Impact of climate change and environmental pollution on population health in the Arctic



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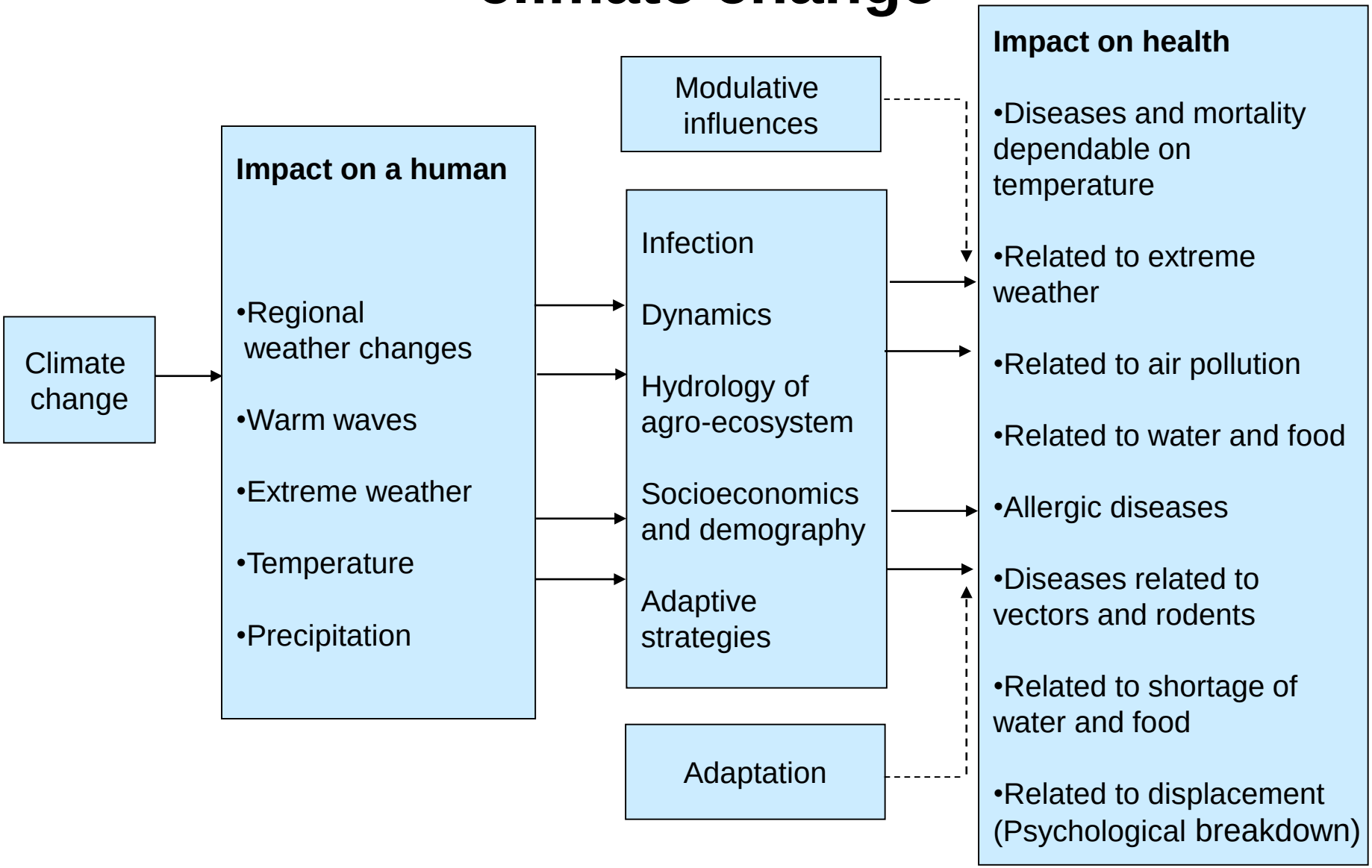
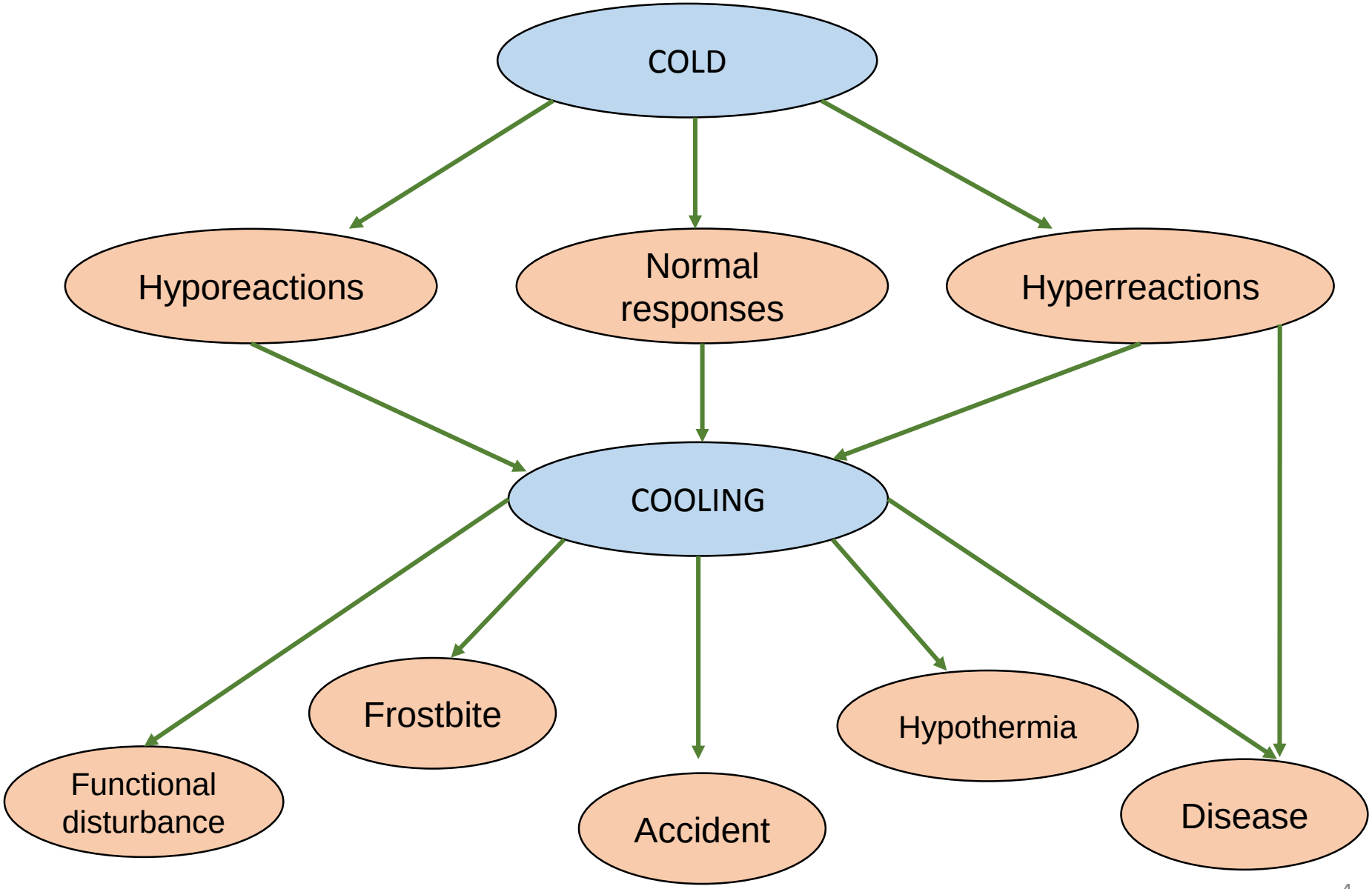
Content

- **Climate change consequences in the Arctic region**:
  - Direct health outcomes
  - Indirect health outcomes
- **Effects of Arctic pollution on population health**:
  - Environmental contaminants
  - Biomonitoring
  - Health effects associated with contaminants

Major human-health implications of climate change



Interaction between temperature and health



Cold injuries

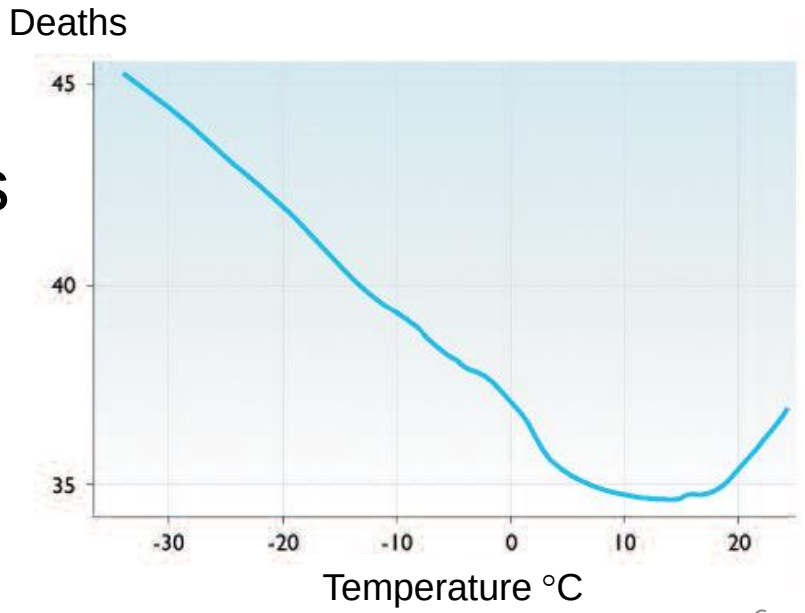
- Cold-related injuries are immediate pathological consequences of cold exposure
- Cold exposure: coldest winter days and high wind speed (risk of frostbite is low at > -10°C; risk of frostbite is high at < -25°C)
- The rate of slip and fall injuries increases with decreasing temperature (0 ºC and below)
- Injuries (frostbite, hypothermia) are linked to body cooling

In the Russian Arctic is 11 000 of hospitalizations due to cold injuries and 4 000 of deaths from hypothermia per year




Cold-related diseases

- Cardiovascular diseases
- Cerebral vascular diseases
- Respiratory diseases
- Peripheral circulatory diseases
- Cold urticaria
- Musculoskeletal diseases
- Cold-related immune effects



WHO project “Impact of climate change on human health and assessment of adaptation in the north of the Russian Federation”

Relative risk of mortality in the period of cold temperature waves (-21.5 C) in Arkhangelsk, 1999-2008 (Varakina, 2011)

Causes of death	Age groups	RR
Infarct	30-64	1.44*
	65+	1.32*
Stroke	30-64	1.29
	65+	1.37*
Respiratory diseases	30-64	1.41
	65+	1.32
External causes	30-64	1.47*
	65+	0.99

** - relative risk is statistically significant at 95% level*

The decrease in the average daily temperature for every degree below -12.8°C is accompanied by increasing in the number of calls for external causes among the population in the age group of 60 years and older by 1.6% (95% CI: 0.1% -3.2%)

Indirect climate change consequences for human health in the Arctic region

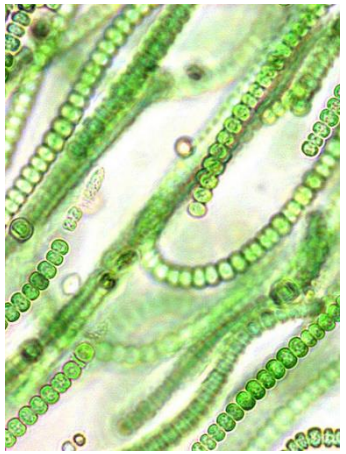
Increased the movement of organohalogens and mercury from lower latitudes to the Arctic; greater bacterial methylation of mercury → food contamination

Warming climate ⟶ southern plant, insect, animal species expand their ranges further north ⟶ new zoonotic diseases

Higher winter temperatures in the Arctic ⟶ increase of winter survival of infected animals ⟶ the risk of hunter / consumer exposure

Warmer waters in tundra ponds ⟶ supporting of toxin-producing cyanobacteria and toxin-producing algal blooms; new water-born disease (tularemia)

Longer Arctic summers and warmer winters ⟶ increase use of commercial shipping ⟶ new rat-born infection (tick-borne encephalitis)

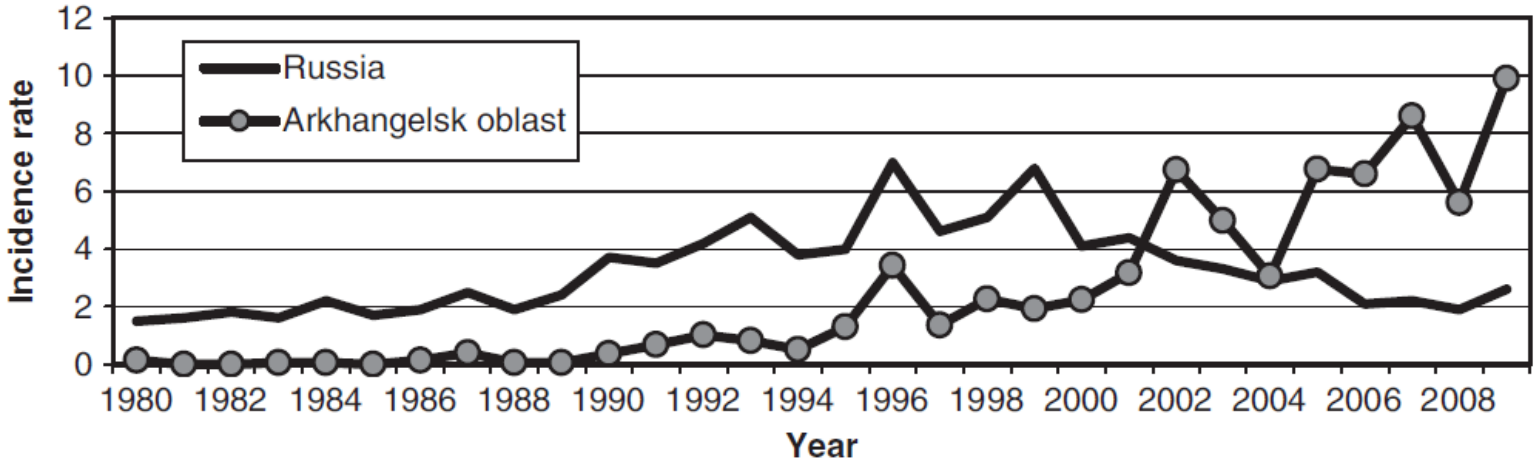


Cyanobacteria

Algal blooms

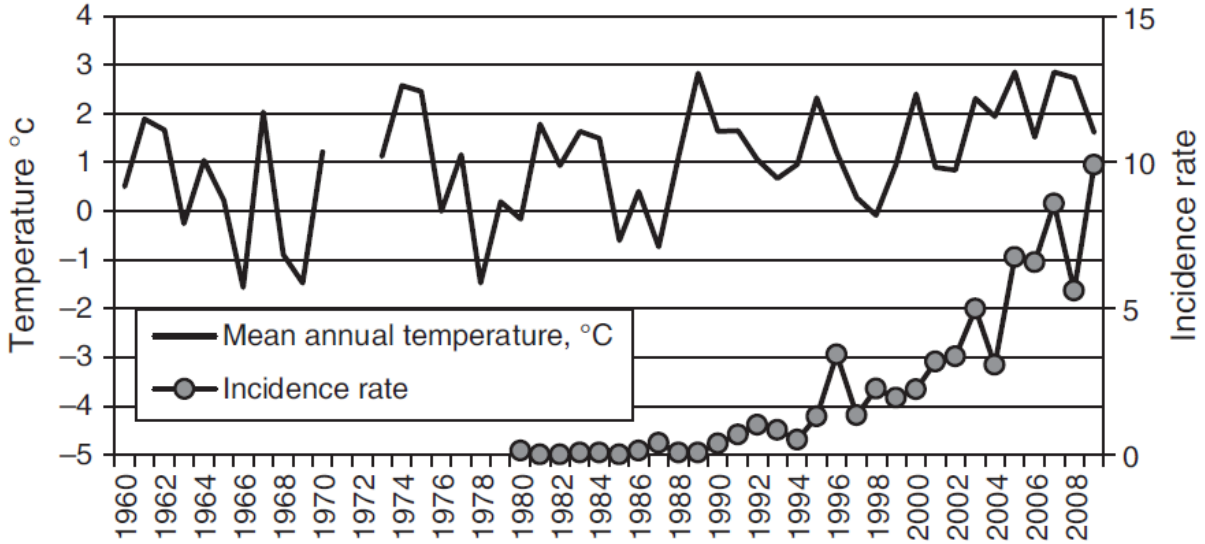
Tick-borne encephalitis (TBE) incidence in the Arkhangelsk region and Russia in 1980 – 2009

Ixodes tick



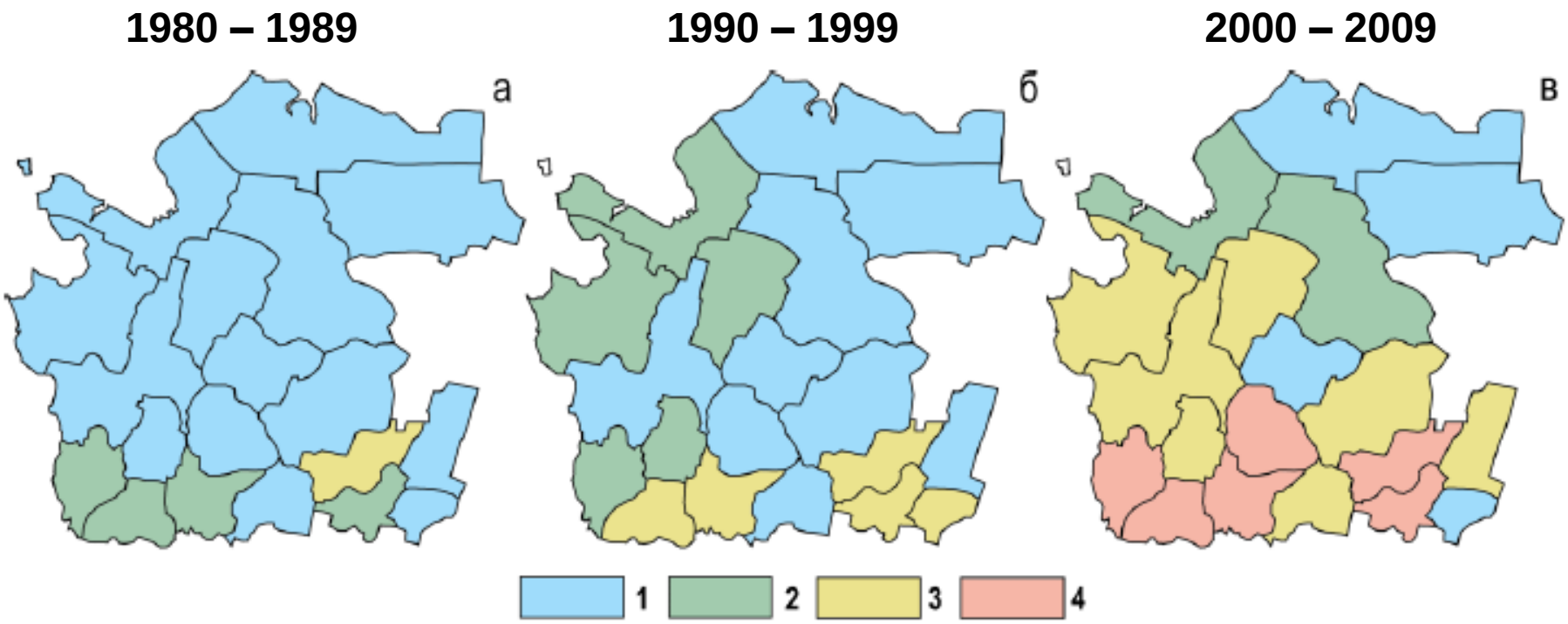
Mean annual temperatures (1960 – 2009) and TBE incidence rates in the Arkhangelsk region (1980- 2009)

Warmer temperatures increase the length of seasonal periods of ixodic tick activity



Tokarevich, 2011

Tick-borne encephalitis incidence rate in the Arkhangelsk region in 1980 – 2009 (averaged over each decade), per 100 000



1: 0.0 **–** 0.1 cases; **2:** 0.1 **–** 1 cases; **3:** 1 **–** 10 cases; **4:** 10 **–** 100 cases

The number of TBE cases increased 40-fold in 30 years: from 162 in 1980 to 6,450 in 2009

Tokarevich, 2011

Water related diseases

"any significant adverse effects on human health, such as death, disability, illness or disorders, caused directly or indirectly by the condition, or changes in the quantity or quality, of any waters" (WHO, 2012)

Water-borne diseases
(bad quality water)

- Campylobacteriosis
- Cryptosporidium infection
- E.Coli infection
- Giardiaosis
- Hepatitis A
- Hepatitis E
- Tularemia
- Yersiniaosis
- Paratyphoid fever
- Shigellosis
- Typhoid fever

Water-washed diseases
(inadequate water quantity)

- Trachoma (ocular blindness caused by Chlamydia trachomatis)
- Bacterial skin infections (Staphylococcus aureus furunculitis)
- Respiratory infections (respiratory syncytial virus bronchiolitis)

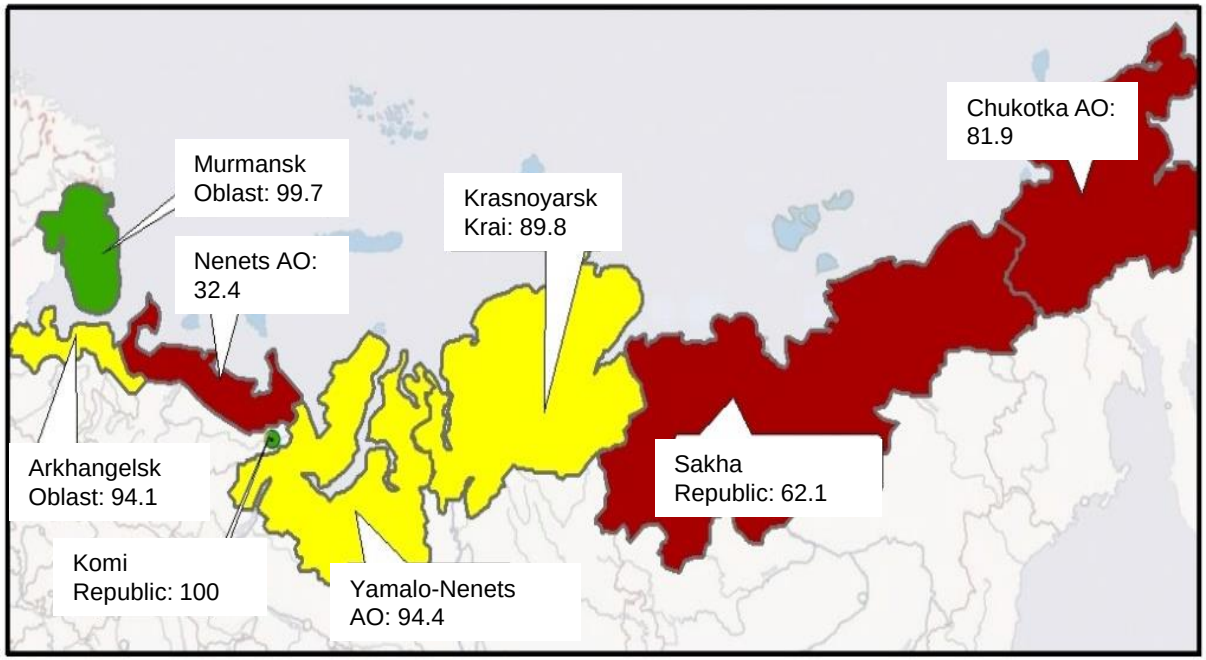
Compulsorily registered waterborne diseases in Sweden 2011

Diseases	Arctic Sweden	Sweden
Campylobacteriosis	57.8	86.6
Cryptosporidium infection	31.6	3.9
Enterohaemorragic E coli infection	2.1	5.0
Giardiaiosis	12.8	11.0
Hepatitis A	1.1	0.5
Hepatitis E	0	0.1
Paratyphoid fever	0.2	0.1
Shigellosis	2.3	4.7
Typhoid fever	0.5	0.1
Vibrio infection exkl. cholerae	0	0.2
Yersiniaosis	4.1	3.6
Entamoeba histolytica Infection	0.2	1.7
Legionellaosis	2.7	1.3
Tularaemia	13.9	3.6
Total	129.7	123.0

Nilsson, 2013

Drinking water related contaminants

Provision of the population (%) with centralized household and drinking water supply in the Russian Arctic in 2017



Population (%) provided with quality drinking water in 2017

Regions	Urban	Rural
Murmansk Oblast	100	97
Komi Republic	99	87
Krasnoyarsk Krai	99	62
Sakha Republic	97	66
Yamalo-Nenets AO	92	72
Chukotka AO	94	58
Arkhangelsk Oblast	85	**47**
Nenets AO	84	**50**

Potential water threats (WHO, 2005):

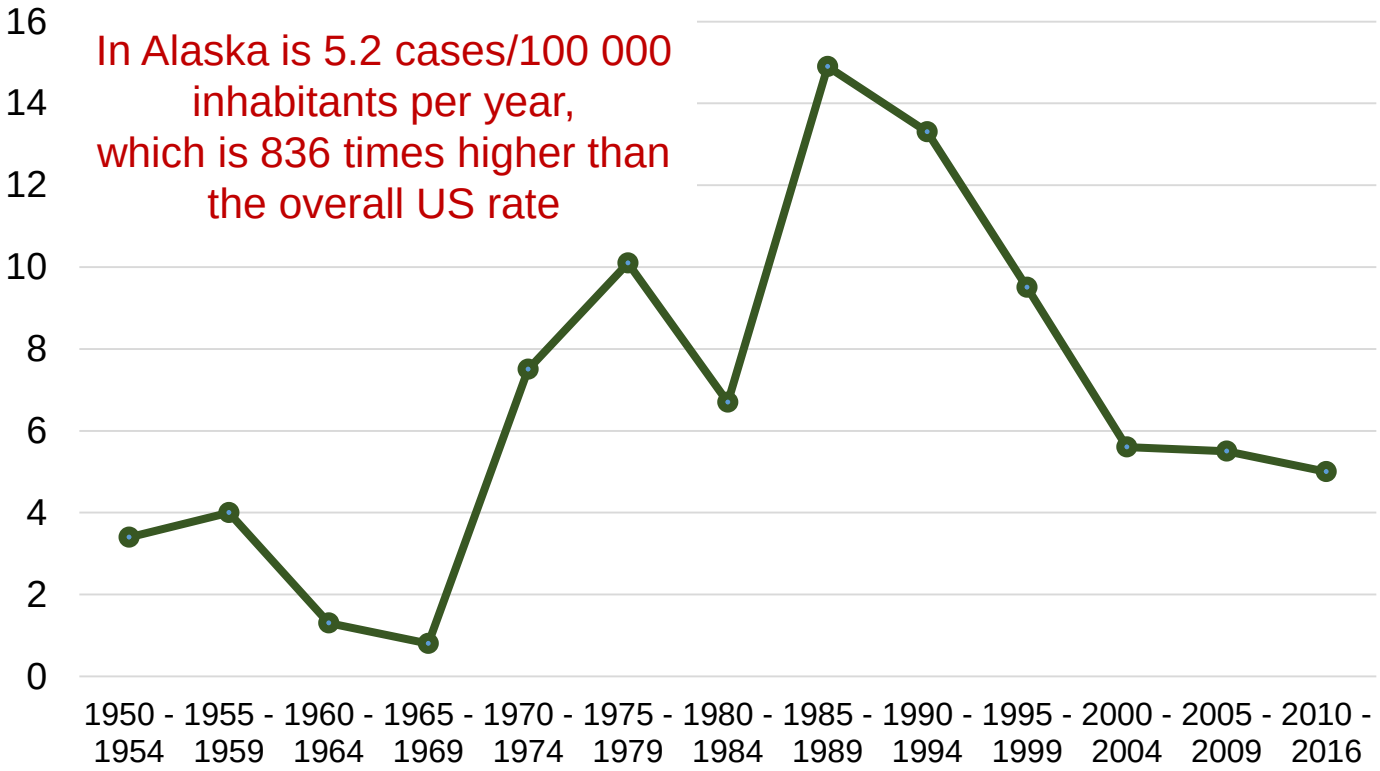
- naturally occurring chemicals
- chemicals from industrial sources and human dwellings
- chemicals from agriculture
- chemicals used in water treatment

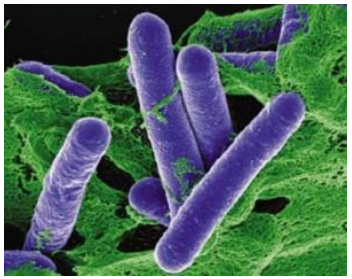
Novikova Yu.A., 2017; Rospotrebnadzor, 2017

Sources of food contamination

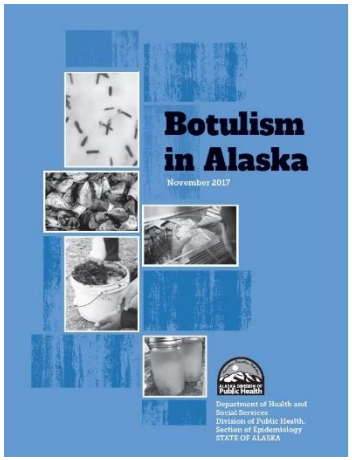
- Food storage / processing / preparation at home
- Pollution of soil and water in and around settlements
- Use of toxic insecticides for the treatment of farmed animals
- Use of technical oils and liquids for imbuing of wood and other construction materials
- Second-hand use of waste technical containers and barrels for souring plants and vegetables
- Prolonged fermentation of meat and fish in ground pits
- Biomagnification of PCBs and certain pesticides in marine food webs

Foodborne botulism incidence, 1950 – 2016 per 100,000 Alaska Natives



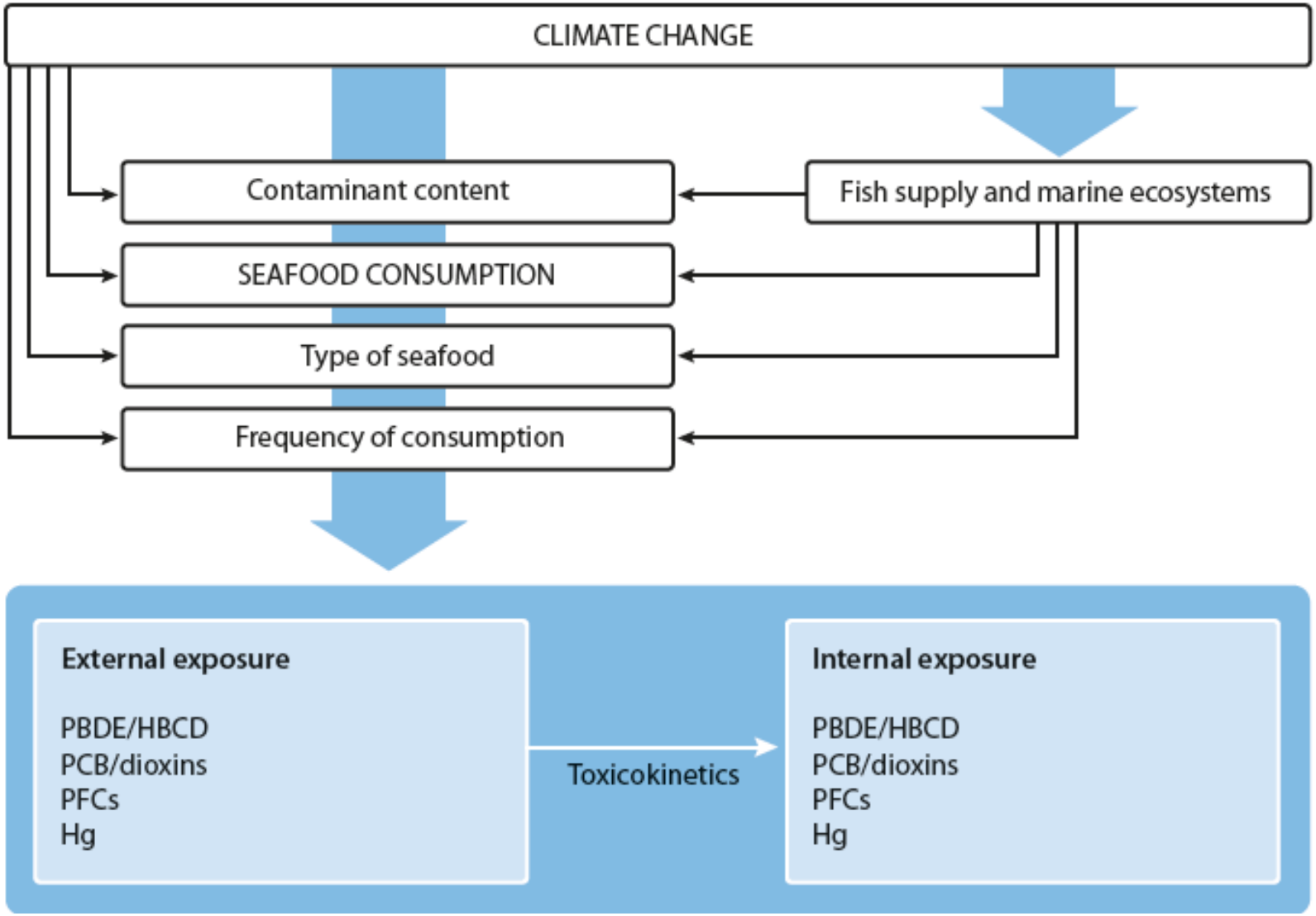


Clostridium botulinum



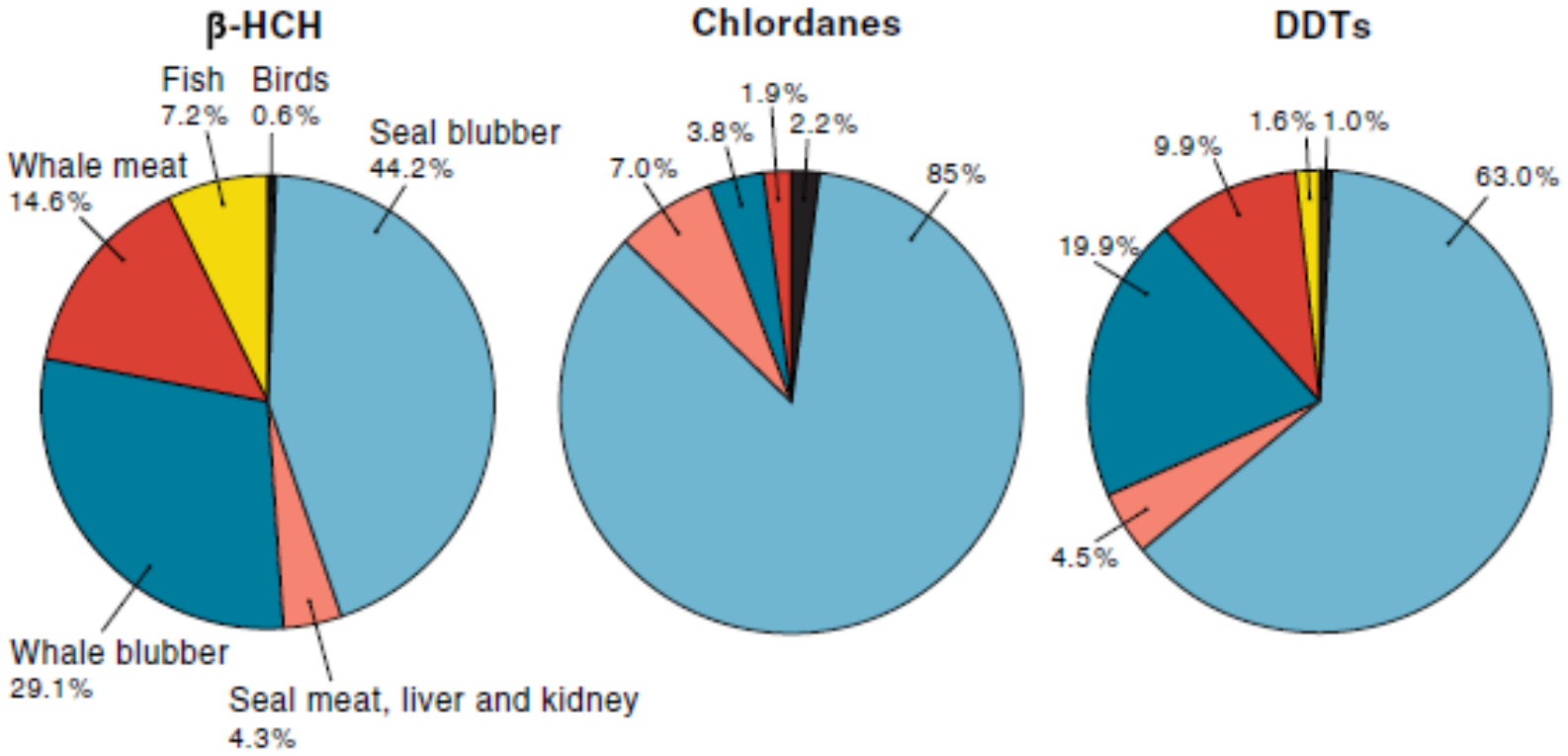
The main cause of the botulism is consumption of contaminated traditional fermented aquatic game foods such as fish and seal

Interaction between climatic change and internal exposure to contaminants from seafood consumption



Brantsater and Knutsen, 2013

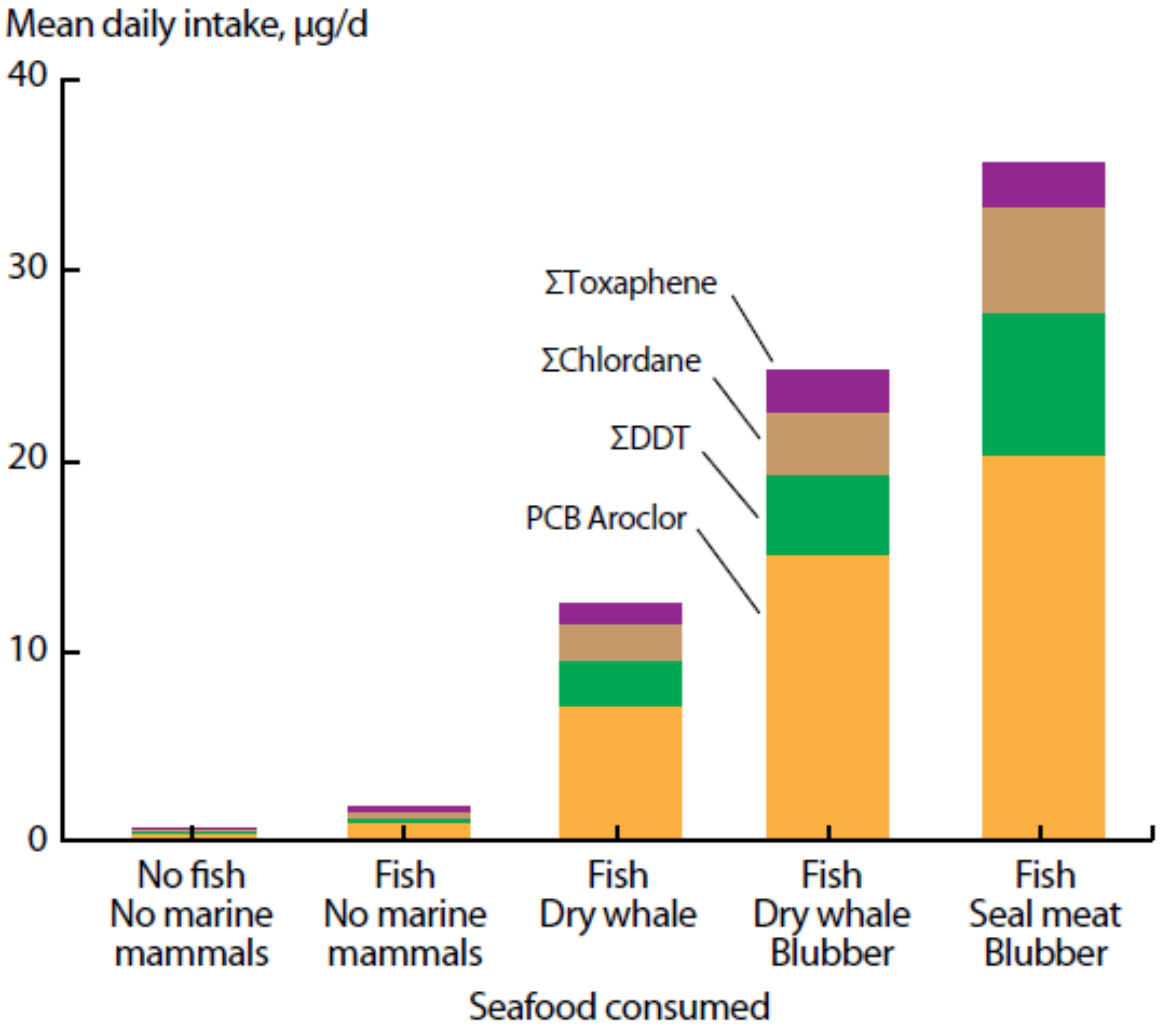
Contribution of different traditional foods to dietary exposure to organochlorines in southwestern Greenland



AMAP, 2002

Daily intake of POPs in 90 daily food portion as a function of seafood types present in the diet (AMAP, 2009)

95% of mercury exposure due to seafood contamination



Visual presentation of advice concerning consumption of traditional foods in the Far North of Russia (Dudarev and Sychov, 2005)

Green: consumption unlimited

Yellow: recommended to limit consumption to 300 – 400 g/day

Pink: recommended to limit consumption to 100 g/day

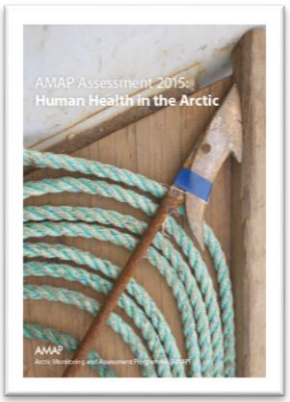
Red: recommended to replace with alternative food

Ringed seal 	*Bearded seal* 	*Walrus* 	*Whale* 	*Reindeer* 
Meat	**Meat**	**Meat**	**Meat**	**Meat**
Fat	**Fat**	**Fat**	**Fat**	**Fat**
Liver	**Liver**	**Liver**	**Liver**	**Liver**
Kidney	**Kidney**	**Kidney**	**Kidney**	**Kidney**

Hare 	*Salmonoids* 	*Marine fish* 	*Ducks and grees* 	*Tundra birds* 
Meat	**Meat**	**Meat**	**Meat**	**Meat**
Fat	**Fat**	**Fat**	**Fat**	**Fat**
Liver	**Liver**	**Liver**	**Liver**	**Liver**
Kidney				

The Arctic Monitoring and Assessment Programme (AMAP) http://www.amap.no/

AMAP assessment 2009: Human health in the Arctic



AMAP assessment 2015: Human health in the Arctic

Location of recent and ongoing blood monitoring, temporal trend and human health cohort studies around the Arctic

- **Scope of the AMAP biomonitoring:** pesticides, polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyl (PCBs), perfluorinated compounds (PFCs), metals, total lipids, cholesterol, triglycerides

- **Media** for monitoring environmental contaminants are blood, breast milk, urine, hair

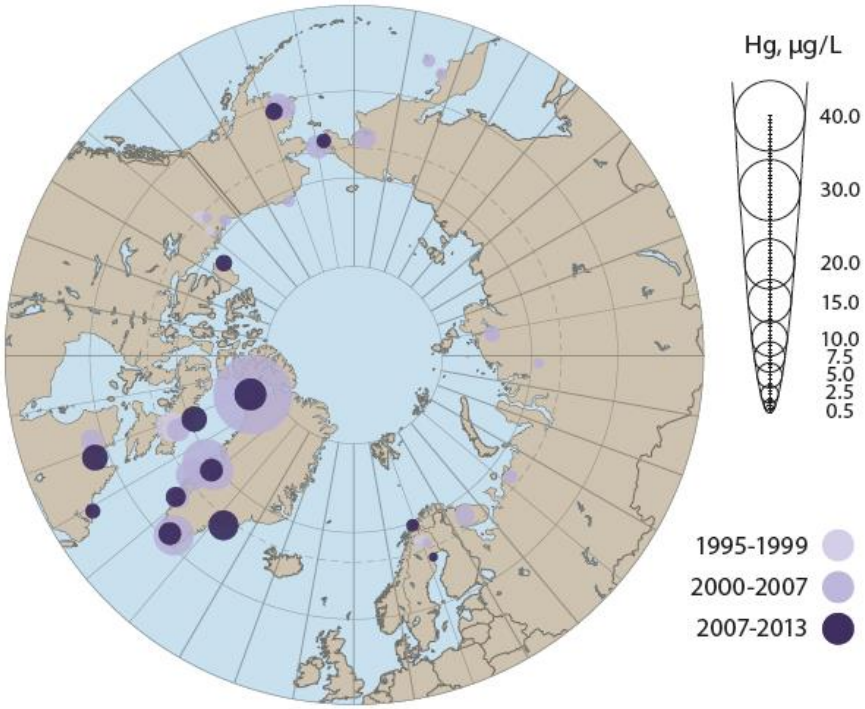
Change over time in pollutant levels in human blood within the Arctic region

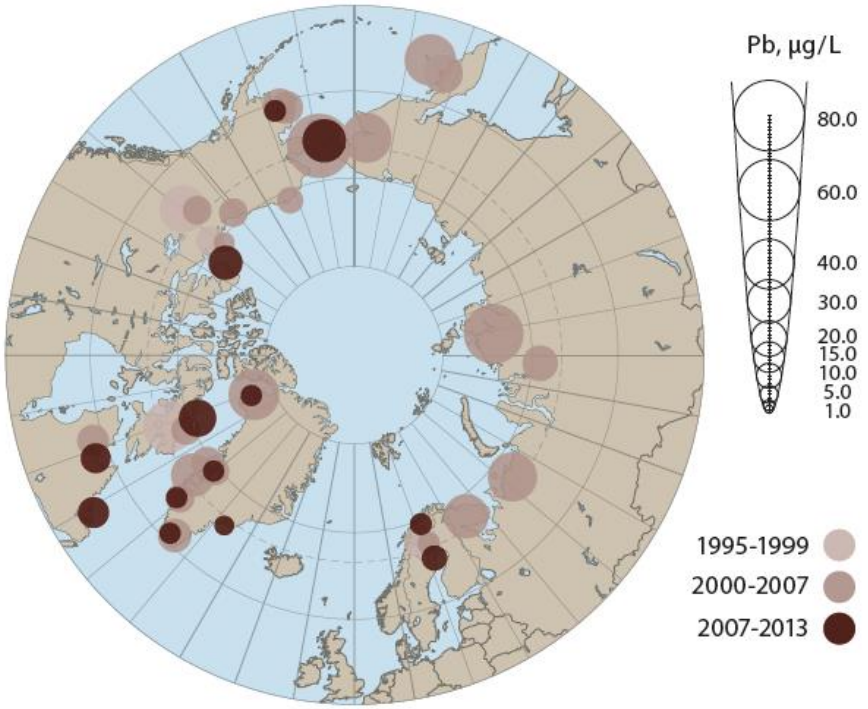
Contaminant	Media	Region	Units	1996 – 2004	2004 – 2009	2009 – 2013
PCB153	Maternal blood	Northern Norway	µg/kg plasma lipid	52	24.8	
p,p'-DDT	Child's blood	Faroe Islands	µg/kg plasma lipid	613		180
HCB	Maternal blood	Alaska	µg/kg plasma lipid	14.0	22.0	15.9
Mirex	Child's blood	Nunavik, Canada	µg/kg plasma lipid	4.1	2.3	–
Pb	Maternal blood	Chukotka, Russia	µg/L whole blood	37.5	29.6	–
Hg	Maternal blood	Greenland	µg/L whole blood	6.3	–	4.0
Cd	Maternal blood	Alaska	µg/L whole blood	0.57	0.44	0.20
PFOS	Maternal blood	Sweden	µg/L	2.56	1.88	1.67

PFOS - Perfluorooctanesulfonic acid

AMAP, 2015

Circumpolar concentrations of Hg and Pb, µg/L whole maternal blood





AMAP, 2015

Health outcomes in children related to exposure to organohalogens *in utero* and/or in early age

Compound	Exposure	Health end point
hexachlorobenzene (HCB)	*In utero*	Small length for gestational age Poor social behavior at 4 years Attention deficit hyperactivity disorder at 4 years Overweight at 6 years
DDE	*In utero*	Prematurity Delay in mental and psychomotor development at 1 year Increase in urinary coproporphyrins Asthma at 4 and 6 years
DDT	*In utero* 4 years	Decrease of cognitive skills at 4 years Alteration of thyroid hormones
β-hexachlorocyclohexane (β-HCH)	*In utero* 4 years	Alteration of thyroid hormones Alteration of thyroid hormones
PCBs	4 years	Alteration of thyroid hormones
PBDEs	4 years	Attention deficit hyperactivity disorder, poor social behavior

Other outcomes: neurobehavioral, immunological, reproductive, cardiovascular, endocrine and carcinogenic effects

AMAP, 2015


Thank you for
your attention!