

Urbanization: an increasing source of river pollution in the 21st century?

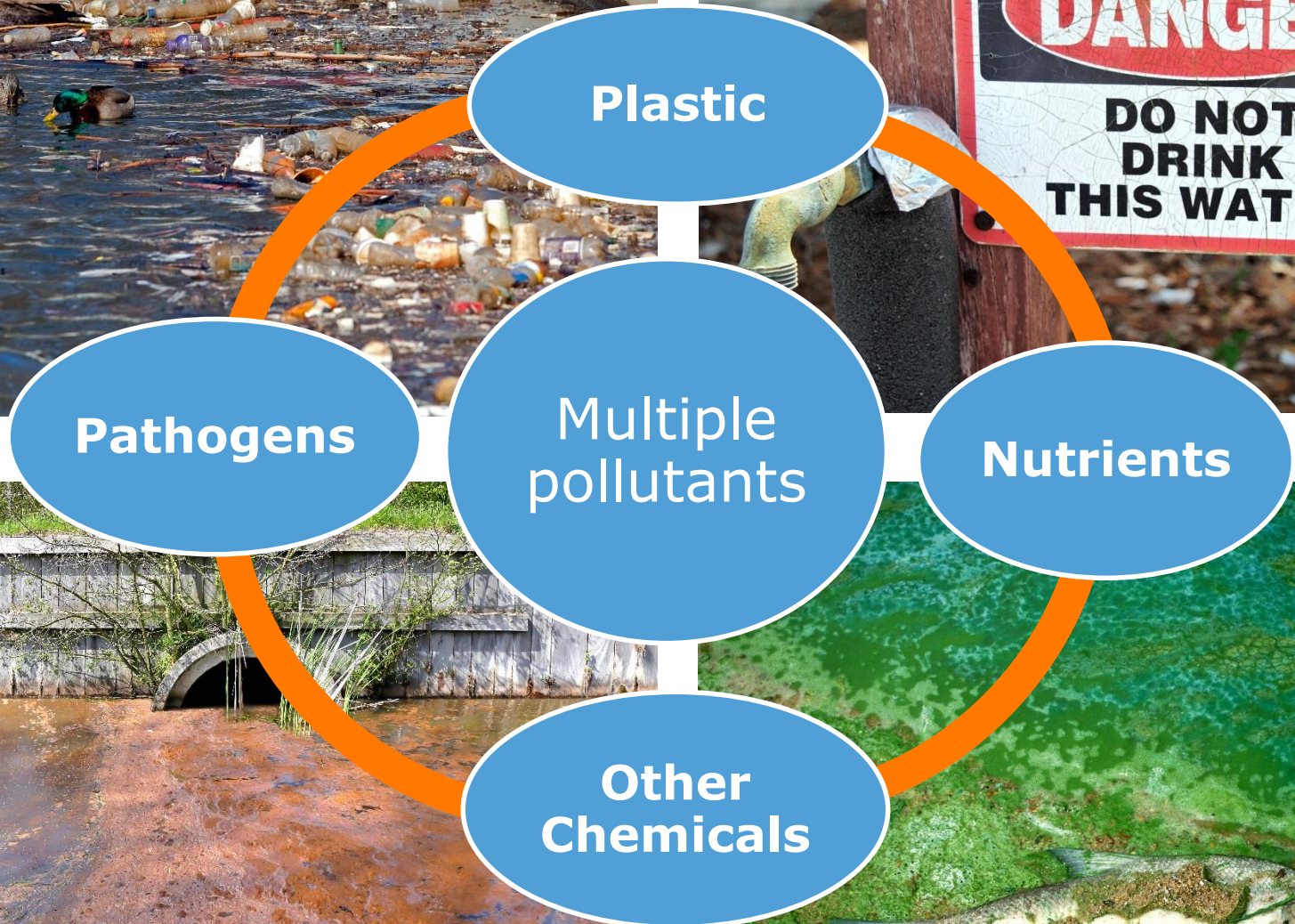
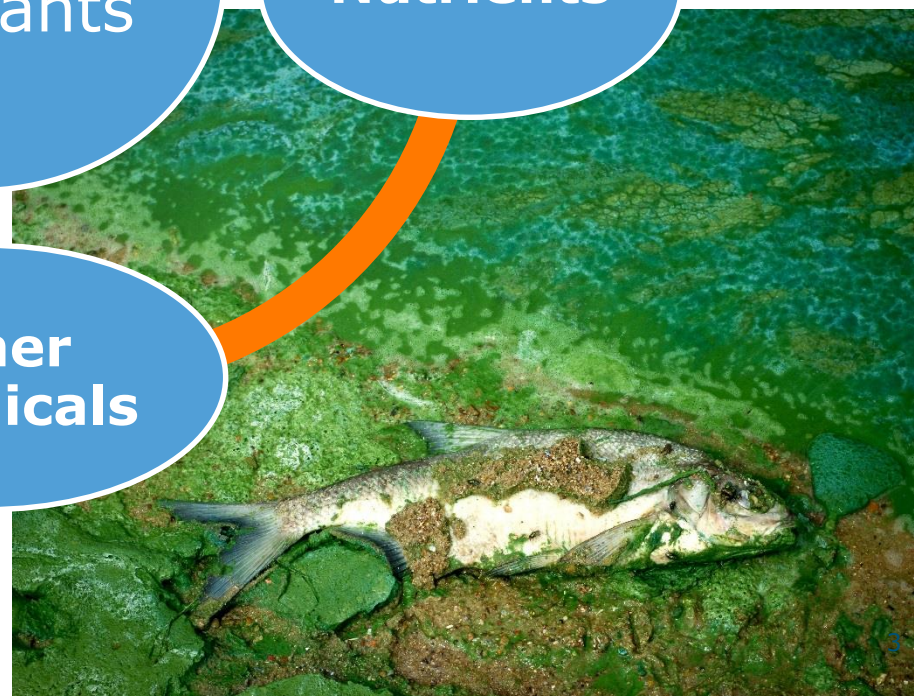
Maryna Strokal

Water Systems and Global Change Group
Wageningen University & Research

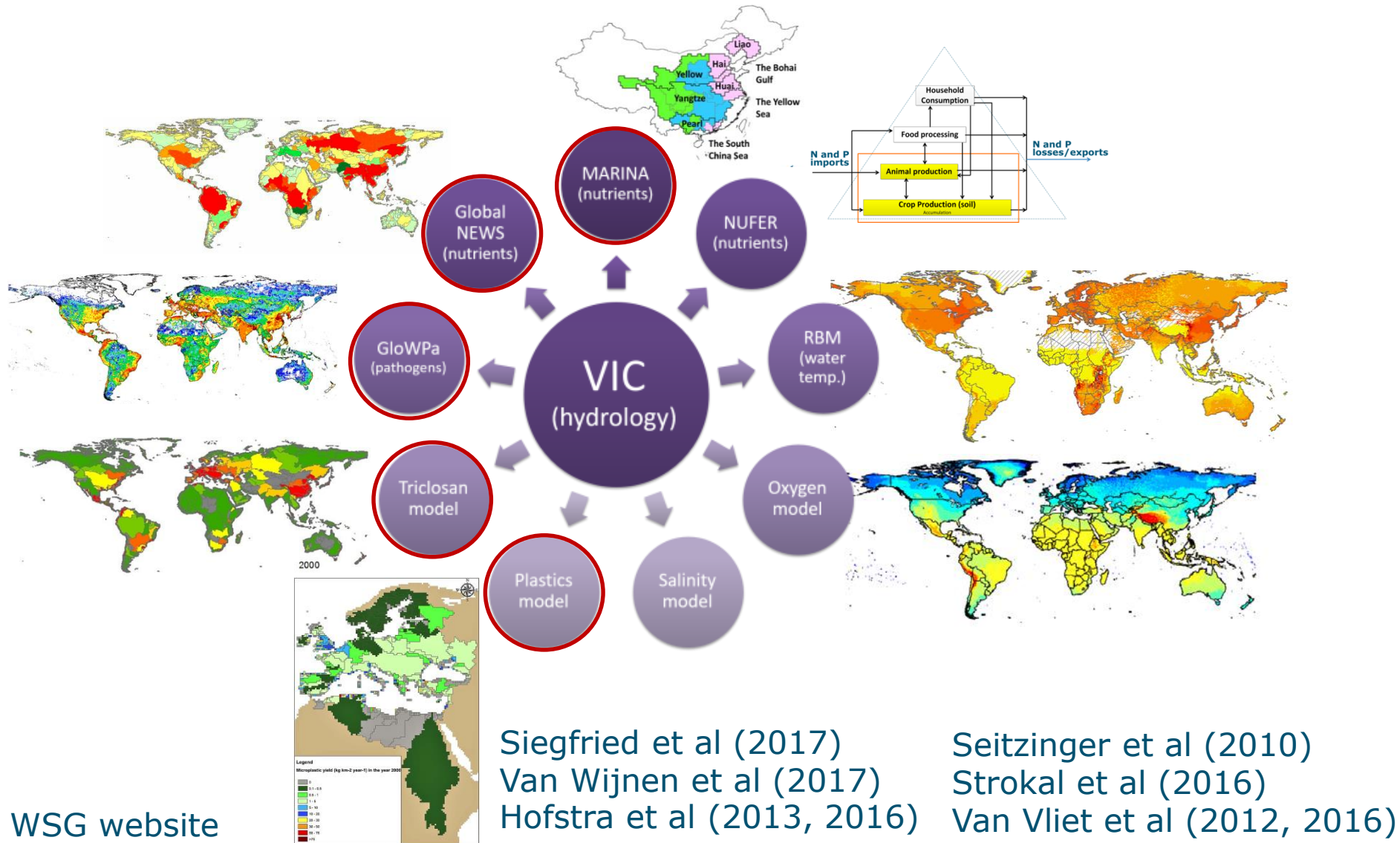


Message

Increased sewage connection will increase river pollution



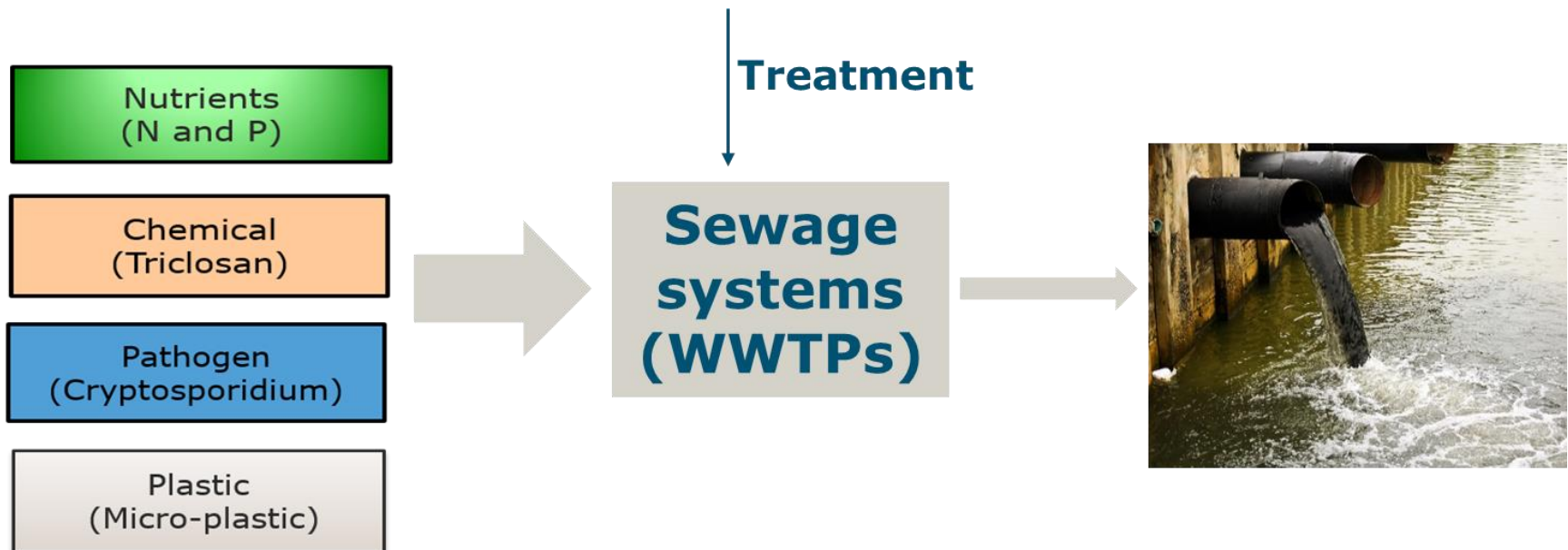
Wageningen approach: multi-pollutant assessment of river quality



Siegfried et al (2017)
 Van Wijnen et al (2017)
 Hofstra et al (2013, 2016)

Seitzinger et al (2010)
 Strokal et al (2016)
 Van Vliet et al (2012, 2016)

Multi-pollutant assessment of river pollution from sewage systems



Future 2050

- **Low** population growth*
- **High** economic development*
- **High** urbanization*
- **More people** connected to sewage systems**

Two scenarios**

```
graph TD; A[Two scenarios**] --> B[S1 Treatment slightly improved]; A --> C[S2 Treatment largely improved];
```

S1

Treatment

slightly improved

S2

Treatment

largely improved

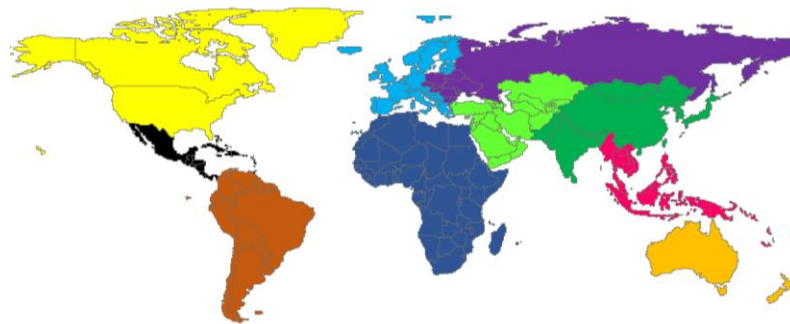
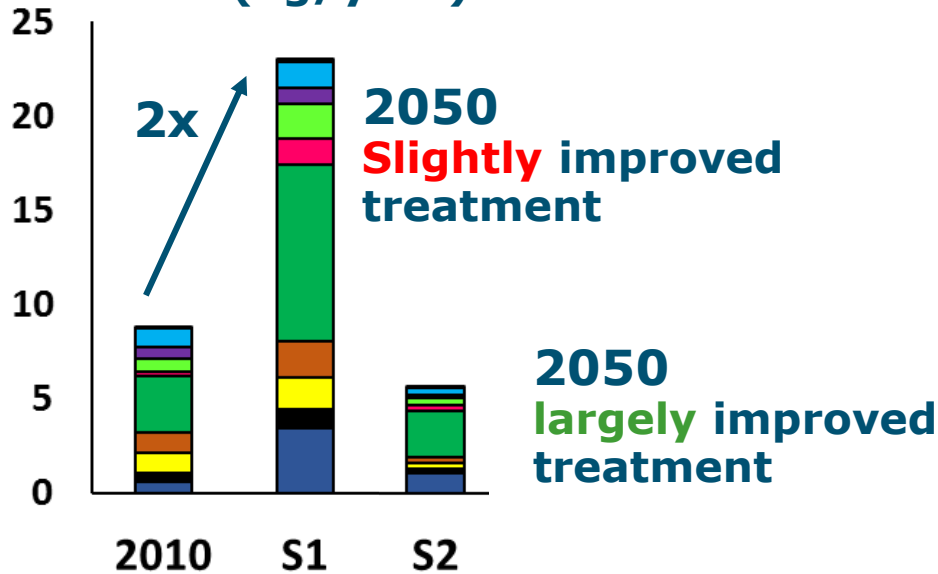
*Based on the Shared Socio-economic Pathway 1:

- Jones and O'Neill (2016)
- Leimbach et al (2017)

**Strokhal et al (in prep)

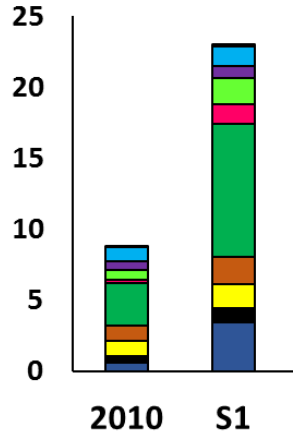
River pollution from sewage systems

Nitrogen inputs to rivers (Tg/year)

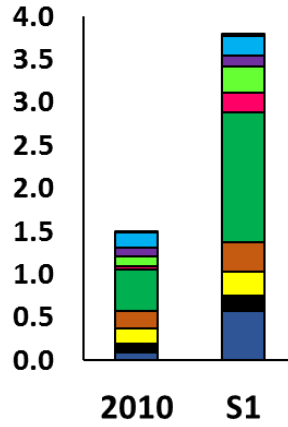


River pollution from sewage systems

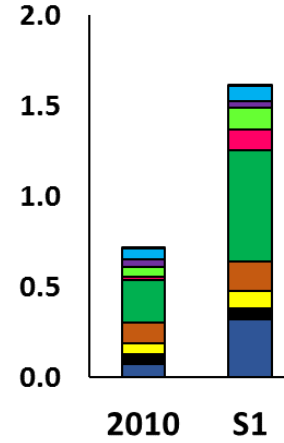
Nitrogen
(Tg/year)



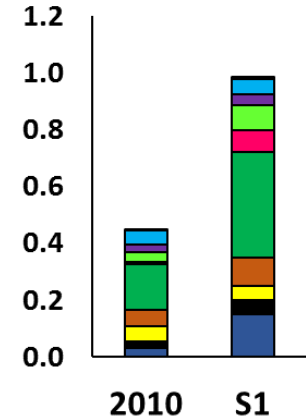
Phosphorus
(Tg/year)



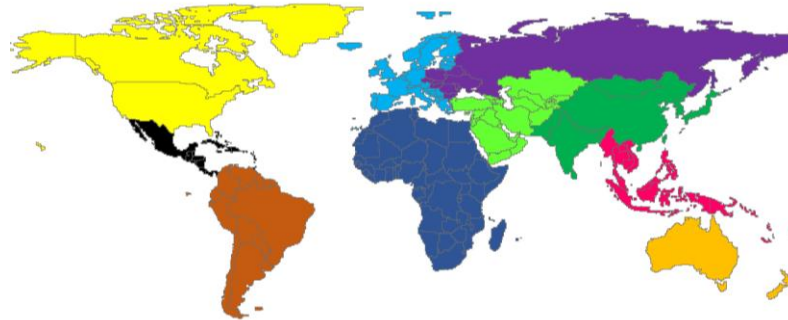
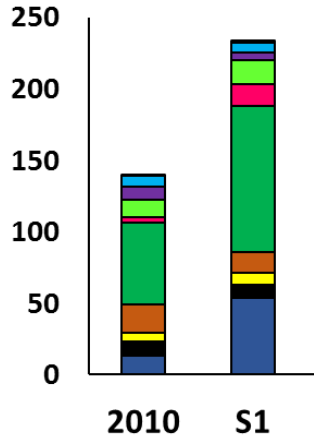
Triclosan
(kton/year)



Micro-plastic
(Tg/year)



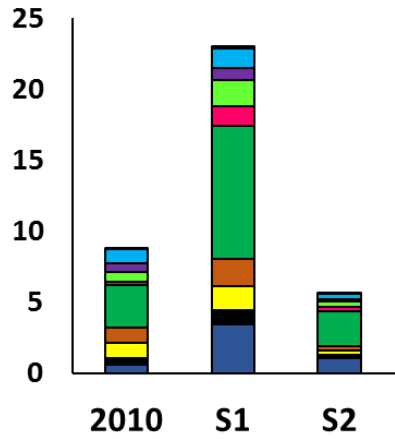
Cryptosporidium
(10^{15} oocysts/year)



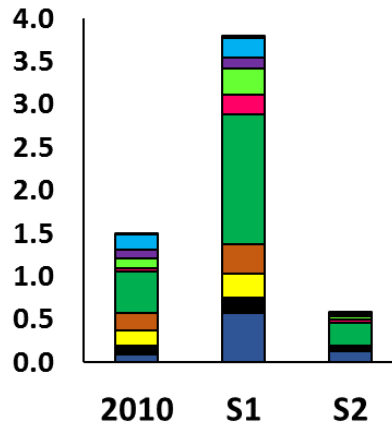
- Africa
- America (Central and Caribbean)
- America (Northern)
- America (Southern)
- Asia (Eastern and Southern)
- Asia (South-Eastern, including Malenesia)
- Asia (Central and Western)
- Europe (Eastern) and Russia
- Europe (Western, Northern, Southern)
- Australia and New Zealand

River pollution from sewage systems

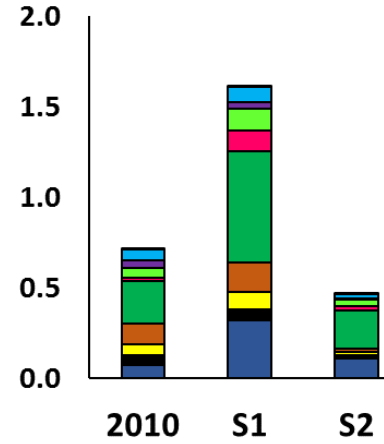
Nitrogen
(Tg/year)



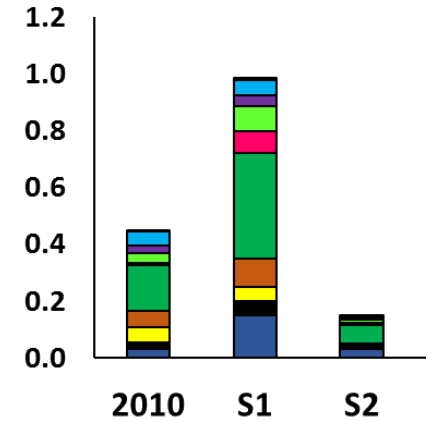
Phosphorus
(Tg/year)



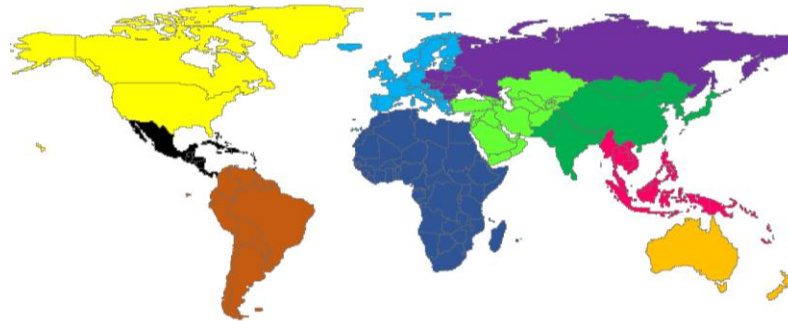
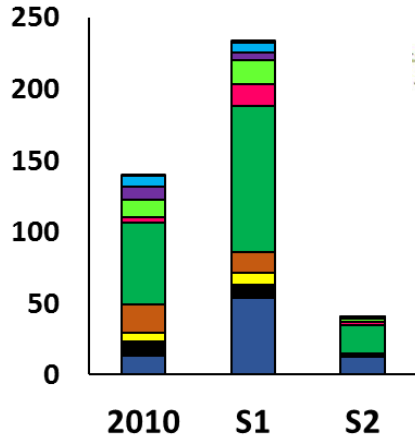
Triclosan
(kton/year)



Micro-plastic
(Tg/year)



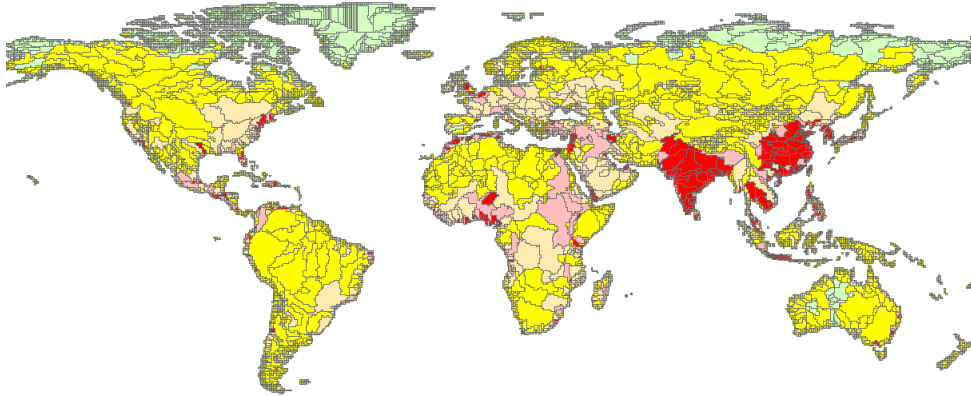
Cryptosporidium
(10^{15} oocysts/year)



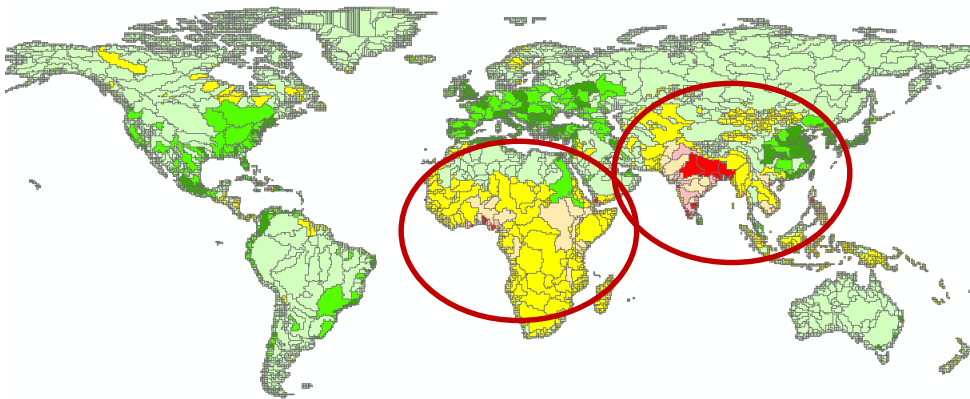
- Africa
- America (Central and Caribbean)
- America (Northern)
- America (Southern)
- Asia (Eastern and Southern)
- Asia (South-Eastern, including Malenesia)
- Asia (Central and Western)
- Europe (Eastern) and Russia
- Europe (Western, Northern, Southern)
- Australia and New Zealand

Sub-basin analysis of river pollution

Treatment **slightly** improved

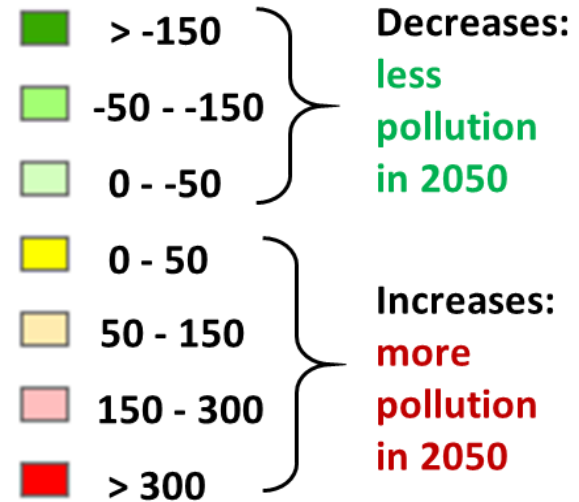


Treatment **largely** improved



Changes in pollution levels between 2010 and 2050

Nitrogen
kg/km²/year



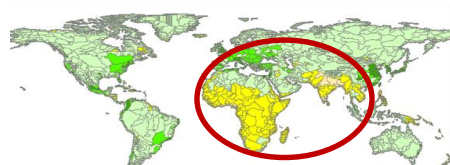
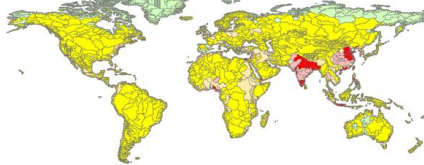
Sub-basin analysis of river pollution

Treatment slightly improved

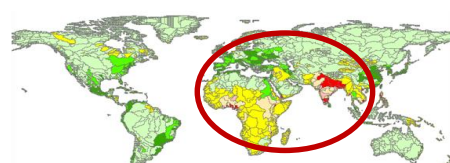
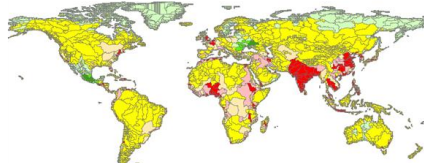
Treatment largely improved

Changes in pollution levels between 2010 and 2050

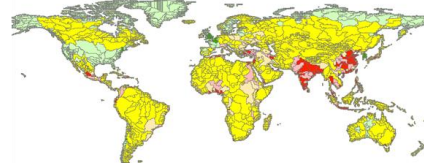
Phosphorus (kg/km²/year)



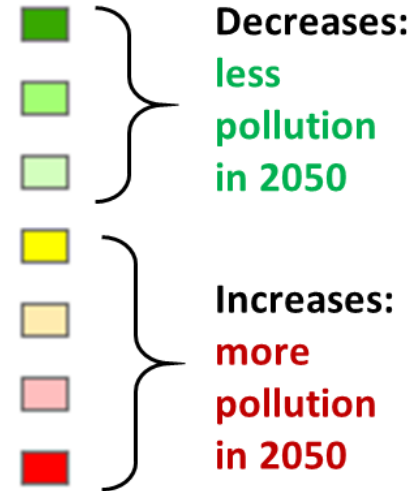
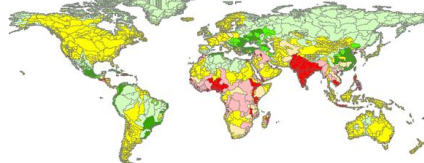
Triclosan (g/km²/year)



Micro-plastic (kg/km²/year)



Cryptosporidium (10⁷ oocysts/km²/year)



	Nitrogen kg/km ² /year	Phosphorus kg/km ² /year	Triclosan g/km ² /year	Micro-plastic kg/km ² /year	Cryptosporidium 10 ⁷ oocysts/km ² /year
Dark Green	> -150	> -60	> -10	> -10	> -100
Light Green	-50 - -150	-20 - -60	-5 - -10	-5 - -10	-50 - -100
Very Light Green	0 - -50	0 - -20	0 - 5	0 - 5	0 - 50
Yellow	0 - 50	0 - 20	0 - 5	0 - 5	0 - 50
Light Orange	50 - 150	20 - 60	5 - 10	5 - 10	50 - 100
Red-Orange	150 - 300	60 - 150	10 - 20	10 - 20	100 - 300
Dark Red	> 300	> 150	> 20	> 20	> 300

Sub-basin analysis of river pollution

Treatment **slightly** improved

Treatment **largely** improved

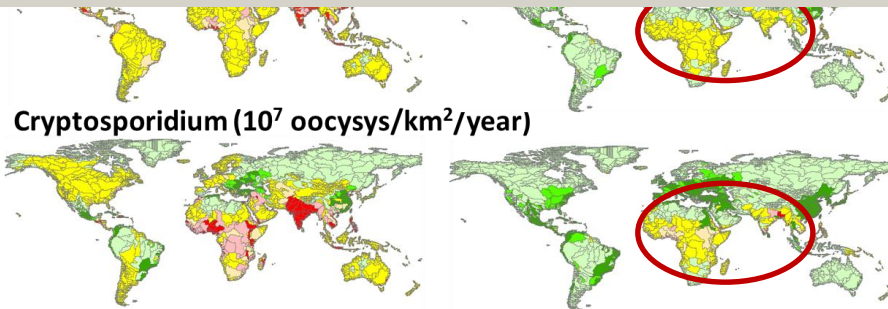
Changes in pollution levels between 2010 and 2050

Phosphorus (kg/km²/year)



Important reasons:

1. Total population
2. Sewage connection
3. Treatment efficiencies



Cryptosporidium (10⁷ oocysts/km²/year)

Nitrogen kg/km ² /year	Phosphorus kg/km ² /year	Triclosan g/km ² /year	Micro-plastic kg/km ² /year	Cryptosporidium 10 ⁷ oocysts/km ² /year
> -150	> -60	> -10	> -10	> -100
-50 - -150	-20 - -60	-5 - -10	-5 - -10	-50 - -100
0 - -50	0 - -20	0 - 5	0 - 5	0 - 50
0 - 50	0 - 20	0 - 5	0 - 5	0 - 50
50 - 150	20 - 60	5 - 10	5 - 10	50 - 100
150 - 300	60 - 150	10 - 20	10 - 20	100 - 300
> 300	> 150	> 20	> 20	> 300

Messages

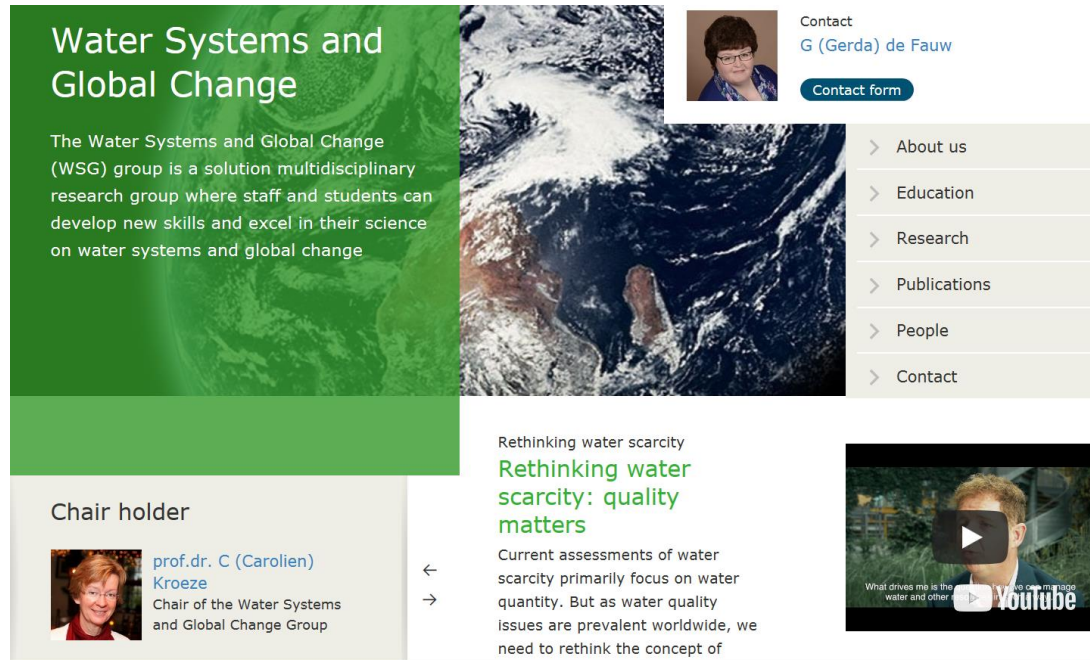
Increased sewage connection will increase river pollution if the waste water is not treated

- 1. Increased sewage connection**
- 2. Improved treatment**
- 3. Future hotspots:** African and Asian sub-basins

Thank you

Contact:
maryna.strokal@wur.nl


Acknowledgement



Water Systems and Global Change

The Water Systems and Global Change (WSG) group is a solution multidisciplinary research group where staff and students can develop new skills and excel in their science on water systems and global change

Chair holder

 **prof.dr. C (Carolien) Kroeze**
Chair of the Water Systems and Global Change Group


Contact
G (Gerda) de Fauw
[Contact form](#)

- > About us
- > Education
- > Research
- > Publications
- > People
- > Contact

Rethinking water scarcity
Rethinking water scarcity: quality matters

←
→

Current assessments of water scarcity primarily focus on water quantity. But as water quality issues are prevalent worldwide, we need to rethink the concept of



<https://www.wur.nl/en/Expertise-Services/Chair-groups/Environmental-Sciences/Water-Systems-and-Global-Change-Group.htm>