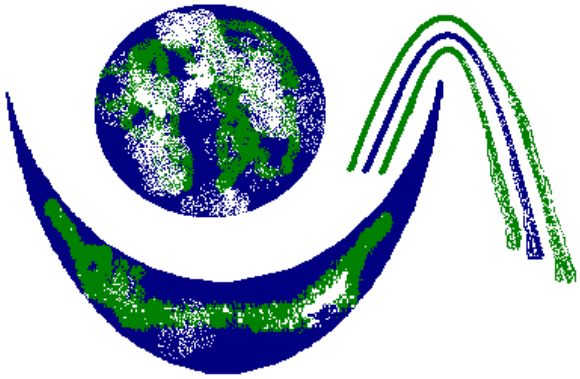
Training for health professionals



Module – *Food & Waterborne diseases*

Outline training

- Objective
- Definitions
- Effect climate change on Food & Waterborne Diseases (F&WD)
- Specific information for each F&WD
  - Health effects
  - Current situation
  - Future situation
  - Actions needed
- Summary

Climate-TRAP

Training objective

- To learn how to be prepared for changes in public health due to climate change

- Take home message
  - Health impact
  - Mitigation and adaptation
  - Preventive measures on individual & community level

Climate-TRAP

Definitions

- **Mitigation** = reducing the severity of climate change (reducing greenhouse gas concentrations)

- **Adaptation** = preparing for change (adjusting our systems to reduce harm from climate effects)

Climate change

Climate change will alter the hydrological cycle not only by altering mean meteorological measures but also by increasing the frequency of extreme events such as excessive floods and droughts.

Affect both water availability and water quality.

Climate directly has an impact on waterborne infectious diseases through effects on precipitation patterns (variability and intensity) and water temperature.

Water-borne diseases

- Water-borne outbreaks have the potential to be rather large but the actual disease burden in Europe is difficult to approximate and most likely underestimated (Bartram et al, 2002). In 2006, only 17 water-borne outbreaks were reported by five European countries, obviously an incomplete reporting.

Exposure

Overflow and run-offs

Some regions problems with extreme amounts of rain and unpredictable flood discharges.

The combined sewer systems continue to pose a major threat to water quality: designed to carry both storm water and sanitary wastewater through the same pipe to a sewage treatment plant. During periods of extreme rainfall, the volume of water in the sewer system can exceed the capacity of the system or treatment plant.

In such situations, the system will overflow and discharge the excess wastewater into surface water bodies.

Exposure Drinking water system

- Drought in summer may increase the problems with too low water pipe pressure. Low and negative pressure in the water distribution net may result in intrusion of pathogenic microorganisms if a source of contamination is present, e.g. a leaking sewer main.
- Drop in the consumption of public sector water leads to increased residence time in the distribution network. This may affect the water quality through the development of biofilm sheltering opportunistic pathogens

Exposure Drinking water system

- Disinfection by-products are expected to increase with climate change. Run-offs or low water levels causing microbial contamination, also increase organic precursors in surface water courses.
- Higher summer temperatures will probably also result in higher chlorine doses to balance the effect of temperature on the dynamics of chlorine consumption in distribution networks.

Exposure Surface or recreational water

- The frequency of cyanobacterial blooming is expected to increase.
- Increasing water temperatures may change the ecology of freshwater ecosystems: more algal blooms and degradation of water quality.
- Toxins with a potential to cause acute poisoning of consumers.
- Reduced rainfall during summer periods and droughts in coastal areas and on islands may increase salinisation of freshwater lakes and ground water used for drinking water.

Waterborne disease outbreaks

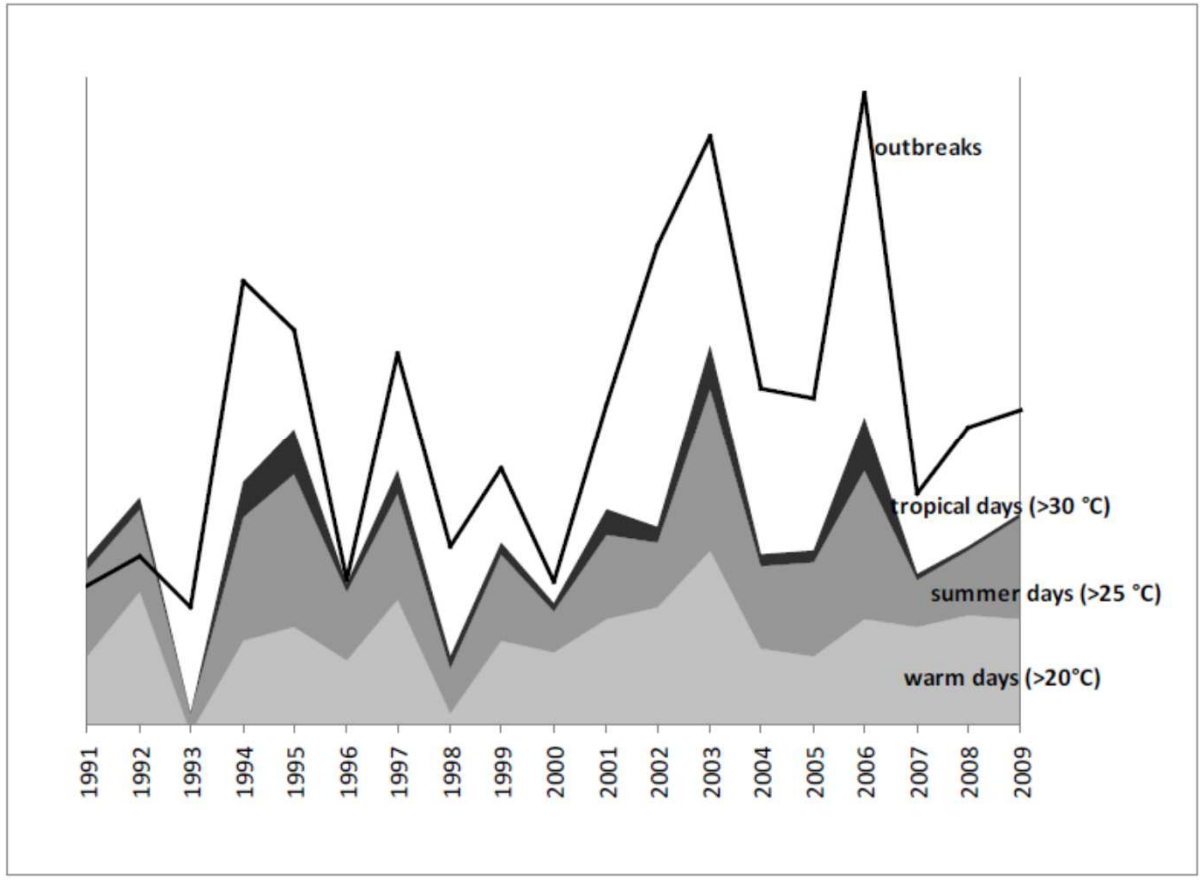


Figure The number of waterborne disease outbreaks associated with recreational water use reported in the Netherlands, 1991-2009, in relation to the number of warm, summer and tropical days in summer.

Climate-TRAP

Pathogens

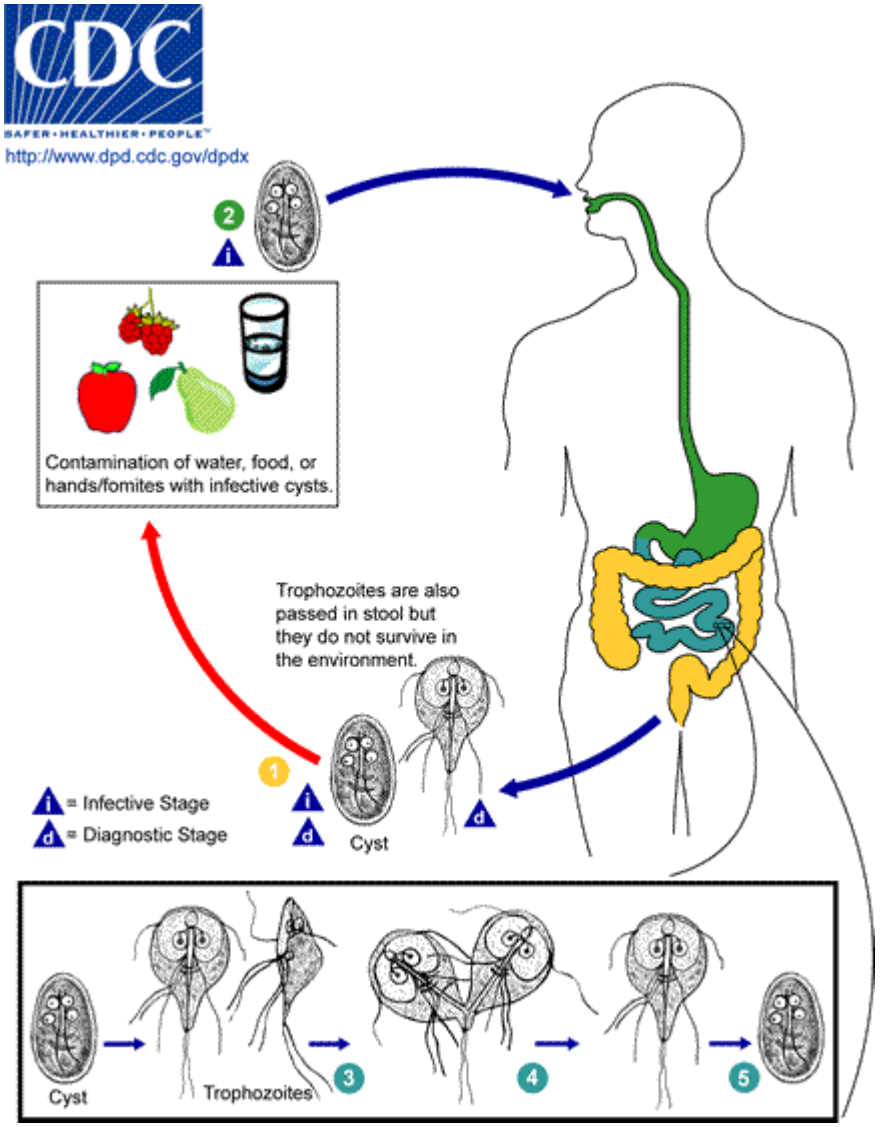
Water-borne pathogens:

parasites

- Giardia
- Cryptosporidium

bacteria

- Vibrio-bacteria



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Transmission

There are different water-transmitted pathogens such as bacteria, viruses, parasites, amoebas or algae. The way they are transmitted via water differs.

Pathogens that are water-transmitted may follow various routes, ranging from water ingestion to transmission via insect vectors, and are classified into four different categories.

according to Bradley (1977) (de Roda, 2010).

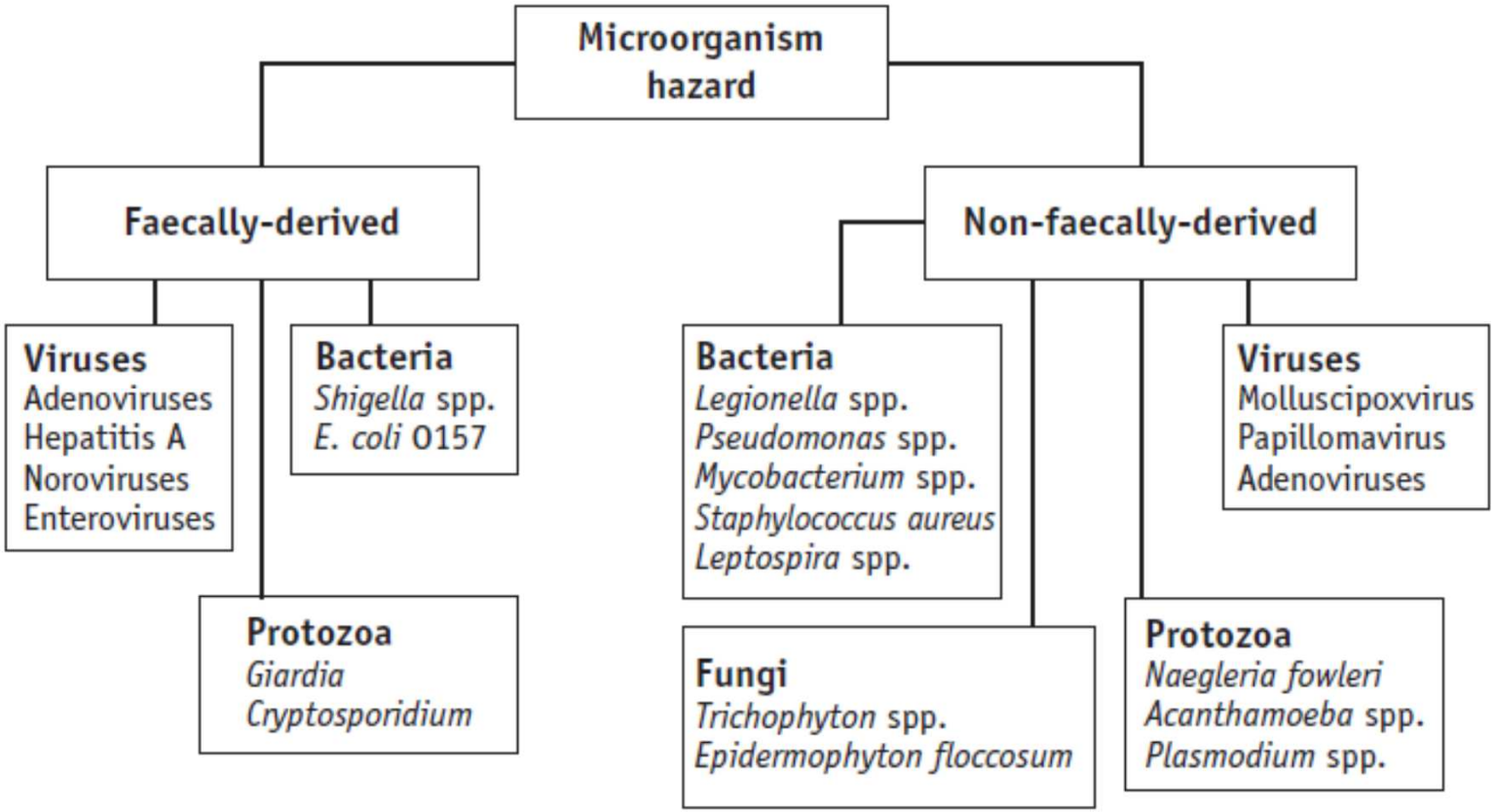
Water-transmitted infectious diseases

Table: divided into four categories according to their transmission route. Adapted from Bradley (1977)

Category	Transmission	Examples
Waterborne	Ingestion of water contaminated by human or animal faeces or urine containing pathogenic bacteria, viruses or parasites	Gastroenteritis, enteric hepatitis, amoebic and bacillary dysentery, cholera, leptospirosis, poliomyelitis, typhoid/paratyphoid fever
Water-washed	Skin, ear or eye contact with contaminated water and poor personal hygiene	Conjunctivitis, trachoma, intestinal helminth infections, leprosy, scabies
Water-based	Parasitical worm infections, the parasites are found in intermediate organisms living in water	Dracunculiasis, schistosomiasis, (tricho)bilharziasis
Water-related	Insect vectors breeding in water or biting near water	Dengue, lymphatic filariasis, malaria, onchocerciacis, trypanosomiasis, yellow fever

- Some water-transmitted pathogens, such as species of non-faecally derived bacteria, amoebas and algae, can grow in aquatic environments. In contrast, other so-called enteric bacteria, viruses and parasites that are faecally derived cannot multiply in water.
- Growth of water-transmitted pathogens in aquatic environments depends on environmental conditions including climate, and on the pathogen characteristics (WHO, 2006).

Pathogens



Recreational water-associated (non-)faecally-derived pathogens. From WHO (2006)

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Bacteria	Health significance[a]	Persistence in raw water supplies[b]	Resistance to chlorine[c]	Relative infectivity[d]	Important animal source
Campylobacter jejuni	High	Moderate	Low	Moderate	Yes
Escherchia coli – pathogenic	High	Moderate	Low	Low	Yes
E.coli – Enterohaemorrhagic	High	Moderate	Low	High	Yes
Legionella spp.	High	May multiply	Low	Moderate	No
Salmonellae	High	May multiply	Low	Low	Yes
Shigella spp.	High	Short	Low	Low	No
Yersinia enterocolitica	Moderate	Long	Low	Low	Yes
Viruses					
Adenovirus	Moderate	Long	Moderate	High	No
Enterovirus	High	Long	Moderate	High	No
Astrovirus	Moderate	Long	Moderate	High	No
Norovirus	High	Long	Moderate	High	Potentially
Sapovirus	High	Long	Moderate	High	Potentially
Rotavirus	High	Long	Moderate	High	No
Protozoa					
Cryptosporidium parvum	High	Long	High	High	Yes
Giardia intestinalis	High	Moderate	High	High	Yes

Impact on health care

Increased risk of pathogens in drinking or surface water:

- infants, elderly, pregnant women, and people with immune systems severely weakened by chemotherapy, AIDS, chronic illness such as diabetes, or pre-infection by another agent

Impact on health care

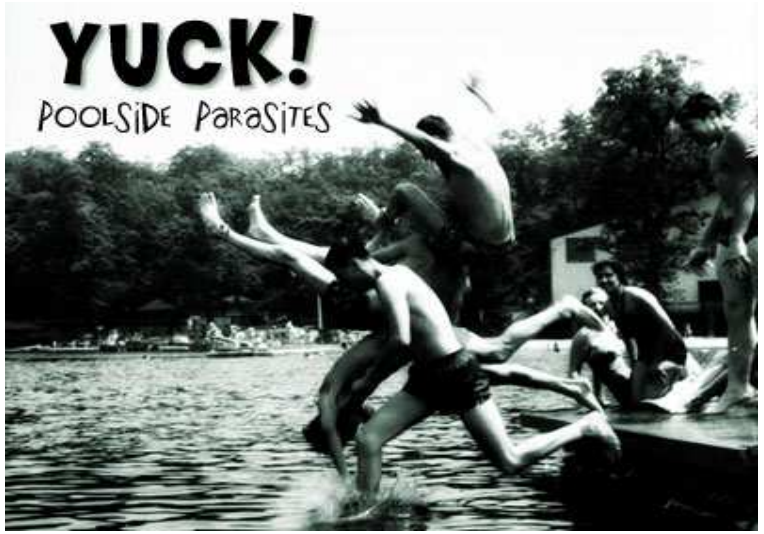
Mainly on general practitioners and medical specialists in the gastro-intestinal care.

Increased medication.

Infectious diseases –waterborne diseases

Waterborne diseases

- Likely increase in cases of Cryptosporidiosis
- Impact of increased temperature on water quality & disinfection



Surface water

- Cyanobacteria may produce a large number of toxins under warm weather conditions in surface water.
- Acute poisoning of consumers .
- Cyanotoxins which are abundant in Europe are microcystine. These can have an oral intake, and uptake in the ileum and are then distributed to the liver.
- Another cyanobacterium which is seen in central Europe is the Cylindrospermopsis raciborskii. This pathogen has seen to be spreading in a northern direction in Europe .

Climate change	Environmental effect	Recreational water-transmitted pathogen fate and behaviour	Recreational water-transmitted pathogens, examples	Recreational water types affected
Temperature increase	Water temperature increase	Growth of pathogens	*Acanthamoeba*, *Aeromonas*, Cyanobacteria, *Naegleria fowleri*, *Pseudomonas aeruginosa*, *Trichobilharzia*, *Vibrio*	Surface water (fresh and marine), natural or green pools, paddling pools, interactive water features
		Inactivation/die-off of pathogens	Adenovirus, *Cryptosporidium*, *E. coli* O157, enterovirus, *Giardia*, hepatitis A virus, *Leptospira*, norovirus, rotavirus, *Shigella*, *Staphylococcus aureus*,	Surface water (fresh and marine), natural or green pools, paddling pools, interactive water features
	Elevated water temperature and water flow	Elevated concentrations of pathogens in surface water	Adenovirus, *Cryptosporidium*, *E. coli* O157, enterovirus, *Giardia*, hepatitis A virus, norovirus, rotavirus, *Shigella*	Surface water (fresh and marine)
Rainfall intensity and frequency	Run-off, sewage overflows and flooding	Intensity and frequency of peak concentrations of pathogens in surface water	Adenovirus, *Cryptosporidium*, *E. coli* O157, enterovirus, *Giardia*, hepatitis A virus, norovirus, rotavirus, *Shigella*	Surface water (fresh and marine)
	Resuspension of river sediments			
Water availability	Decrease in water volume	Pathogen concentrations	*Acanthamoeba*, Aeromonas, Adenovirus, *Cryptosporidium*, Cyanobacteria, *E. coli* O157, enterovirus, *Giardia*, hepatitis A virus, *Leptospira*, norovirus, rotavirus, *Shigella*, *Staphylococcus aureus*, *Trichobilharzia*, *Vibrio*	Surface water (fresh and marine), natural or green pools, paddling pools, interactive water features
	Changes in physiochemical composition of water e.g. salinity	Inactivation/die-off of pathogens	*Acanthamoeba*, *Aeromonas*, Adenovirus, *Cryptosporidium*, Cyanobacteria, *E. coli* O157, enterovirus, *Giardia*, hepatitis A virus, *Leptospira*, norovirus, rotavirus, *Shigella*, *Staphylococcus aureus*, *Trichobilharzia*	
		Growth of pathogens	*Vibrio*	
	Decrease in availability of recreational water sites			Surface water (fresh and marine), natural or green pools, paddling pools, interactive water features

Table Effect of climate change on the environment and fate and behaviour of recreational water-transmitted pathogens

What action’s are needed?

- To put restrictions for fertilizer use is one approach to deal with the cyanobacterial threat water sources.

Climate-TRAP

What action's are needed?

Surveillance of health impacts associated with drinking water should include both water quality and health outcomes.

Technologies such as:

molecular fingerprinting to track contaminant sources

satellite remote sensing to detect algal blooms

Acute gastrointestinal illness monitored in relation to extreme weather

Indicators of drinking water quality to identify local associations.

Water quality monitoring and health surveillance need to be intensified.

Time-series studies (US, France, Russia) possibilities of using on-line water operation data (e.g. turbidity) as indicators of fluctuations of faecal water contamination;

and detect associations with acute gastro-intestinal illness in the population.

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Foodborne diseases

Climate-TRAP

Climate change

Climate change will alter the incidence of foodborne diseases

Climate has directly an impact on foodborne infectious diseases through effects on temperature.

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What influences occurrence of food-borne diseases?

- Food source
- Food storage
- Food preparation
- Food handlers

Food hygiene vs food safety

Food hygiene – microbiological safety of food

Food safety – absence of chemicals/residues

What influences occurrence of food-borne diseases?

- Food source: maybe climate related
- Food storage: climate related
- Food preparation
- Food handlers

What influences occurrence of food-borne diseases?

- Time-temperature abuse
- Infected food handlers or inadequate hygiene during handling of food
- Consumption/use of unsafe food sources

Introduction

Causes of food-borne diseases:

1. Chemical toxins (‘residues’)
2. Biotoxins – endotoxins & exotoxins
3. Infectious agents – exogenous & endogenous (‘zoonoses’)

Pathogens

Foodborne pathogens:

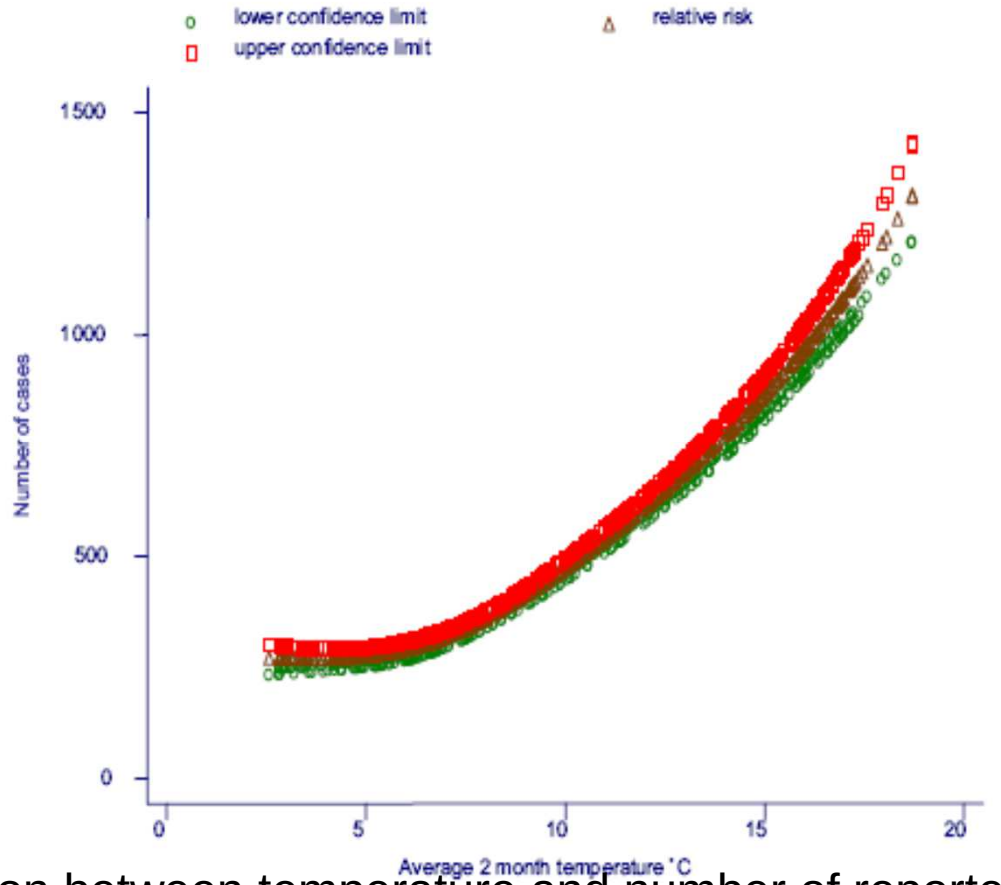
Bacteria

- Salmonella
- Campylobacter

Water and Food-borne Disease: Climate-Susceptible Pathogens

	Rising temperatures	Increasing rainfall	Shifts in reservoir ranges	Sea level changes
Salmonella	X	X	X	
Campylobacter	X	X	X	
Vibrio	X	X		X
Leptospira	X	X		
Enteroviruses	X	X		
Naergleria fowleri	X			
Cryptosporidium	X	X		
Giardia	X	X		

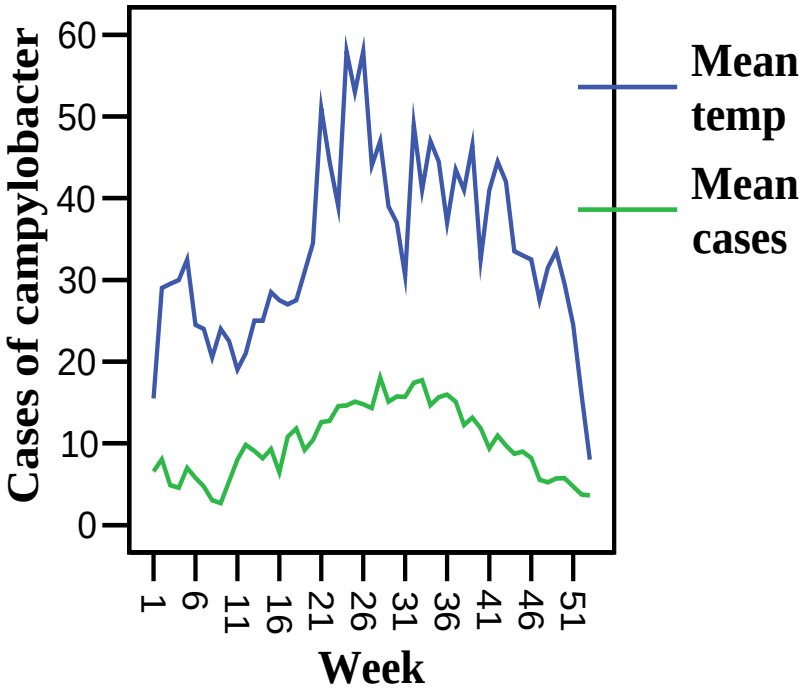
Salmonellosis and temperature rise



Modelled association between temperature and number of reported cases of salmonellosis in England and Wales (adjusted for outbreaks, seasonal factors and holidays)

Salmonella

Country	Threshold temperature ⁰ C	% change per degree ⁰ C rise above threshold
Poland	6	8.7
Scotland	3	4.7
Denmark	15	1.1
England and Wales	5	12.4
Estonia	13	18.3
The Netherlands	7	9.3
Czech Republic	-2	9.5
Switzerland	3	8.8
Slovak Republic	6	2.5
Spain	6	4.9
Ireland	2.7	7.4



(Sources: Kovats, Cullen)

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Foodborne diseases

Summary

- Likely increase in cases of food poisoning
- Incidence dependent on future food hygiene behaviour
- Evidence confirms the effect of temperature on salmonellosis
- Role of temperature in Campylobacter transmission remains uncertain

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Introduction

Endotoxins & exotoxins

lipopolysaccharide (LPS) : protein

part of bacterium : extracellular

no toxoid : toxoid

low potency : high potency

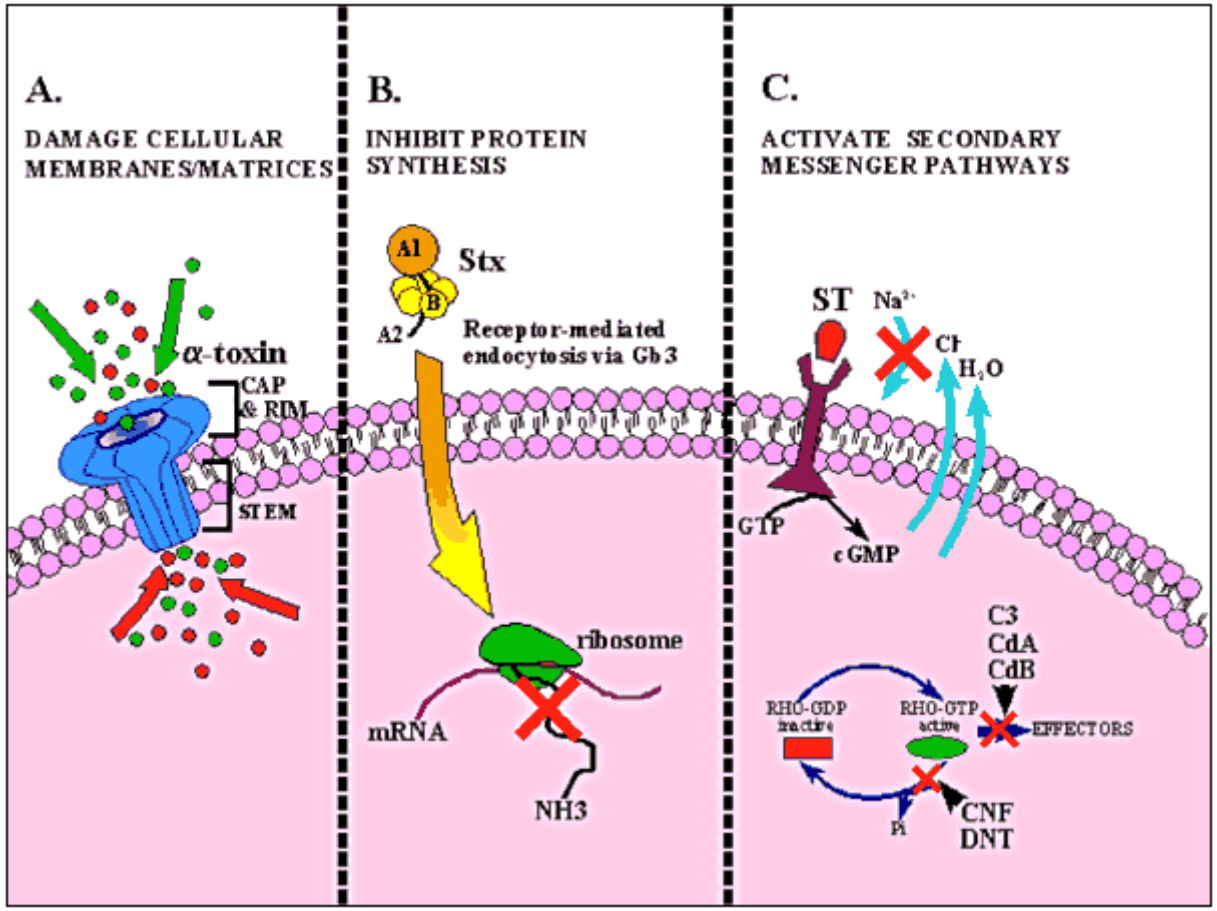
low specificity : high specificity

Mode of action of some bacterial toxins

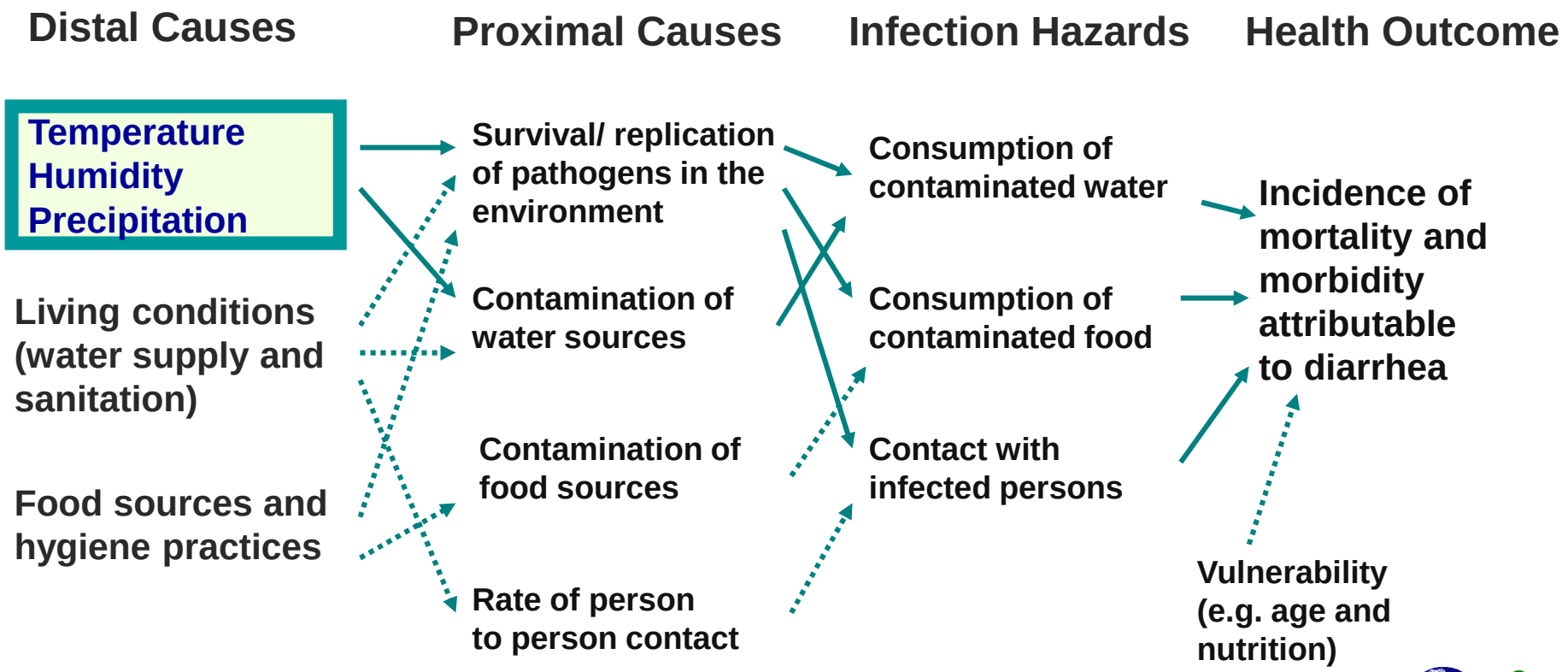
S. aureus – A
(alpha-toxin)

E. coli – B
(shiga toxin)

C. botulinum – C
(exo-enzyme)



Pathways for Weather to Affect Health: Example = Diarrheal Disease



Source: WHO

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Health effects

- Upper GIT – nausea & vomiting
- Lower GIT – cramps & diarrhoea
- Neurological signs
- General symptoms

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Symptoms

Upper GIT signs

Nausea, retching, vomiting, abdominal pain, diarrhoea & prostration

- *S. aureus* and its toxins
- *B. cereus* and its toxin

Symptoms

Lower GIT signs

Lower abdominal cramps & diarrhoea

- *Clostridium perfringens, Bacillus cereus*
- *Salmonella*, *Shigella*, ET *E. coli*, *Yersinia enterocolitica*, *Campylobacter jejuni*, *Vibrio cholera*

Symptoms

Lower GIT signs, continued

Lower abdominal cramps & diarrhoea

- *Giardia intestinalis*
- *Cryptosporidium parvum*

Symptoms

Neurological signs

Visual disturbances, vertigo, tingling sensation & paralysis

- *Clostridium botulinum*

Types of illnesses/diseases

General symptoms

Fever, chills, malaise, prostration, aches, swollen lymph nodes

- *S. typhi*, *L. monocytogenes*, *C. jejuni*
- Hepatitis A

Pathogenic Bacteria

- *Salmonella spp.* - GIT / skin
- *E. coli* O157:H7 - GIT
- *Campylobacter spp.* - GIT *(esp. poultry)*
- *Staphylococcus aureus* toxin - Human *(nostrils and hands)*
- *Yersinia enterocolitica* - GIT
- *Listeria monocytogenes* - Soil, skin, faecal material
- *C. botulinum, C. perfringens* - Soil, skin, faecal material

Risks of contracting food-borne disease depend on:

Host susceptibility

Age

General health

Risk assessment – variable infective doses

- Interaction – food substrate & environment
- pH susceptibility
- Type and strain

Impact on food safety

Climate change and variability may have an impact on the occurrence of food safety hazards at various stages of the food chain, from primary production through to consumption.

Impact on food safety

Climate change and variability may have an impact on the occurrence of food safety hazards at various stages of the food chain, from primary production through to consumption.

Which?

Impact on food safety

Some potential impacts include:

- Increasing microbial food contamination and associated food-borne diseases;
- Increasing animal diseases and vectors of transfer of animal pathogens from animals to humans;
- Modifying the patterns of fungi and mycotoxin contamination;
- Increasing harmful algal blooms in coastal areas;
- Increasing environmental contaminants and chemical residues in the food change;
- Increasing illnesses due to food contamination in emergencies.

Impacts on food safety - example

Mycotoxins in maize in Europe

Maize can support different mycotoxin-producing moulds, such as *F. graminearum, F. verticillioides, and A. flavus.*
In 2003, prolonged hot and dry weather in Europe caused an outbreak of *A. flavus*, with consequent problems of aflatoxin contamination (aflatoxins are extremely toxic, mutagenic, and carcinogenic compounds) in forage and silage, an uncommon occurrence in Europe.
Aflatoxins, produced by few species belonging to *Aspergillus* are expected to become more prevalent with the foreseen climate change.

Aspergillus flavus in maize.

Photo: CIMMYT. Taken from Maize diseases: a guide for field identification.

Prevention of Food Poisoning
WHO ‘ten golden rules’

- Food processed for safety
- Thoroughly cook
- Eat immediately
- Store carefully
- Reheat thoroughly

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Prevention of Food Poisoning
WHO ‘ten golden rules’

- No contact between raw & cooked
- Wash hands
- Keep food preparation surfaces clean
- Protect from pests
- Use potable water