Deltares

enabling delta life

Collaborating on innovative and sustainable solutions for integrated water management

Understanding disease transmission and health risks through water systems

Eline Boelee

Senior researcher/advisor water, environment & health

August 25, 2020

Deltares in brief

- We are working on **smart innovations** in the field of water and subsurface
- We are **the knowledge partner** of the Dutch government.
- We make our knowledge applicable **worldwide**
- We are a **strategic partner** and **trusted advisor** internationally.
- We provide **specialist consultancy** internationally.

877
Number of employees

79%
University / Ph.D.
39 nationalities

Regional offices in Abu Dhabi, Singapore and Indonesia

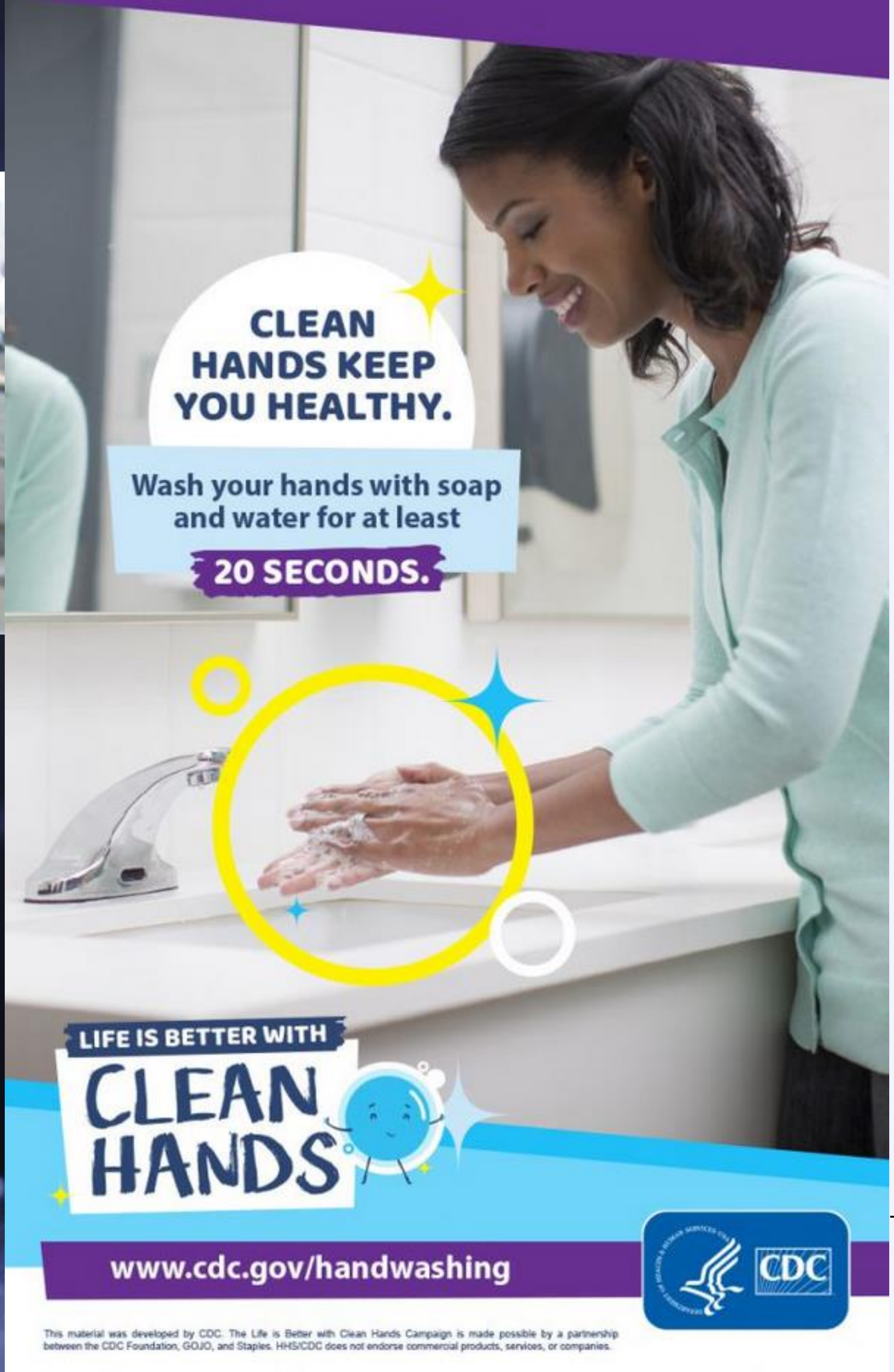
118
m€
Net turnover

ADB Deltares

Understanding disease transmission and health risks through water systems


COVID-19 UPDATE:
Tap Water is SAFE
and Has No Wait Lines.


Help Prevent the Spread of
COVID-19*
("novel coronavirus")
Clean surfaces that are touched a lot.
WARNING MIX BLEACH WITH WATER ONLY WARNING
1 CLEAN UP SURFACES
2 DISINFECT SURFACES
1/3 CUP CHLORINE BLEACH*
1 GALLON WATER
1 MIN
3 WASH YOUR HANDS
20 SEC


CLEAN HANDS KEEP YOU HEALTHY.
Wash your hands with soap and water for at least
20 SECONDS.
LIFE IS BETTER WITH
CLEAN HANDS
www.cdc.gov/handwashing
CDC
This material was developed by CDC. The Life is Better with Clean Hands Campaign is made possible by a partnership between the CDC Foundation, GOJO, and Staples. HHS/CDC does not endorse commercial products, services, or companies.


RESTROOMS
CLOSED
DUE TO THE RISK OF VIRUS TRANSMISSION
Sorry for the inconvenience but we care about your health and well-being!
Scott County


LOCKDOWN'S POSITIVE
IMPACT ON GANGA

the Source IWA

FEATURED STORY

Features

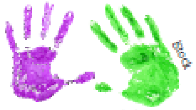
COVID-19: an opportunity to recover better

August 18, 2020

The water sector has found itself caught up in the current pandemic in many ways. Our responses can help shape a more resilient future...

SIWI

7 WAYS COVID-19 CHANGES THE WATER WORLD



1 Calls for sanitation for all

Hopefully, the many handwashing campaigns can lead to important health gains. But can the pandemic also raise awareness of the plight of the 40 per cent of the global population who don't have water and soap at home? The world is still not on track to achieve universal water and sanitation by 2030, as pointed out by global leaders in a Call to Action on Covid-19 initiated by Water and Sanitation for All.

2 Vulnerable groups hardest hit

SIWI and UNICEF are monitoring the global response to Covid-19 from a water, sanitation and hygiene perspective. Many governments now ensure that people are not cut off from water and sanitation services in the middle of the pandemic for failure to pay a bill. Water is also being trucked to informal settlements and more handwashing facilities have sprung up in public places. But more needs to be done for vulnerable groups, including people without a home or who are living in shelters or refugee camps.

3 Growing interest in One Health

The pandemic has made more people aware that rapid population growth and rampant development are putting humans and animals in increasingly close quarters, making it easier for diseases to jump between species. To tackle this kind of zoonotic epidemics, countries need to apply the concept of One Health, recognizing the links between humans, animals, and the environment. A new report from the UN Environment Programme calls for governments to develop plans to combat future pandemics by addressing root causes such as poverty, environmental degradation and increased demand for meat.

4 New role for water utilities

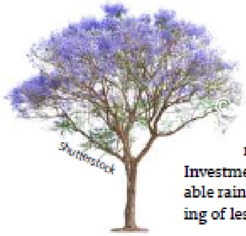
Underinvestment in the water sector is a chronic problem in many countries and the economic crisis could make matters worse. At the same time, the water industry is now courted by other sectors interested in monitoring wastewater to detect signs of disease at an early stage. The increased use after the Covid-19 outbreak could lead to new technology and speed up the digitalization of the sector, according to Dragan Savic, Chair of the IWA Digital Water Programme Committee.

5 Water more important

The CEO Water Mandate has issued a pledge for the business sector to strengthen its commitment to responsible water and sanitation policies in response to Covid-19. It is likely that access to water will be an increasingly important factor when companies are starting to rethink their supply chains. Though many struggling companies may temporarily be less focused on sustainability, many believe that focus on resilience will grow. Research indicates that socially responsible companies performed better during the first corona-related stock market downturn.

6 Weaker environmental protection

Illegal deforestation and poaching have in many places spiked during lockdowns and could be further fueled if the economic crisis forces national parks to lay off staff. Ecotourism, which used to be an important source of income, has almost disappeared. There is also concern over growing violence against environmental defenders, which could be facilitated by the increased use of surveillance to stem the pandemic and that may be a lasting legacy of Covid-19. In Brazil, indigenous leaders fear increased violence and that their land will be invaded by illegal loggers. .



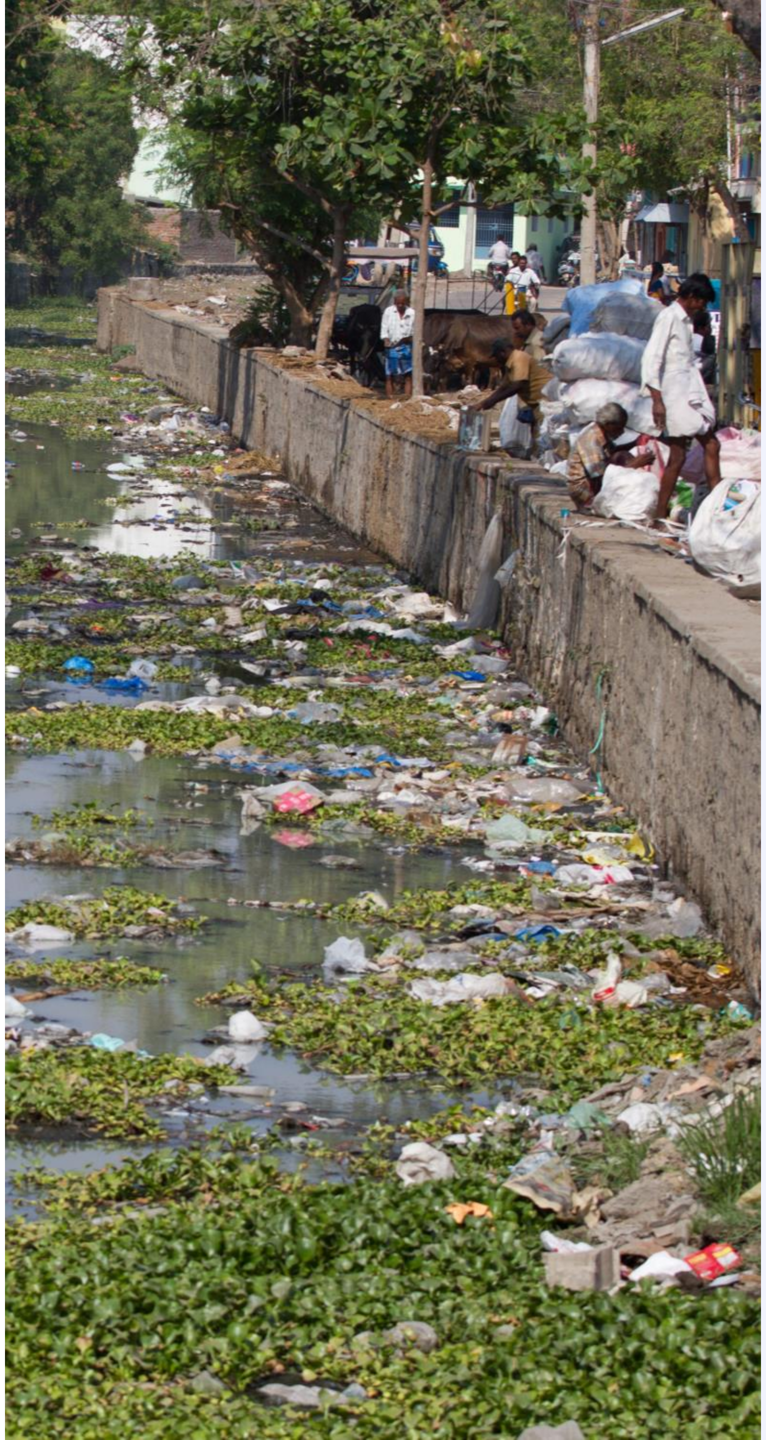
7 Time for a blue-green recovery

A growing number of international institutions call for green stimulus packages and more focus on resilience. In many countries, people are returning to the countryside after losing their jobs in the city. Investments are needed to help small-scale farmers cope with challenges such as floods, drought, and unpredictable rainfall. Many will need to shift to new practices, including agroforestry, rainwater harvesting and the growing of less thirsty crops. Rethinking agriculture is one of the main challenges in the post-Covid world.

ADB

Table of contents

- Water, disease and health (risks)
- Fate and transport of pollutants
- Microbiology and early warning
- Vector-related diseases
- Predicting the health burden
- Key messages



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Water, disease and health (risks)

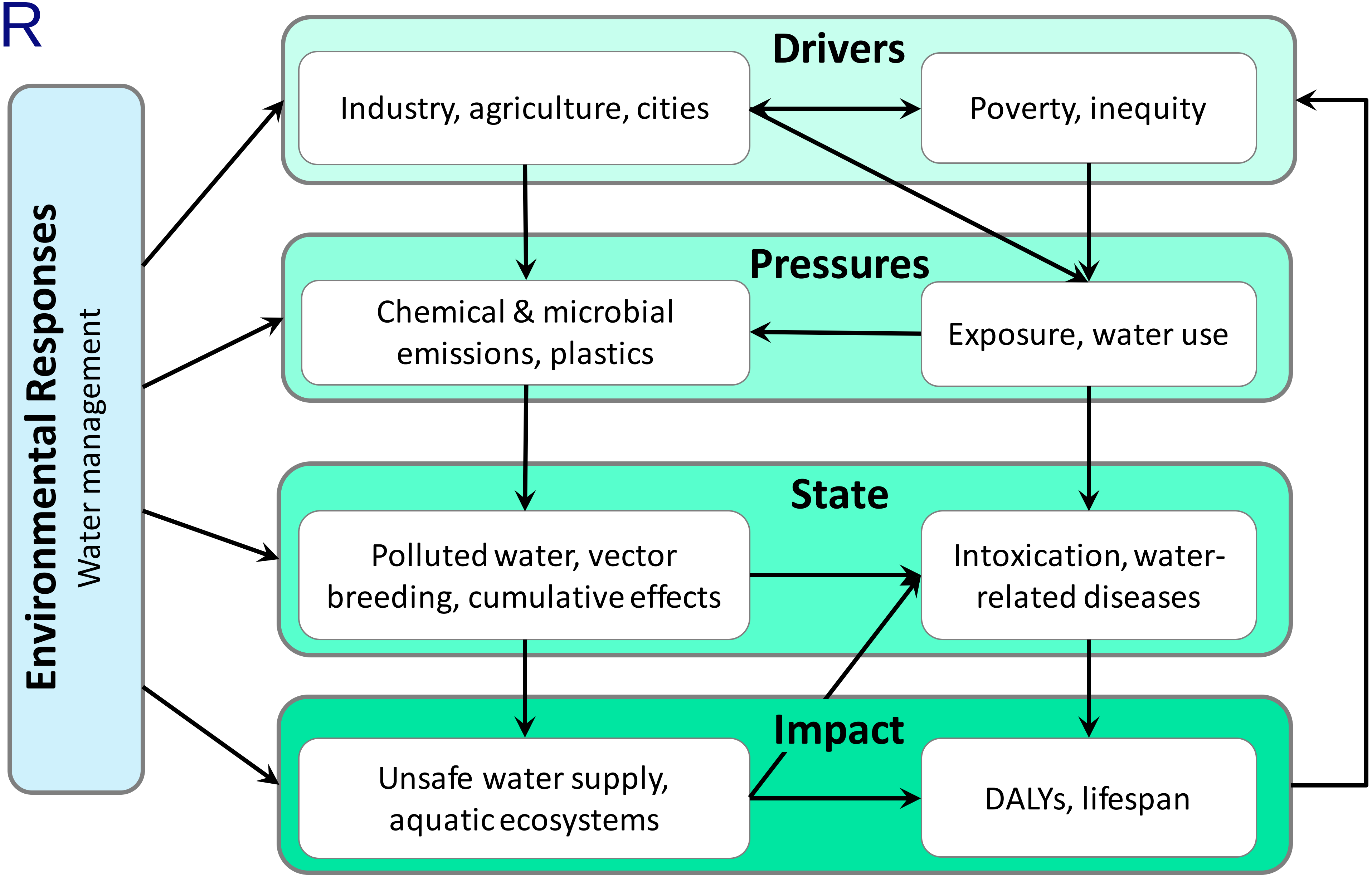
Impact ↑ or ↓


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Water, disease and health (risks)

Figure: Deltares

DPSIR



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http://dx.doi.org/10.1016/j.actatropica.2019.03.011

Water, disease and health (risks)

Figure: Deltares

By type

- Chemicals and waste
- Microbiology (pathogens)
- Vectors and intermediate hosts

$\left.\begin{array}{l} \\ \\ \end{array}\right\}$ and plastics

- Related to
  - Presence of surface water
  - Domestic wastewater
  - Industry: chemicals, temperature
  - Ecosystem health

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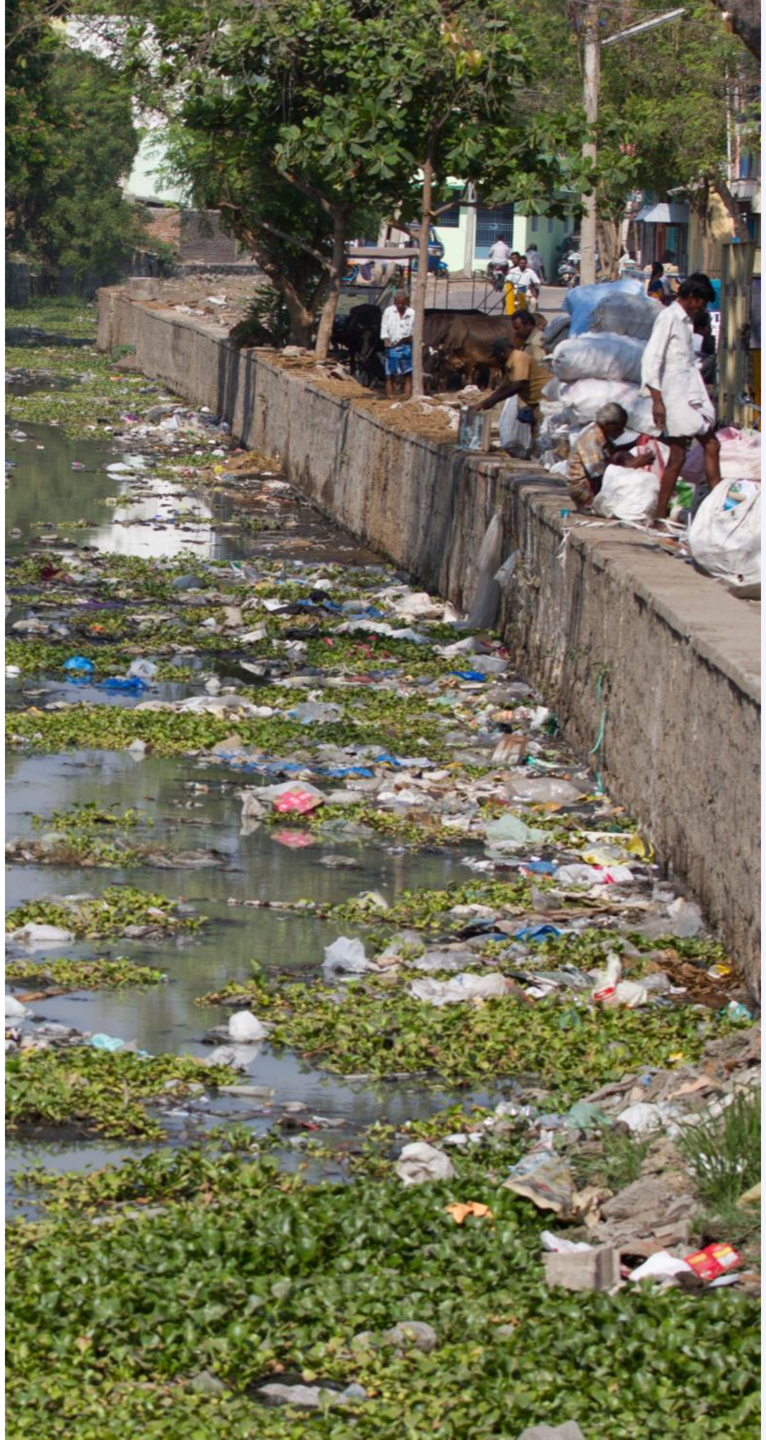


Deltares research & innovation agenda on water and health

Building on earlier work on fate and transport of chemical compounds

1. Water-related infectious diseases:

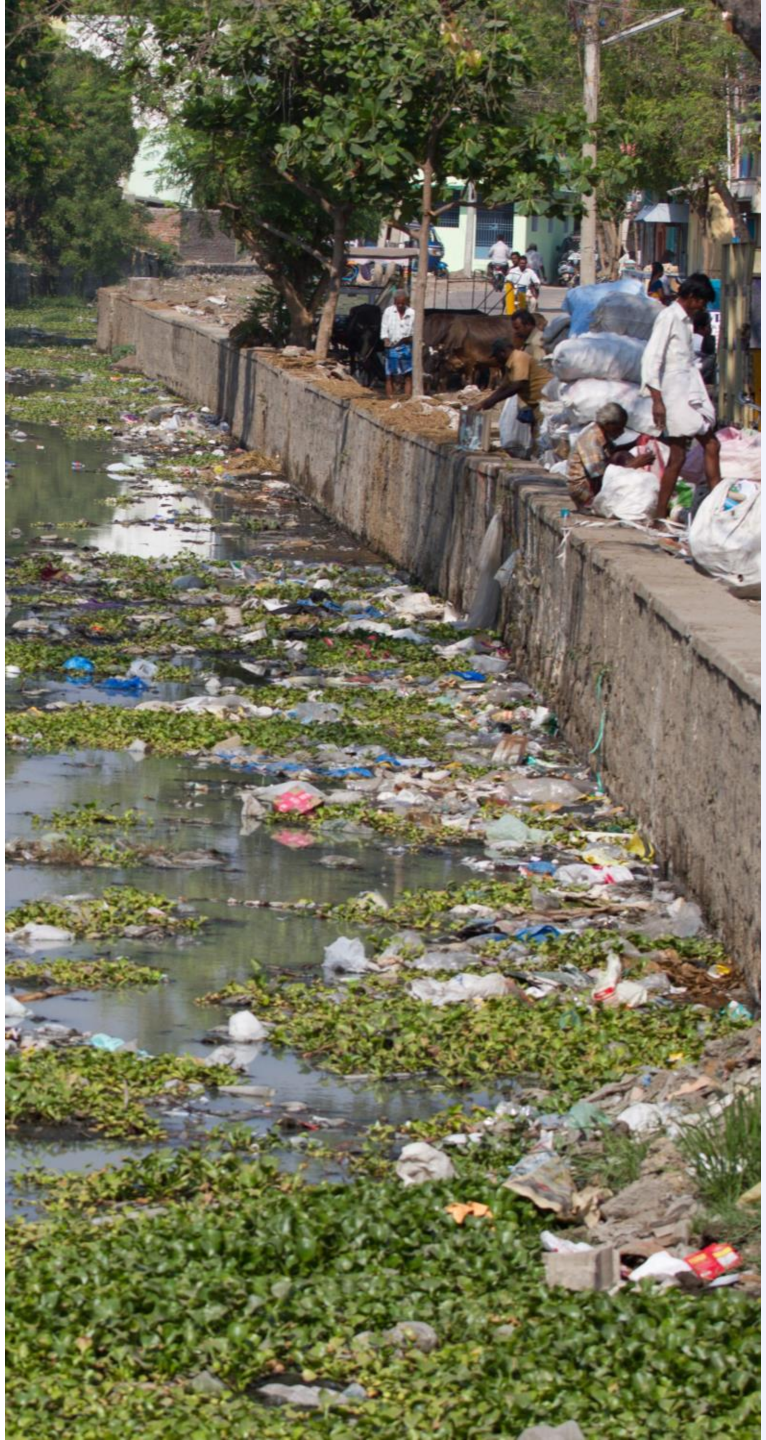
   Predicting unintended effects of environmental change

2. Future health risk under extreme weather:

   Early warning for waterborne pathogens

3. Predicting the health burden of (urban) river basin management:

   Setting new priorities



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Fate and transport of pollutants

Chemical and organic pollutants

Pressure

Industry: heavy metals, hydrocarbons

Agriculture: nutrients, pesticides

Cities: emerging substances

Plastic waste

- Litter
- Micro and nano plastics
- Chemicals leaching from plastics

State

Emissions

Fate and transport

In groundwater, freshwater, oceans

Impact

Ecological effects

Burden of disease?

Fate and transport of pollutants

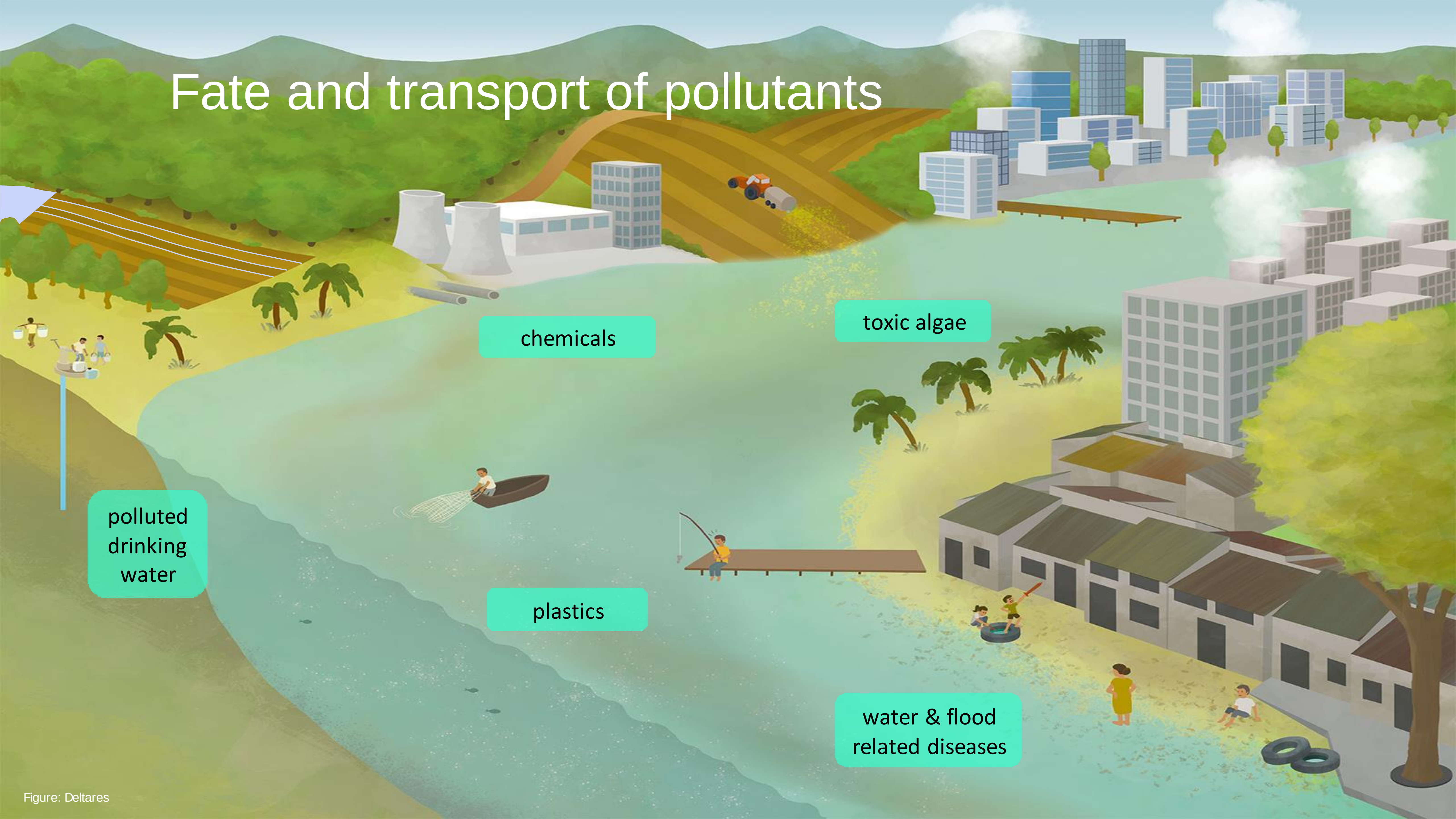
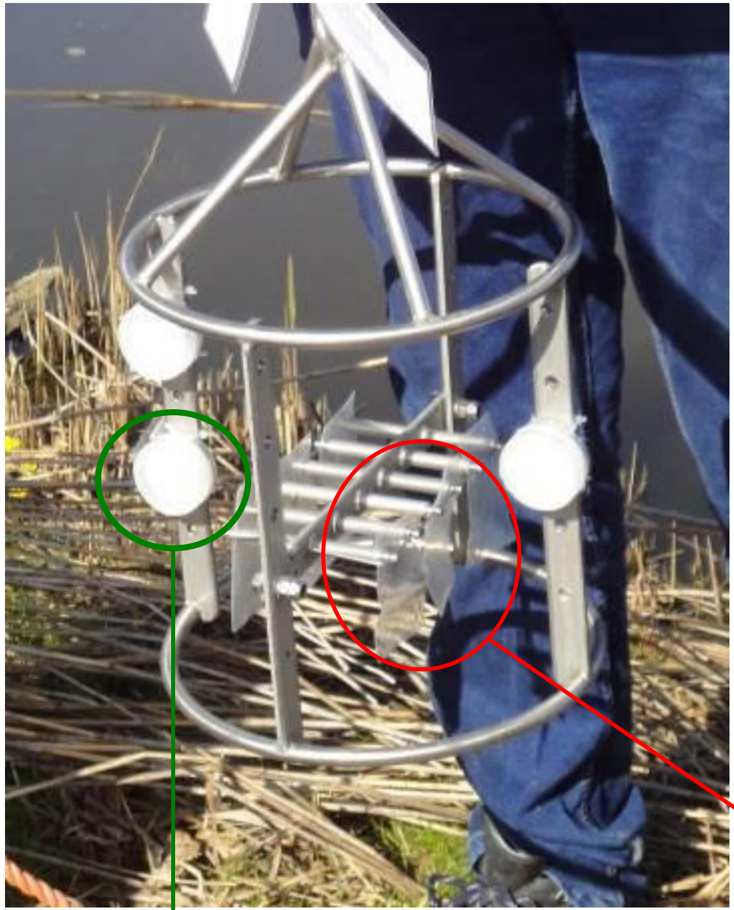


Figure: Deltares

Example
Monitoring: passive samplers



Silicon rubber

Speedisk

Integrated water quality modelling

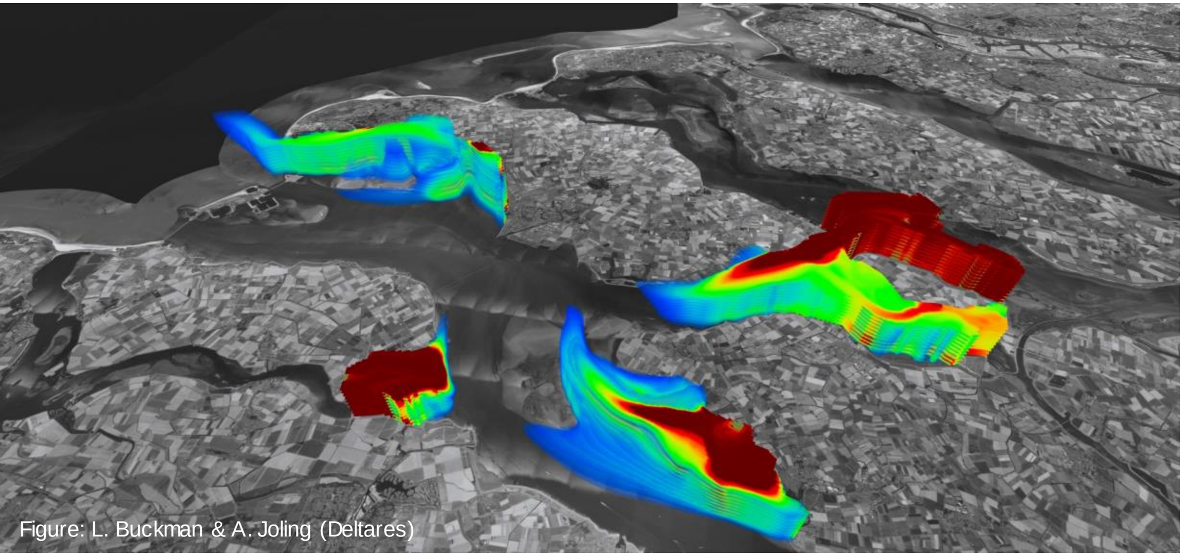


Figure: L. Buckman & A. Joling (Deltares)

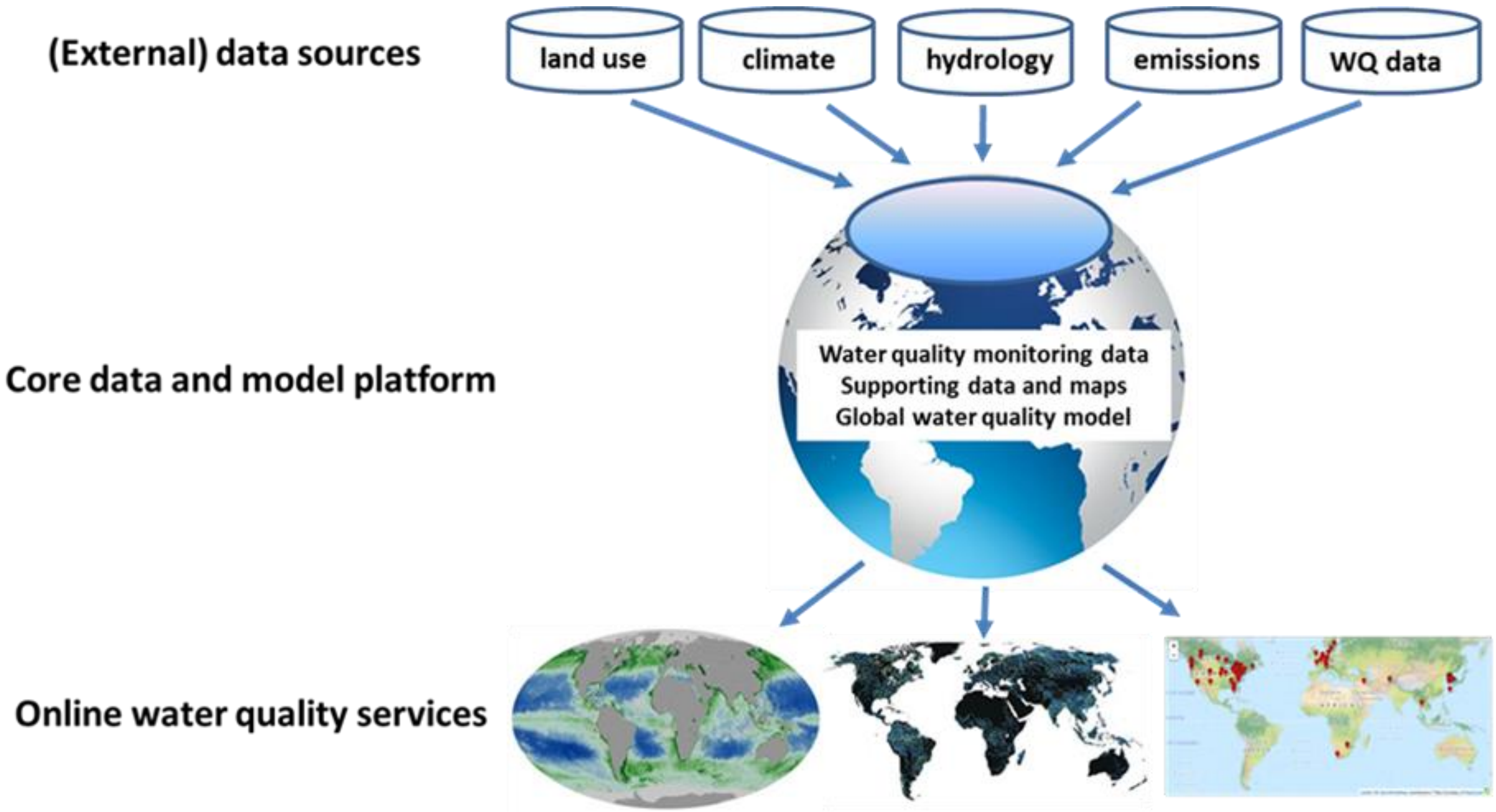
Open source tools

Support management of aquatic ecosystems

Visualisation of changes in water flow and quality

Global model and platform

Global model and data monitoring platform



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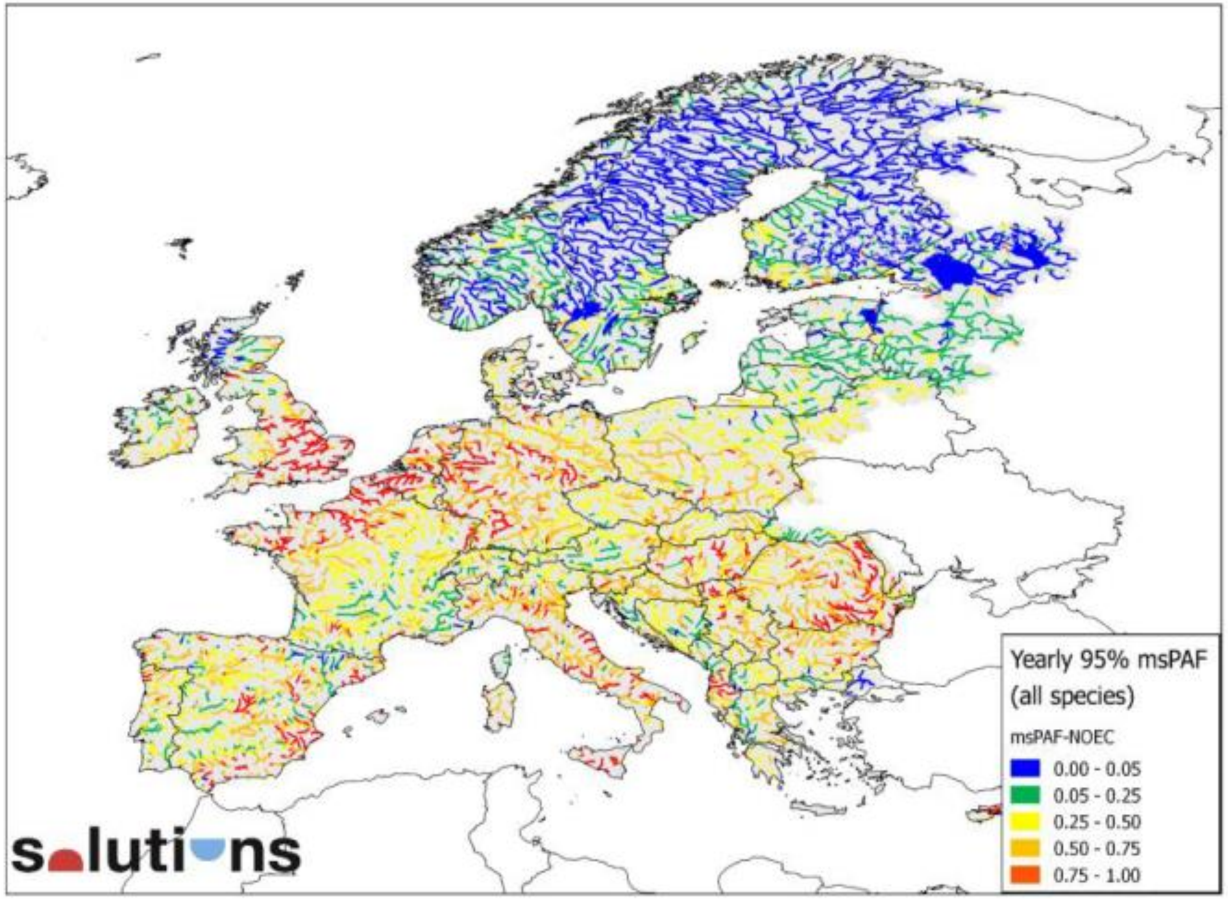
Example

EU project SOLUTIONS

- Train of models
  - Hydrology
  - Emissions
  - Fate and transport
  - Exposure
  - Ecotoxicity
  - **Effects?**

- Can be used for new substances



https://www.solutions-project.eu/

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Plastic

- **Identification** of sources
- **Plastics leakages** (Emission Model)
- **Integrated assessment** (sources-to-sea)

SOURCES

Where is it coming from? Who are the polluters?

- **Transport modeling** – rivers and sea
- **Hydrology** and **hydrodynamics**
- **Biodegradation** processes

TRANSPORT & FATE

Where does it go and accumulate?

SOLUTIONS

What can be done?

- **Stakeholders** participation/engagement
- Optimization and effectiveness of **clean-up**
- **Good practices** for ML prevention

IMPACTS

How it impacts society, ecosystems, economic sectors?

- **Research** (ecosystems, human health, sediment interaction)
- **Risk & environmental impact assessments**

Microbiology and early warning

Microbiology and early warning

Pressure

Agriculture & Cities: pathogens

Plastic waste as substrate

Link to WASH

Climate change: extreme weather

State

Pathogens

- *E. coli*, cholera, *Leptospira*, viruses, harmful algal blooms

Fast and accurate monitoring

Modelling: transport and forecast

Also via emergencies (flood events, camps)

- Hotspot evaluation
- Health risk assessment

Impact

Water-borne diseases

Anti Microbial Resistance (AMR)

Microbiology and early warning

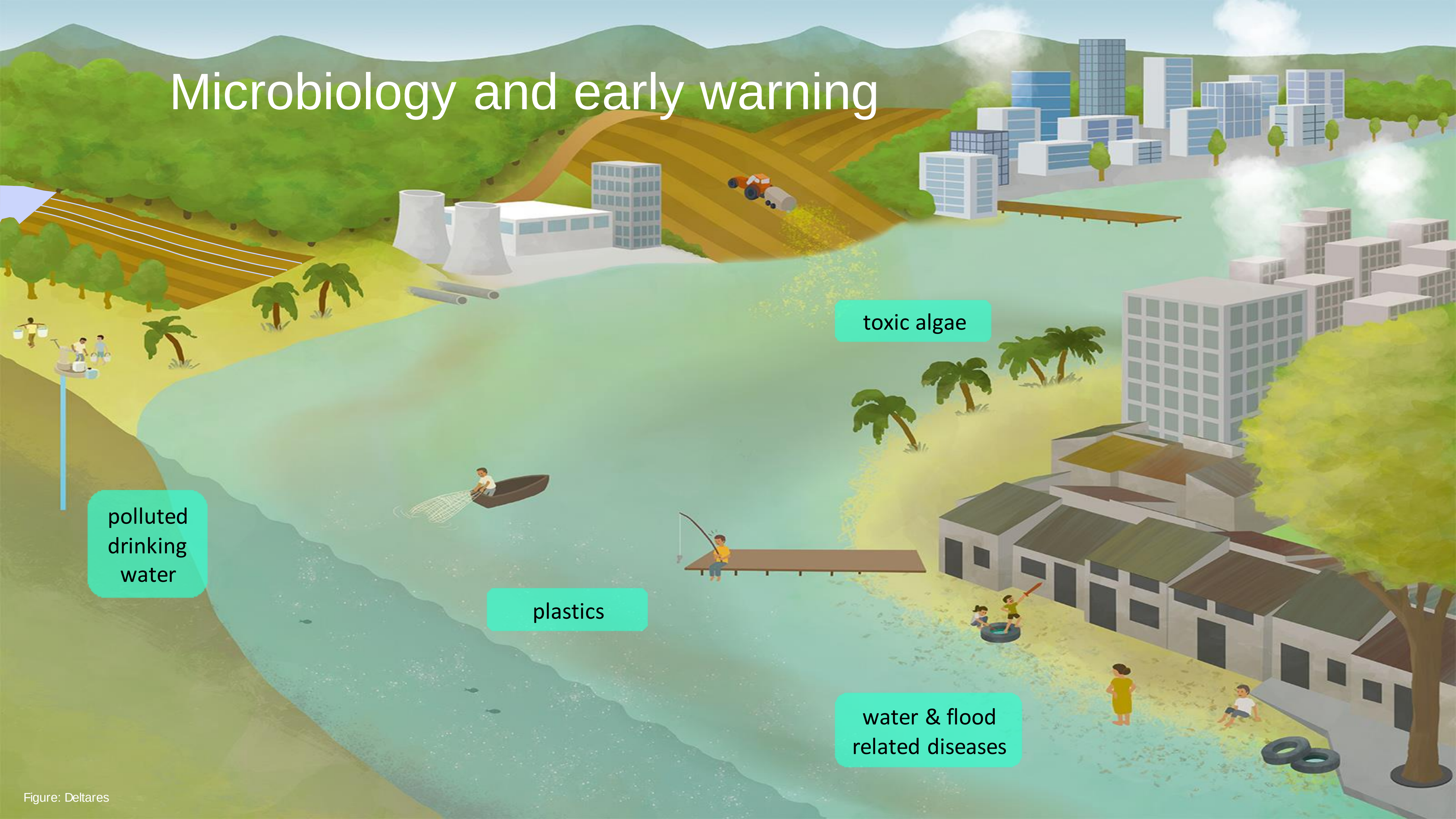
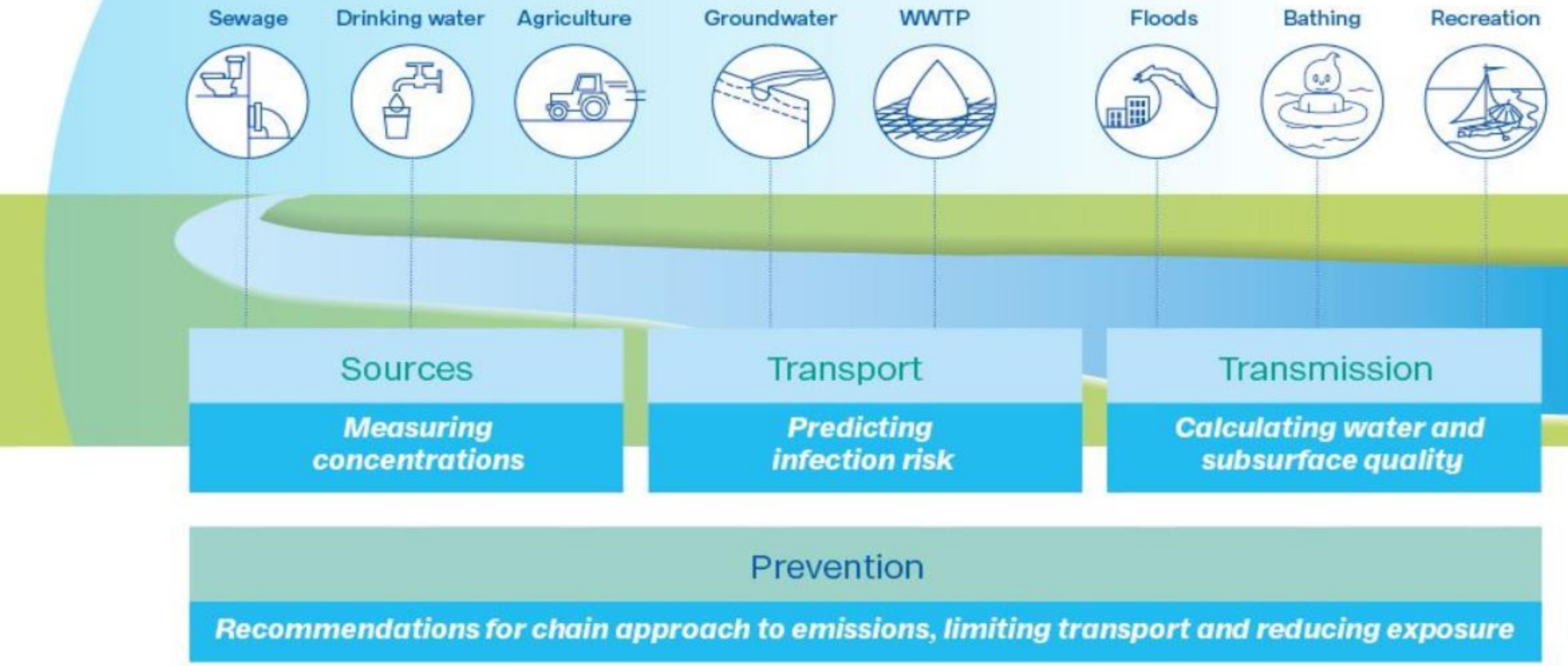


Figure: Deltares

Conceptual infographic

Deltares

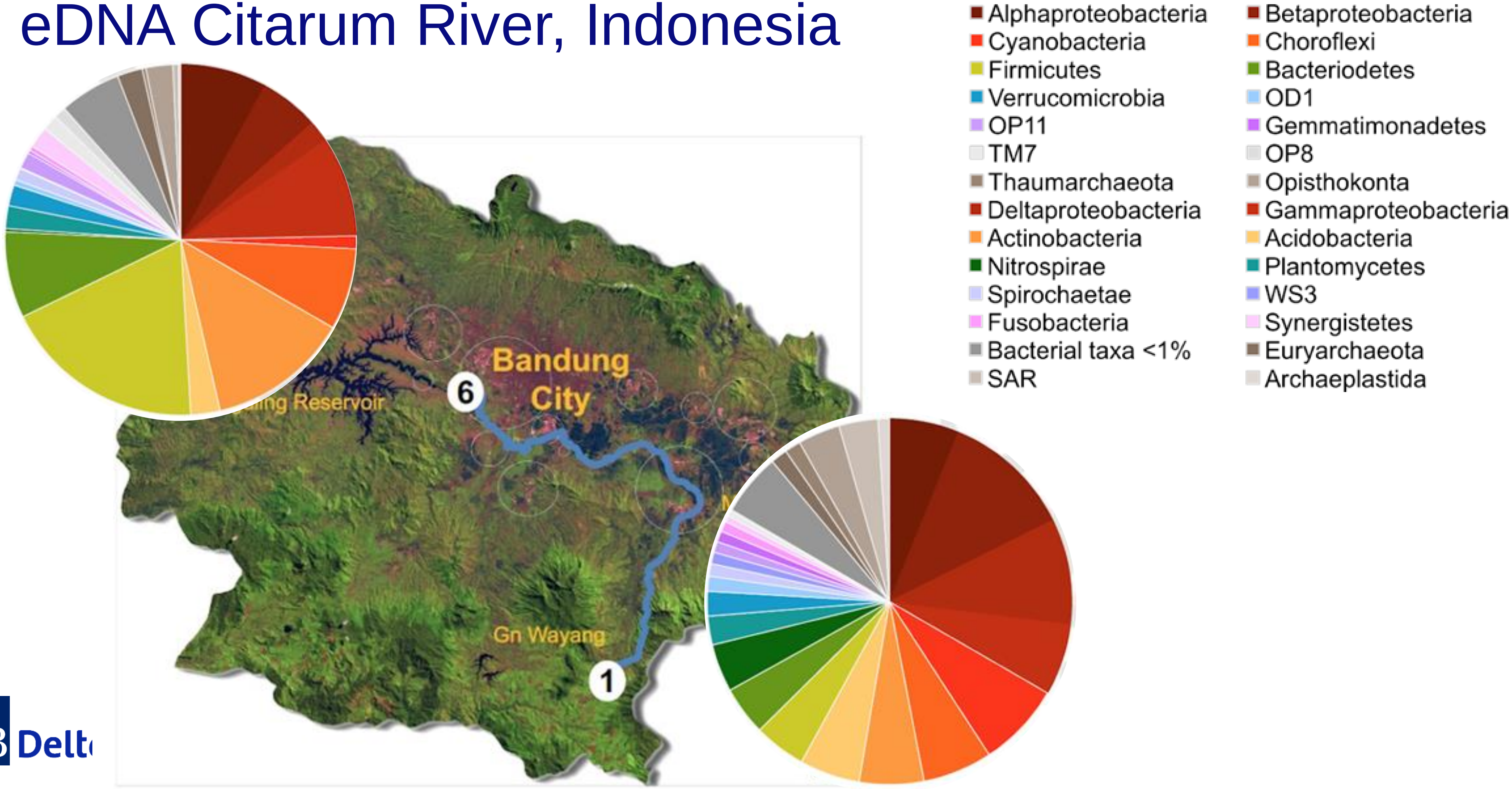


Example
Monitoring

- On-site detection of DNA (mobile qPCR)
- *E. coli, Leptospira,* cyanotoxines
- Tested and compared to laboratory analysis
- Highly suitable for near real-time monitoring

Example

eDNA Citarum River, Indonesia



Example
Operational forecasting of bathing water quality

- Pathogenic bacteria: in England, South-Africa and Singapore
  - Stormwater overflows
  - EU directives
- Harmful algal blooms (blue-green algae)
  - Many lakes/ reservoirs
  - Some marine areas
  - Nutrients, temperature
- Early warning
  - Data assimilation
  - Use of satellite data
  - Real-time monitoring data

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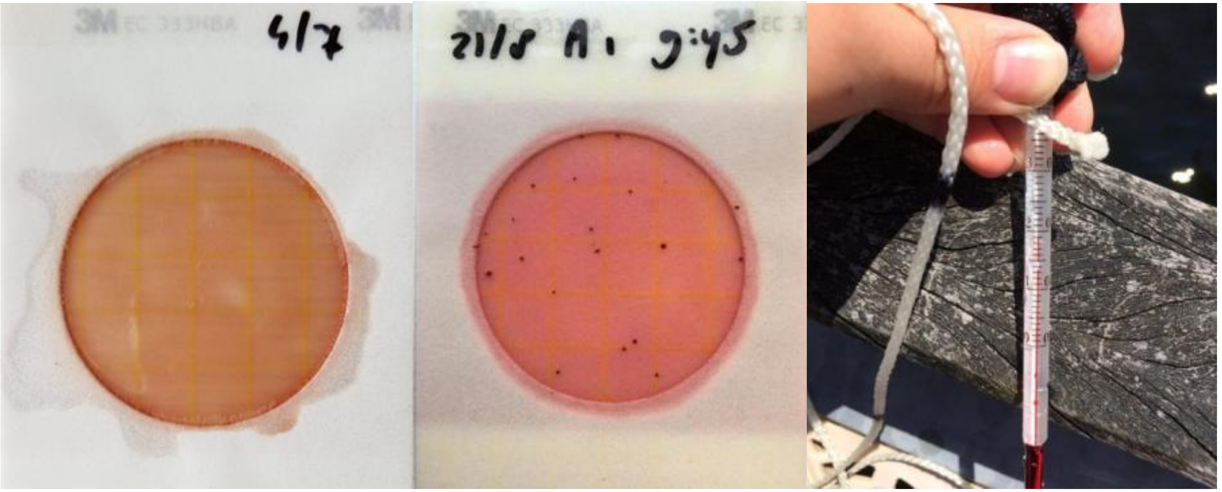
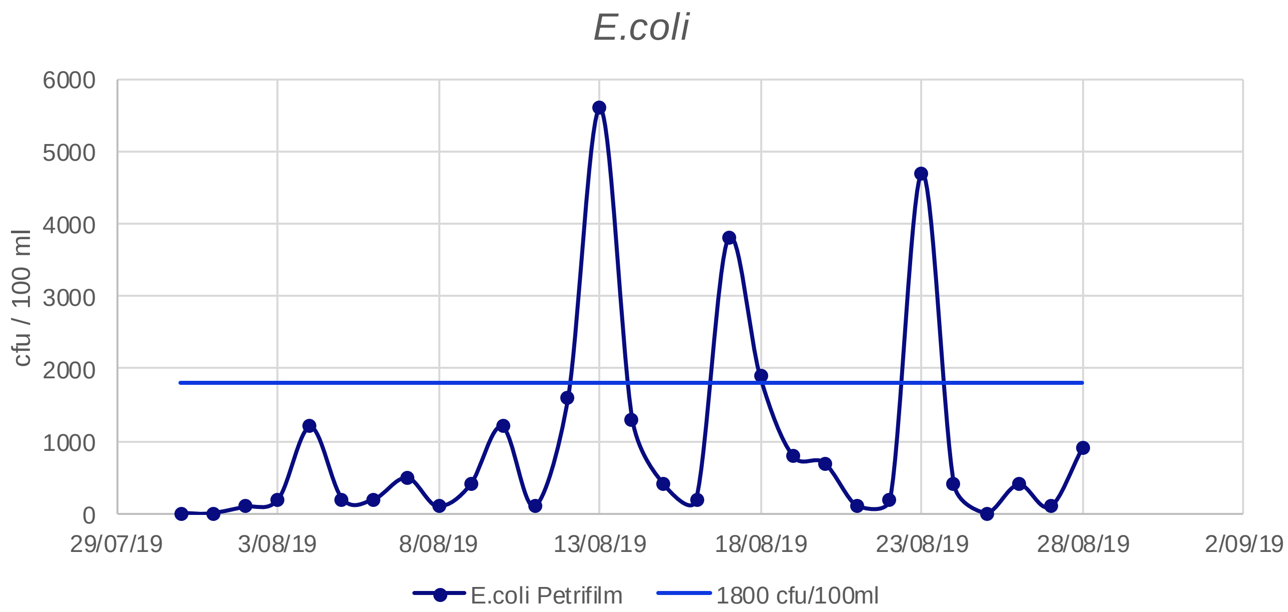
Example

Innovative monitoring: citizen science





Antimicrobial resistance

Resistant genes spread in aquatic environment

- Sewage from hospitals, cities
- Agriculture: livestock, (shell) fish, crops

Wastewater treatment plants as hotspots

- Mix of faeces, manure and resistant genes
- Nutrient-rich environment with susceptible new host organisms

Role of Deltares

- Understanding transport of AMR via water
- Development of interventions, e.g. alternative treatment

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Example

SAMPAN - Environmental routes of antimicrobial-resistant bacteria to and from hospitals (Rotterdam, Rome, Jakarta)

Human-water interface

Uniform surveillance strategy: human and environment

Health impacts of plastics

Leaching of toxic chemicals

Micro- and nano-sized plastic particles

Ingestion affects immune response

Reservoirs and transport for pathogens

Breeding sites and shelter for mosquitoes


Photo: Manan Vastsyayana

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(Micro)plastics as vector for pathogens

- Monitoring and modeling spread of particles
- Monitoring pathogens on clean introduced plastic particles in diches, lakes and river environments
- Environmental partner in health research: environmental sampling of plastics used in medical research (blood/brain and intestinal barriers)

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Vector-related diseases

Vector-related diseases

Pressure

Presence of surface water

dams, reservoirs, wetlands, irrigation systems, ditches, coasts, urban blue/green spaces

Ecosystem health & water quality

Linked to WASH

Plastic waste

Climate change

State

Transmitted by mosquitoes, flies, via snails, rats

Protozoa, viruses, bacteria, helminths

Impact

Burden of disease

Environmental management

Vector-related diseases

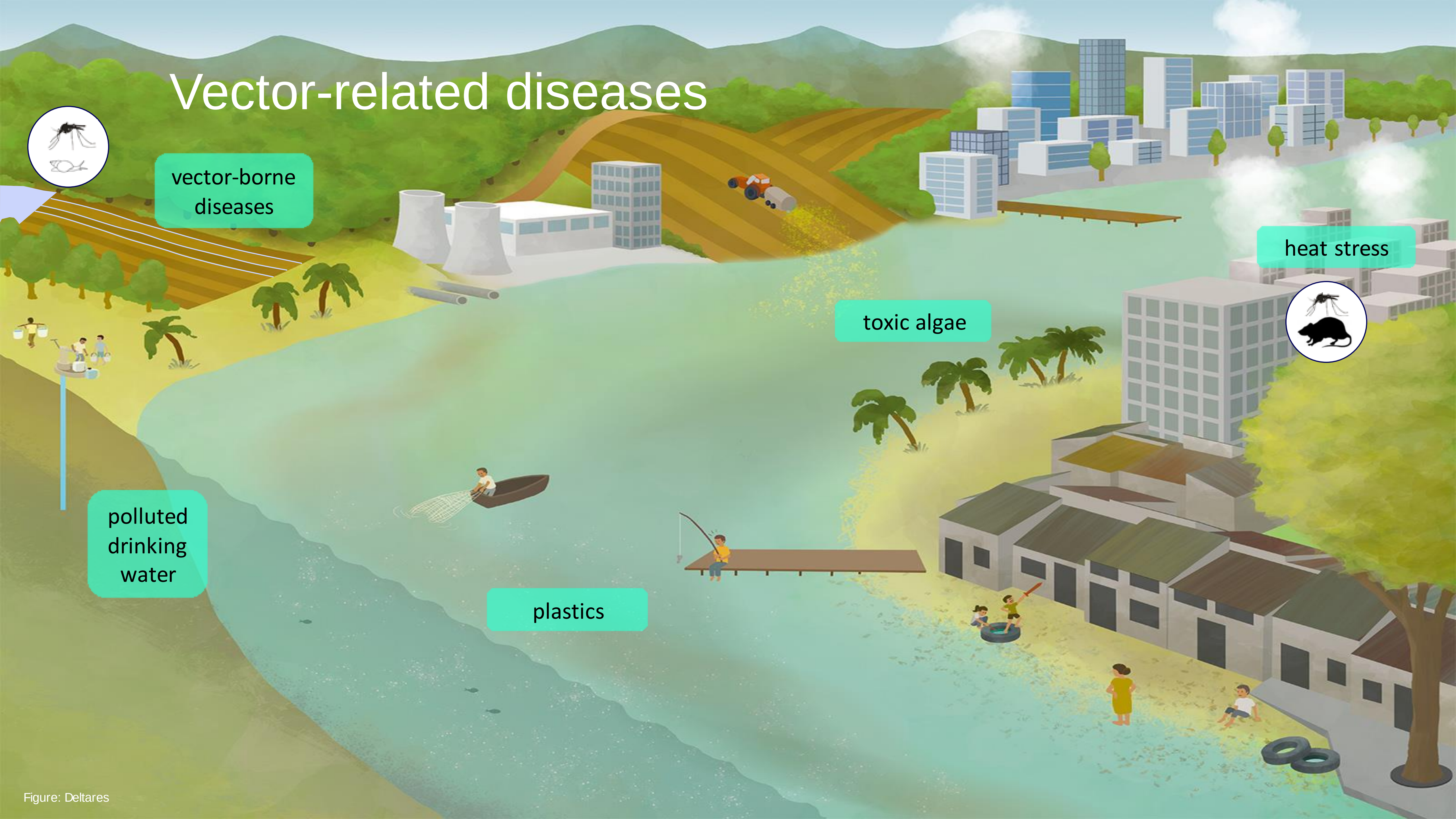


Figure: Deltares

Example project
One Health PACT – Predicting Arboviruses Climate Tipping Points

[Deltares/PACT website](#)

Understanding the drivers

Scenarios 2100: understanding and predicting outbreaks and tipping points for changes in

- Climate
- Farming practices
- Water management
- Importation risks

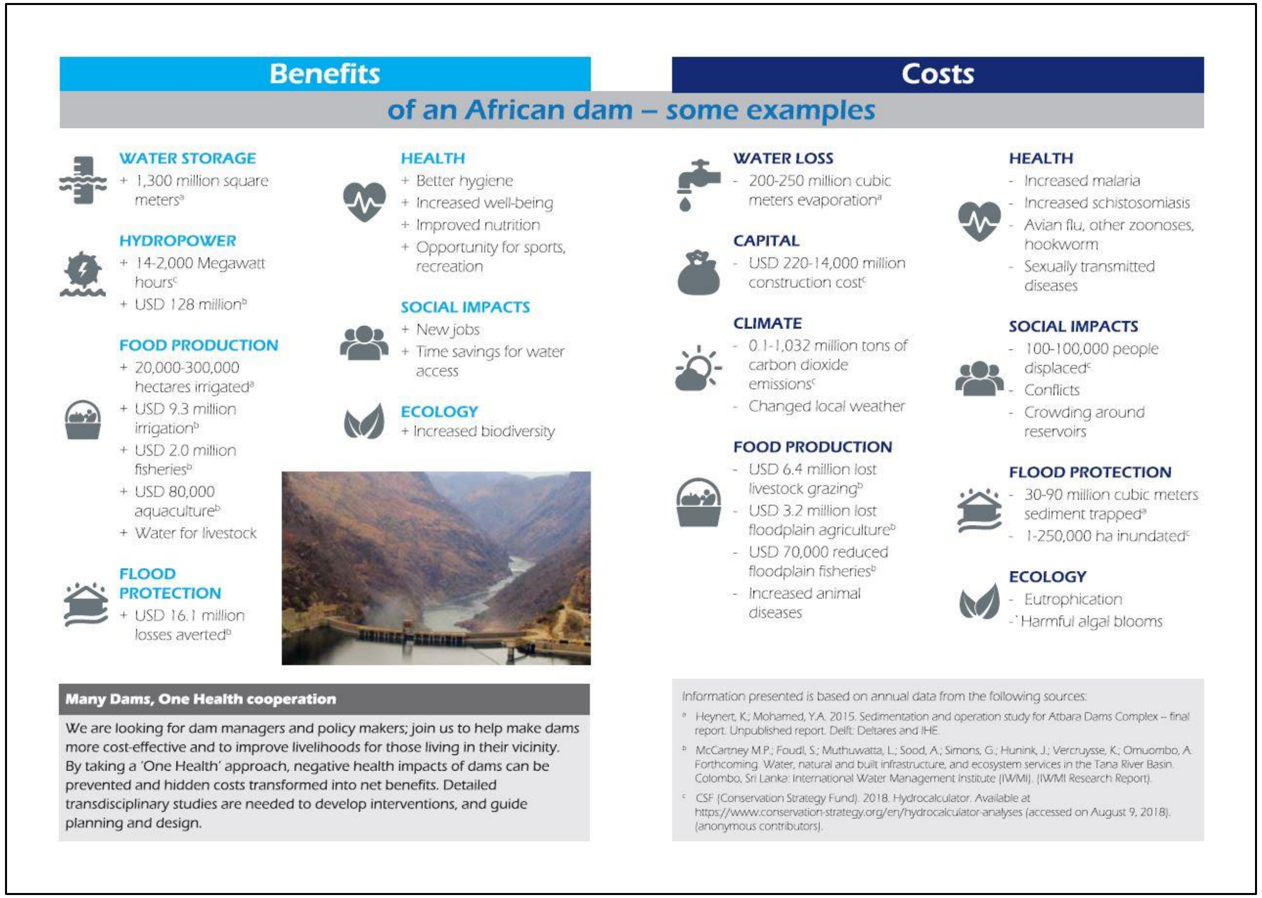
RBM Partnership To End Malaria

Multi-sectoral action

Multi-sectoral collaboration is key in light of the challenges faced in malaria control and elimination including insecticide and drug resistance, mobility of populations, climate change and funding shortfalls. To end malaria for good, we need concerted action of stakeholders across different sectors beyond the health sector.

Link to RBM/multi-sectoral action

Example
Reservoir management – extend to Asia



Predicting the health burden

Predicting the health burden

Pressure

All of the above

Industry, Agriculture, Cities

Climate change

State

Fate and transport of pollutants

Microbiology and early warning

Vector-related diseases

Impact

Direct health impacts

- Pollutants, water-borne diseases
- Including floods and droughts

Ecosystem-mediated health impacts

- Altered infection risk (AMR)
- Vector-related diseases
- Mental health
- Affected crop yields, contaminated food

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Predicting the health burden

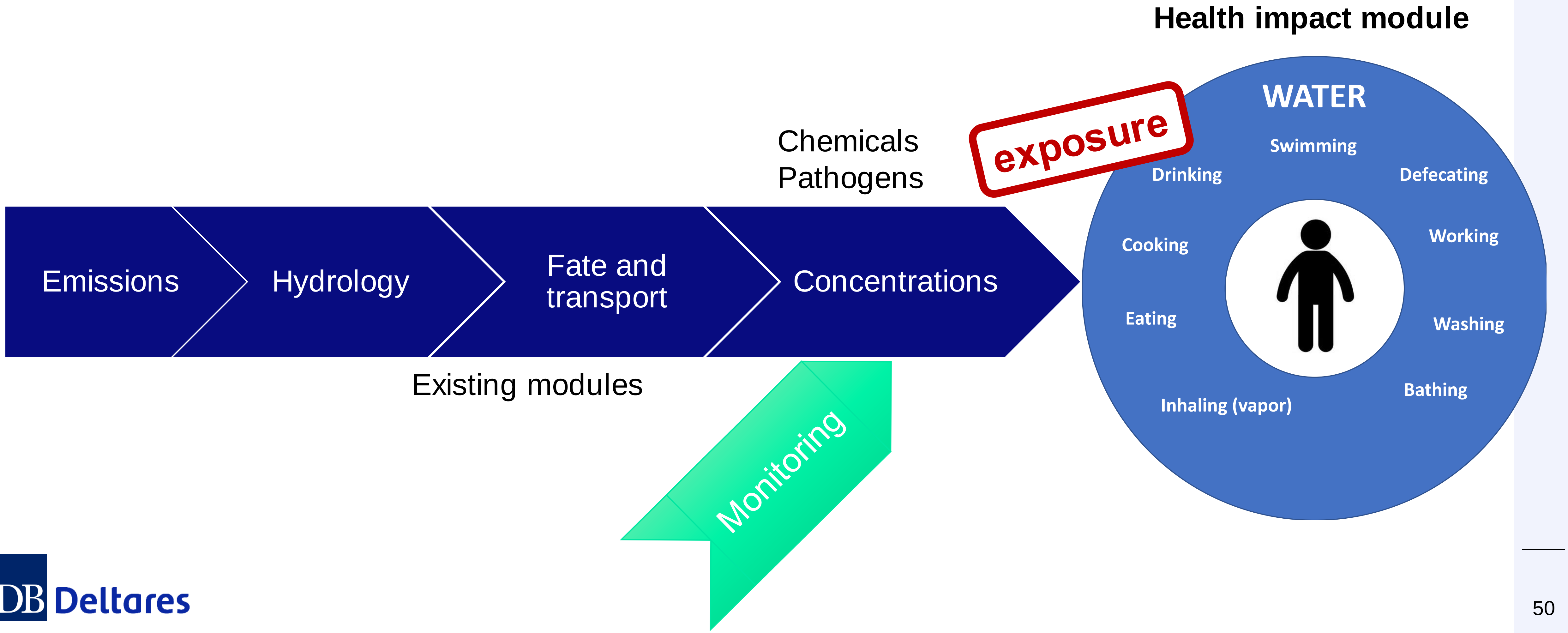
Figure: Deltares


Industrial & domestic emissions

Agricultural (crops, livestock, fish) & domestic emissions

Direct, chronic exposure in daily use

D-Health: post-processing of Delft-3D suite



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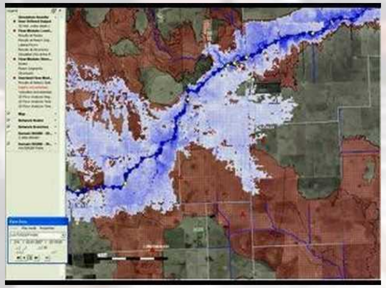
Application: Floods and Health

Graph: G. Geerling (Deltares)

FIAT-like approach (same input data)

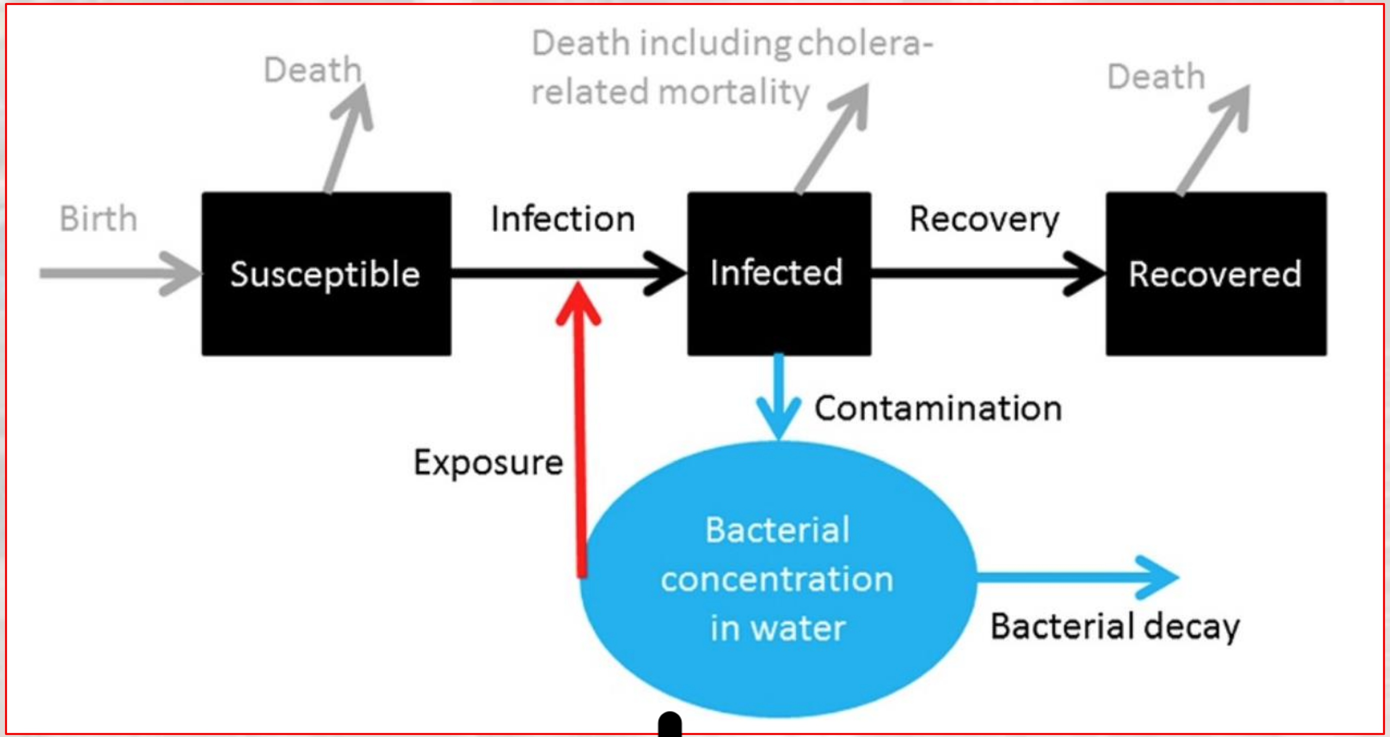


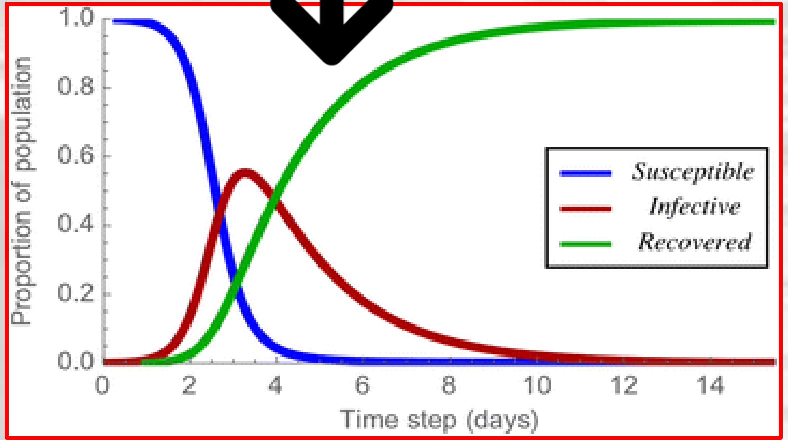
Flood maps

+

Population maps

= Susceptible population





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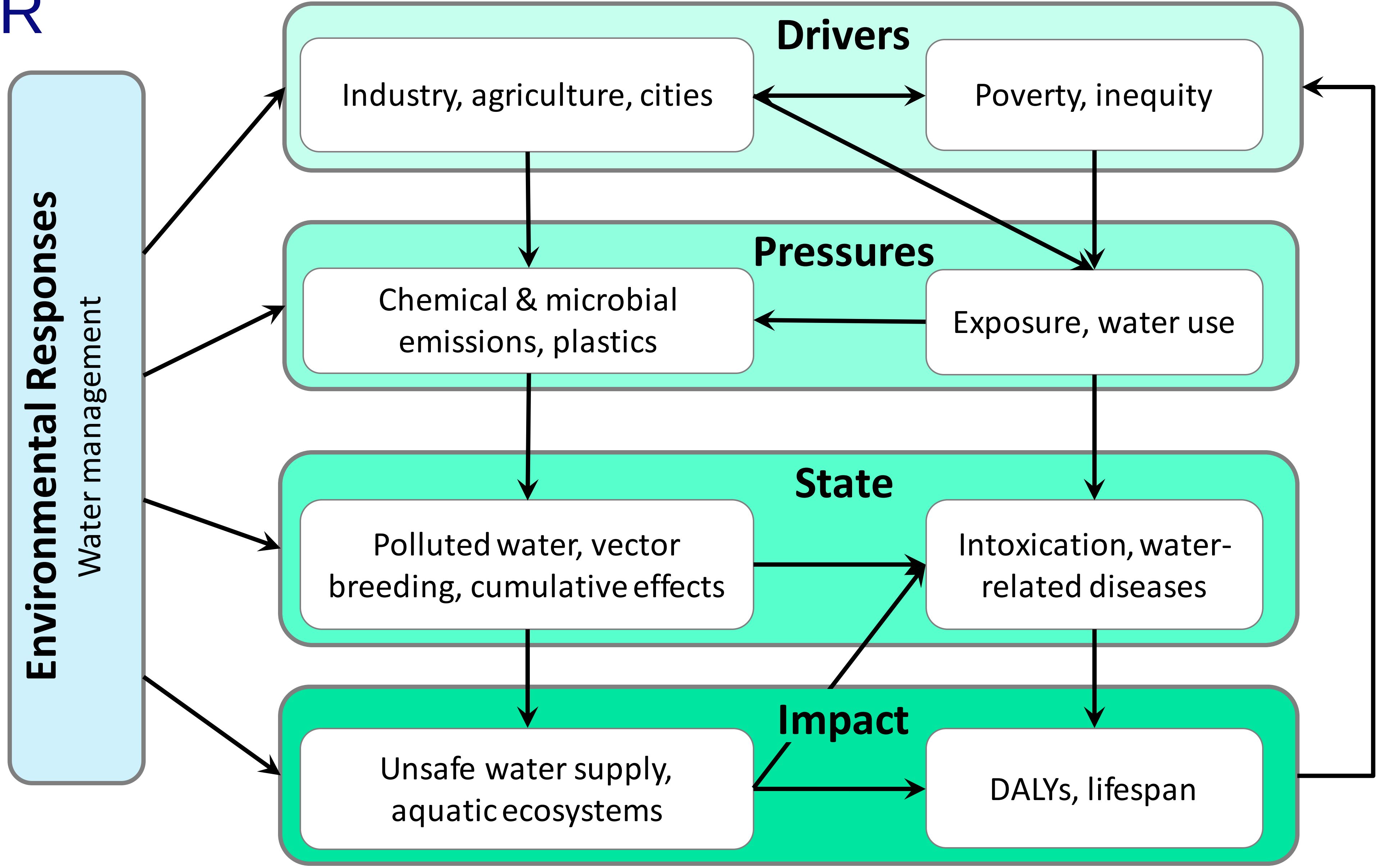
https://dx.doi.org/10.1186/1742-7622-11-1

Key messages

Water, disease and health (risks)

Figure: Deltares

DPSIR



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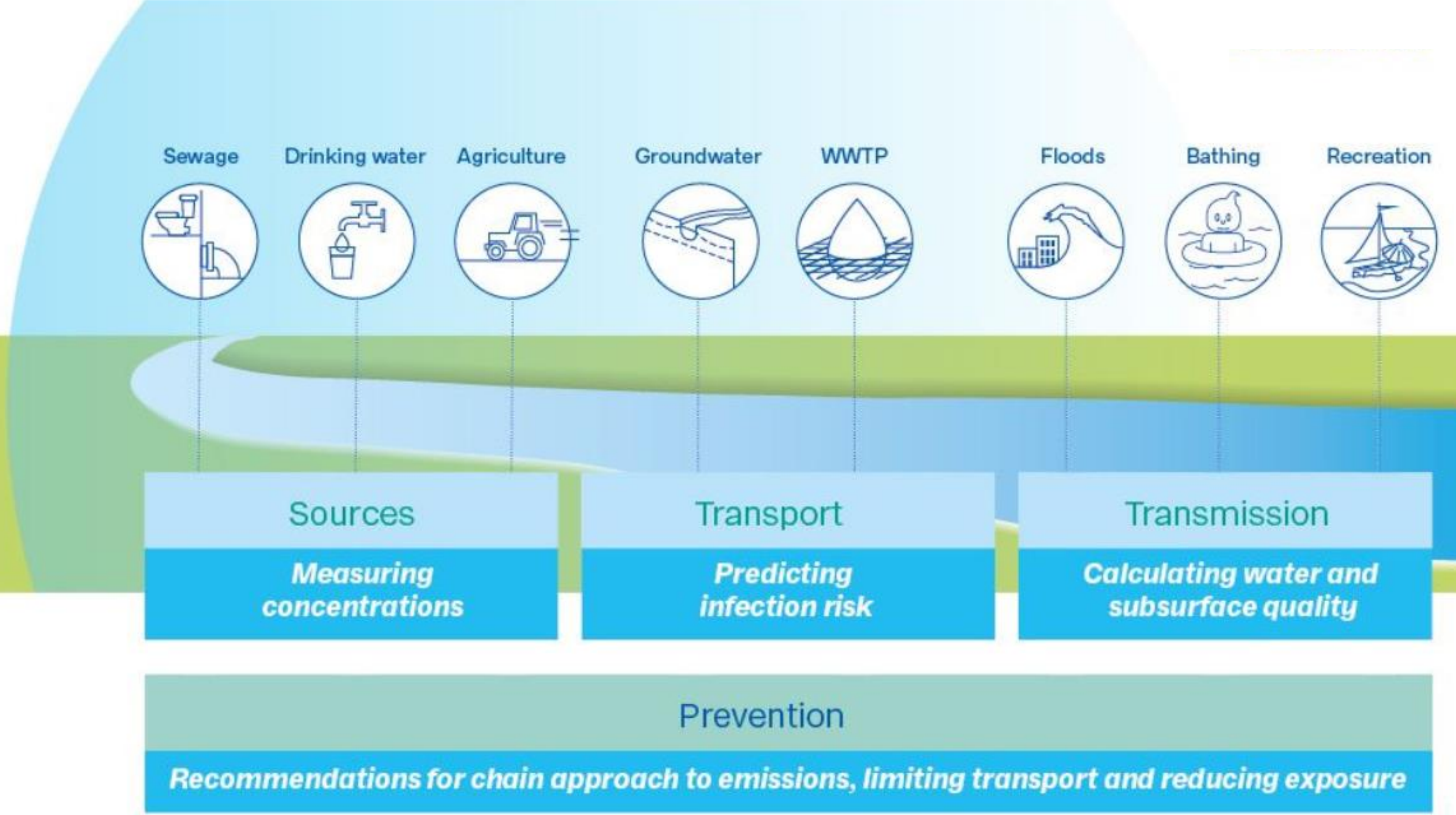
Conceptual infographic



Vision: co-manage water and public health

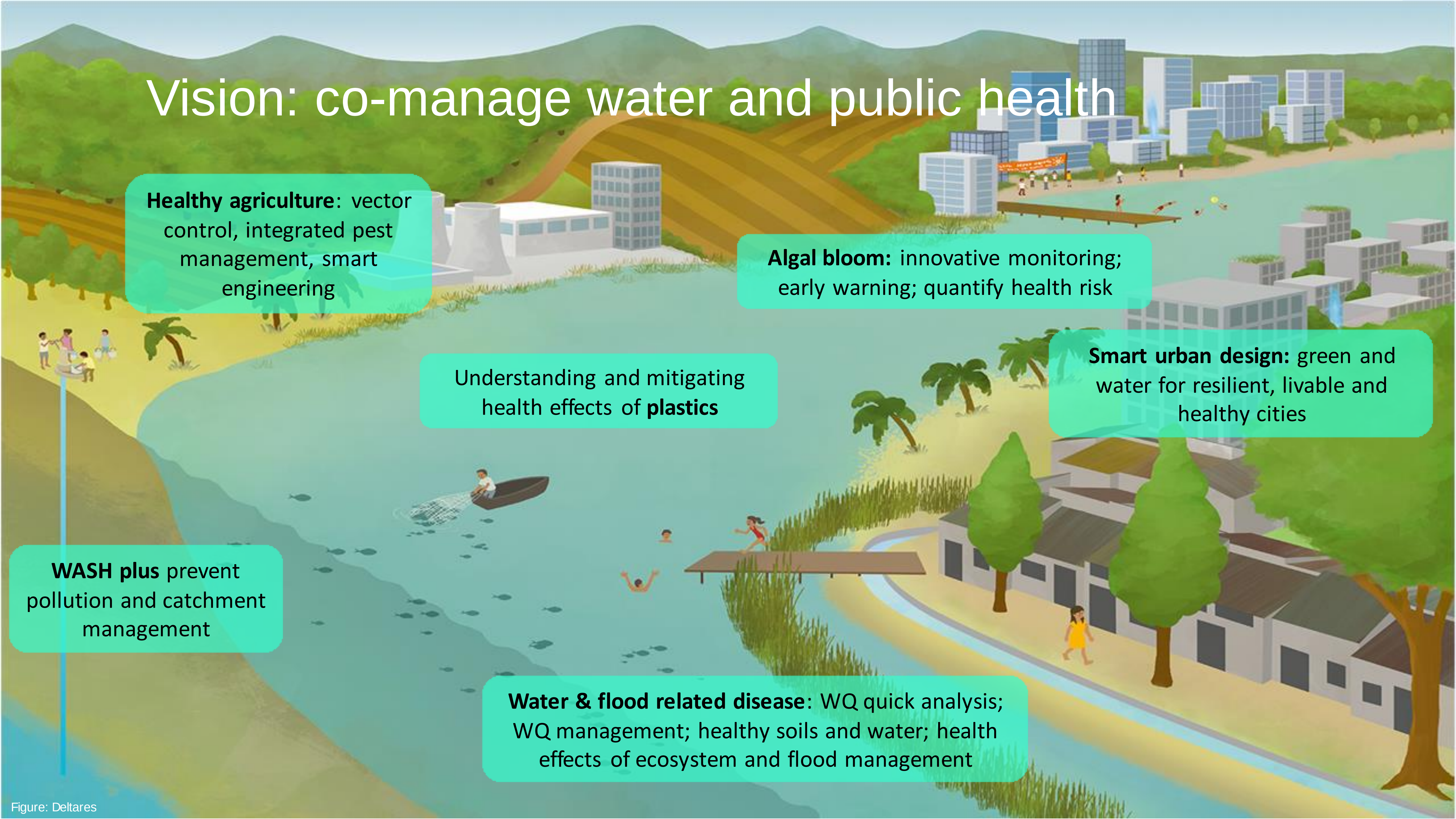


Figure: Deltares

Deltares' support to co-managed water and health
Innovative tools and approaches

Fate and transport of pollutants

- Passive sampling
- Integrated modelling database and tools
- Plastic waste

Vector-related diseases

- One Health approach, incl. environmental management

Microbiology (incl. AMR) and early warning

- Mobile qPCR
- Citizen science
- Operational forecasting water quality
- Pathogens on plastic

Predicting the health burden

- D-Health
- Floods (FIAT)
- Micro and nano plastics
- Dams and reservoirs

Questions?

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