After Doha: Is Europe underway to less mitigation of its carbon-footprint and to more adaption to the fast growing global water-footprint ?

Erik P.C. ROMBAUT, Master in Biology, Asst. Prof. , LUCA, Belgium.
Hoger Architectuurinstituut Sint-Lucas (LUCA, school of Arts),
Hoogstraat 51, B-9000 Gent / Paleizenstraat 65-67, B-1030 Brussel.
KaHo Sint-Lieven, Hospitaalstraat 23, B-9100 Sint-Niklaas.
+ 32 (0)3 7707147. erik.rombaut@scarlet.be

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Mitigation <u>or</u> adaptation: a false dilemma.

- Of course, the title of this presentation (mitigation <u>or</u> adaptation) is somewhat provocative: **Also Europe will have to do both**.

- But one cannot deny that after the Doha debacle, the European (public) opinion is less likely to accept financial investments in a further decrease in carbon emissions, and questions the European (mitigation) vanguard, especially in comparison with the US.

- On the other hand, European (public) opinion is more and more convinced that there is a growing need for huge financial investments in adaptation to climate change, especially in sea-level rising and flood-preventing related spatial problems.

- All these feelings are now reinforced by the financial crisis in Europe…

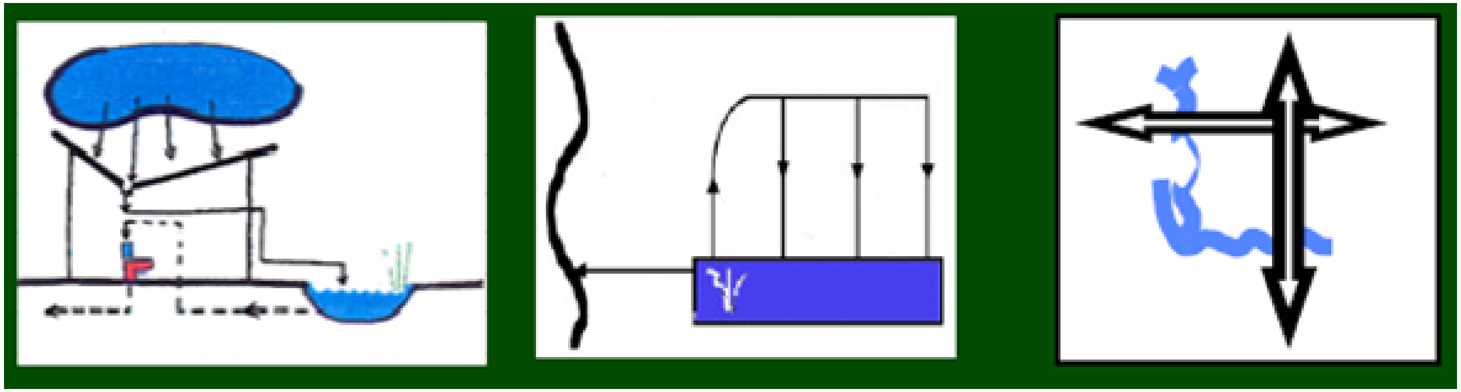
- So all these feelings lead to the creation of this **<u>false dilemma</u>**

So smart solutions have to combine both mitigation and adaptation.

- Smart solutions will have to be designed at all levels together, and touching all flows (e.g. water, material, energy…)

Example: The use of water as an organizing principle at different levels in urban and rural environment is urgently needed.

From Tjallingii, 2009.



Building level

District level

City level and rural areas

= INTEGRAL WATER MANAGEMENT

First of all, Unfortunately, the concept of water-footprint is often used for different purposes:

1. The ‘water footprint of a product’

which is the volume of fresh water used to produce the product, summed over the various steps of the production chain, when and where the water was used: so a water footprint includes a temporal and spatial dimension.

(Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. and Mekonnen, M.M. (2011) The water footprint assessment manual: Setting the global standard, Earthscan, London, UK. / Hoekstra, A.Y. and Chapagain, A.K. (2008) Globalization of water: Sharing the planet's freshwater resources, Blackwell Publishing, Oxford, UK)

2. The ‘water footprint of human activities’

Which has to do with impact of human activities on quality and quantity of water systems: evaporation, erosion, flooding, sea-level rising, etc …

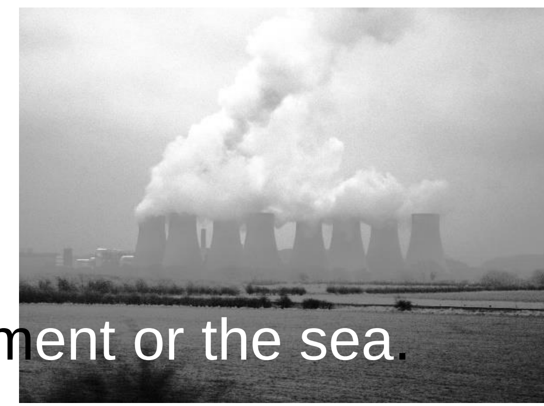
Part 1:
The 'water footprint of a product'

[Hoekstra & Chapagain, 2008]

The water footprint of a product

Green water footprint

► volume of rainwater evaporated or incorporated into product.



Blue water footprint

► volume of surface or groundwater evaporated, incorporated into product or returned to other catchment or the sea.

Grey water footprint

► volume of polluted water.

The water footprint of a cow

Food

► 1300 kg of grains
(wheat, oats, barley, corn, dry peas, soybean, etc)

► 7200 kg of roughages
(pasture, dry hay, silage, etc)

99%

Water

► 24000 litres for drinking

► 7000 litres for servicing.

1%

http://milkgenomics.org

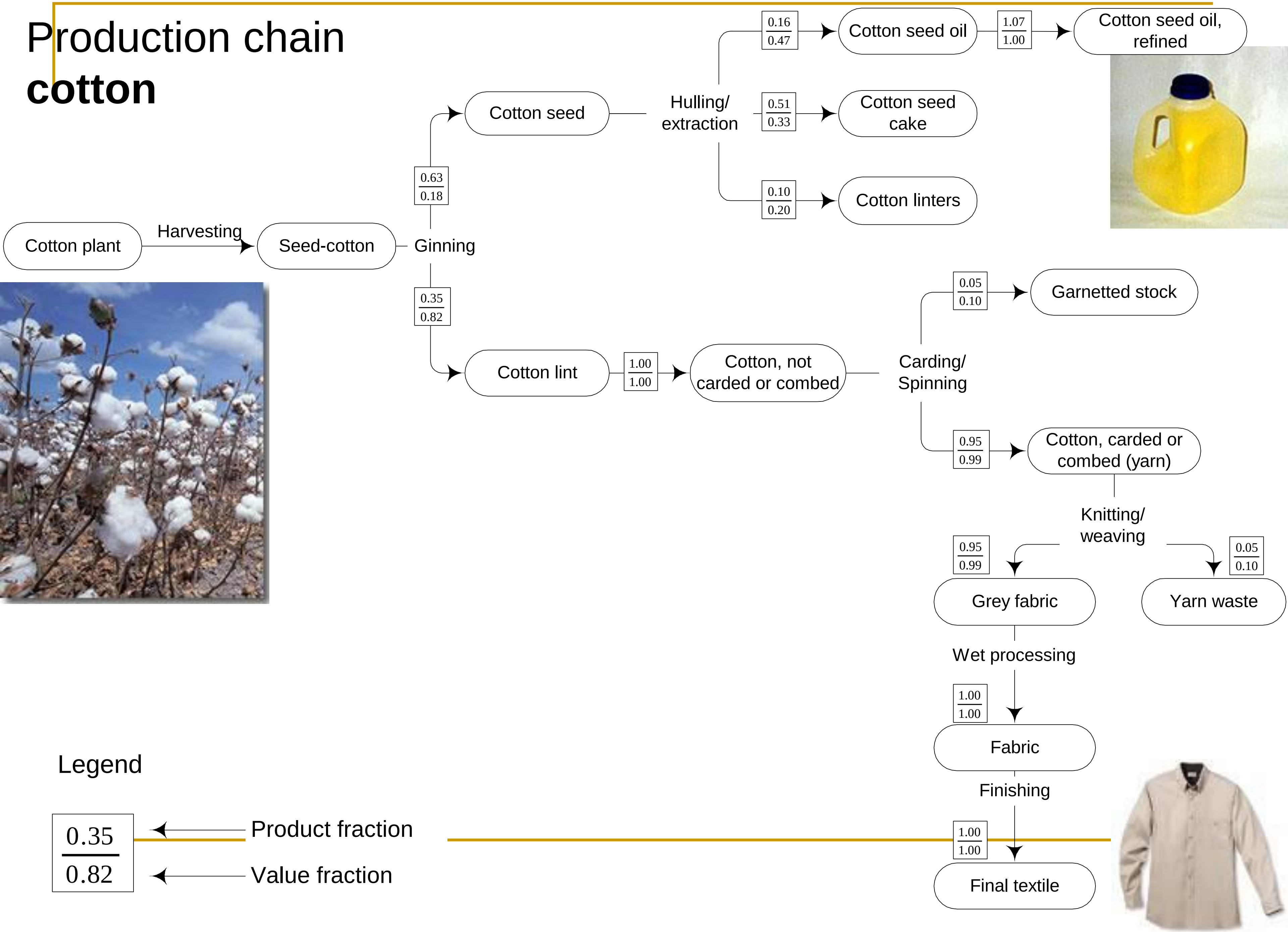
[Hoekstra & Chapagain, 2008]

[Hoekstra & Chapagain, 2008]

Meat versus vegetarian diet

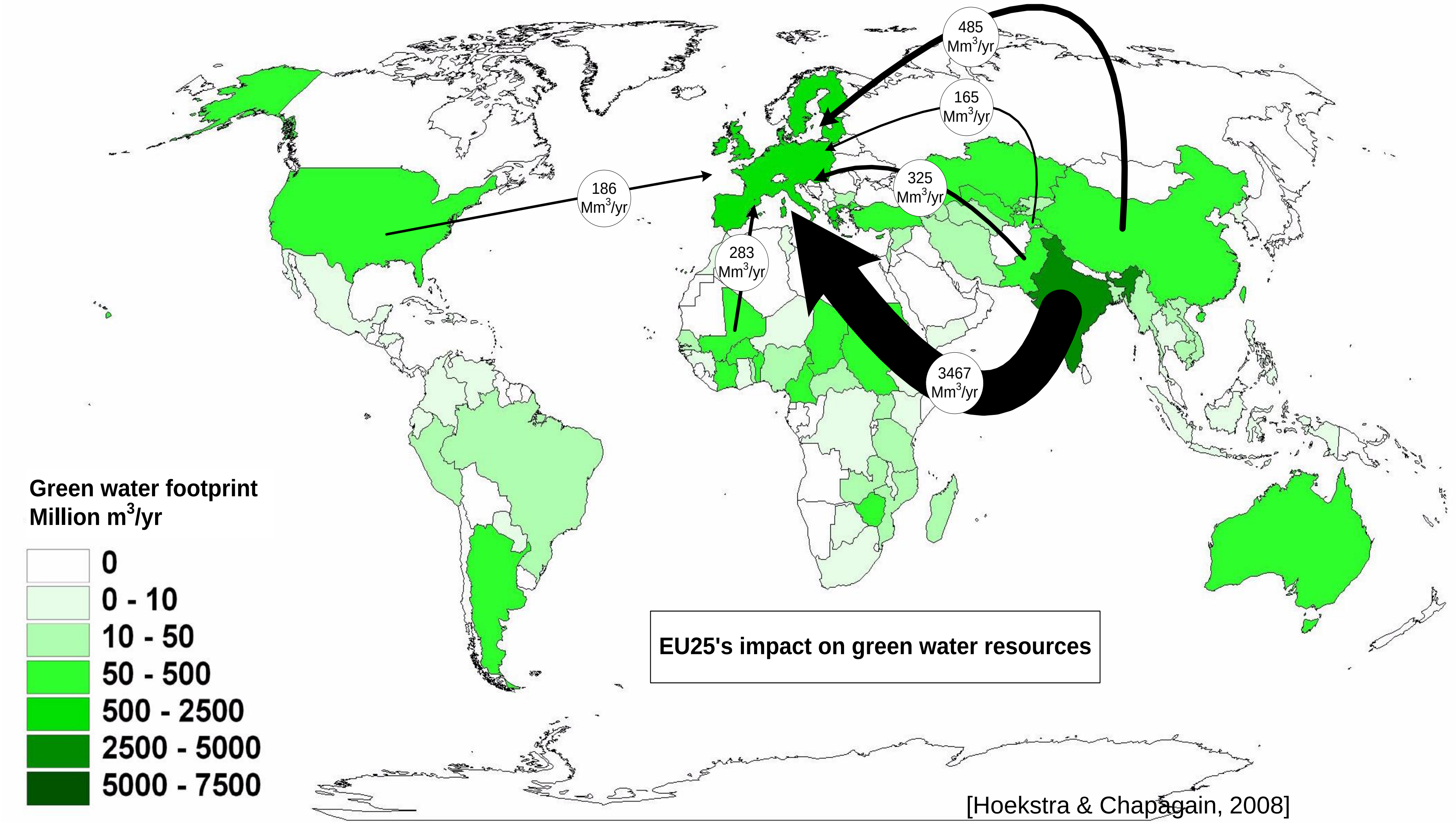
	Meat diet	kcal/day	litre/kcal	litre/day	Vegetarian diet	kcal/day	litre/kcal	litre/day
Industrial countries	Animal origin	950	2.5	2375	Animal origin	300	2.5	750
	Vegetable origin	2450	0.5	1225	Vegetable origin	3100	0.5	1550
	Total	3400		3600	Total	3400		2300
Developing countries	Animal origin	350	2.5	875	Animal origin	200	2.5	500
	Vegetable origin	2350	0.5	1175	Vegetable origin	2500	0.5	1250
	Total	2700		2050	Total	2700		1750

Production chain
cotton



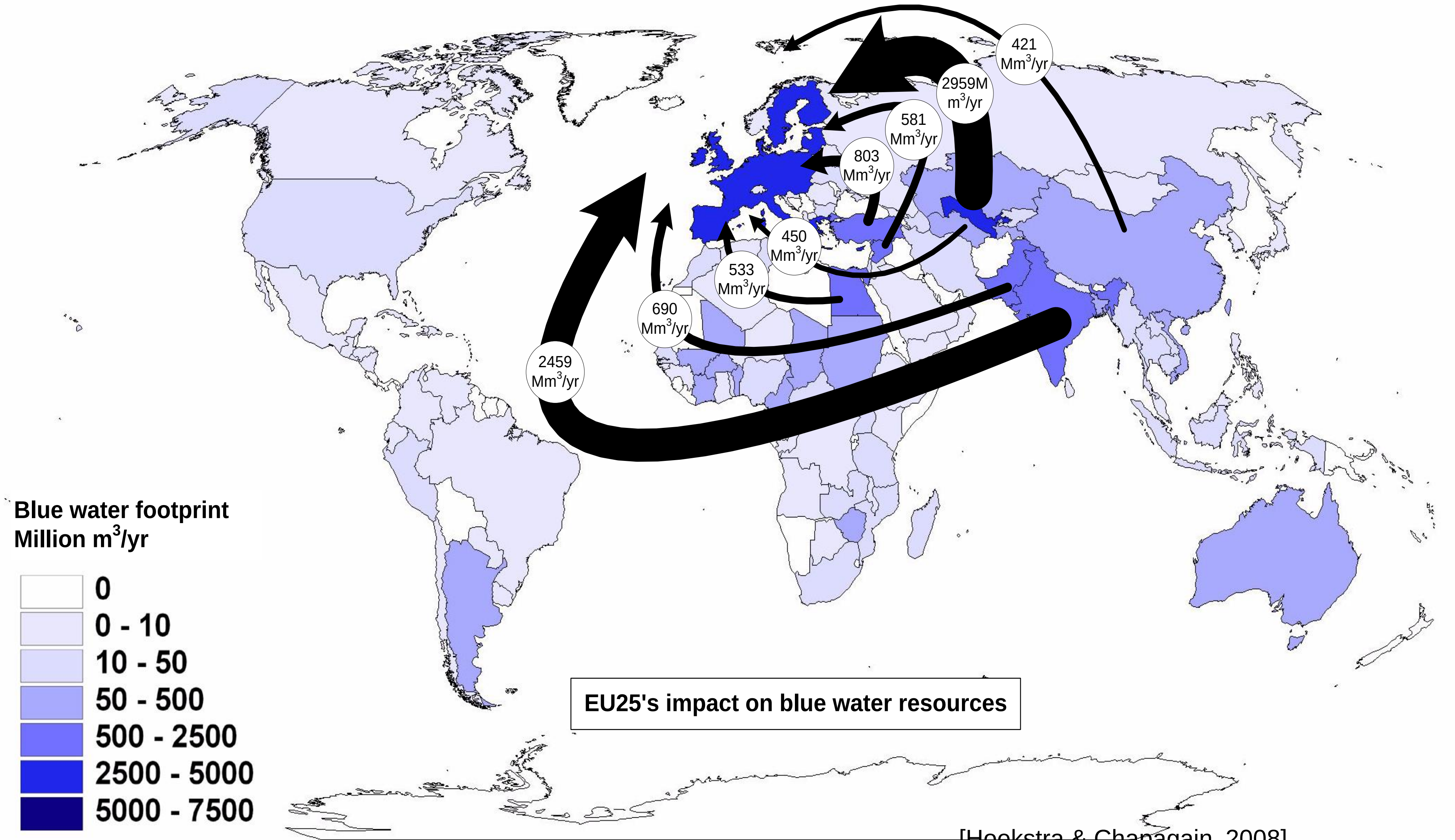
[Hoekstra & Chapagain, 2008]

Water footprint of EU's cotton consumption (green water)



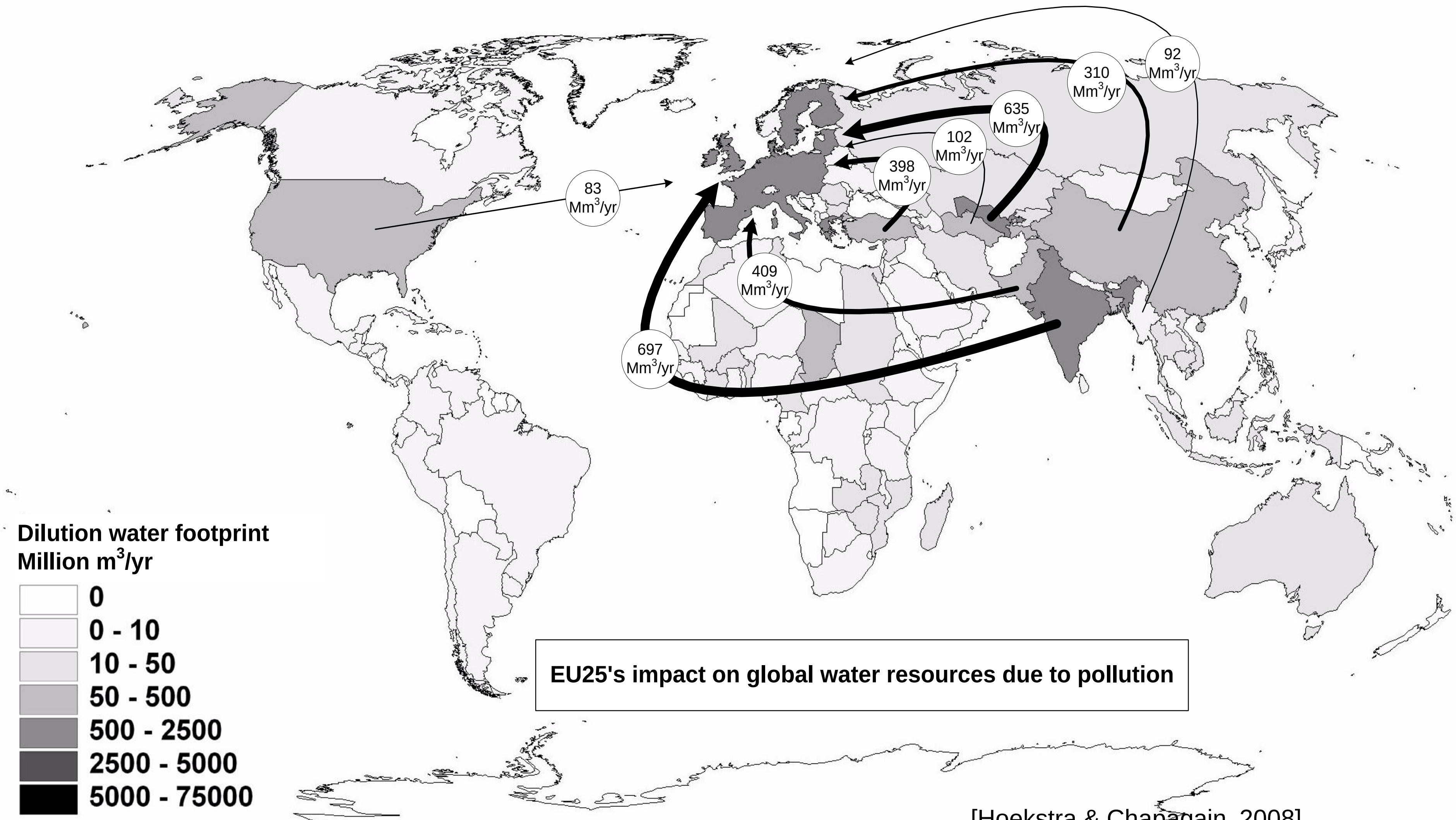
[Hoekstra & Chapagain, 2008]

Water footprint of EU's cotton consumption (blue water)



[Hoekstra & Chapagain, 2008]

Water footprint of EU's cotton consumption (grey water)



[Hoekstra & Chapagain, 2008]

The water-energy nexus

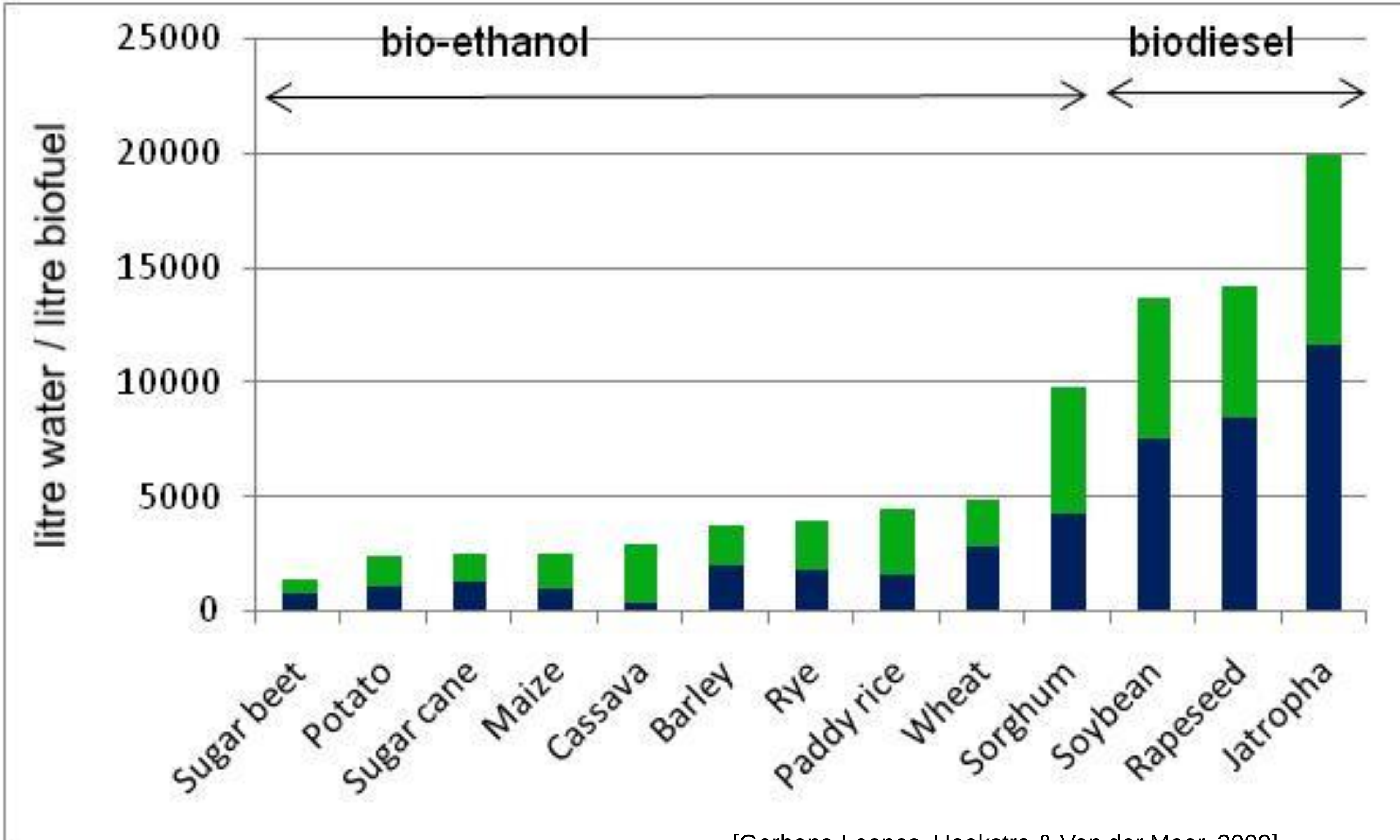
- The water-sector is becoming more energy-intensive:
  - E.g.: desalination
  - Pumping deeper groundwater
  - Large-scale (inter-basin) water transport

The water-energy nexus

The energy-sector is becoming more water intensive: biomass

[Hoekstra & Chapagain, 2008

Water footprint of biofuels from different crops [litre/litre]



[Gerbens-Leenes, Hoekstra & Van der Meer, 2009]

Water footprint of national consumption

► total amount of water that is used to produce the goods and services consumed by the inhabitants of the nation.

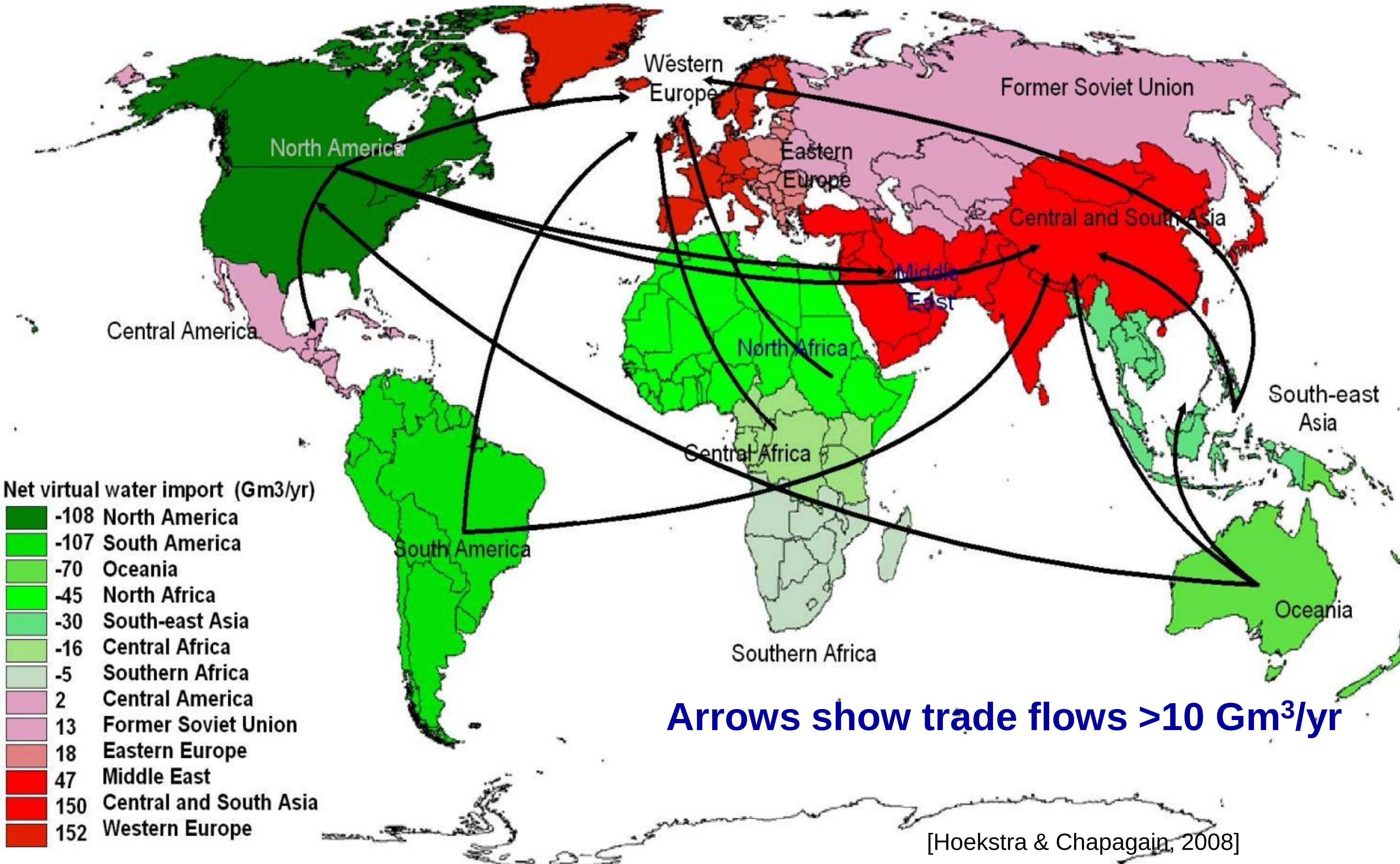
► two components:

- internal water footprint – inside the country.
- external water footprint – in other countries.

► water footprint of national consumption =
water footprint within the nation + virtual water import
– virtual water export

[Hoekstra et al., 2009]

Regional virtual water balances
(only agricultural trade)



Arrows show trade flows >10 Gm³/yr

[Hoekstra & Chapagain, 2008]

Part 2:

Reducing the 'water footprint of human activities'

- 1. Brief overview of some relevant European legislation
- 2. Some basic climatological insights
- 3. Suggestions for further smart solutions, decreasing carbon-footprint together with waterfootprint.

"DIRECTIVE 2000/60/EC, establishing a framework for the community action in the field of water policy" **EU Water Framework Directive** (WFD).

http://ec.europa.eu/environment/water/water-framework/index_en.html

- The WFD strives towards a sustainable water use, also for future generations.
- The WFD aims to secure water resources and water quality in Europe and to weaken the effects of floods and droughts. It stands for an approach by (international) river basin, beyond administrative boundaries and limitations.
- The WFD is imposing specific environmental quality standards of surface and groundwater and proposes different measures through river basin management programs
- The WFD is also imposing all the 27 EU-memberstates to readapt the river systems in order to make them accessible again (physically and in terms of water quality) for migratory fish species and other organisms (1).

(1)That is one of the reasons why The Netherlands currently have problems with the European Commission, because they've been building hermetic closed dams along the North Sea to protect against flooding, after the 1953 flood disaster. So The NL will have to adjust these plans, combining flood protection with biodiversity and accessibility of river systems for migratory organisms

http://www.ictam.com/Site_pages_NL/-EUROPE/nederland_n.htm
http://www.geschiedeniszeeland.nl/tab_themas/themas/deltawerken/deltawerken/ l

Brief overview (1) of some ecological problems of the Deltaplan (NL)

Eastern Scheldt storm surge barrier.

http://www.coastlearn.org/pp/caseholland.html
www.scheldenet.n

Brief overview (2) of some ecological problems of the Deltaplan (NL)

- The ***gradient salt-brackish-fresh*** water, crucial for a wide variety of wildlife has suddenly disappeared and was replaced by a ***sharp boundary between salt and fresh***.
- The fresh water at the ***inland side*** of the dams suffers from ***pollution*** (minerals from agriculture) which leads to ***bloom of poisonous algae***. In summer time, more and more risks for anaerobic fermentation because periods with anaerobic conditions increase (due to less tidal refreshment of water bodies)

Brief overview (3) of some ecological problems of the Deltaplan (NL)

- More and more ***discharge problems*** of growing amounts of ***fresh river water*** are occurring (due to precipitation changes and due to increasing rainwater run-off from urban areas).

- The disappearance of the tidal regime and dynamics has consequences for water quality and for wildlife. A lot of ***migratory organisms*** cannot reach inland areas, nor can the come back to sea. As a result there are severe ecological consequences felt far inland.

- ***Unpleasant consequences*** for fishing, mussel and oyster breeding and local communities depending on these ***fishery activities.***

DIRECTIVE 2006/118/EC (12/12/2006) on protection of groundwater against pollution and deterioration. **The EU groundwater directive.** http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:372:0019:0031:EN:PDF)

- The groundwater directive, which is a daughter of the WFD, provides a framework for prevention and control measures to prevent pollution of **groundwater**. These measures aim to assess the chemical status of groundwater and to decrease the presence of polluting substances.

DIRECTIVE 2007/60/EC (23/10/2007) on the assessment and management of flood risks. **The EU Flood directive.** http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:288:0027:0034:EN:PDF

- The Floods Directive requires EU Member States to make an **inventory of areas are at risk of flooding**. They have to be mapped, and management plans have to be set up. Guidelines are: international solidarity, a river basin approach, prevention measures.

An integrated river basin approach: international coordination between the 27 EU- member states is obligatory.

Example: River basins of the river *Yser*, *Scheldt* and *Meuse* in Belgium are also extending into **The Netherlands**, **France** and **Germany**,
So the management committee is composed internationally

The European NATURA 2000 - Network

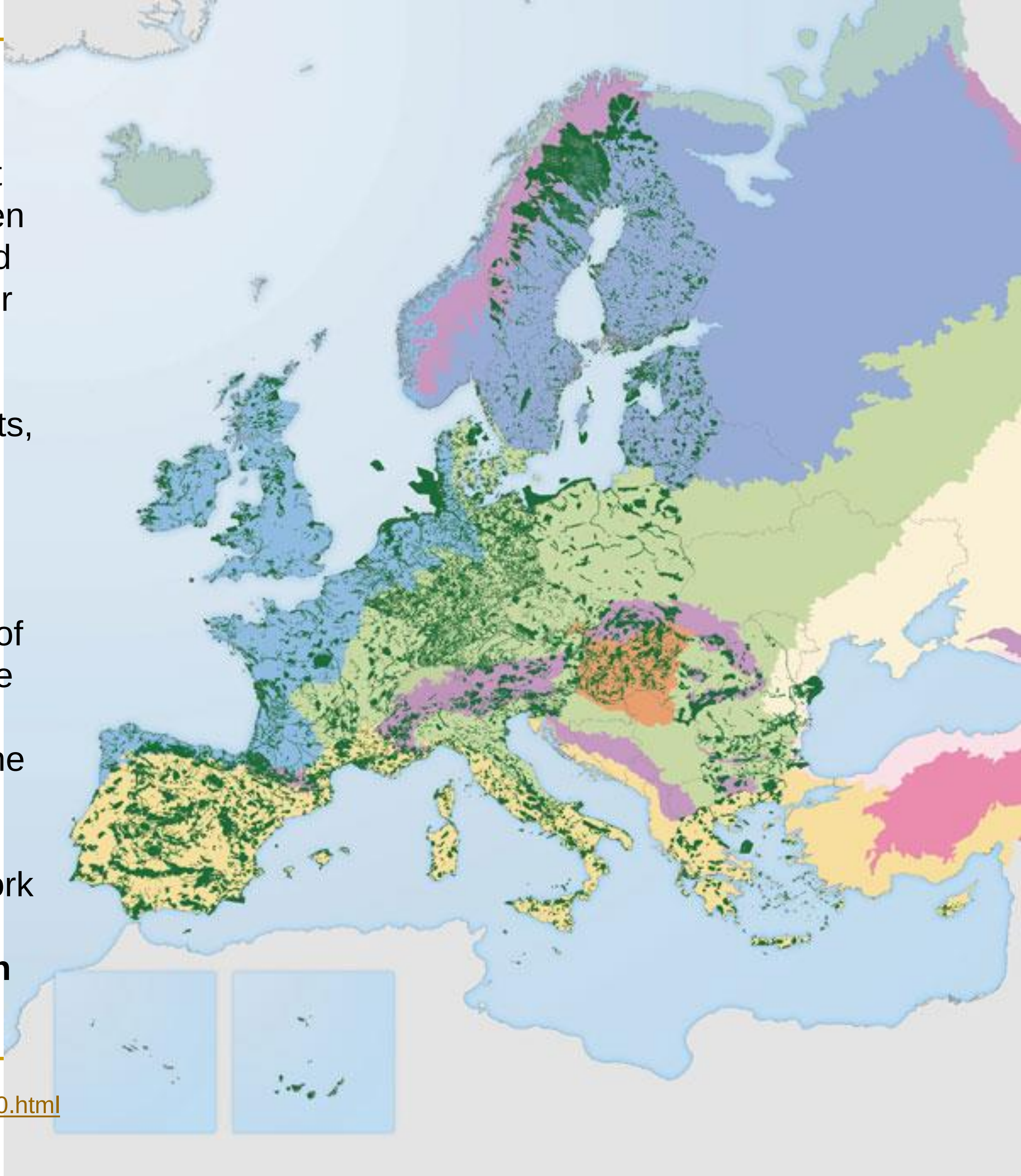
- The Birds Directive: Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (this is the codified version of original Directive 79/409/EEC as amended)
- The Directive was adopted over concerns for migratory birds and the decline of bird populations across the then European Economic Community (EEC). The Directive has special provisions for the protection of bird species and important sites for birds.
- The Habitats Directive: Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora
- This Directive provides for the protection of a long list of species (animals other than birds and plants) and habitats within the European Union. For a full listing of these, please see the Annexes to the Directive.
- These two Directives provide a strong and modern framework for the conservation of species, sites and habitats which all EU Member State have to adopt (transpose) into their national legislation. The European Commission has the role to guide, support and monitor the transposition and implementation of the Directives.
- One of the key obligations of the Directives on the EU Member States is to establish a network of protected areas for nature, on land and sea, called Natura 2000 within their European territory. This network, that is expected to cover more than 15% of the EU terrestrial territory when complete is a great conservation achievement and unique in the world.
- The Heads of State and governments of the European Union agreed in 2001 to halt biodiversity decline by 2010 (the so-called “2010 target”). The main tools in this effort are the following two pieces of binding EU legislation, which were adopted by the Member States of the EU and the European Parliament:

http://www.birdlife.org/eu/EU_policy/Birds_Habitats_Directives/index.html

Naura 2000 represents the most ambitious initiative ever undertaken to conserve valuable habitats and species across all 27 EU-member states. Thanks to these two Directives, countries are able to coordinate their conservation efforts, irrespective of political or administrative borders.

This network is designed to conserve over a thousand rare, threatened and endemic species of wild animals and plants and some 230 natural and semi-natural habitats listed in the annexes of the two EU Directives.

Around 25,000 sites have been included in the Natura 2000 Network so far making this **the largest network of nature conservation areas anywhere in the world**



http://www.natura2000tourism.eu/aboutnatura2000.html

DIRECTIVE 2002/91/EC (16 dec. 2002)
on Energy Performance of Buildings
The EU EPBD directive.

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:001:0065:0071:EN:PDF

- Was inspired by the Kyoto Protocol which committed the EU to reduce CO_2 by 8% by 2010, to 5.2% below 1990 levels. The directive came into force on 4 January 2006 and requires member states to comply with Article 7 (Energy Performance Certificates), Article 8 (Inspection of boilers) and Article 9 (Inspection of air conditioning systems) within three years of the inception date.

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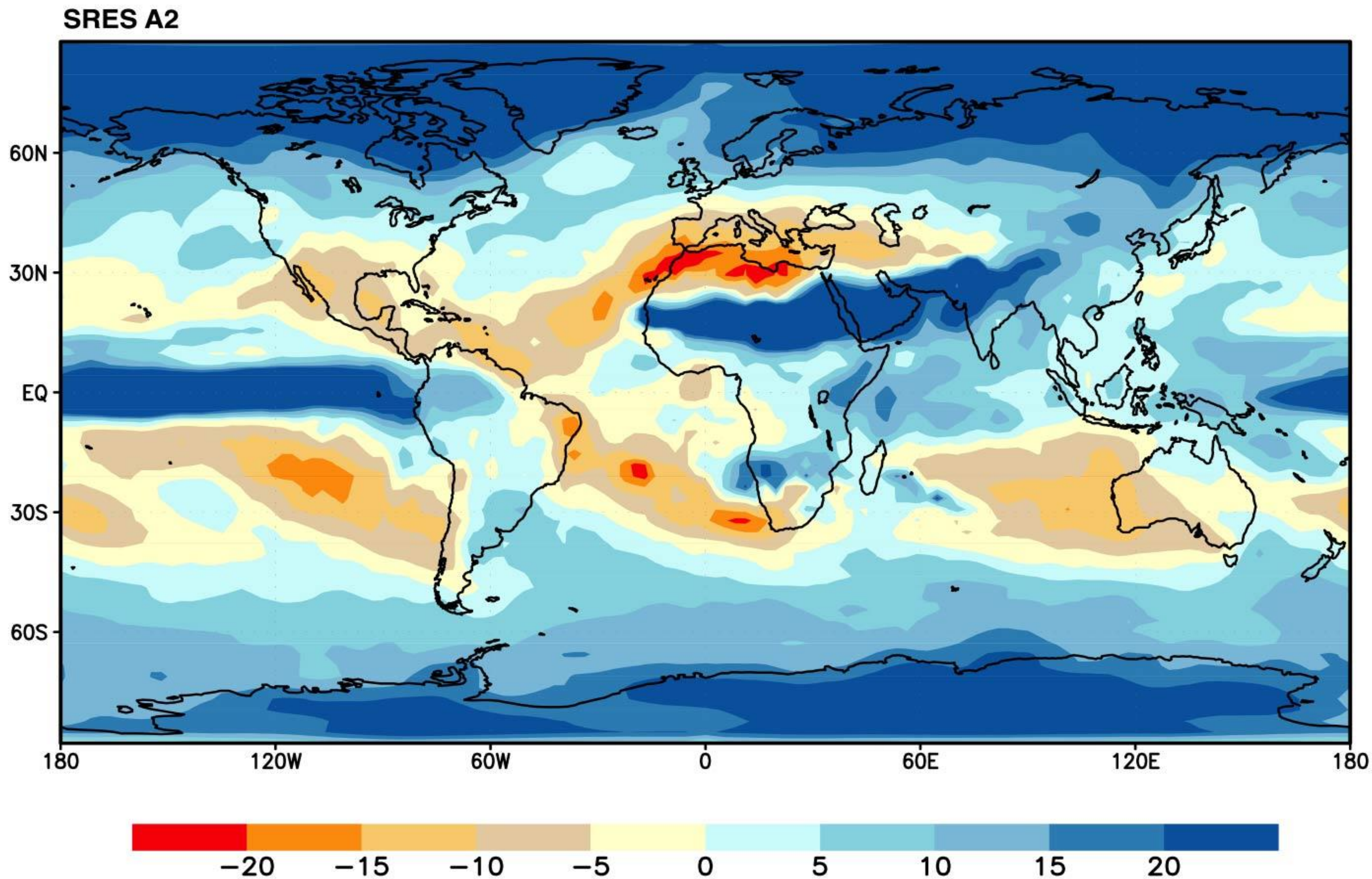
The link of rural and urban water management with local and global climate change.

- See level rising is influencing the discharge of fresh river water into the see.
- Climate change not only has its influence on **global temperatures**, but as a consequence also on global **precipitation** patterns.
  - The hotter the air, the more *absolute humidity* (water vapour) it can contain, the more precipitation (rain or snow) will follow.
  - Climatologists are predicting severe changes in precipitation, also in Europe, with desertification expected in the Mediterranean region, and a lot more precipitation in Scandinavia.
  - because of the influence of human activities on the so-called *small en large water cycles* (see further).

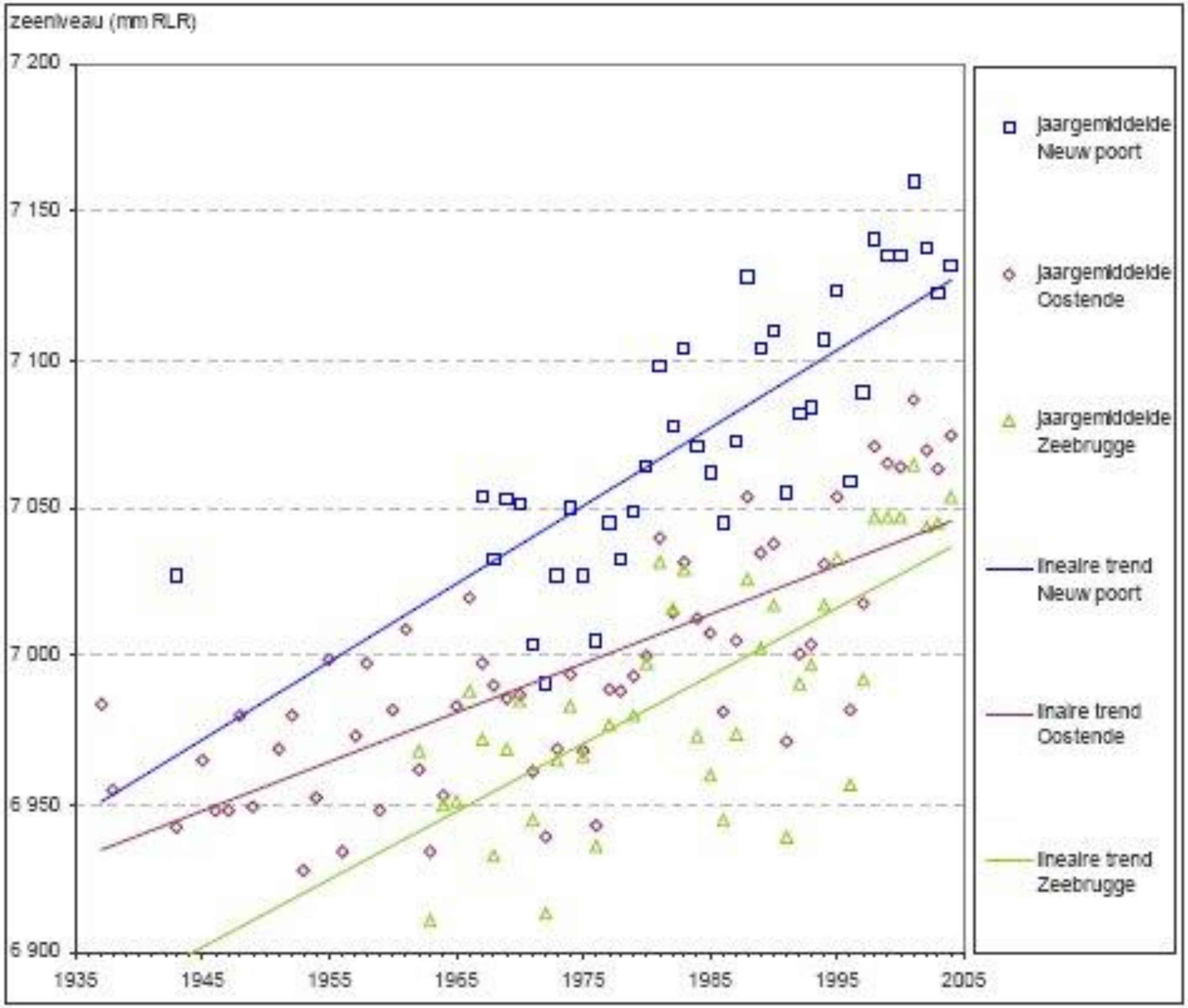
(source: Van Ypersele, 2011) Precipitation changes in 2080: results from one climate model for IPCC scenario A2



See level rising in Belgium.

(currently
3,5 à 4 mm/year)

Figuur 63: Evolutie zeeniveau aan de Belgische kust (Oostende, 1937-2004; Nieuwpoort, 1943-2004; Zeebrugge, 1962-2004)



Het zeeniveau wordt uitgedrukt in mm RLR (Revised Local Reference). Daarbij zijn de data van een lokale referentie omgezet t.a.v. het internationaal refentieniveau.

Bron: VMM op basis van Afdeling Kust en PSMSL (2005).

The Belgian River ‘**Scheldt**’ as a case.

There has been a lot of dredging in the Scheldt, to make it navigable for large ships to Antwerp harbour (more than 80 km from the Northsea)

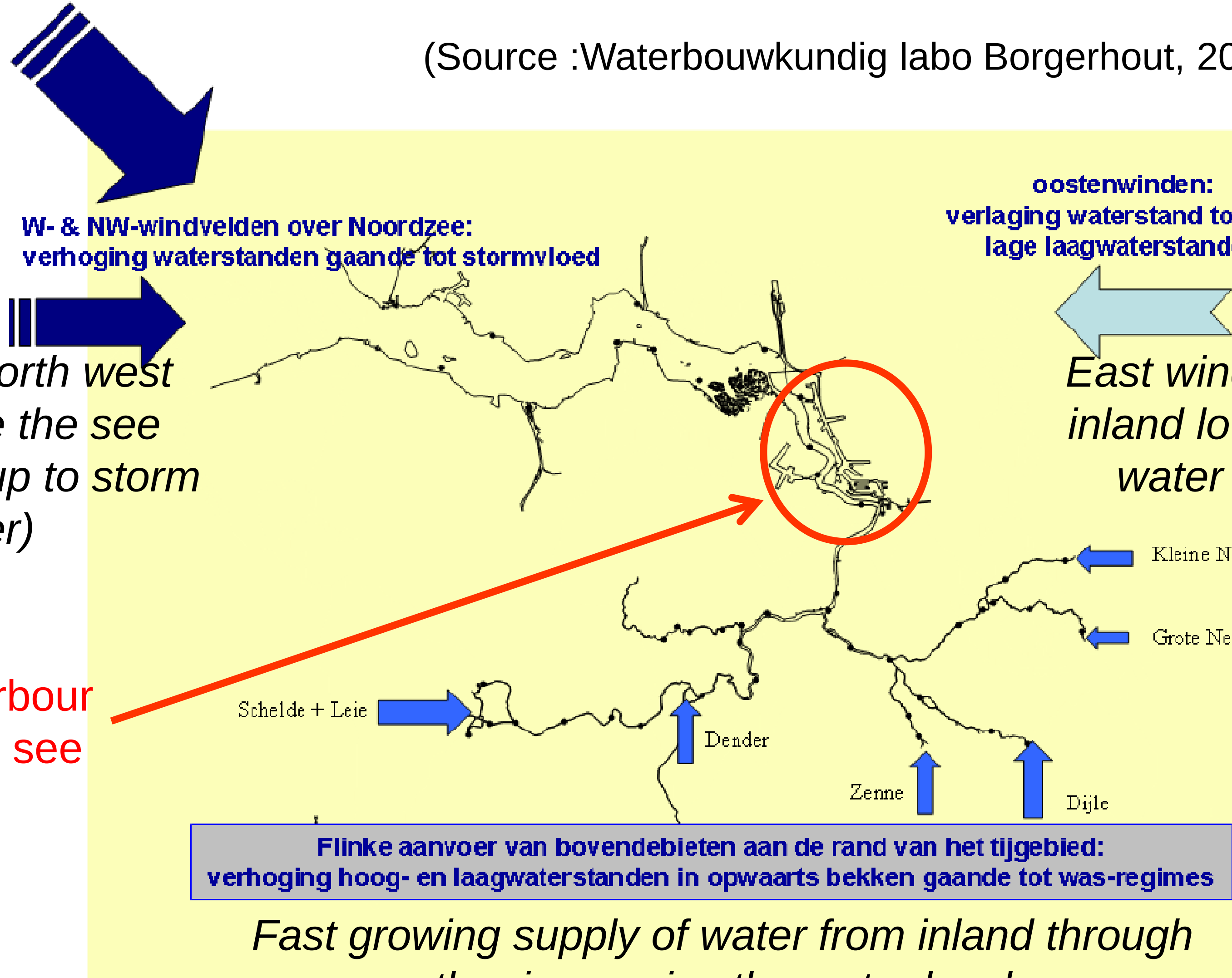
G: Gent / A: Antwerpen

http://www.psmarine.nl/nieuws/?page=overzicht&id=94

http://pro.vnsc.eu/kaarten

The Belgian River ‘**Scheldt**’ as a case.

(Source :Waterbouwkundig labo Borgerhout, 2008).



West and north west winds raise the see water level (up to storm water)

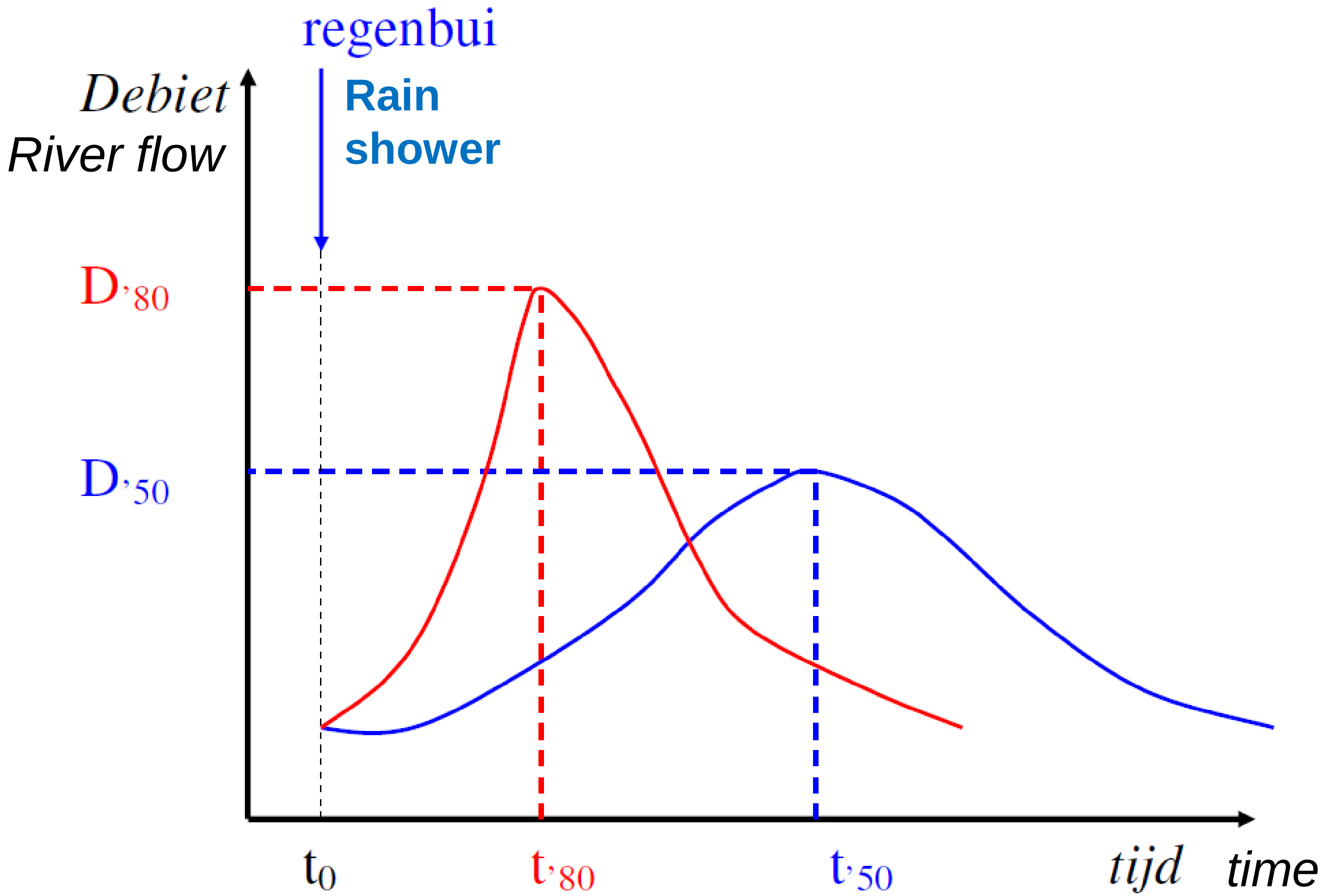
East winds from inland lower the water level

Antwerp harbour 80 km from see

Fast growing supply of water from inland through the rivers raise the water level

Figuur 1 - Zeescheldebekken:
algemeen liggingsplan met schetsmatige aanduiding van de grootste tij-beïnvloedende componenten

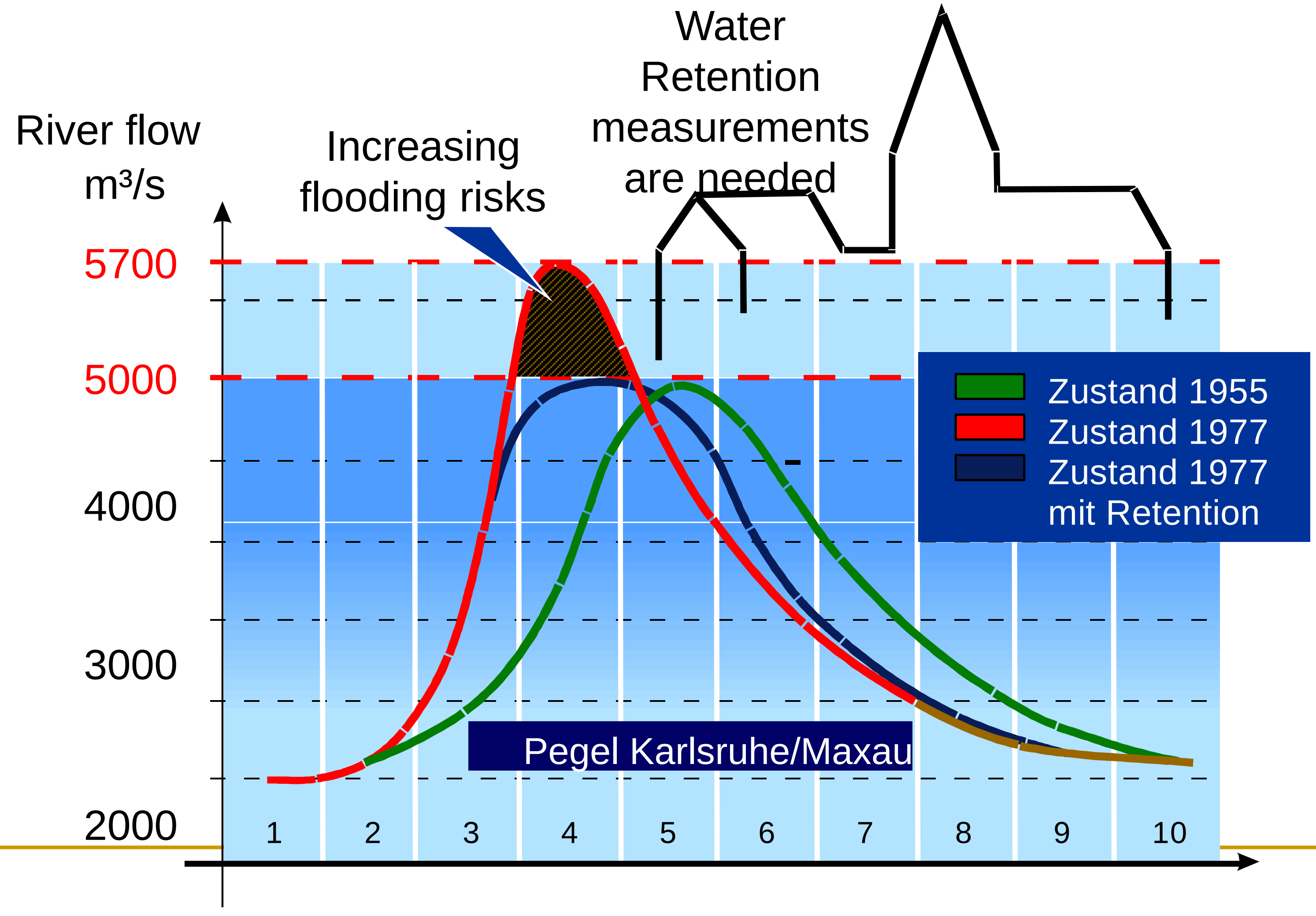
Example: Hydrological research of the **Bellebeek** (Belgian inland brook), (Van der Beken, 1984, University Brussels)



Current peak river flow rates from inland to the North Sea are **higher** and come **earlier** in the time after a rain shower, compared with the years 1950.

The same is the case all over Europe: example of the river **Rhine**, in the border region between France and Germany.

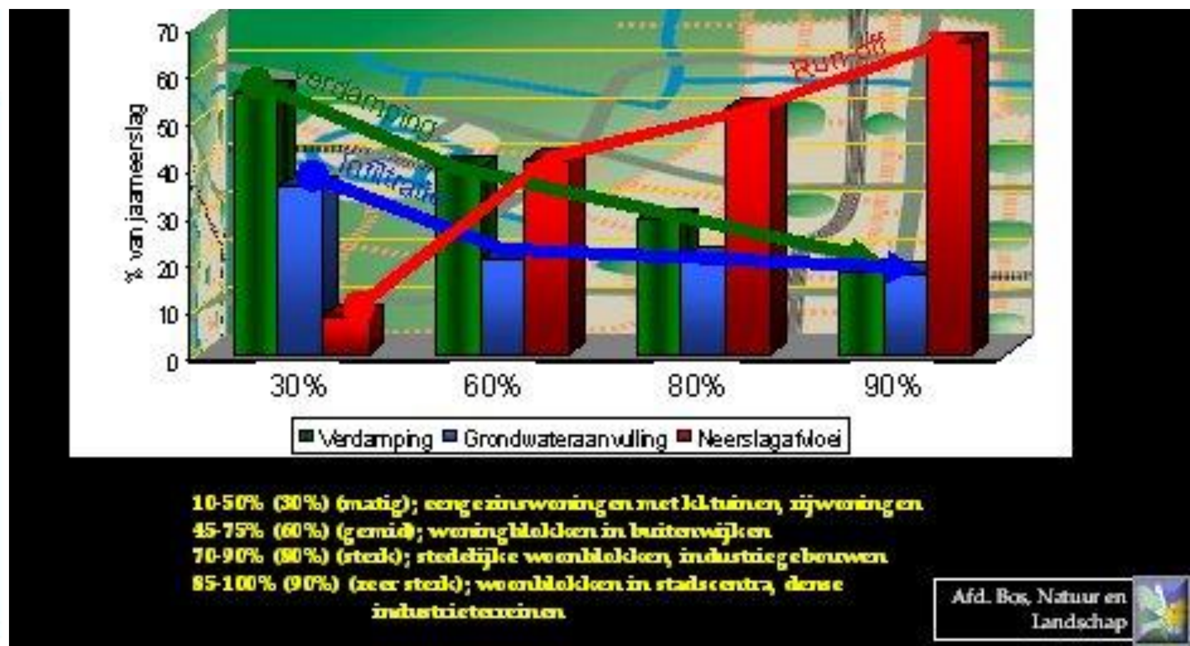
Source: Das Integrierte Rheinprogramm des Landes Baden-Württemberg (Hochwasserverschärfung)



<u>Main urban causes</u>: Sealing surfaces with impermeable concrete, roofs, pavements, … causes increasing amounts of rainwater which can not infiltrate and which is mostly drained into mixed sewage systems.

Increasing RUN OFF

Rural Urban

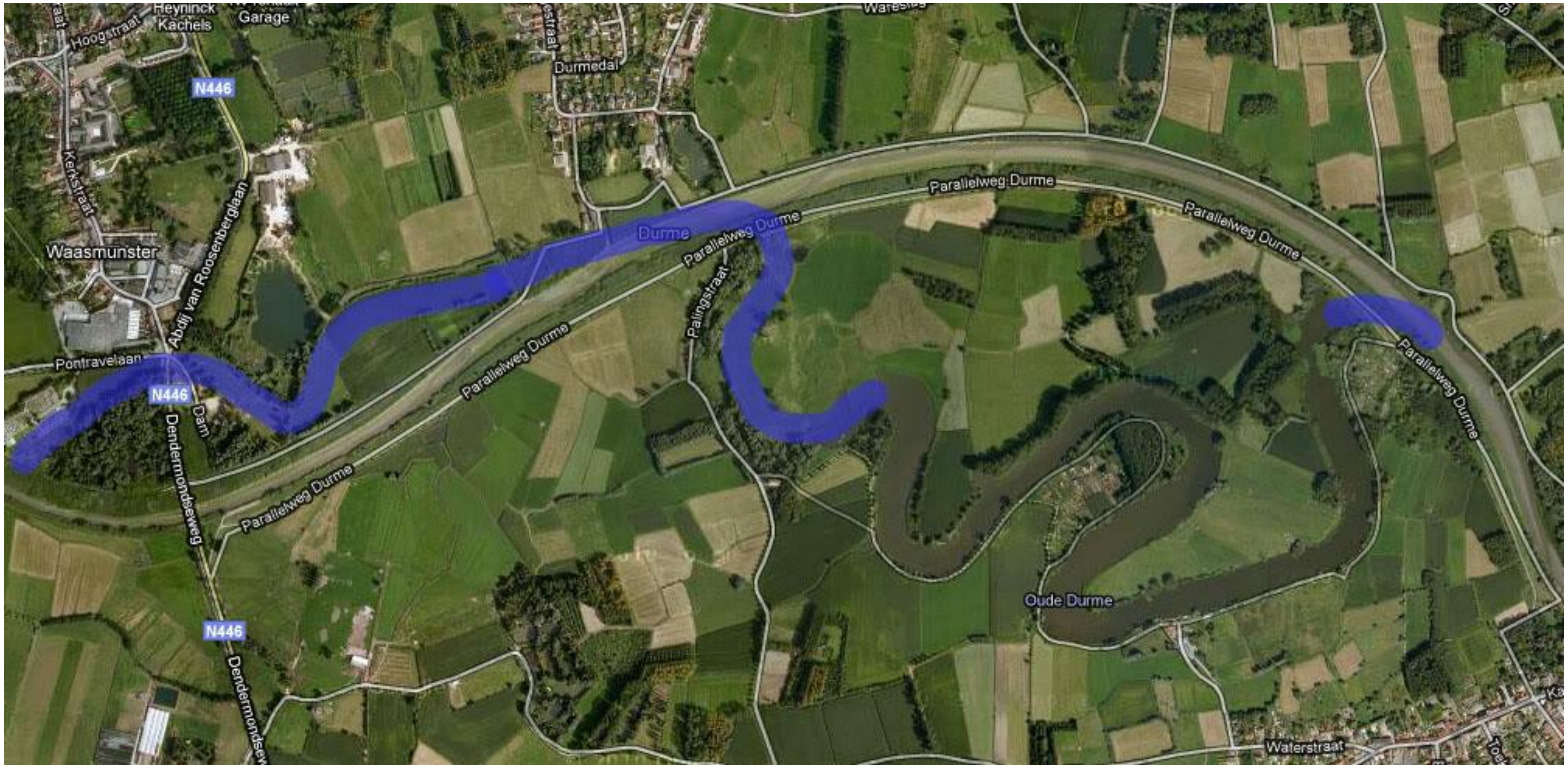


Symptom Control by ‘river standardization’ programs: stream widening and straightening. (ecological ‘law of conservation of misery’(1).

The river Marck (B) is being ‘(AB)normalised’.

(1) The so-callled law of *conservation of misery* will occur every time when people try to solve the symptoms in stead of tackling the causes of the problem.

Straightened river Durme in the municipality Waasmunster (B) (in blue the former riverbed ‘Old Durme’)



trobken.weebly.com/durme.html

<u>Main rural causes</u>: Hydraulic rough landscape in the municipality of Voeren (B) suffers from **<u>deforestation</u>** …

Noorbeek brook valley

terraces

…. followed by **intensification of agriculture** (Heers, Limburg, B), so sponge effect is lost after land consolidation projects

Farmers plowing nowadays perpendicular to contour lines on slopes.
(compare direction of plowing by a tractor with plowing by horses or cows)

CONCLUSION: CAUSES OF SOIL EROSION AND FLOODING (BUT ALSO FOR LOCALLY RISING TEMPERATURES, see further), ALL OVER EUROPE.

Main causes:

- Disappearance of the **rural** hydraulic roughness (sponge effect) of the rural areas. Deforestation, increasing agriculture
- Increasing **urban** impermeability for rain water of cities.

- As we will study later in this presentation, both causes have at the same time also serious consequences for the local temperature and heat distribution

Continuous widening and straightening the rivers and brooks was dislocating the problems downstream in Europe , while the rising sea level complicates the drainage of river water from the inland to the sea

North Sea → ○ ← *Inner land*

↓

Floods and dam breaches

1976: B (Ruisbroek, *Rupel*)
1995: The Netherlands (*Maas* en *Rhine*)
1997: Poland, Germany, Czech republic (*Oder*, *Elbe*, *Morava*)
1998: B (lots of brooks and rivers)
2002: Austria, Germany (*Elbe*, Dresden) , CZ (*Moldau*, Praag)
2005: Romania – Alpine region.
2010: B (lots of brooks and rivers*, Dender),* Slovakia
2012: Great-Britain (all over the country)

To be continued ….

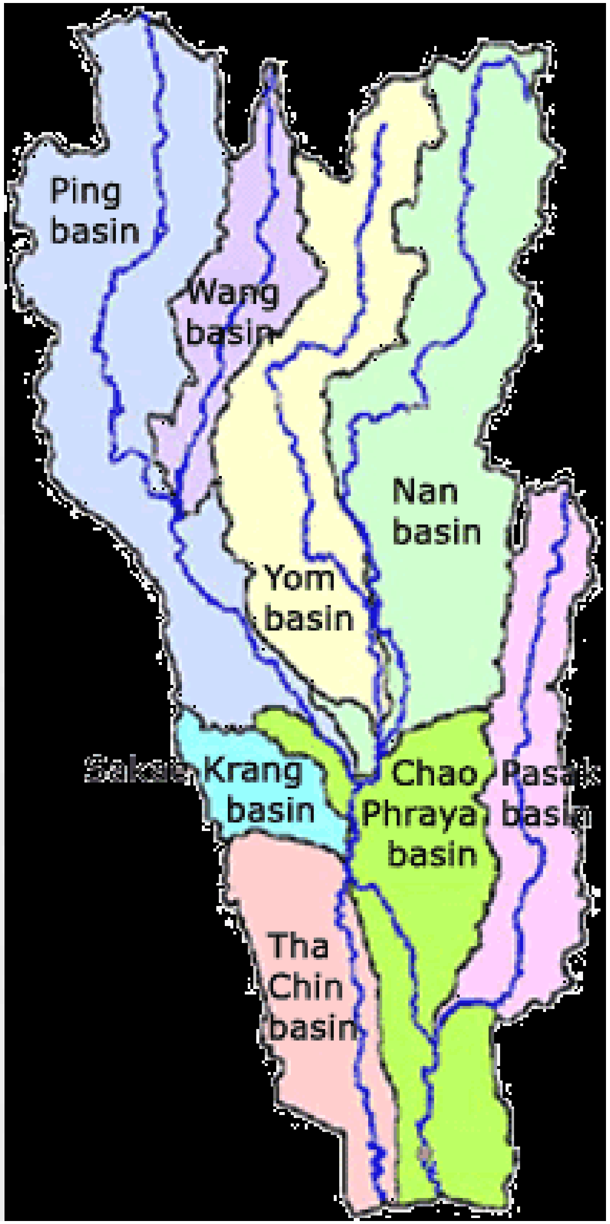
Chao Praya River basin , Thailand Table to be supplemented with the 2011 floods

Main features of the major floods in the lower Chao Phraya River basin

		1942	1983	1995
Human Intervention	Forest cover[a]	166,000 km^2	106,000 km^2	92,000 km^2
	Area denuded	--	60,000 km^2	74,000 km^2
	Reservoir capacity	Nil	23,000 million m^3	24,000 million m^3
	Flood protection	2,230 km^2	12,900 km^2	14,400 km^2
	Urban area[b]	51 km^2	389 km^2	528 km^2
Natural Causes	Rainfall upstream	Exceptionally Heavy	Unusually heavy (Sep.to Nov.)	Unusually heavy to Exceptionally heavy
	Rainfall in Bangkok	Normal	Unusually heavy (Aug.to Nov.)	Normal to unusually Heavy
	Tides	Normal spring tide with additional seasonal effects	Normal spring tide with additional seasonal effects	Normal spring tide with additional seasonal effects

a Northern and central regions of Thailand.

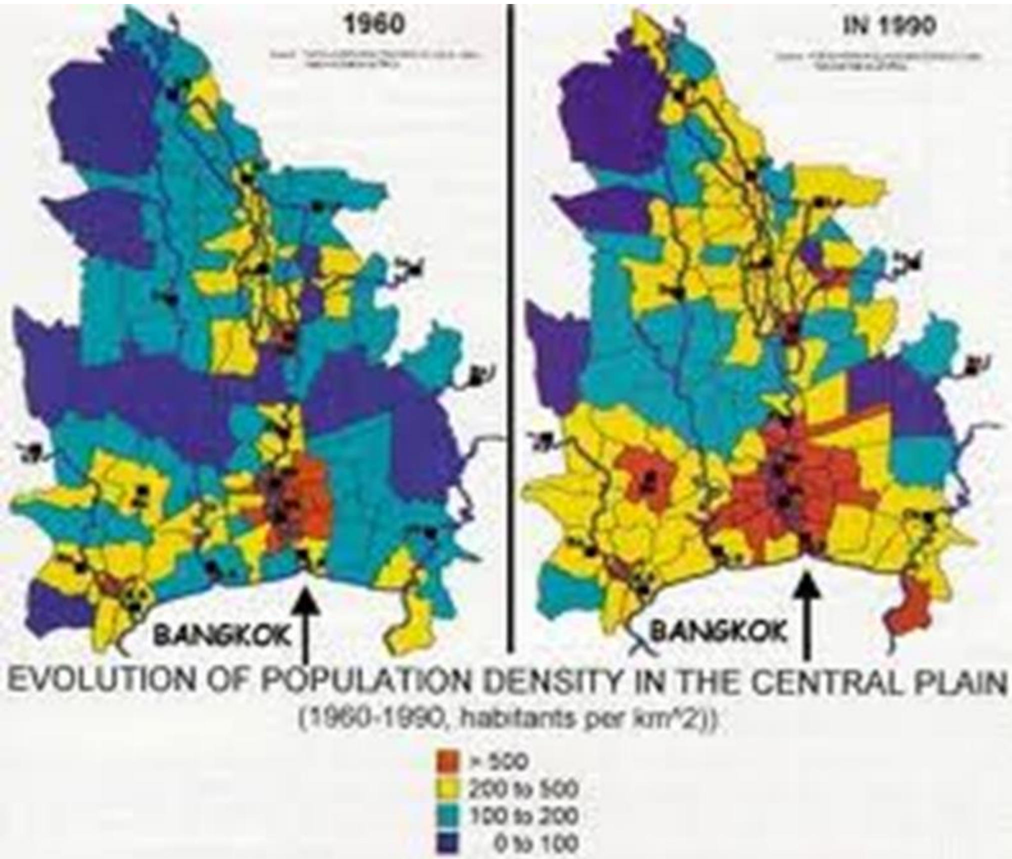
b Bangkok area only.

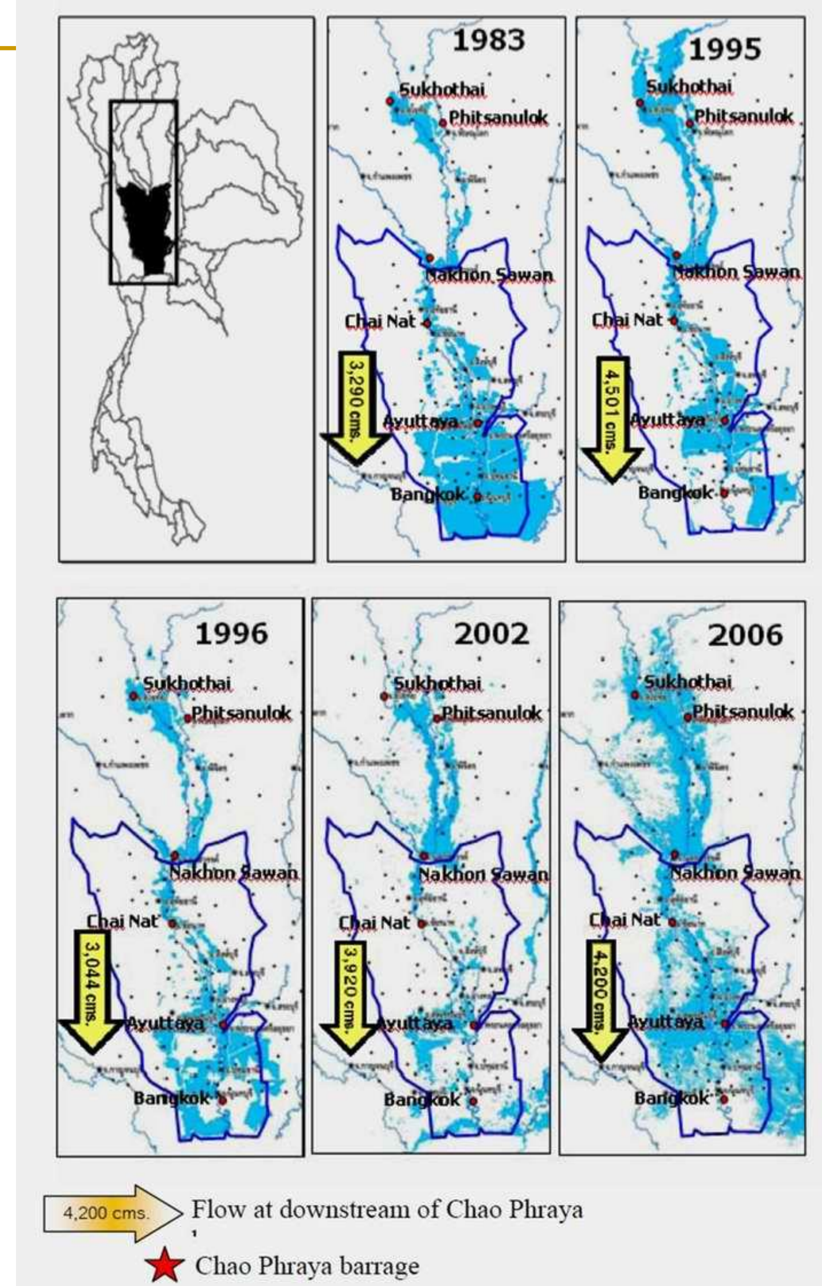


source http://webworld.unesco.org/water/wwap/case_studies/chao_phraya/detailed_view.shtml

http://bebasbanjir2025.wordpress.com/pengendalian-banjir-mancanegara/thailand

Bangkok and surroundings 1960's – 1990's





http://www,goodstuff4u.multiply.com

http://bebasbanjir2025.wordpress.com/pengendalian-banjir-mancanegara/thailand/

So, as in *Europe* flooding in *Thailand* has mainly the same causes

- Natural causes, combined with man-made causes:

As in Europe, the main natural causes in Thailand are overbank flow of the rivers, heavy (heavier) rainfalls and stronger tides due to see level rising.

As in Europe , the most common man-made causes in Thailand are deforestation, uncoordinated urban development, over-abstraction of groundwater, and destruction of flood embankments.

How to explain changes in local precipitation and temperatures in Europe ?
The concept of the **large and small watercycles**.

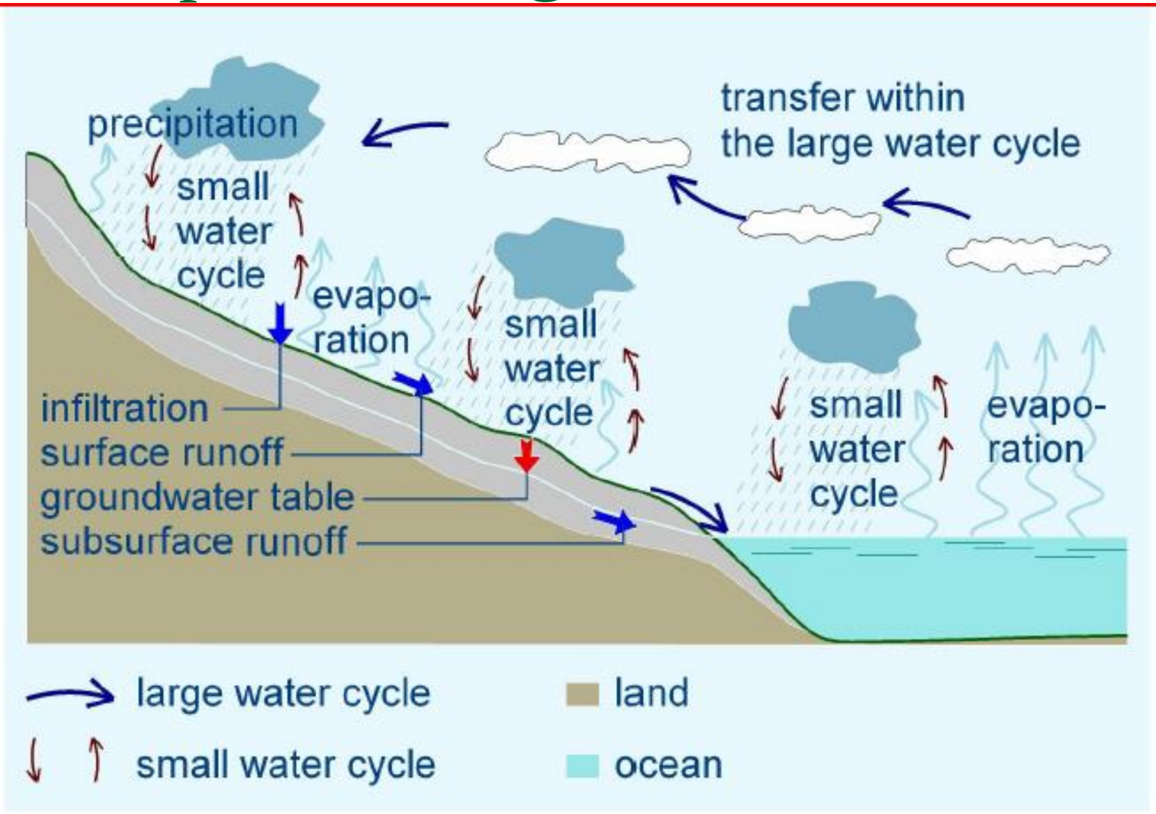


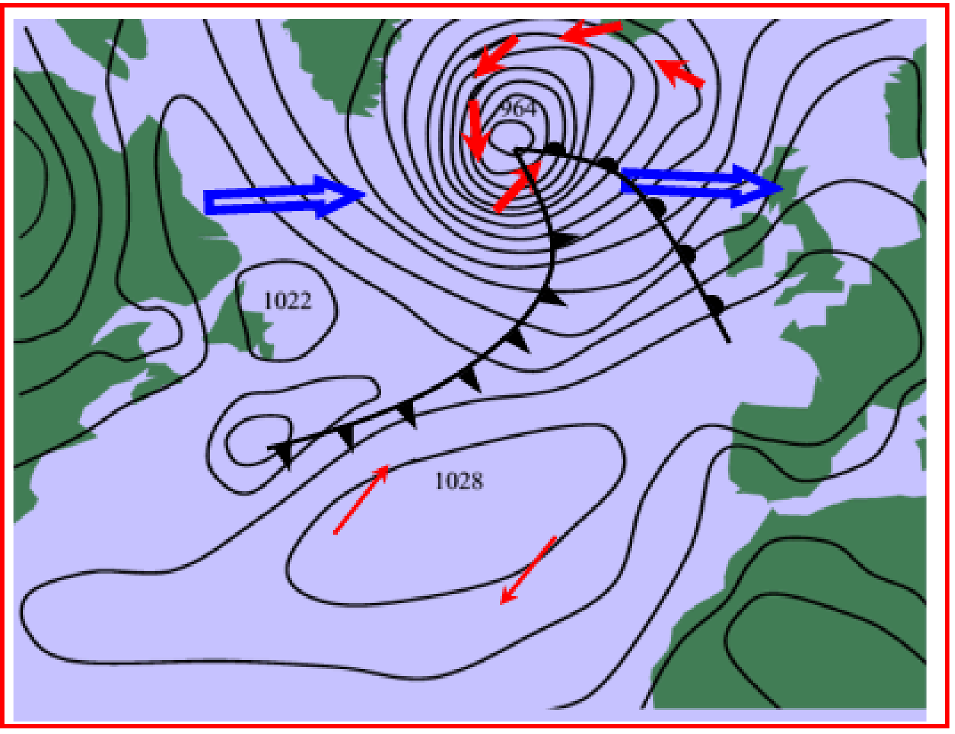
Fig. 1 **The large and small water cycles on land**

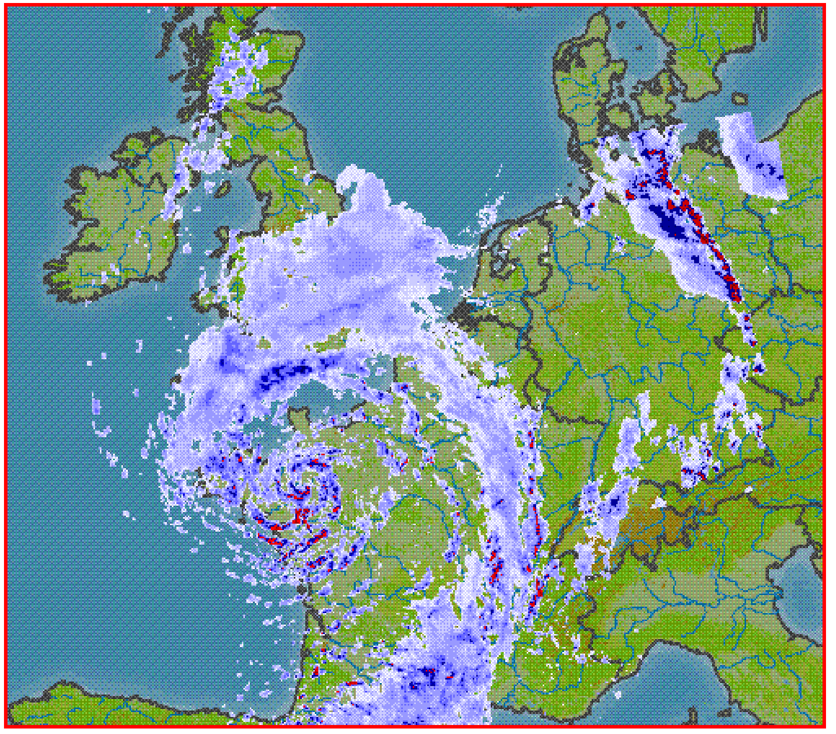
The **large water cycle**: exchange of water between oceans and land.

- 550.000 km³ of water evaporates / year into the atmosphere, 86 % from seas and oceans, 14 % from land.
- Atmospheric precipitation falls 74 % over the seas and 26 % over land.
- So there is a contribution from oceans, endowing the land with 12 % (86 % - 74 %) more water than is locally evaporated. This surplus is transported over a great distance above the land by clouds.

Source: Kravčík, M. et al., 2008. Water for the recovery of the climate. A new water paradigm. Košice (Slowakia), Typopress-publishing house, ISBN 978-80-89089-71-0. 122 pp. Ill

The large water cycle: Depressions on the Atlantic ocean and North sea bring precipitation towards Europe,





www.kayarchy.co.uk

The **small water cycle**: a closed circulation of locally evaporated and transpirated water, which falls again as precipitation in the same region.

- Average rainfall in Slovakia is 720 mm/year. Input from oceans is 310 mm/year. Locally produced precipitation through small water cycles is 410 mm/year (!!). So the regional precipitation comes for more than 50 % from locally evaporated water.

- So mankind cannot transform and drain the land limitlessly, without having a serious impact on its local precipitation: the volume of the small water cycle will gradually decrease. So a self-reinforcing phenomenon of further drying-out of the local environment is started: more urbanisation and run-off, less evapotranspiration, less local rainfall, more drought and sensible heat, higher temperatures because the cooling effect of the evapotranspiration is decreasing....

Forests, wetlands, especially moorland, are contributing very much to local evapotranspiration, and to local small water cycles, cooling down local temperatures, increasing local air humidity (fog).

www.natuurrondleidingen.nl

Moorlands in Finland.

Contribution to the local water cycle, through the evaporation of a swimming pond.

Especially in dry urbanised regions it is important to restore the local contribution to the small water cycles, as is shown by this swimming pond example in which the local rain water is harvested from adjacent roofs, evaporating into the air.

The cooling effects of water evaporation and of transpiration through **vegetation**.

- 80-90 % of the plant biomass is water, water is also needed for photosynthesis.
- **Evaporation** includes the vaporization from the soil and from plant surfaces. **Transpiration** is the water taken by the roots, transported through the plant and leaving through the stomata of the leaves (which can be opened and closed, regulating the amount of transpiration). The total amount of involved water is **evapotranspiration**
- Because the vaporization of water needs a lot of latent heat, this system cools the local area down. The evaporation of 3 litres/m^2 of water needs 7,5 MJ /m^2. This is far more than the solar energy needed for photosynthesis: the production by photosynthesis of 10 grams plant material requires only 170 kJ.

The cooling effect of vegetation.

Infrared spectrum | Visible spectrum

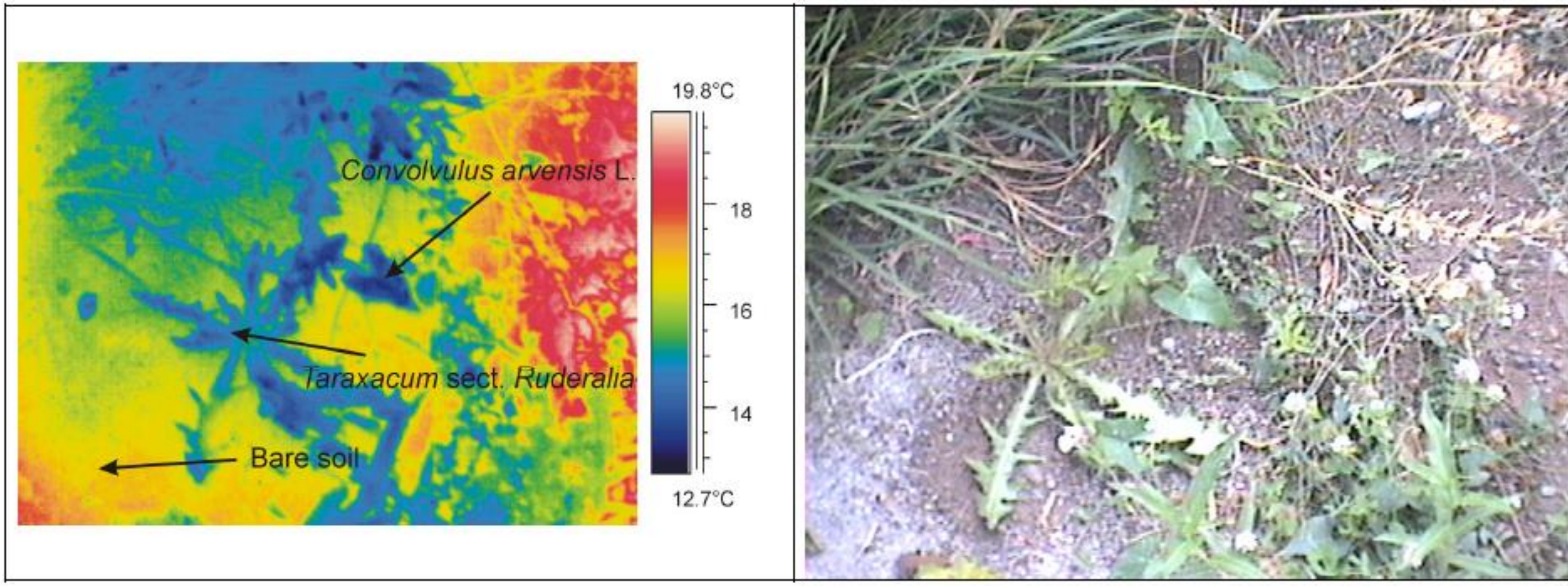


Fig. 7 **Photographs of thin vegetation in the infrared spectrum and in the visible spectrum**. The bare surface of the ground is visibly warmer than the surface of the leaves cooled by transpiration. (Třeboň, Czech Republic, 12 July 2002, 10:00 hrs).

A stable water cycle, over time.

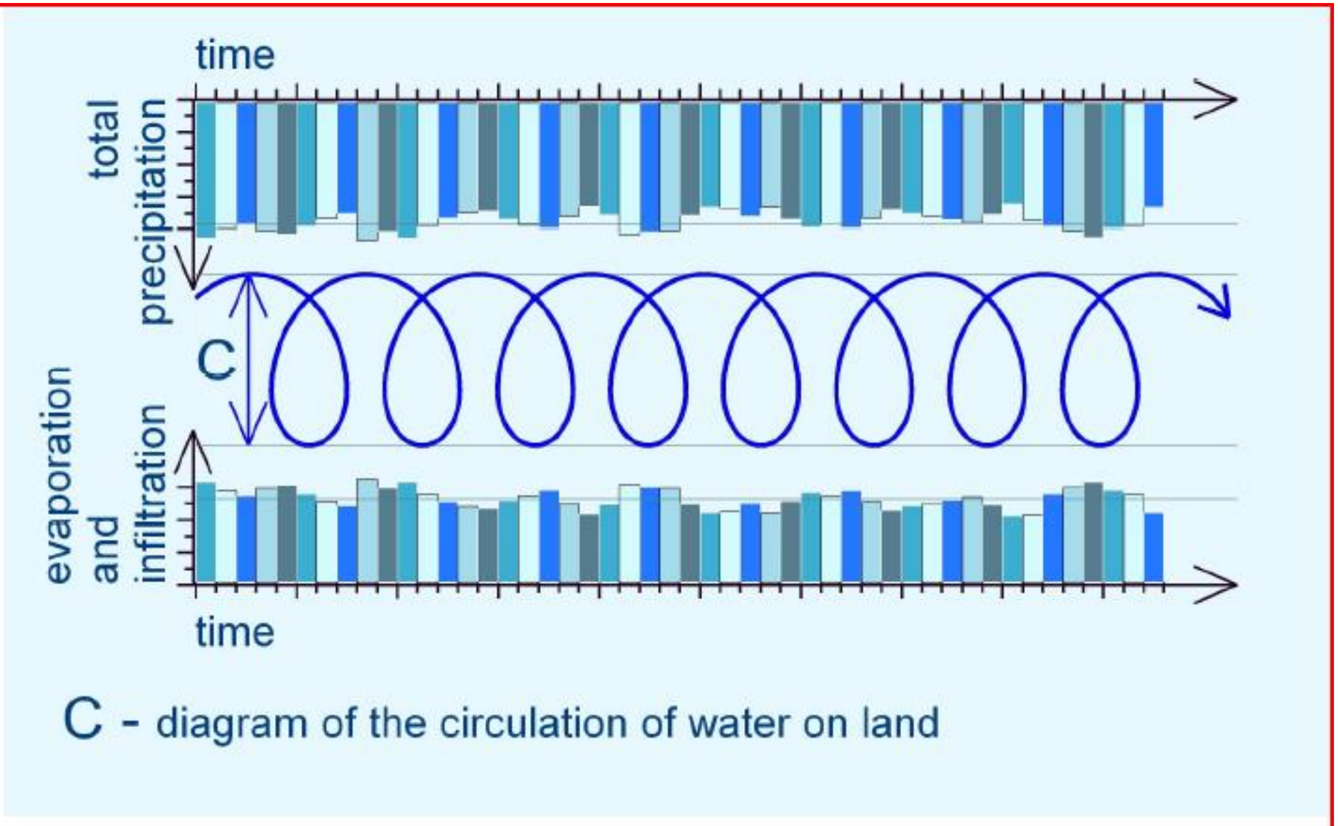


Fig. 2 **Diagram of the long-term stable water cycle on land**

Stable local evapotranspiration leads to stable small water cycles providing local precipitation

Consequences of decreasing the small water cycle.

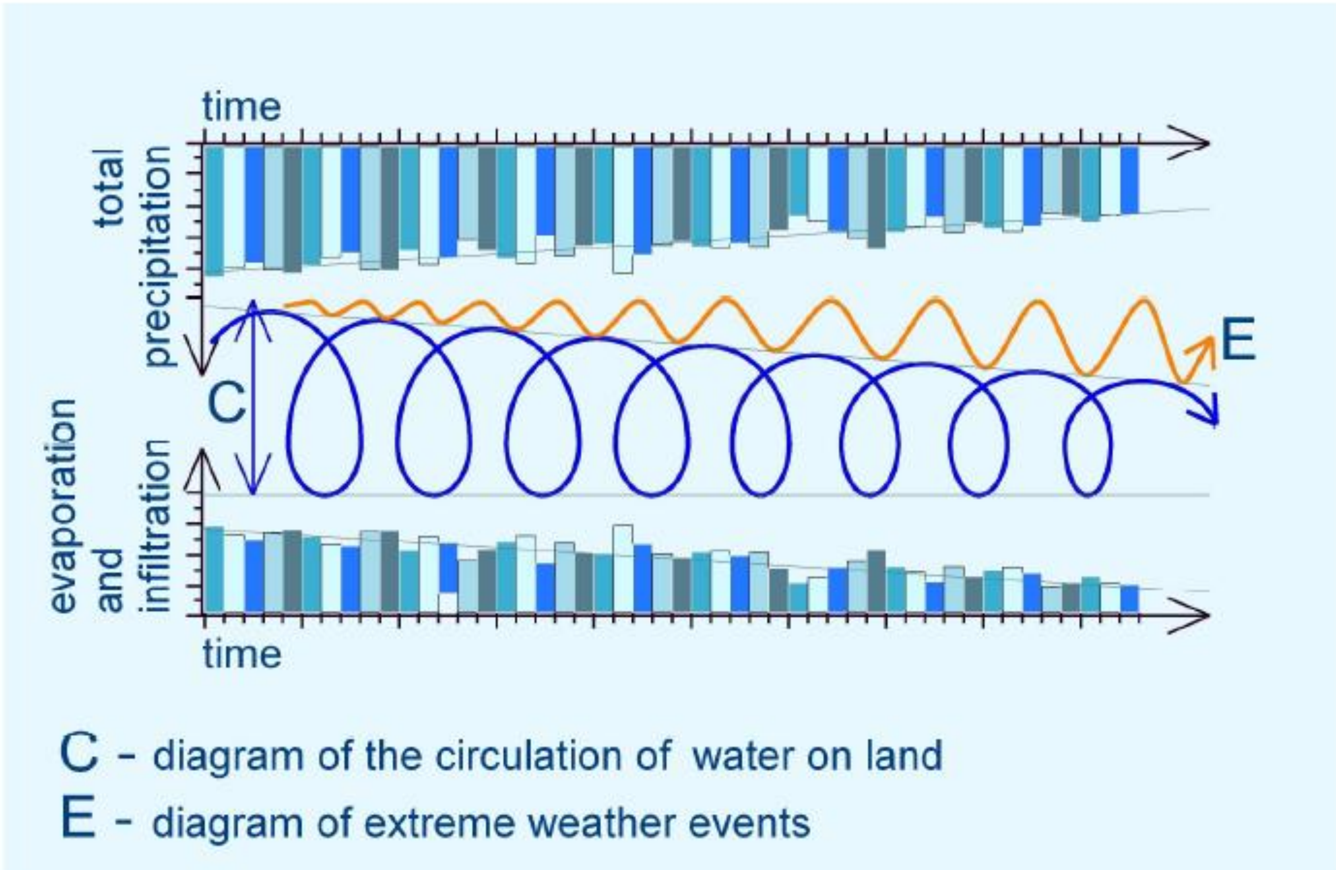


Fig. 17 **The growth of extreme weather with the decrease of water in the small water cycle**

Less evapotranspiration leads to decreasing locally generated rainfall and increasing risks for extreme weather events

So, as long as landscapes are wet, local temperatures are kept moderate, ….

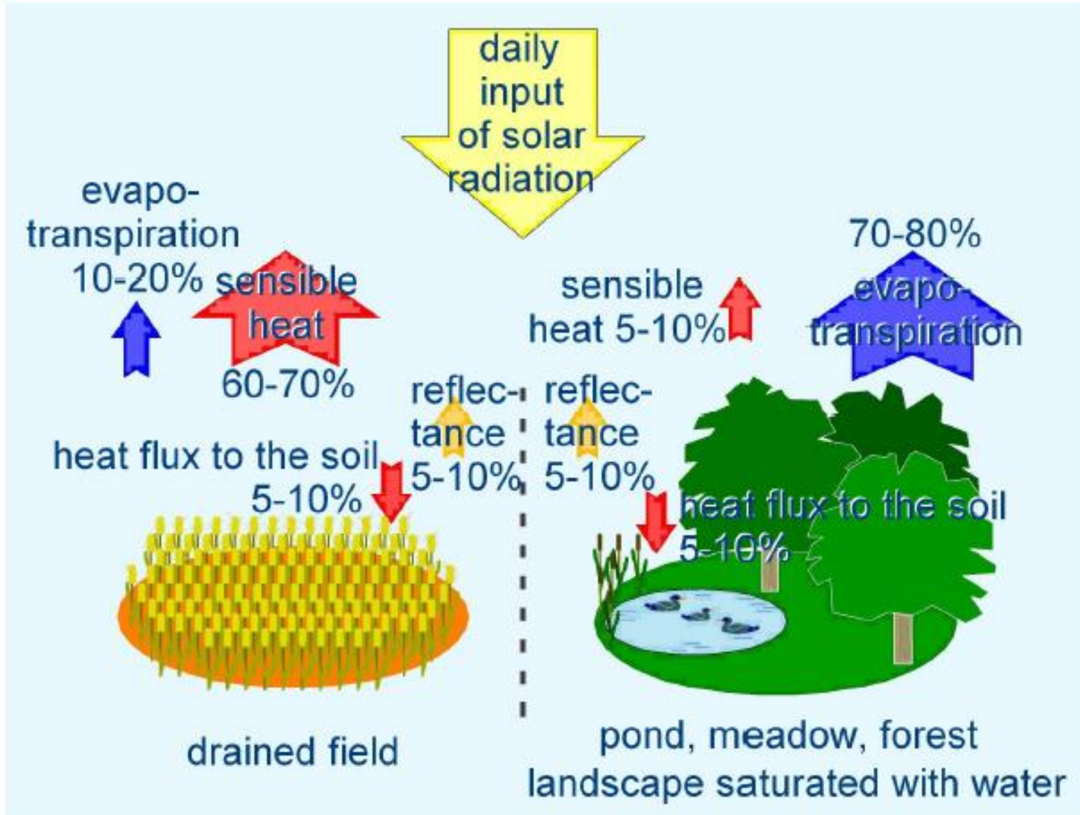
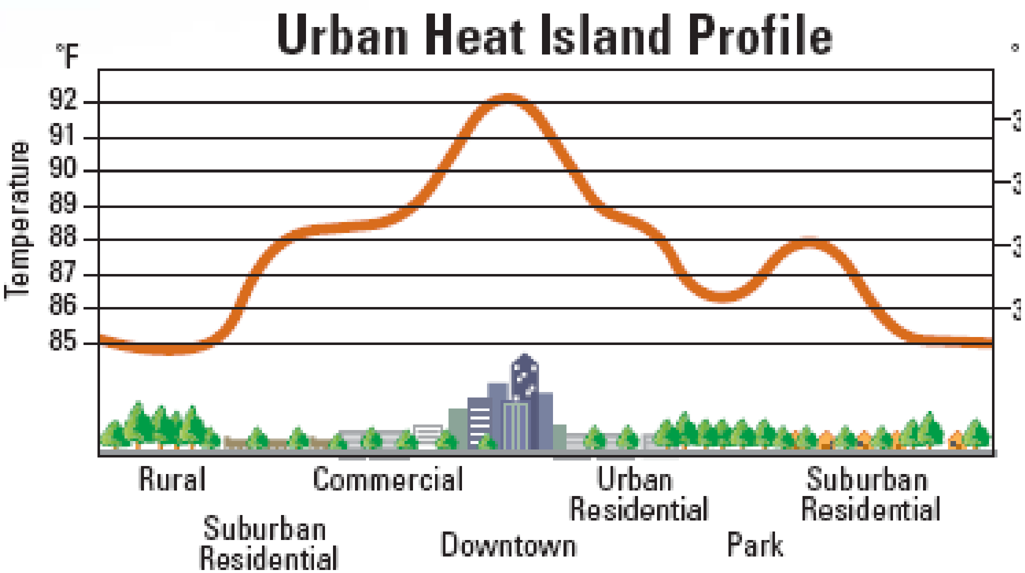


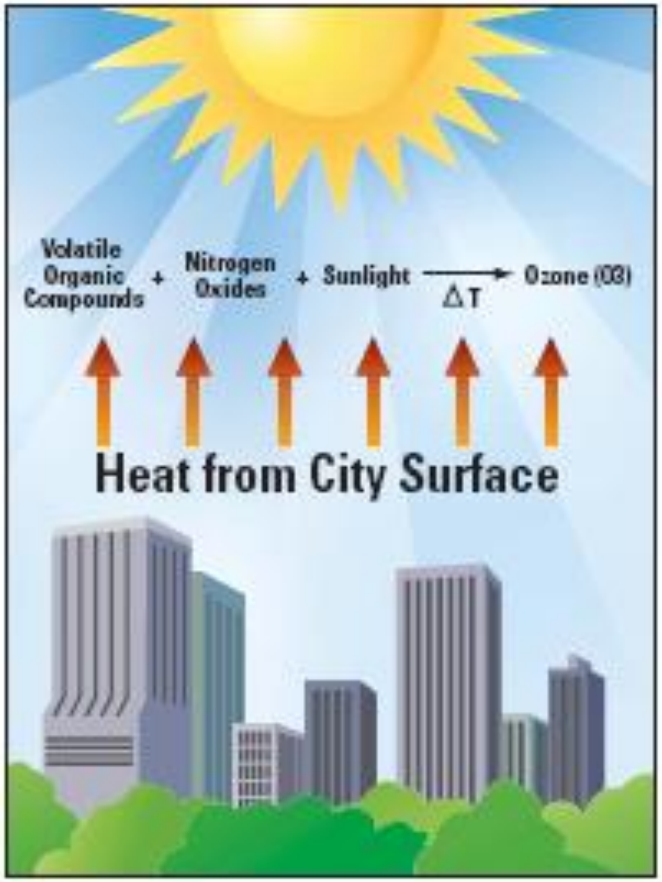
Fig. 4 **The distribution of solar energy on drained land and on a landscape saturated with water**

The input of solar energy is turned into sensible heat, in dry landscapes. Wetlands turn solar energy into latent heat, taken away by evapotranspiration.

… which is one of the causes of the **urban heat island effect** (UHI).



Heat islands are often largest over dense development but may be bı up by vegetated sections within an urban area.

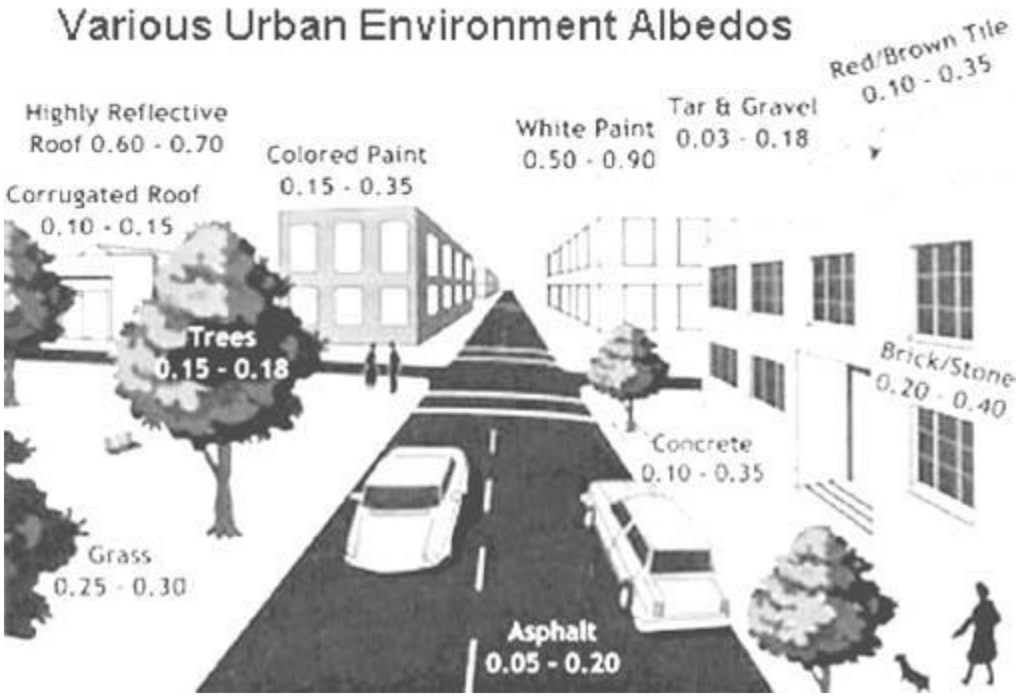


Ozone forms when precursor compounds react in the presence of sunlight and high temperatures.

http://www.epa.gov/heatislands/resources/pdf/HIRIbrochure.pdf

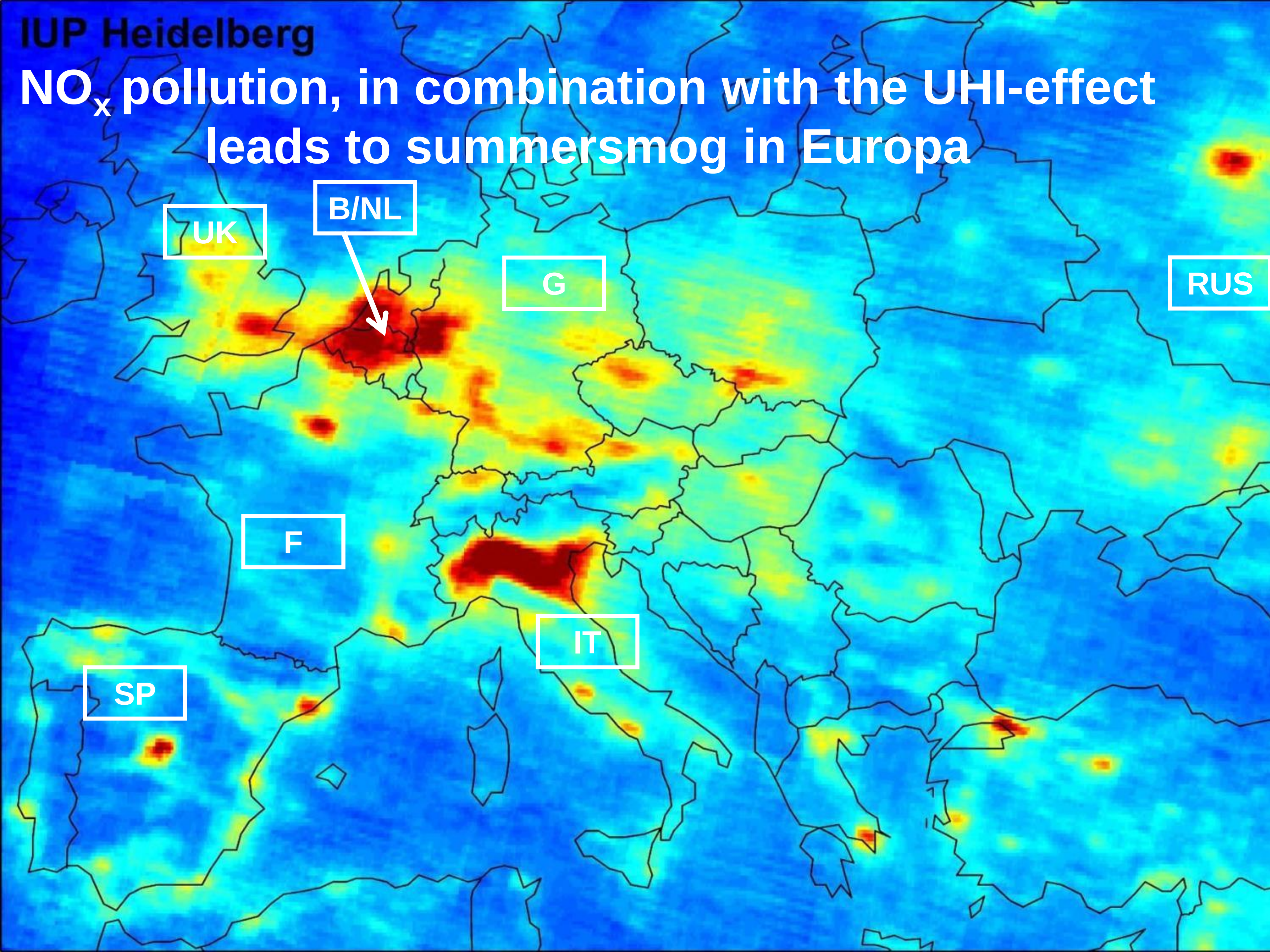
Albedo

The most influential property in the formation of urban heat island is that of albedo. Albedo is defined as the ration between the light reflected from a surface and the total light falling upon a surface. As the picture shows, albedo can range greatly. Clearly, the albedo of vegetation is much greater than that of civil structures, resulting in structures absorbing much more solar radiation than trees and plants.



http://pupclass.blogspot.com/2009/01/urban-heat-island-formation-in-context.html

NO_x pollution, in combination with the UHI-effect leads to summersmog in Europa

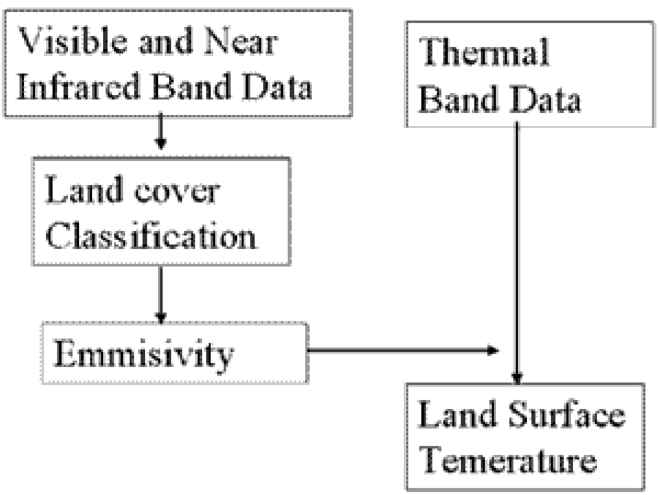


UHI-effect: a 'hot' scientific topic

Gartland, Lisa. 2008 . Heat Islands. London, Earthscan,

ISBN 978-1-84407-250-7

Some Asian examples



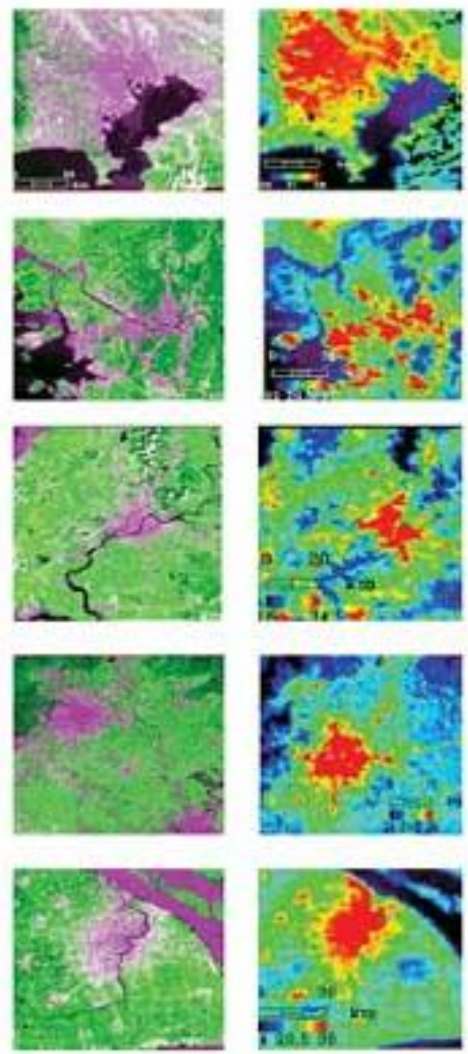
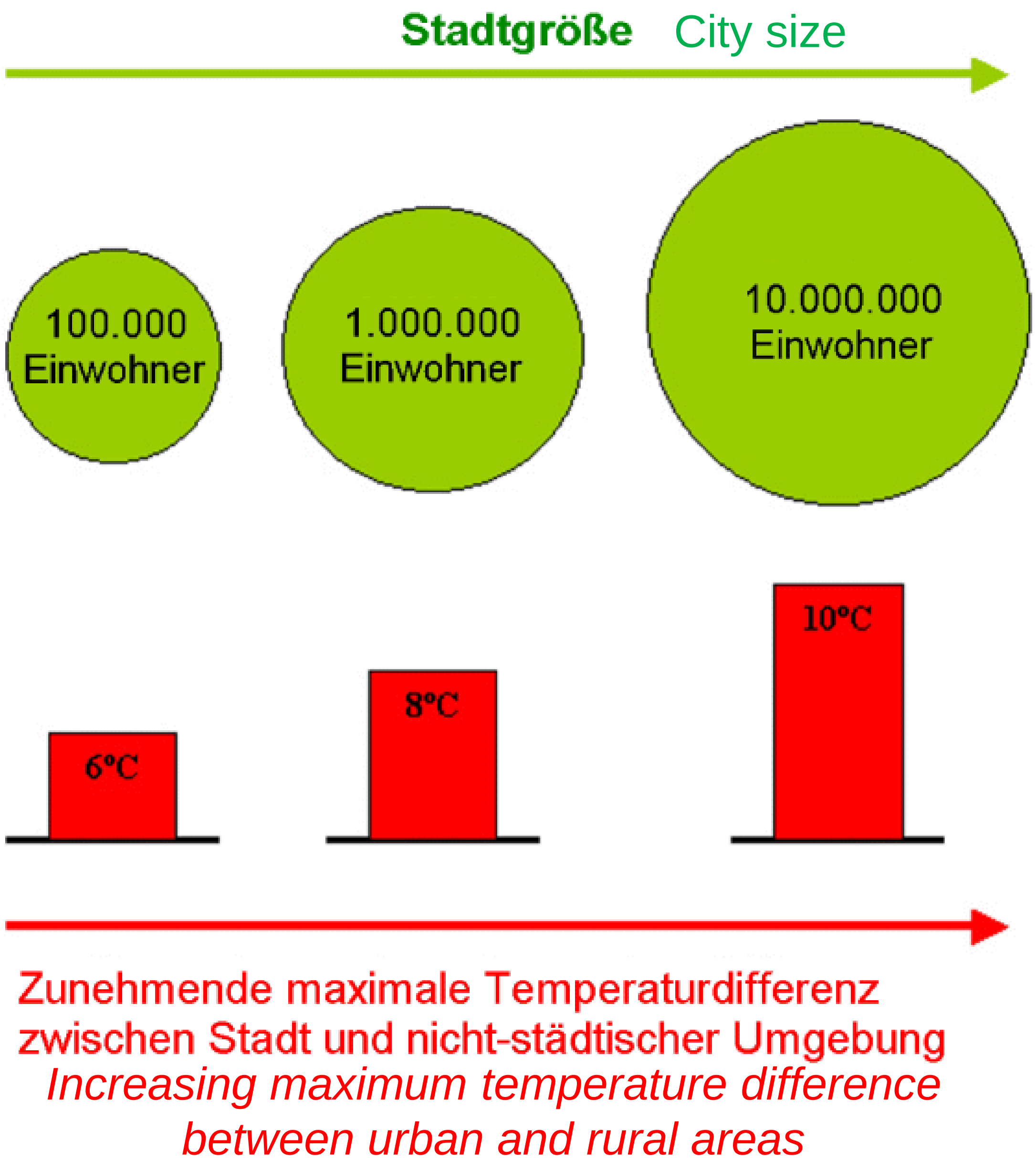


Fig-3 Visible band and thermal band for the study sites (Tokyo, Seoul, Pyongyang, Beijing and Shanghai, from top)

Monitoring Urban Heat Environment in East Asia, Shiro Ochi et al, Institute of Industrial Science, University of Tokyo

Source: http://www.gisdevelopment.net/application/urban/overview/urbano044pf.htm



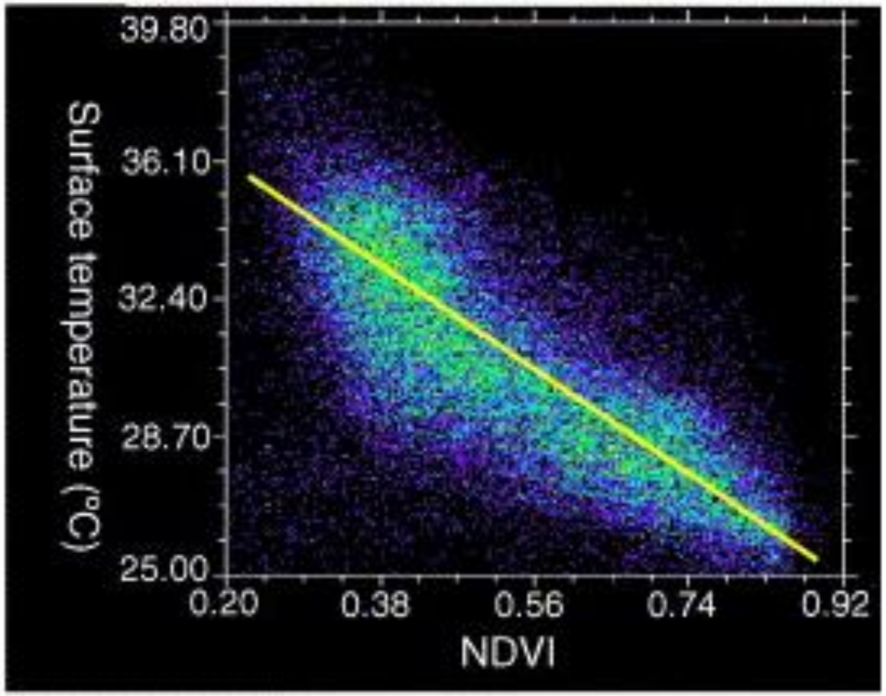
The amount of the urban heat island effect is depending on the number of citizens, on the size of the city.
Attention: This has little to do with temperature *averages* but deals with increasing *extremes*.
Grafik: Anita Bokwa, Pawel Jezioro
(From S. Lippke, 2010)

As in so many other concentric growing unplanned cities, also **Bangkok** suffers from these problems: heat island effect and summersmog,

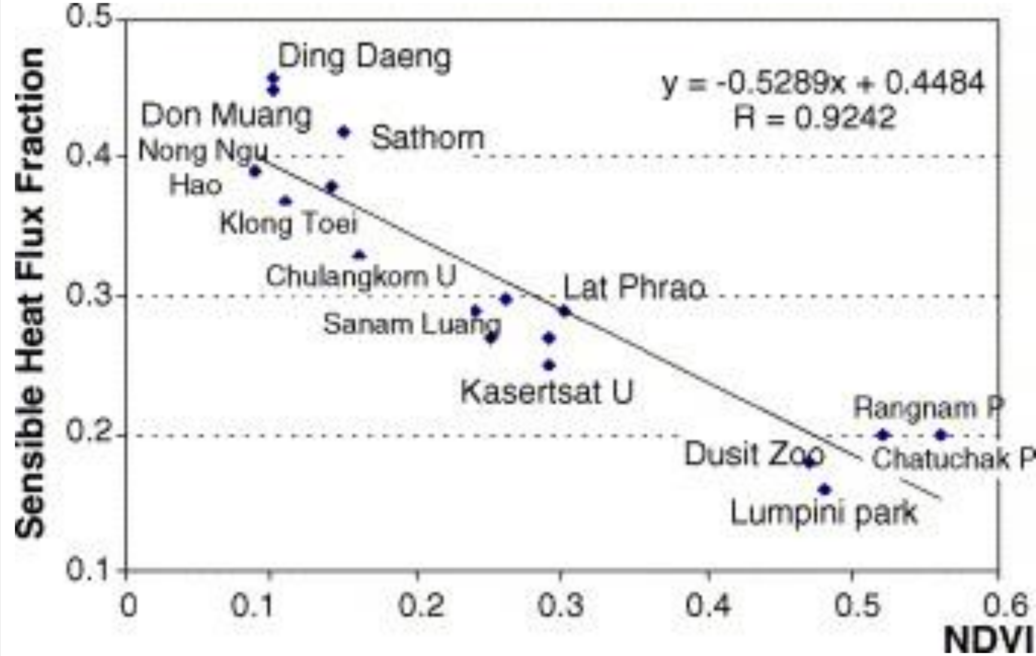
http://www.zoover.be/thailand/thailand/bangkok

http://www.tkolar.com/travel/Asia/Thailand/Bangkok/Bangkok.html

Effects of vegetation on UHI-effect: The example of Bangkok (International Journal of Applied Earth Observation and Geoinformation Volume 8, Issue 1, January 2006, Pages 34–48)



Scatterplots of day-time surface temperature vs. vegetation index for Bangkok in February 2002.



Effects of vegetation cover on the sensible heat fluxes in 18 sampled Bangkok's neighborhoods.

Source: Assessment with satellite data of the urban heat island effects in Asian mega cities, by Hung Trana, et al, Daisuke Uchihamab, Shiro Ochib, Yoshifumi Yasuokab

The destruction of the small water cycles by urbanisation.

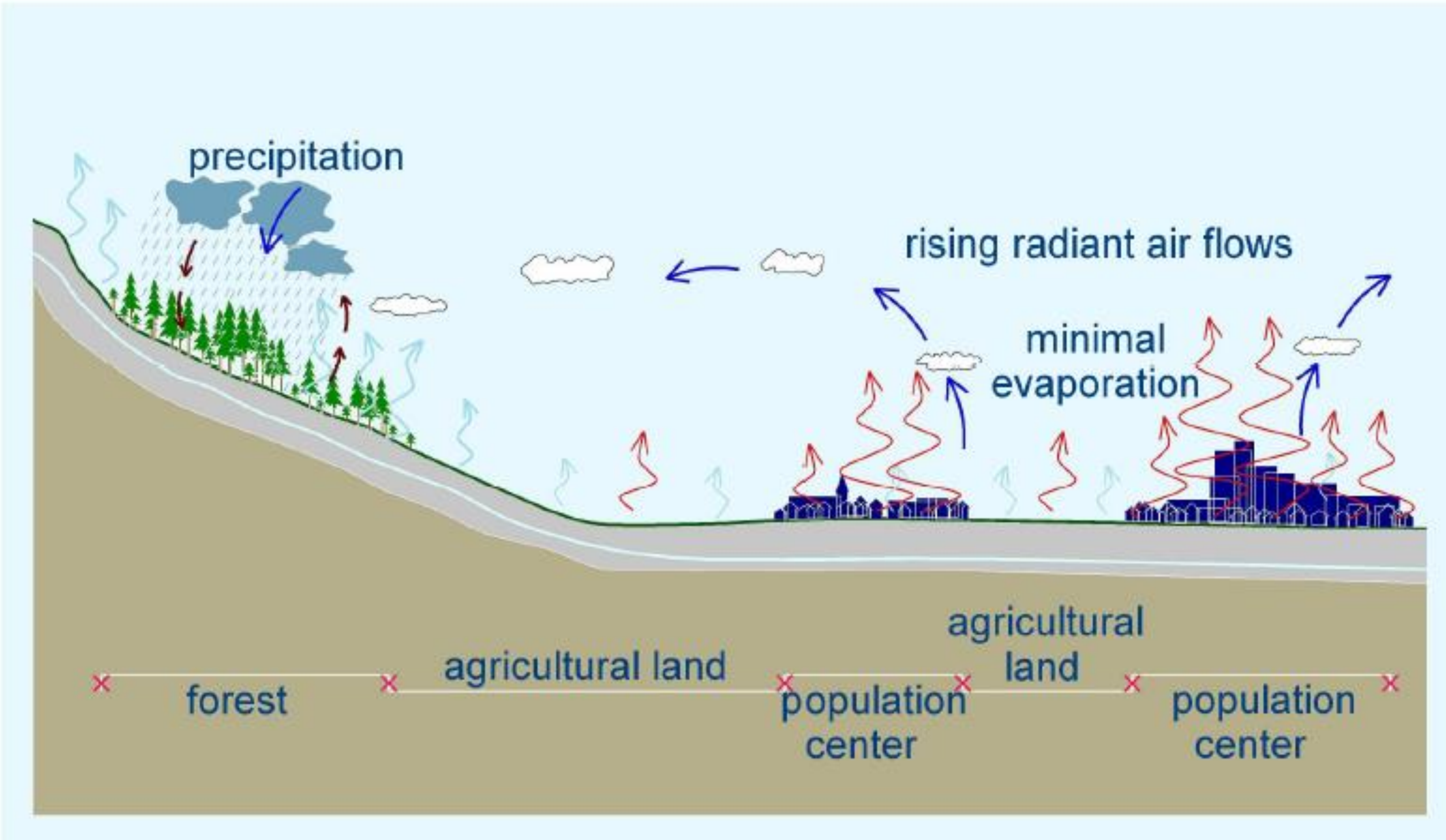


Fig. 18 **The impact of the transformation of land on the destruction of small water cycles**
Rising radiant flows push clouds to cooler environments.

Small water conservation measurements, such as here in the Tatra mountains (Slovakia) do matter, for *local climate* but are also *preventing flooding* downstream

***Fig. 35* A Water Forest in the High Tatras – building water conservation measures on territory destroyed by a natural disaster**

An example of the renewal of vegetation and hydrological stabilization of a territory through the conservation of water on land.

Restoring the small water cycles leads to local climate recovery and decreases extreme weather events.

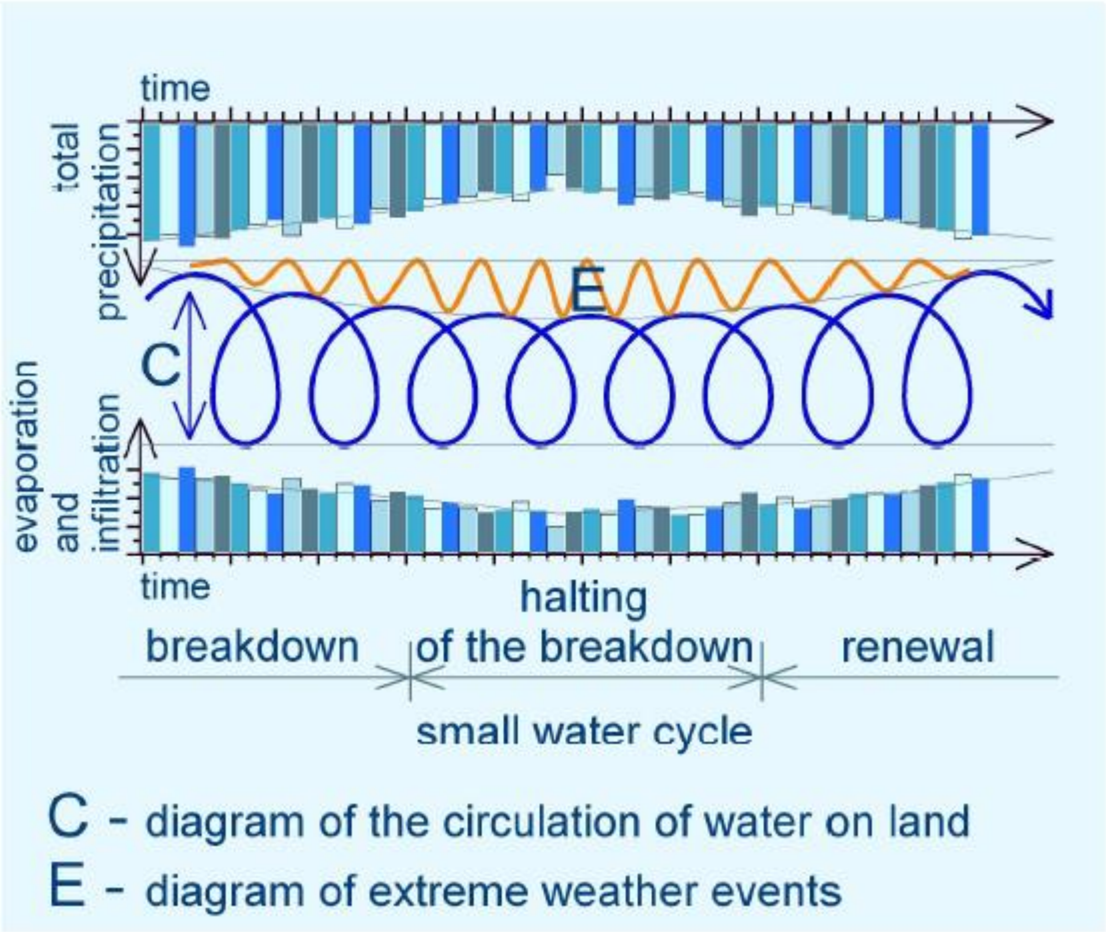


Fig. 27 **The course of destruction of the small water cycle over land until it is halted and then renewed to its original state**

Tackling desertification by restoring small water cycles (1)

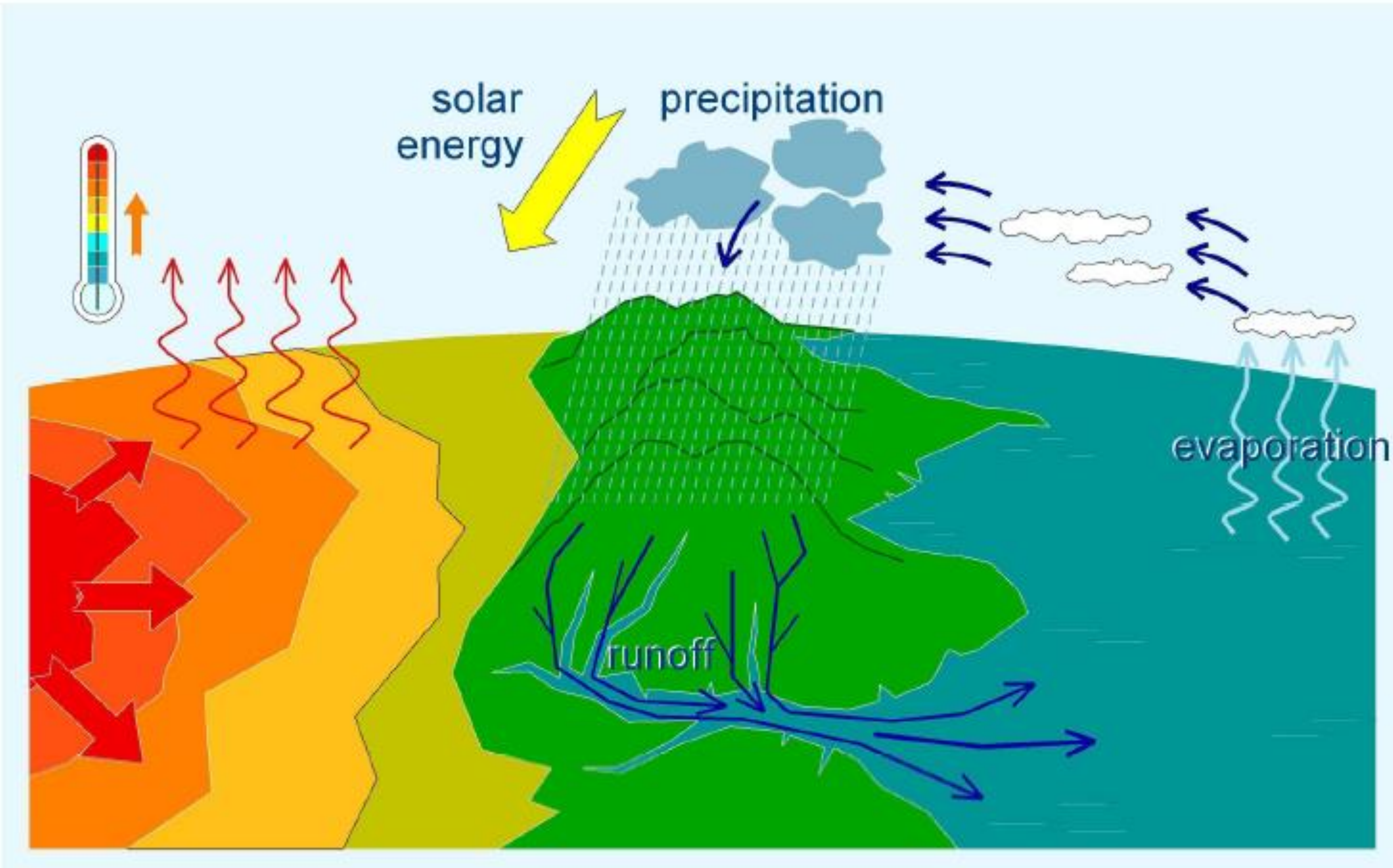


Fig. 28 Diagram of the expansion of deserts or semideserts with the breakdown of the small water cycle

Tackling desertification by restoring small water cycles (2)

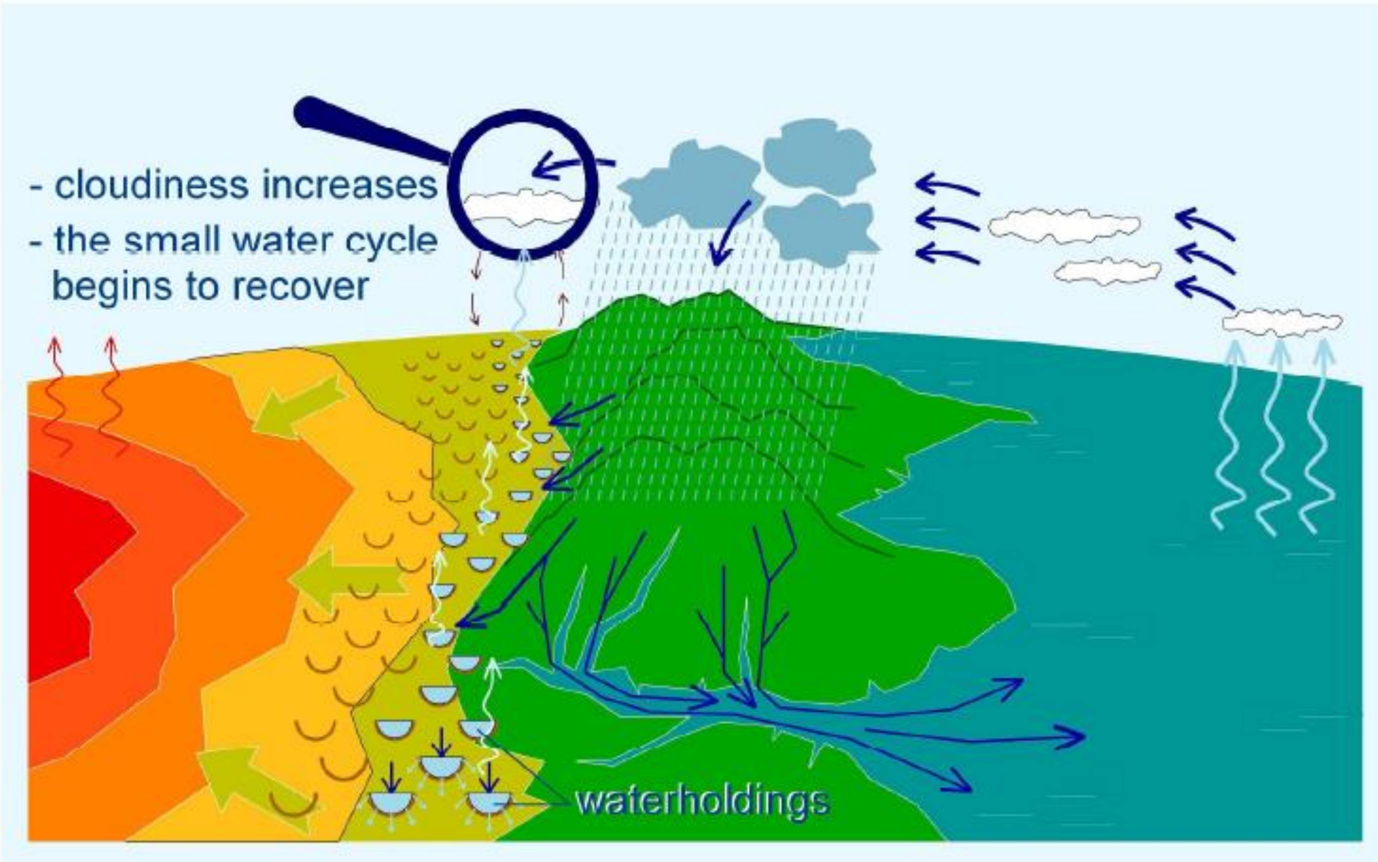


Fig. 29 Waterholding measures on the edge of critical areas
Their role is to harvest and hold water from the small water cycle from adjacent lands, or water from the large water cycle (even in deserts it rains occasionally). The period in which the water cycle is renewed depends on circumstances (the hydrological and pedological conditions, success of the growth of protective vegetation, etc.).

Tackling desertification by restoring small water cycles (3)

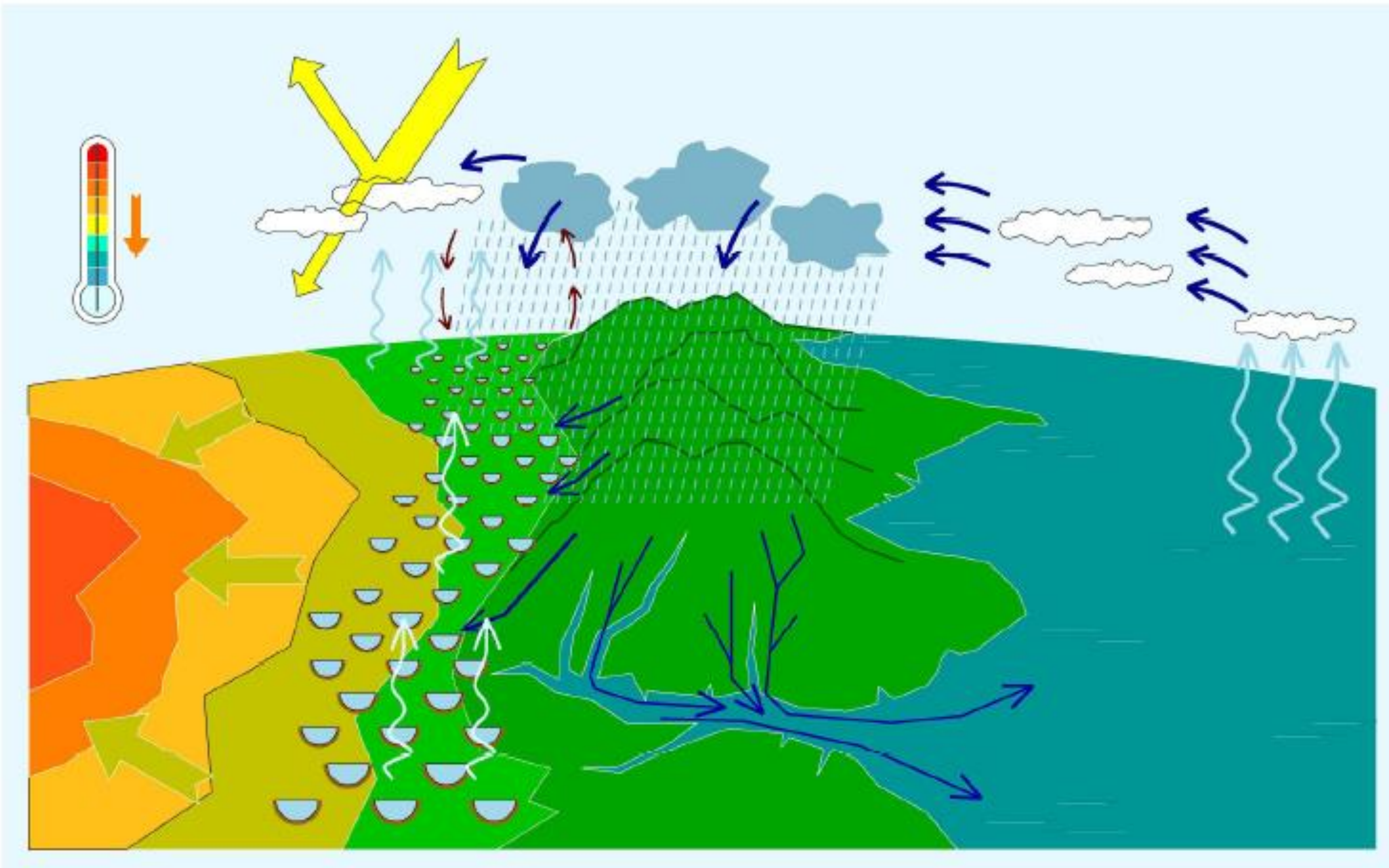
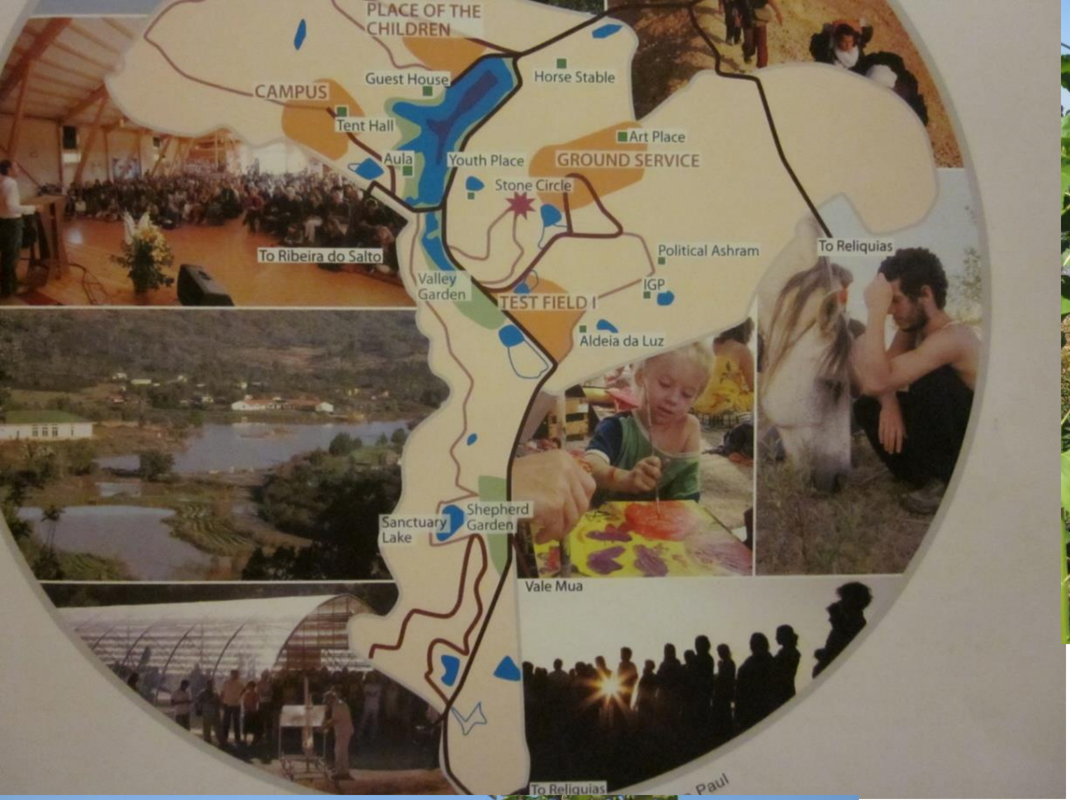


Fig. 30 **Decreasing areas of desert**
The climate recovers in an area with a renewed small water cycle and it can possibly be used as a forefront for further expansion of the hydrological recovery of land.

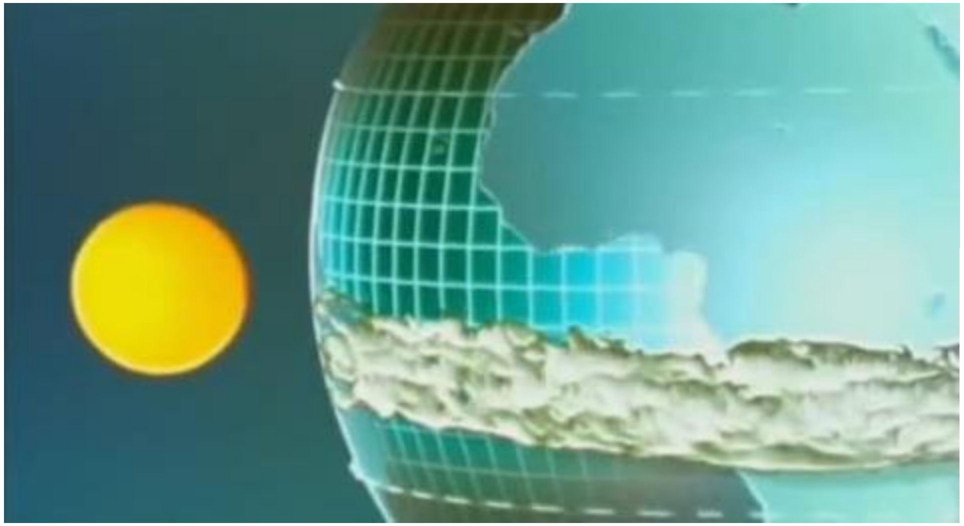
Case study: Tamera ecovillage (Portugal): restoring water landscapes in Alentejo, a region in the southern part of Portugal, threatened by desertification.

Tackling desertification in Portugal.
Construction of a new dam, to create more waterlandscapes in the ecovillage of Tamera(the ' New South Lake')

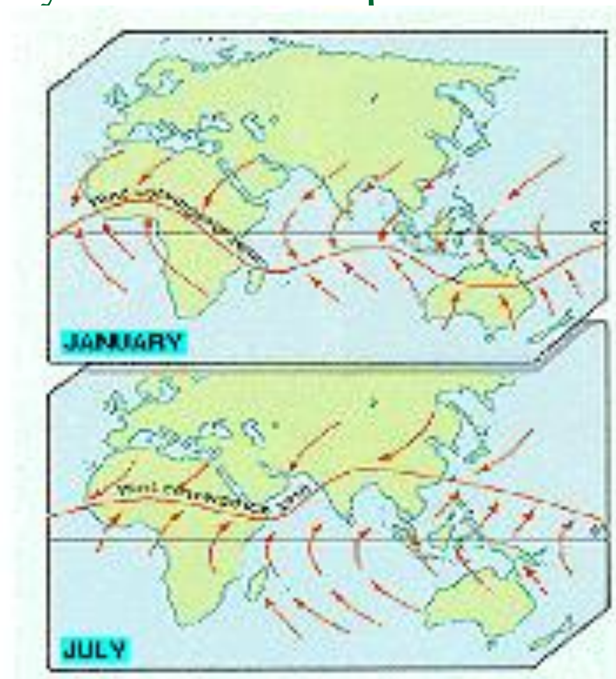
(http://www.tamera.org/index.php?id=50)



The result: water landscapes in ecovillage Tamera (www.tamera.org)

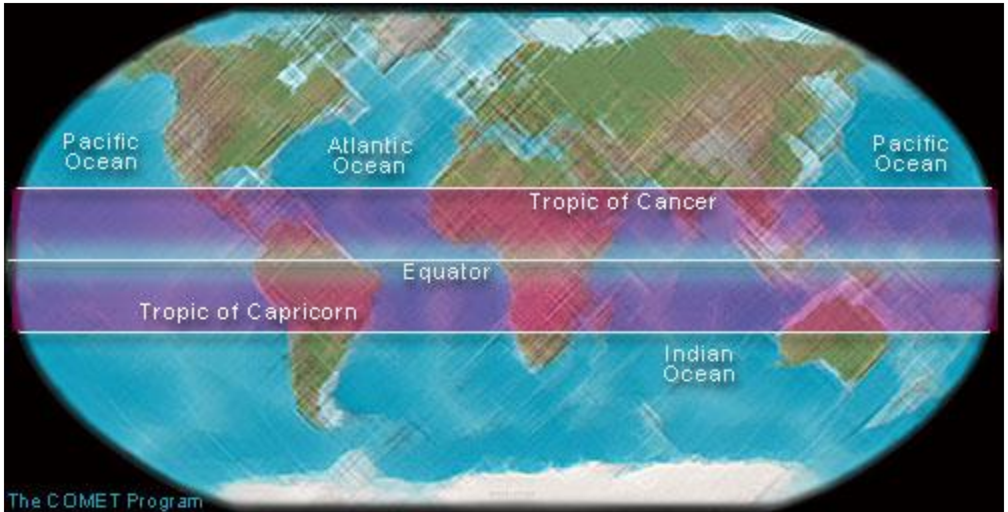


In (sub)tropical regions of course the monsoon system is important



monsoon rains react at the booth of the Sun, with alternation of dry and wet seasons as a consequence

- http://www.youtube.com/watch?v=ueaib127Ebk On global dimming



Monsoon system

Nevertheless, also for these subtropical regions local evaporation from rainforests is very important for the local and even for global climate

http://www.ucar.edu/news/features/hurricanes/htc_desc.htm

http://www.pacificislandtravel.com/nature_gallery/monsoonsandstorms.html

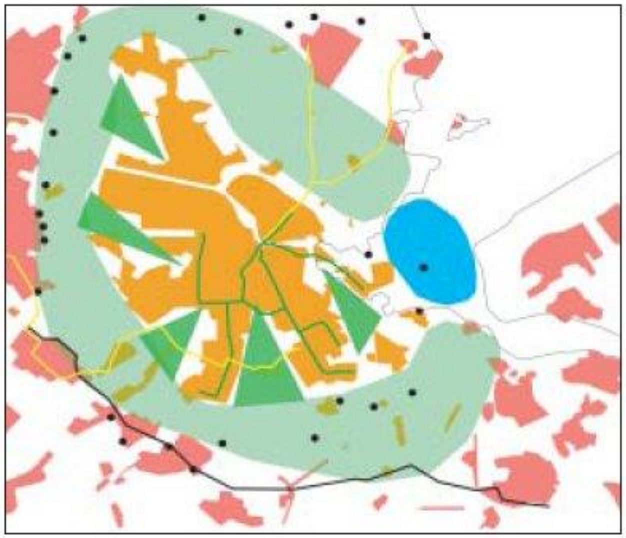
Part 2:

Reducing the ‘water footprint of human activities’

- 1. Brief overview of some relevant European legislation
- 2. Some basic climatological insights
- 3. Suggestions for further smart solutions, decreasing carbon-footprint together with waterfootprint.

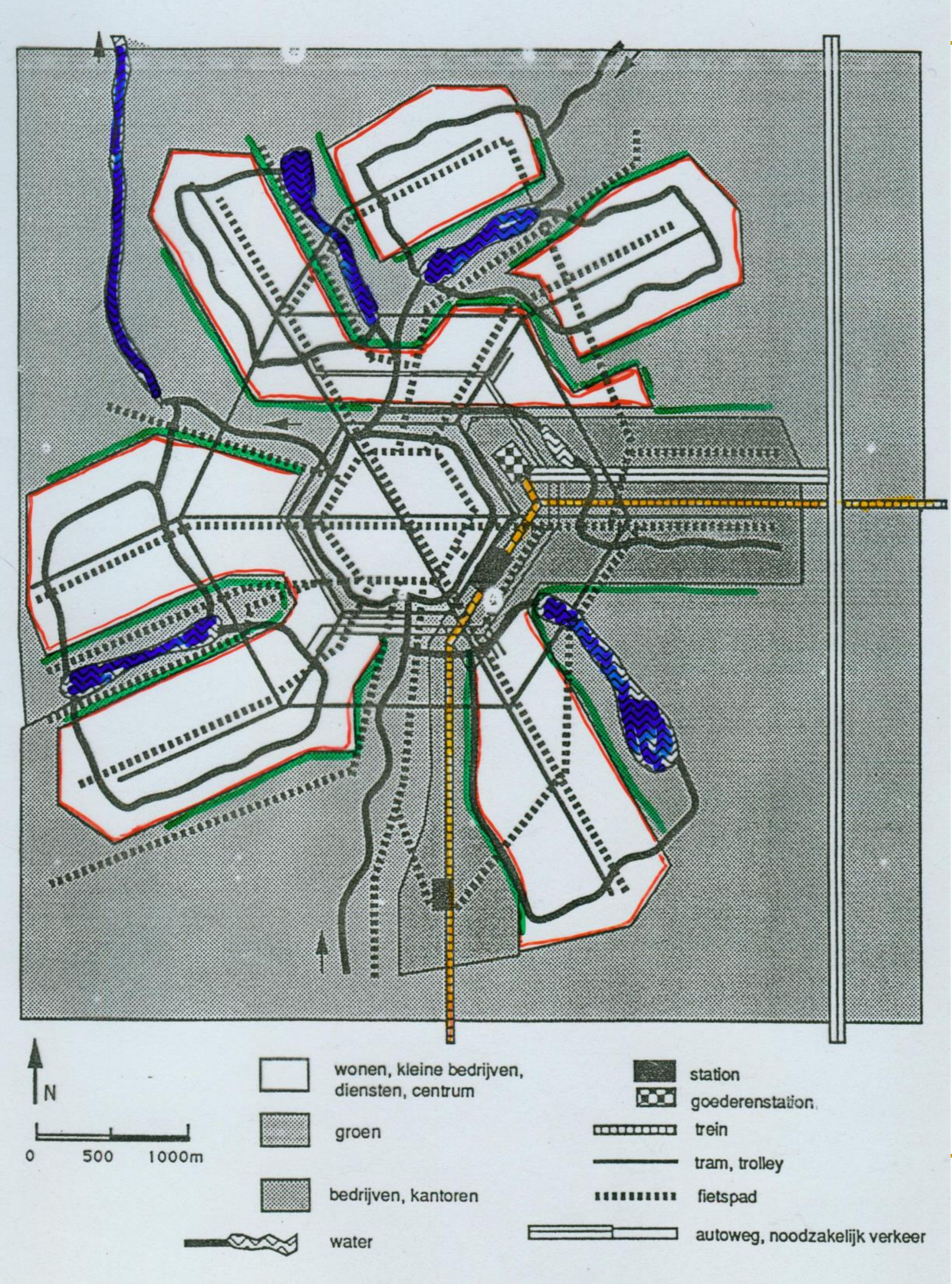
<u>In lobe-cities</u> the blue-green fingers are penetrating deep into the city centre.

e Amsterdamse lobbenstad ligt een
one. Daaromheen ontstaat langzamer-
en krans met bebouwing, een
amde kransstad.
sterdam 'finger city' is surrounded by
belt. A garland of construction is
ly appearing around it, a so-called
city.



Amsterdam (750,000 inhabitants ; The Netherlands). From Gieling, 2006

the lobe-city model.



Built-up city-lobes

separated by

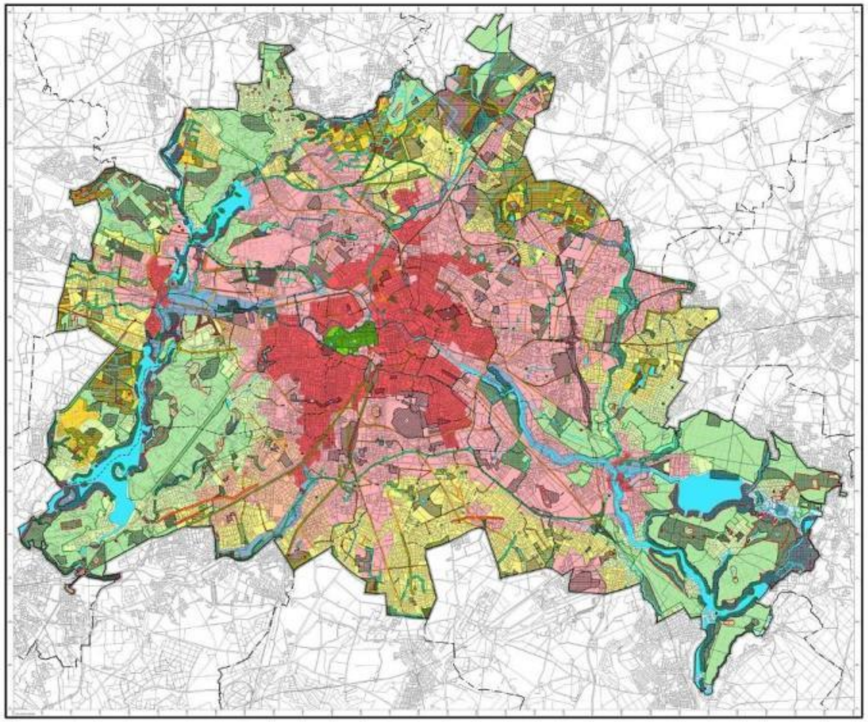
Blue-green fingers (wedges)

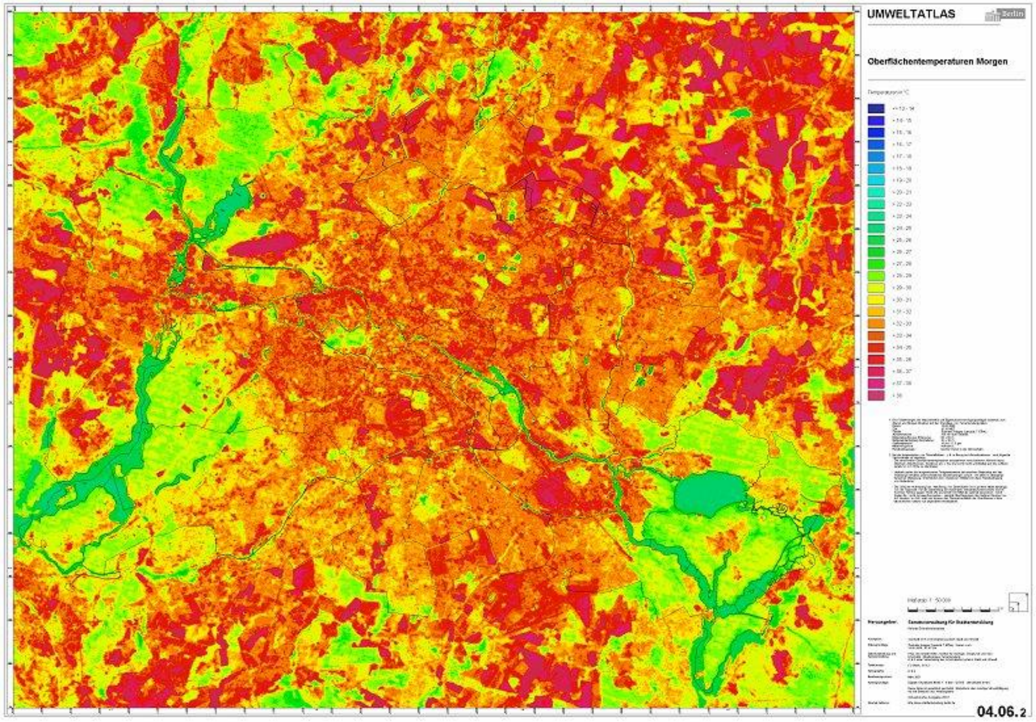
From Tjallingii, 1996

The lobe-city model

- The lobe-city model was developed in the first half of the 20th century.
- To varying degrees, this model was used in Denmark for the “fingerplan” in Copenhagen (Denmark) (1948), the general plan to extend Amsterdam (The Netherlands) (1935) and in cities such as Hamburg, Köln (1927), Berlin, Stuttgart (Germany) and Stockholm (Sweden).
- Also the planners developing Shangai Dongtan (China) as an eco-city, use the concept of blue-green fingers.

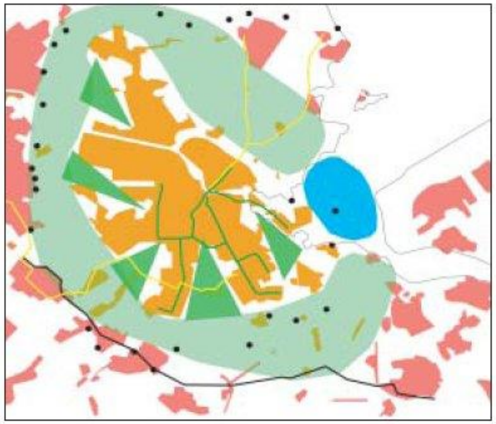
The blue-green fingers are tempering the heat island effect in Berlin (3,400,000 inh. ; Germany)



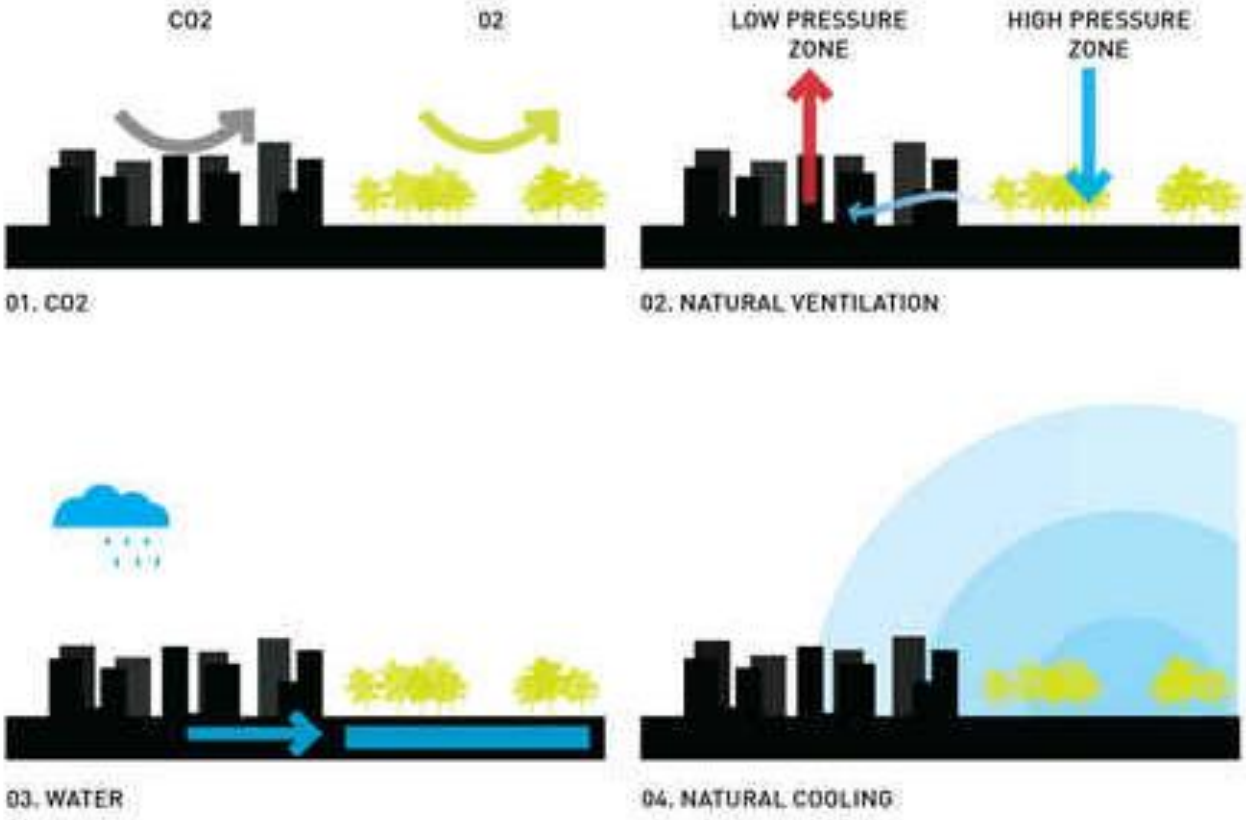


Infrared picture of hot city-lobes and cooler blue-green fingers of Berlin. (Cloos, 2006)

Advantages of a lobe-city city expansion.



▶ Rond de Amsterdamse lobbenstad ligt een groenzone. Daaromheen ontstaat langzamerhand een krans met bebouwing, een zogenaamde kransstad.
The Amsterdam 'finger city' is surrounded by a green belt. A garland of construction is gradually appearing around it, a so-called garland city.



http://www10.aeccafe.com/blogs/arch-showcase/2011/06/18/masterplan-%E2%80%9Cjuzne-centrum%E2%80%9D-in-brno-czech-republic-by-chybikkristof-associated-architects/

The finger plan of Copenhagen (DK)

Finger Plan (Local Plan Office for Greater Copenhagen, 1947)
http://www.pashmina-project.eu/doc/PASHMINA_D2.3.pdf

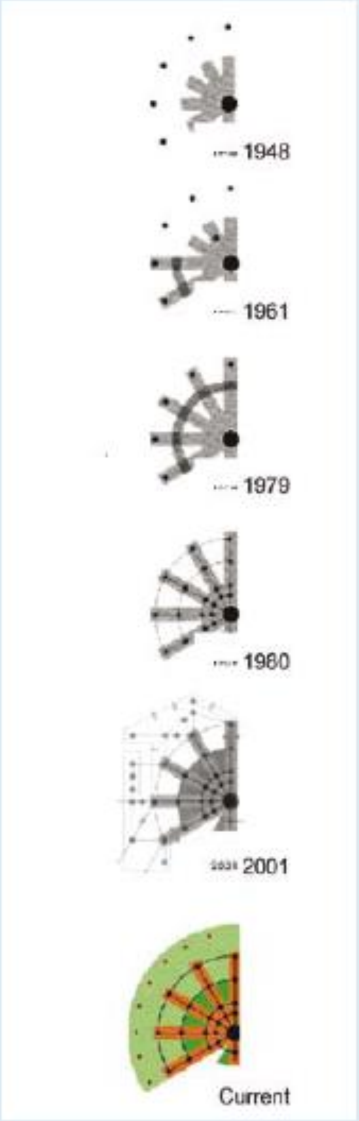


Figure 2. Schematic diagram of the radial development of Greater Copenhagen from 1948 to 2001.

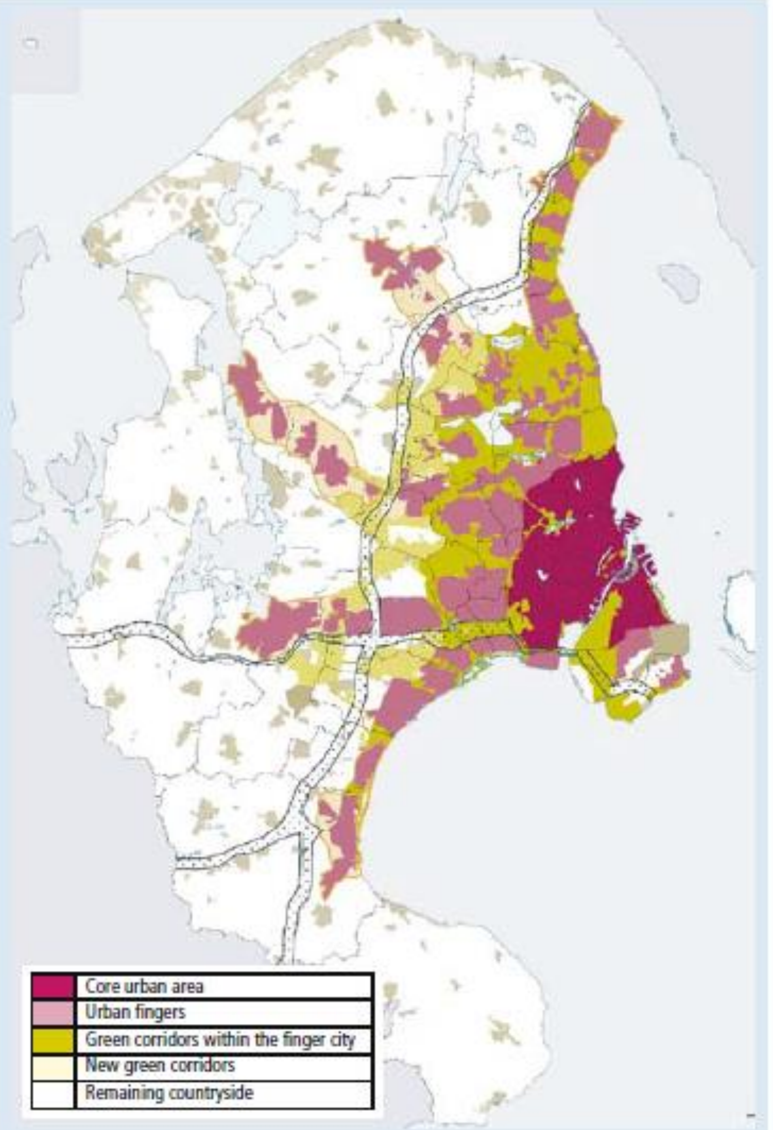


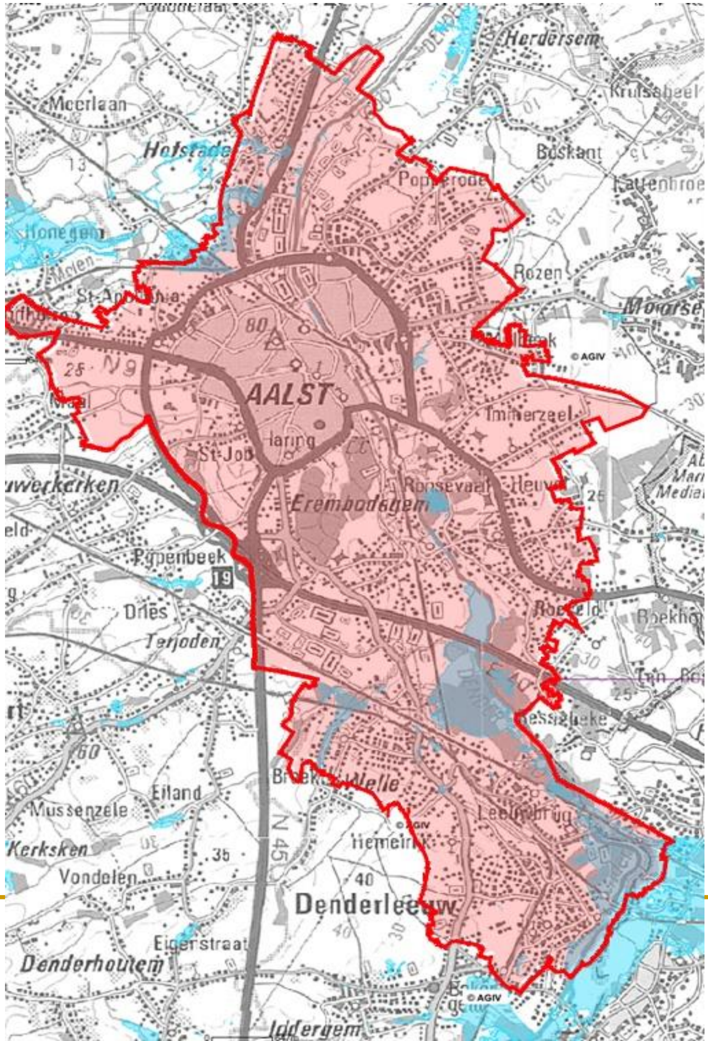
Figure 3.Greater Copenhagen showing the finger-like urban extensions and network of planned green space.

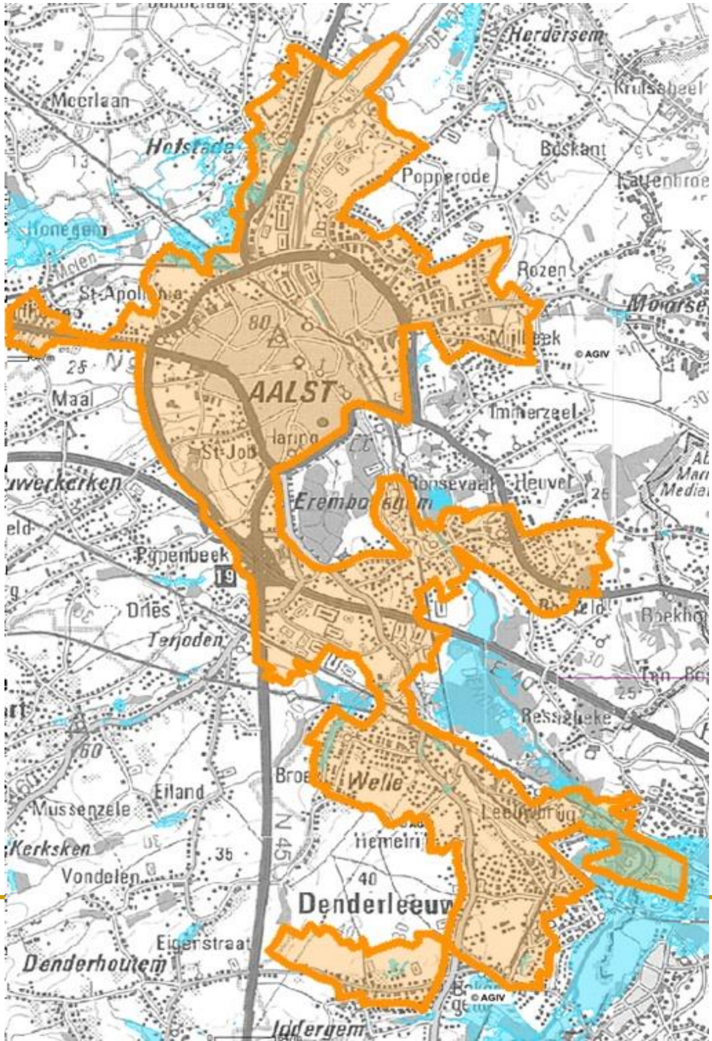
The Finger Plan includes not only the relatively small Municipality of Copenhagen covering the centre part of the city with app. 0.5 mill citizens but in addition take in the Greater Copenhagen Area, and thus also covers 34 adjacent municipalities.

source: UCD, 2008.

Advantages of a lobe-city city expansion: blue-green fingers offer space for flooding

The proposal to expand Aalst in a concentric way (left) is occupying a lot of recently flooded areas (blue zones). The lobe-city (right) excludes those wet areas along the river Dender from city expansion, integrating them into the blue-green fingers





Densely built-up city-lobes, separated from each other by vast blue-green fingers (City of Tübingen ; 85,000 inh. ; Germany)

In the city-lobe *French Quarter* live 240 inhabitants/ha and 50 à 60 labour places / ha are created.

Citizens' densities have to be high enough to enable affordable (light)rail public transport in the city lobes of a lobe city.

The densely populated ecoquarter 'Quartier Vauban' in Freiburg (D.) is frequently connected with the centre of the city by tram.

Densely built-up city-lobes can be heated by small plants for <u>c</u>ogeneration of <u>h</u>eat and <u>p</u>ower (CHP). During hot seasons they can also collectively be cooled, using the same district piping network.

In the city of Tübingen (Germany) the whole city-lobe *Loretto-areal* is heated by a district heating system, connected with a CHP plant.

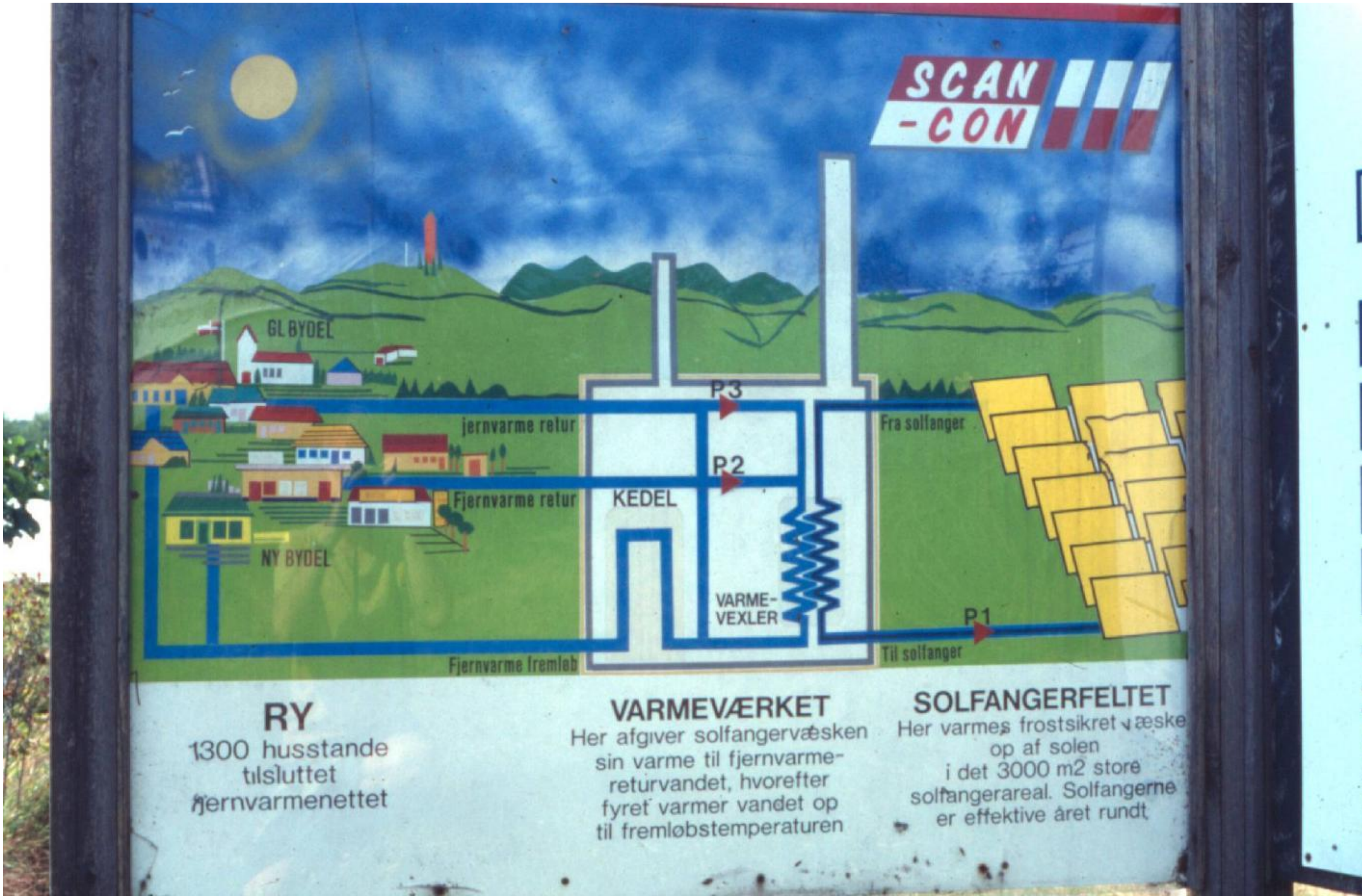
District heating and cooling. Case study Denmark.

http://www.youtube.com/watch?v=-0V5OMS4kzw&feature=endscreen&NR=1

Watch and study this movie carefully.

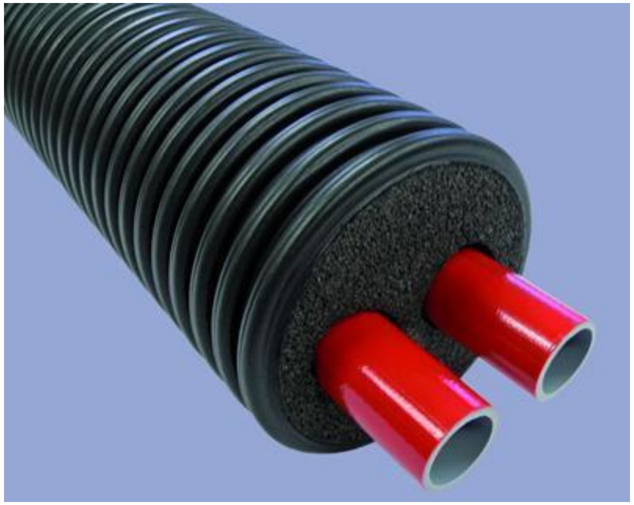
- With over 60% of Danish buildings receiving heating and hot water via District Heating (80% of which comes from surplus energy sources) Denmark is the world leader in District Heating and Cooling Technology. District Heating has played a vital role in reducing Danish energy consumption, to the extent that Denmark has been self-sufficient energy-wise since 1997.
- With District heating and cooling technology Denmark has reduced CO_2 emissions per sq. metre, the share of fossil fuel consumption per sq. metre, and the total energy consumption per sq. metre for space and water heating. In terms of combating climate change and reducing CO_2 emissions, no other technology offers industrial nations the potential of meeting the requirements of energy saving and emissions reduction, without affecting the standard of living and productivity of the nation.
- This information film, produced for the Danish District Heating Marketing Foundation and the Danish Board of District Heating illustrates how Danish technology and expertise may play a vital role in helping other nations achieve better energy efficiency and reduced emissions.

District heating based on the CHP principle. Municipality of Ry (Denmark)



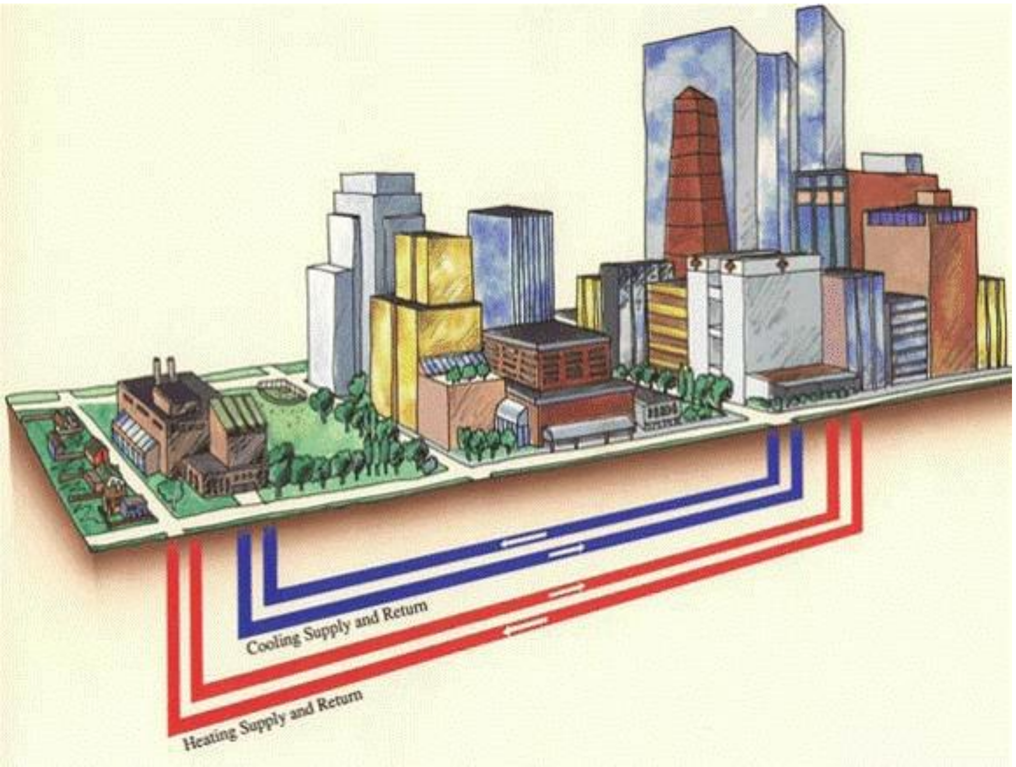
District heating is easy to be combined with the cogeneration of Heat and Power

Riga, Latvia



A well-insulated underground pipeline network provides the transport of warm water in the city and of the cooled water back to the CHP plant.

http://commons.wikimedia.org/wiki/File:2005-08-30-district-heating-pipeline.jpg



Principle of district heating, combined with a CHP plant.

- But then the CHP plant is to be built close enough to customers preferably in the middle of neighbourhoods. An adequate **compactness** of dwellings is needed.
- And there is also the need of a sufficient heat demand in the summer, which argues for **mixing housing with other functions** (restaurants, small businesses, sauna, pool, ...)

http://www.gaiaenergies.com/District%20Energy%20Systems.html

In the city of Freiburg (Germany) the *ecoquarter Vauban* is heated by a CHP on wood (biomass)

Freiburg im Breisgau (Germany)
Plus-energy houses in the eco-quarter *Am Schlierberg*)

Add to all this, measures at the level of the building: Green façades and green roofs also help to decrease **carbonfootprint** (shade) and **waterfootprint**.

Paris (F): Quai Branly

Green wall in Thailand (Pak Chong), shading the building in the All Green Learning Centre (AGLC).

http://www.allgreenleaningcenter.org

Design **water neutral**:
Green roofs are minimising run-off amounts.

Eidfjord (N). Hardangervidda national park

Use succulent plants (such as *Sedum sp.*) for green roofs.

Boxtel (NL). De Kleine Aarde

Green roofs are interesting for biodiversity, summer cooling and water management, …

Westerlo (B). Kamp C

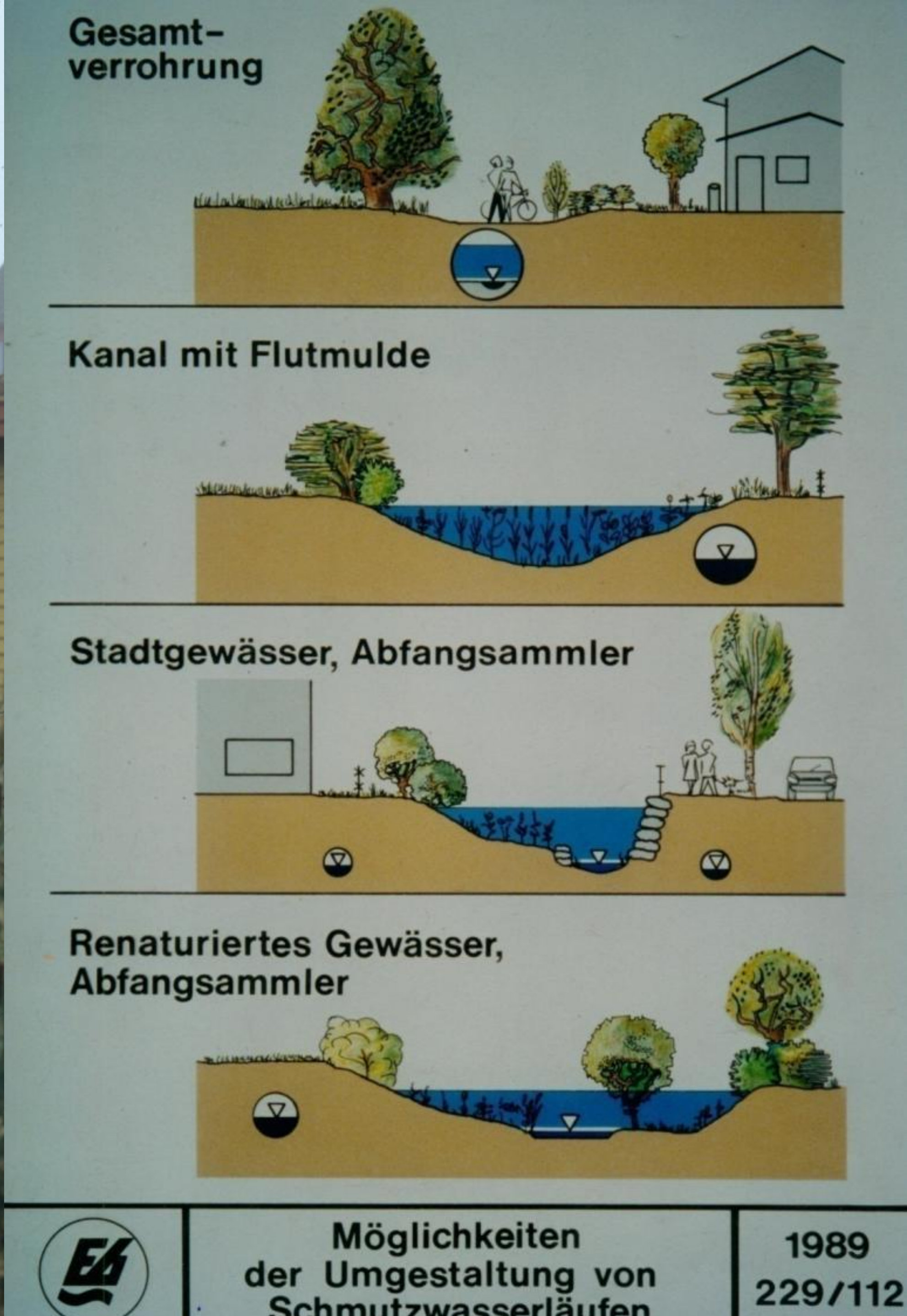
Hovden (N): water neutral ecoquarter.

Separate sewage systems
on city quarter level

Culemborg (NL)

Belfort Bethoncourt (F)

Alphen a/d Rijn (NL):
Ecoquarter *Ecolonia.*
Infiltration pond

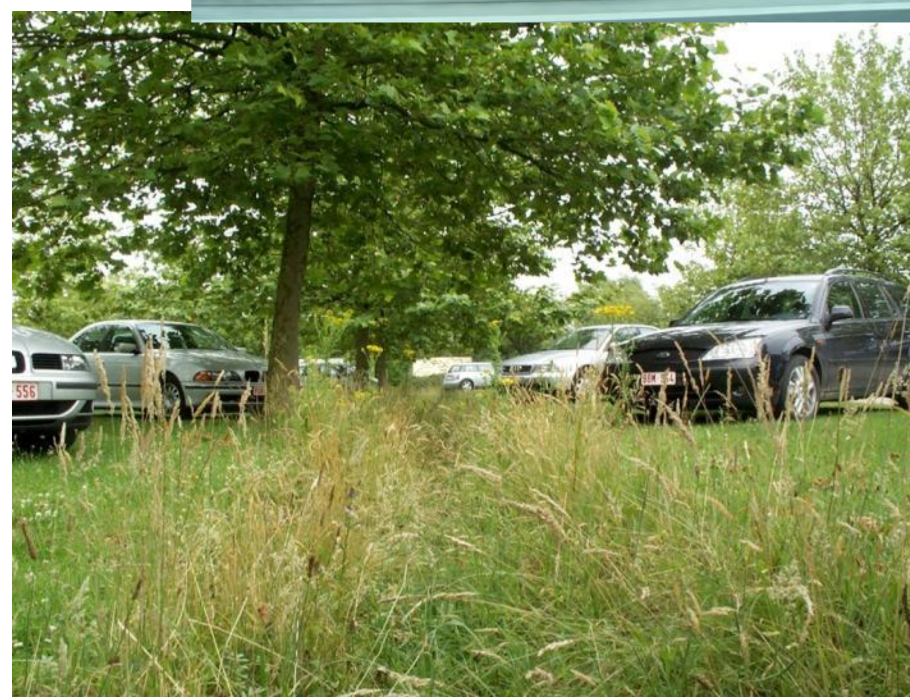


Infiltration zone in Gelsenkirchen (D).

Infiltration zone in the ecoquarter *Kuppersbusch.*

Good examples: permeable parkings.

Mechelen (B). Parking Planckendael (Muizen)



Sint-Niklaas (B). Parking Recreation area ‘De Ster’.

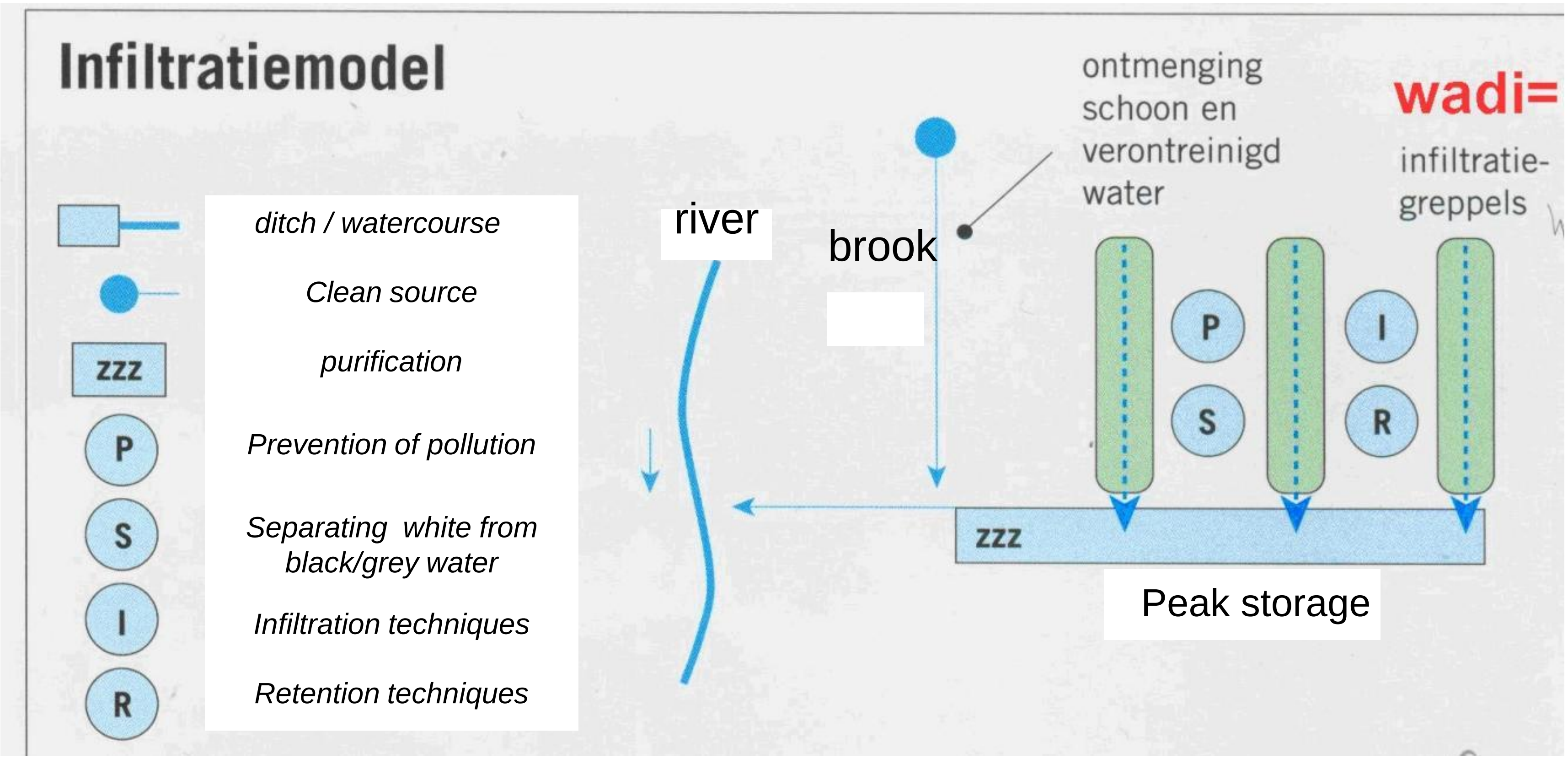
WADI technique.

Werking van een wadi

1. Afvoer van het regenwater gaat niet onder de grond maar naar de regenton of via gootjes naar de weg of naar de wadi.
2. Straat is hol uitgevoerd, zonder straatkolken en loopt af naar de wadi.
3. De kruising met de wadi is tevens verkeersremmer.
4. Regenwater infiltreert. De bodem zuivert het water.
5. Sleuf met kleikorrels om het water te bufferen voordat het verder de grond intrekt.
6. Drainagebuis om de stand van het grondwater op peil te houden.

WADI: a natural regulation of rainwater

THE INFILTRATION MODEL is a guideline for residential areas. Do not discharge rainwater in sewage systems. The aim is **retention** and **infiltration** of clear rainwater in urban areas. This is also important for the creation of wet conditions for plants and animals, while the groundwater level in urban areas often is very low.



STOWA. STICHTING TOEGEPAST ONDERZOEK WATERBEHEER. 2001. Levende stadswateren: werken aan water in de stad. STOWA, ill. ISBN 90 5773 096 3. www.stowa.nl

Enschede (NL): eco quarters

Oikos and Ruwenbosch

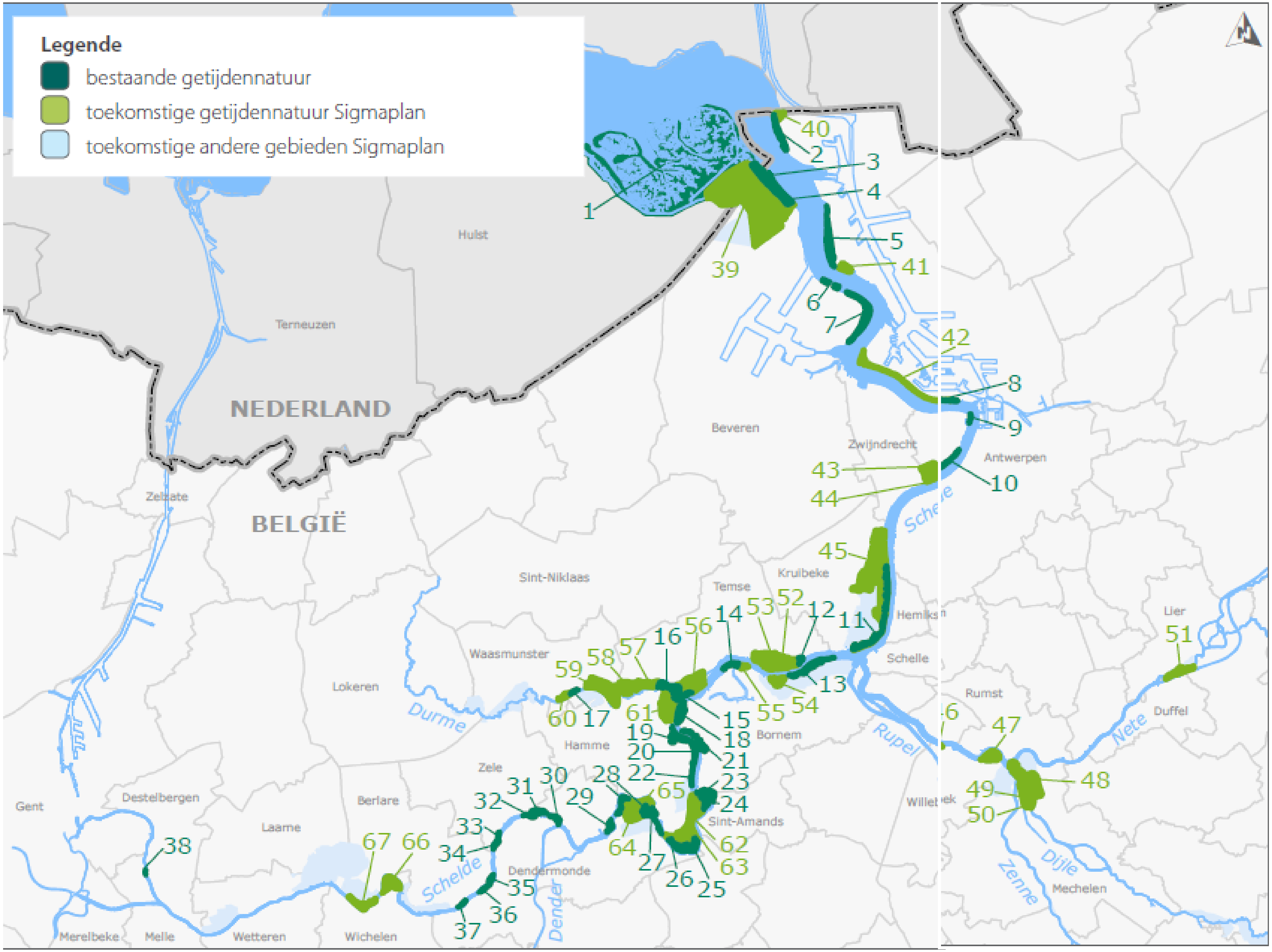
Enschede (NL): eco quarters
Oikos and Ruwenbosch

‘SLOKOP’

The ‘slokop’ is connected with the sewage system and prevents flooding.

In rural areas it is important to give back former winterbeds to the rivers, The example of the river Scheldt in Belgium: situation 2009

Situation 2019



http://www.natuurenbos.be/nl-BE/Over-ons/Projecten/~/media/Files/Publications/2011/SIGMA-brochuregetijdennatuur_oktober2011.ashx

Principle of a Flood control area (FCA)

CONCLUSION (1): Towards climate-proof urban development .

Lobe-cities can **buffer** climate change (global warming and changes in precipitation) because they …:

- …Offer **blue-green fingers** with possibilities to buffer and to infiltrate rainwater, avoiding flooding downstream of the city. An ecologically sound green management of those blue-green wedges can improve and restore urban biodiversity.

- …Temper the urban heat island effect, because the **blue-green fingers** stimulate urban ventilation, based on convection.

CONCLUSION (2): Towards climate-proof urban development .

Lobe-cities can help to **avoid** further climate changes because they…:

- … Show enough compactness and citizens' densities within the built-up **city-lobes**, which therefore can be carried easily by central public (lightrail) transport axes.

- … Provide densely built-up **city-lobes** which can be heated easily with small and local CHP plants, connected to a district heating system (which can also be used for collectively cooling in hot seasons), so carbon emissions for individual heating and cooling can be decreased strongly.

Conclusion (3): lowering carbon footprint **and** water footprint: **both** have to be done. Smart design in both rural and urban areas is urgently needed

- All over Europe (as all over the world) the same kind of problems are occurring: of deforestation with increasing flooding and soil erosion, of rapid urbanisation with a drying and a warming impact on the local climate by destruction of the small water cycles, and increasing the urban heat island problems in cities.
- The *local* changes will become worse due to *global* climate change, that will enlarge the local problems.

So: Think globally and act locally.