides may lose effectiveness or be more rapidly broken down in warmer temp.**

6. Increased exposure of toxicants

- **Extreme precipitation, storms and floods increase the hazardous chemical run-off**
- **Drought increased toxicity**

7. Increased toxicity due to rising temperature

- **Enhanced toxicity of contaminants**
- **Increased concentration of tropospheric ozone**
- **Higher rate of degradation**
- **Increased biotransformation to more bioreactive metabolites**
- **change in distribution of volatile toxins**

8. Changes in salinity and pH

- **Affect marine organisms ability to build carbonate shells**
- **Will affect chemicals that are designed to be more bioavailable at specific pH (i.e. pharmaceutical drugs)**
- **Will affect heavy metal toxicity**

Benefits of climate change on toxicity

- **Reduction of respiratory illness improvements in local air quality due to reduction in the combustion of fossil fuels**
- **Mitigation and climate change measures will reduce the release of particles, PAHs and dust and improve local air quality**
- **GCC may speed up the biodegradation of toxic compounds**

Literature references

Hooper, M.J. et al 2013, “Interactions between chemical and climate stressors: a role for mechanistic toxicology in assessing climate change risks”, Environmental Toxicology and Chemistry, vol. 32,1, pp 32-48.

Noyes, P.D. et al, 2009, “The toxicology of climate change: environmental contaminants in a warming world”, Environmental International 35, 971-986.