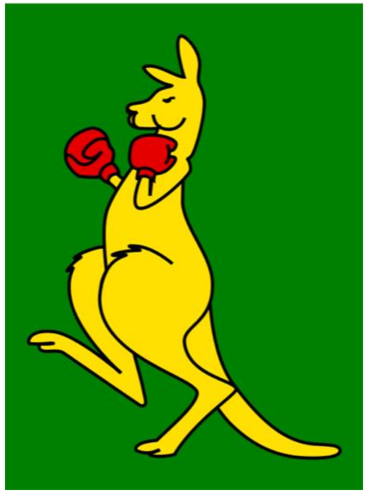
Towards a more sustainable urban

Water management:
Brussels as case study

Approach based on knowing the physical environment(s) and/or mimicking as much as possible the functions of the *natural* watershed setting

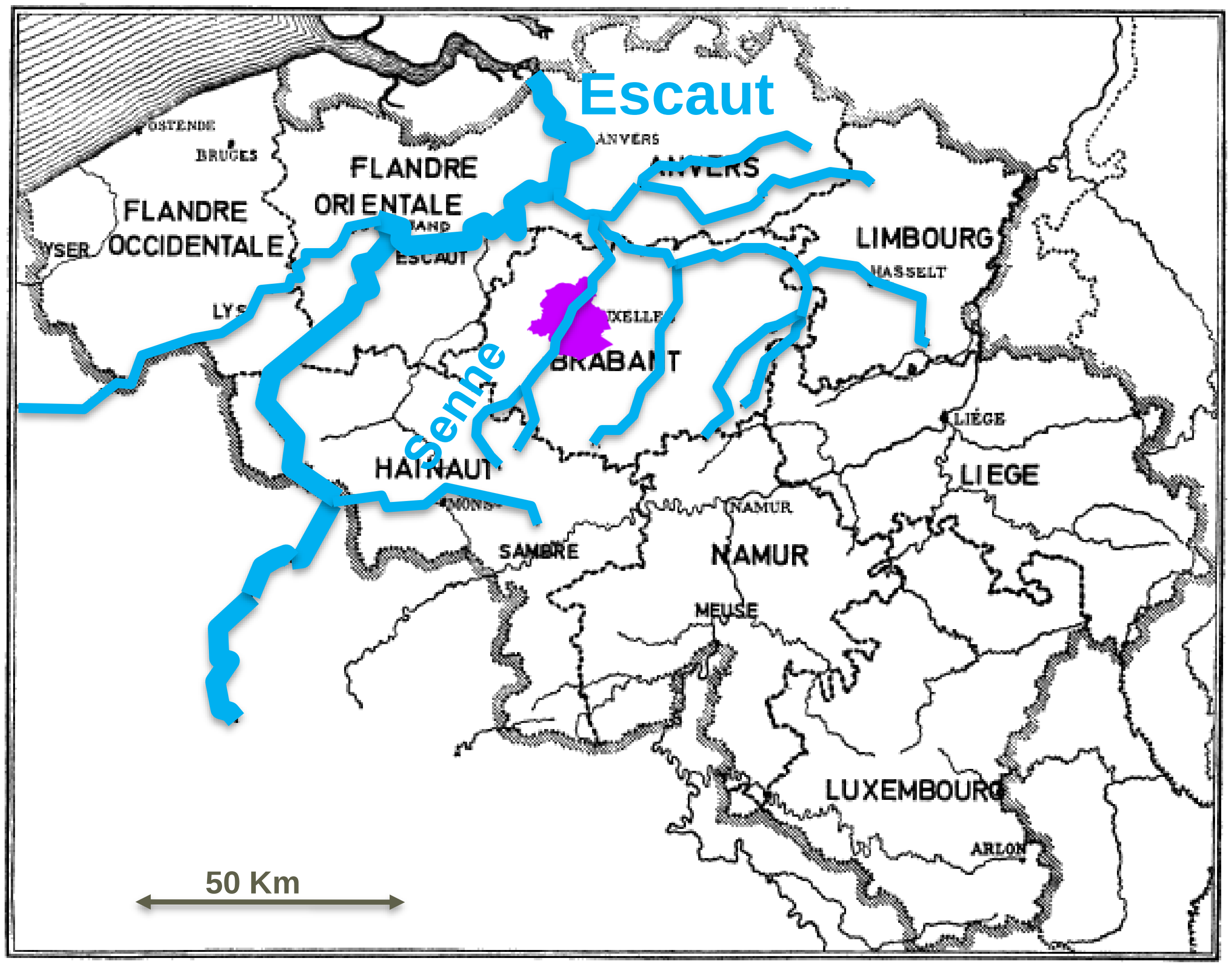


Stop boxing
kangaroo

VUB AMGC ANALYTICAL, ENVIRONMENTAL & GEO-CHEMISTRY RESEARCH GROUP

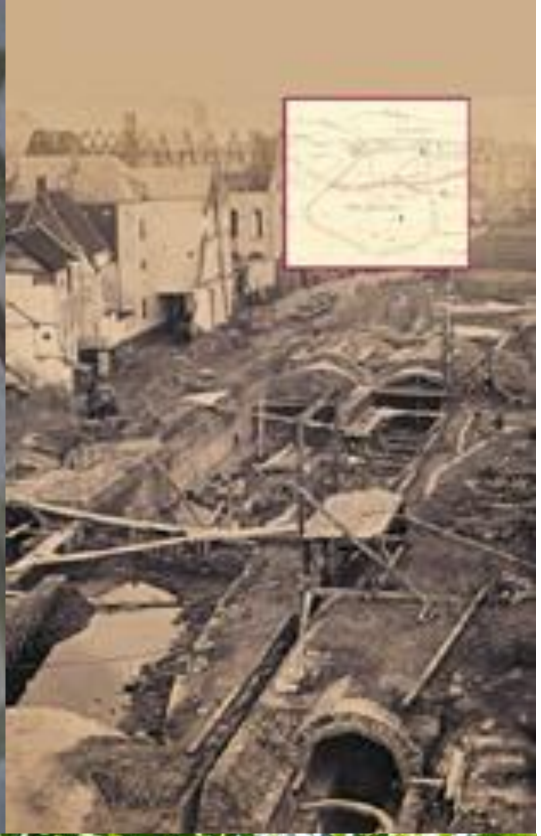
Philippe Claeys

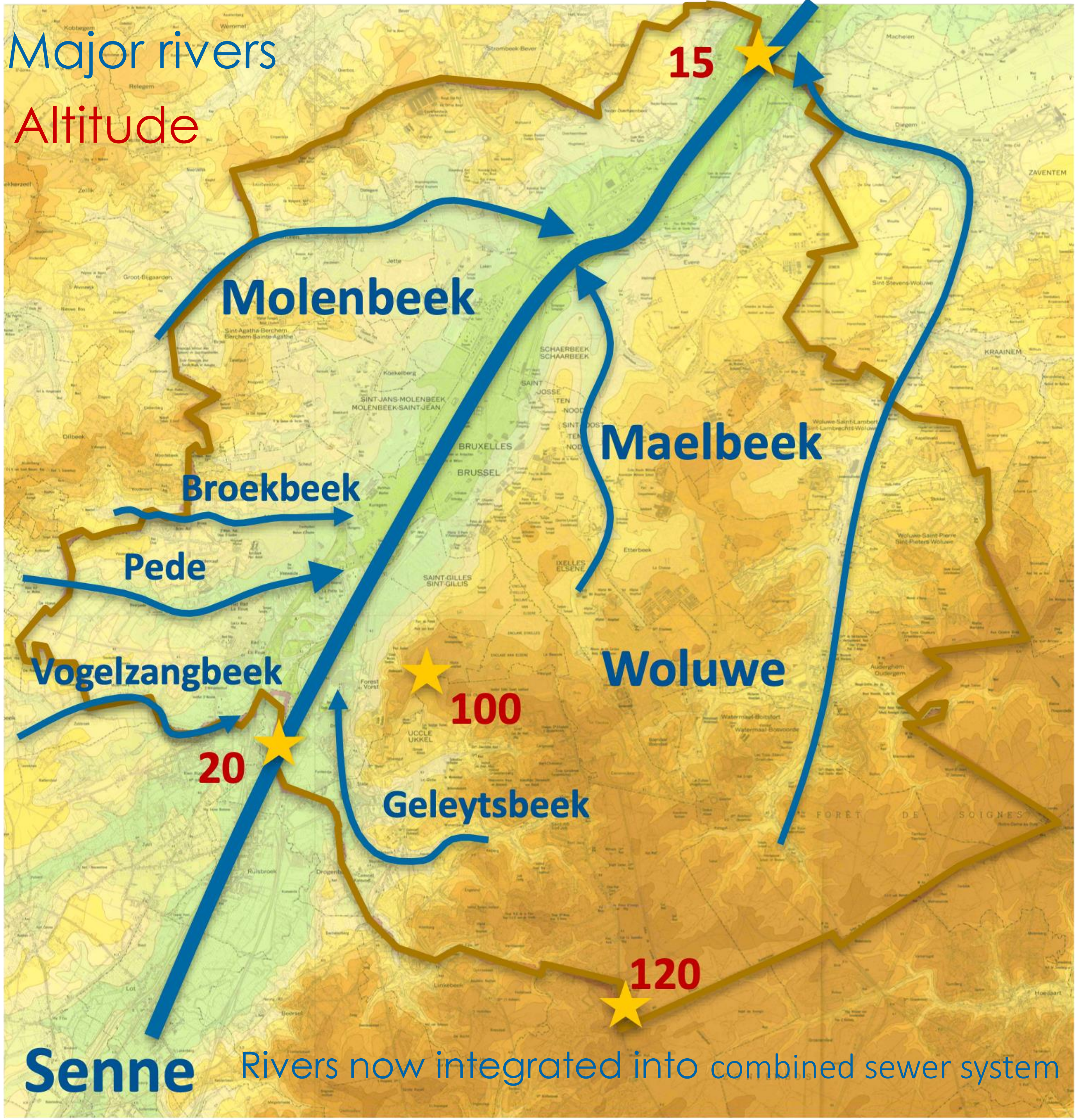
Introduction



Brussels = 161 km^2 = local water management

Brussels = Water city ?



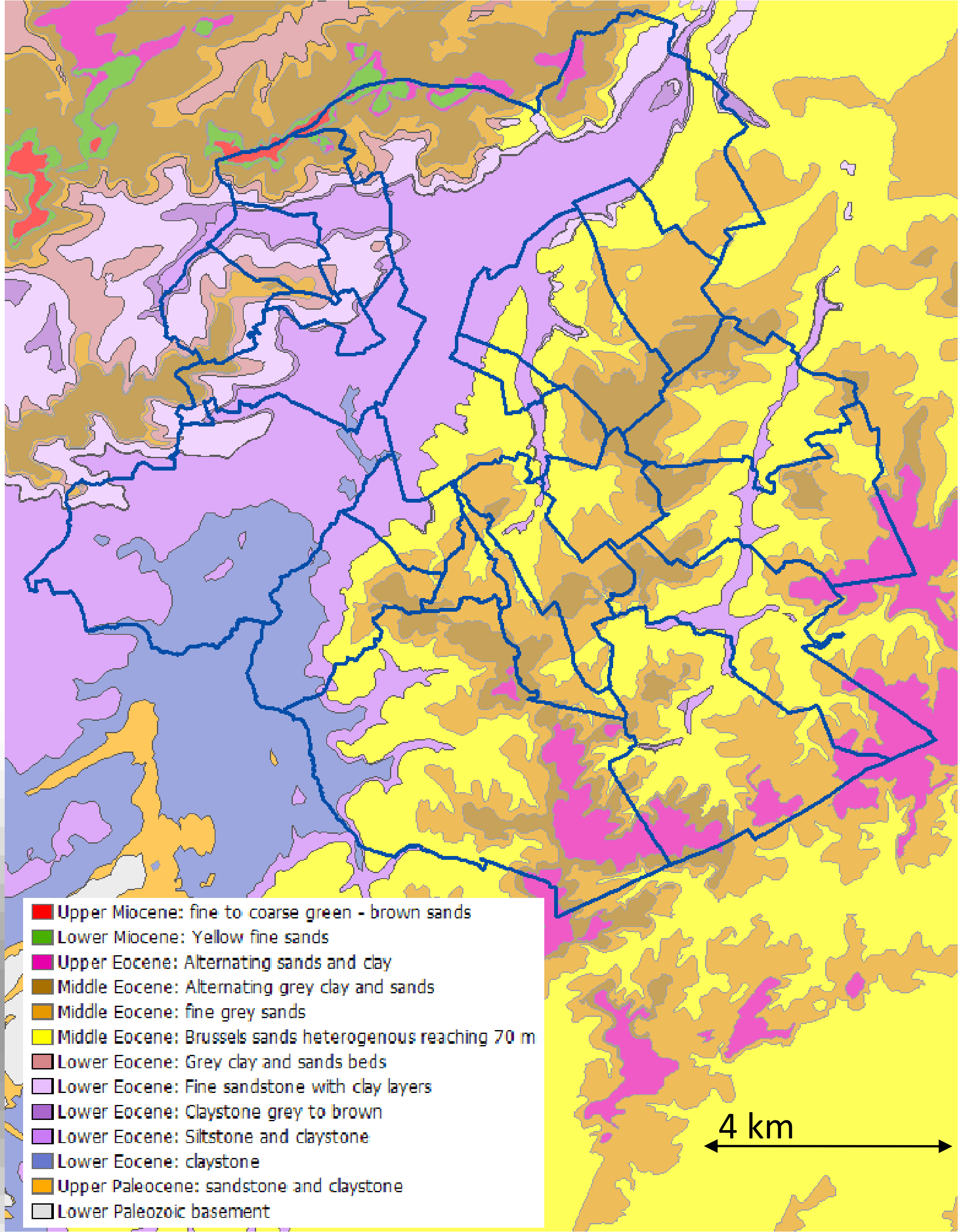


Major rivers
Altitude
15
Molenbeek
Maelbeek
Broekbeek
Pede
Vogelzangbeek
Woluwe
100
20
Geleytsbeek
120
Senne
Rivers now integrated into combined sewer system

The physical environment

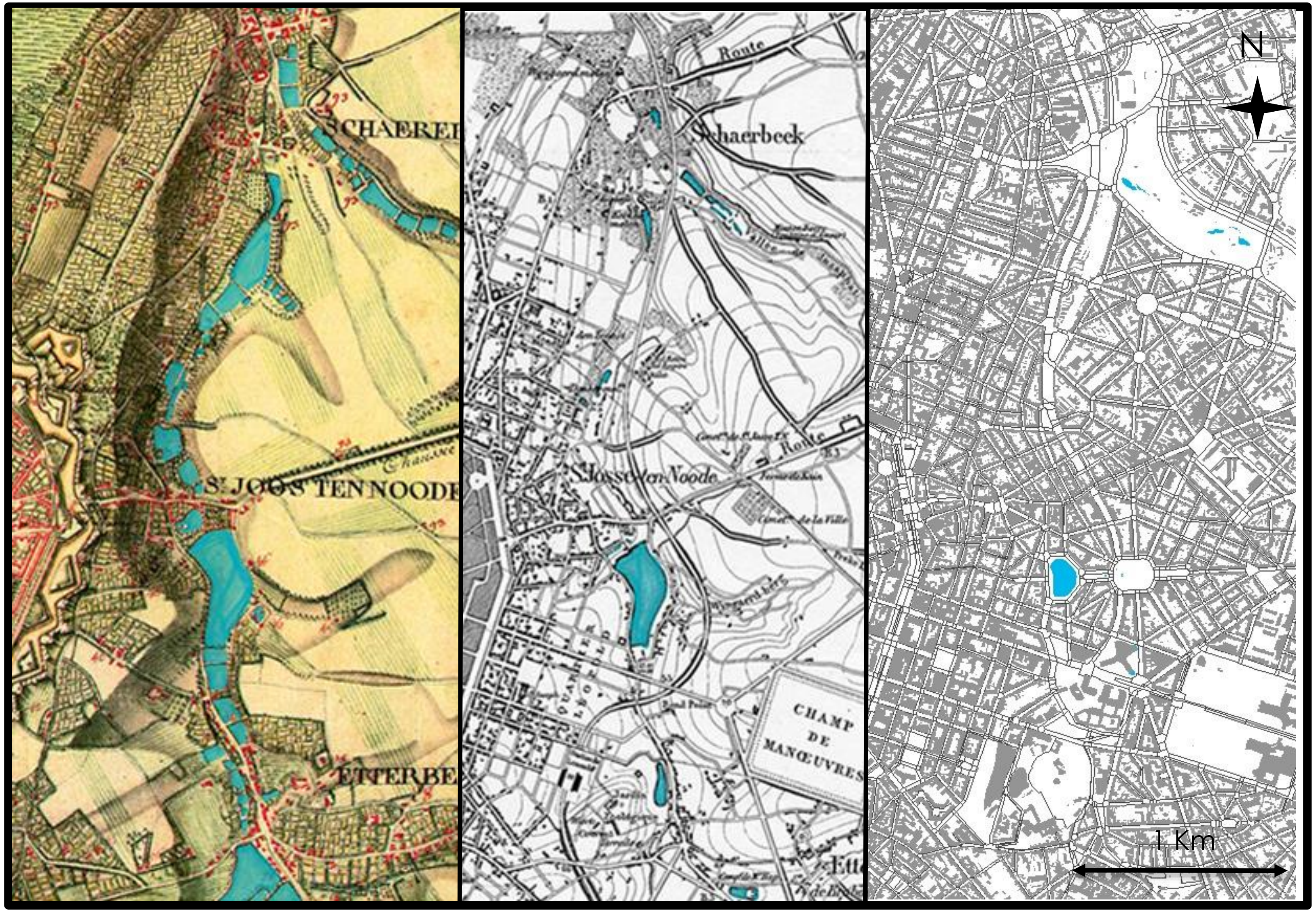
- Sediment of Cenozoic age
- Superficial Quaternary sediments
- Clear E-W & N- S differences
- Hilly topography 15 m à 110 m
- Many narrow valleys but with steep slopes
- Major variations in porosity and permeability of the sediments:

(yellow)	Coarse Sand; very good permeability
(orange)	Fine sand; good permeability
(purple)	Clay; very low permeability



Constant urbanisation: No more escape for excess water

Ferraris 1775 *Vandermaelen 1860* *Brussels Environment 2008*

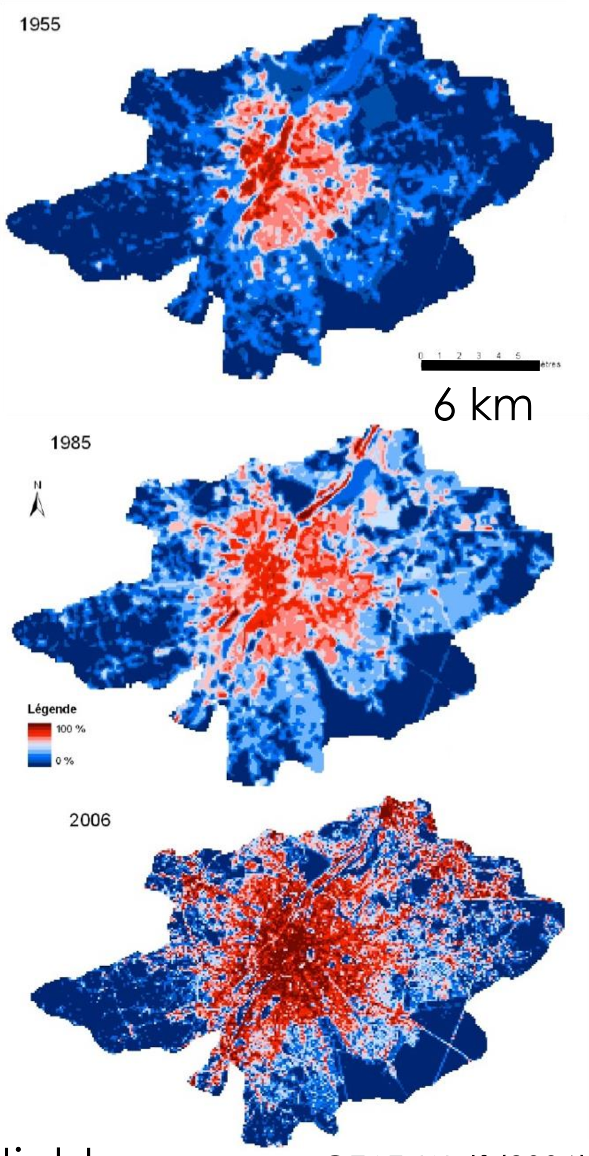


Réalisé avec URBIS

Urbanisation = impermeabilization of surfaces

	Proportion de surfaces imperméables (en %)				
	1955	1970	1985	1993	2006
Anderlecht	19	29	38	42	49
Auderghem	11	20	22	24	29
Berchem Ste Agathe	19	30	39	40	48
Bruxelles	31	37	44	47	52
Etterbeek	60	65	65	70	76
Evere	16	33	41	41	48
Forest	32	41	49	51	63
Ganshoren	20	35	42	**40**	48
Ixelles	49	57	59	64	72
Jette	26	33	40	**39**	47
Koekelberg	48	59	61	62	69
Molenbeek	39	46	52	57	63
Saint Gilles	66	66	66	75	85
Saint Josse	68	**67**	**65**	71	80
Schaerbeek	49	56	59	63	68
Uccle	19	26	27	**23**	32
Watermael-Boitsfort	9	12	13	**11**	16
Woluwe-St-Lambert	20	34	42	**41**	50
Woluwe-St-Pierre	19	30	32	**28**	38

BCR = ~1.1 million people
+20% in 2050



City surface becomes water tight:
limited penetration of H_2O in the subsurface

IGEAT, Wolf (2006)


Run-off increases and saturates sewer system: it overflows


Flooding risk increases as more ground becomes impermeable

Urbanization = Impermeabilization

given % are approximative

Urbanisation

- Increase run-off
- Decrease direct evaporation
- Major decrease in infiltration
- Pollution water/soils/groundwater (sewer exchanges)
- Modifies groundwater recharge

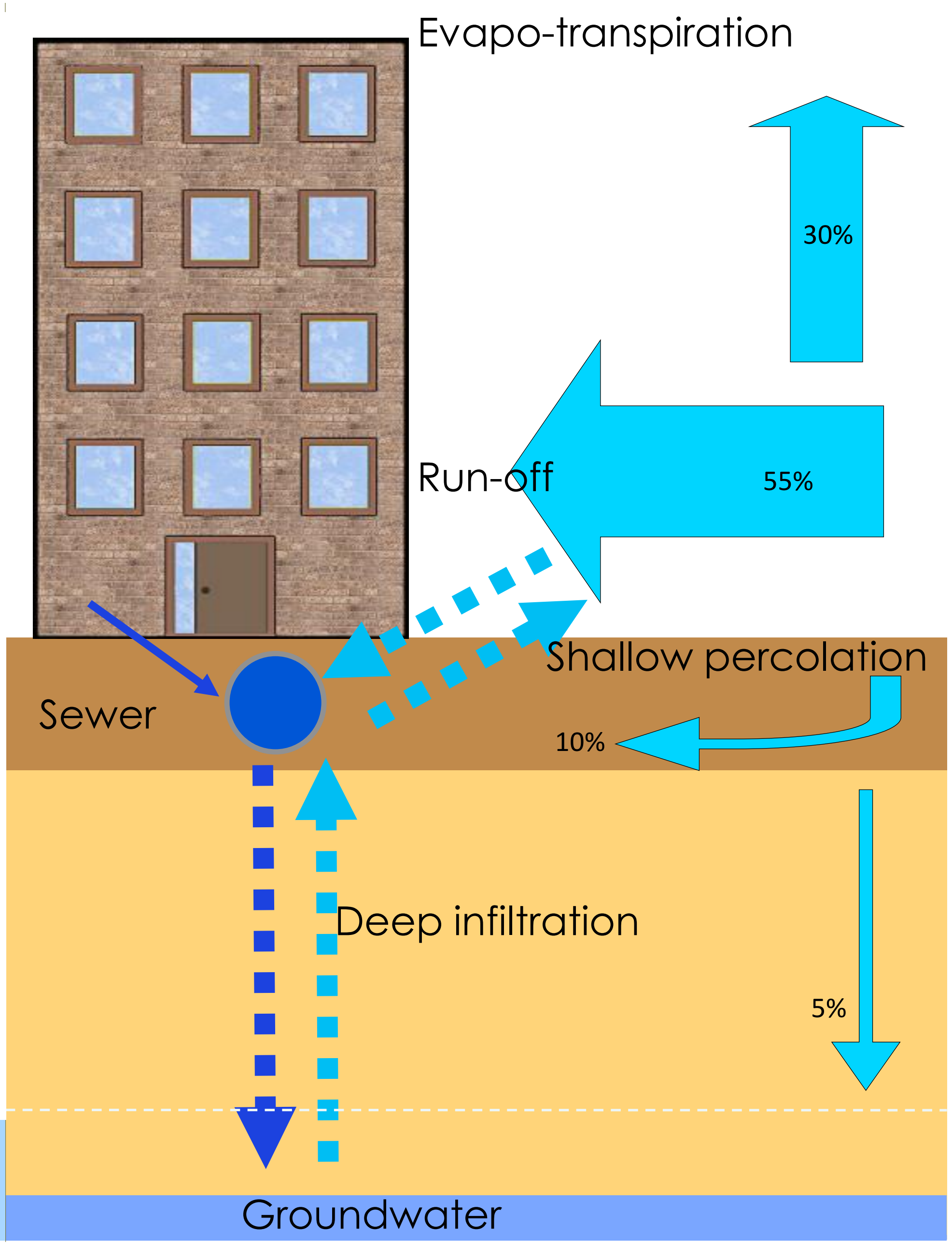
Sewer

= New city H_2O transport agent

- Collects & transports run-off water + when it rains : hydrographic network connections
- Infiltration & exfiltration of water = exchanges with groundwater
- Modifies natural water circulation
- Domestic waters evacuation

Forgotten water cycle buried under the city

Groundwater



de Brouckère - 3

Sewers ~ 150 y old, > 1500 km, repaired 25 km/y : 1.5 G€

Versleten riolen van Brussel krijgen opknapbeurt

De Standaard 24/25-07-20[illegible]

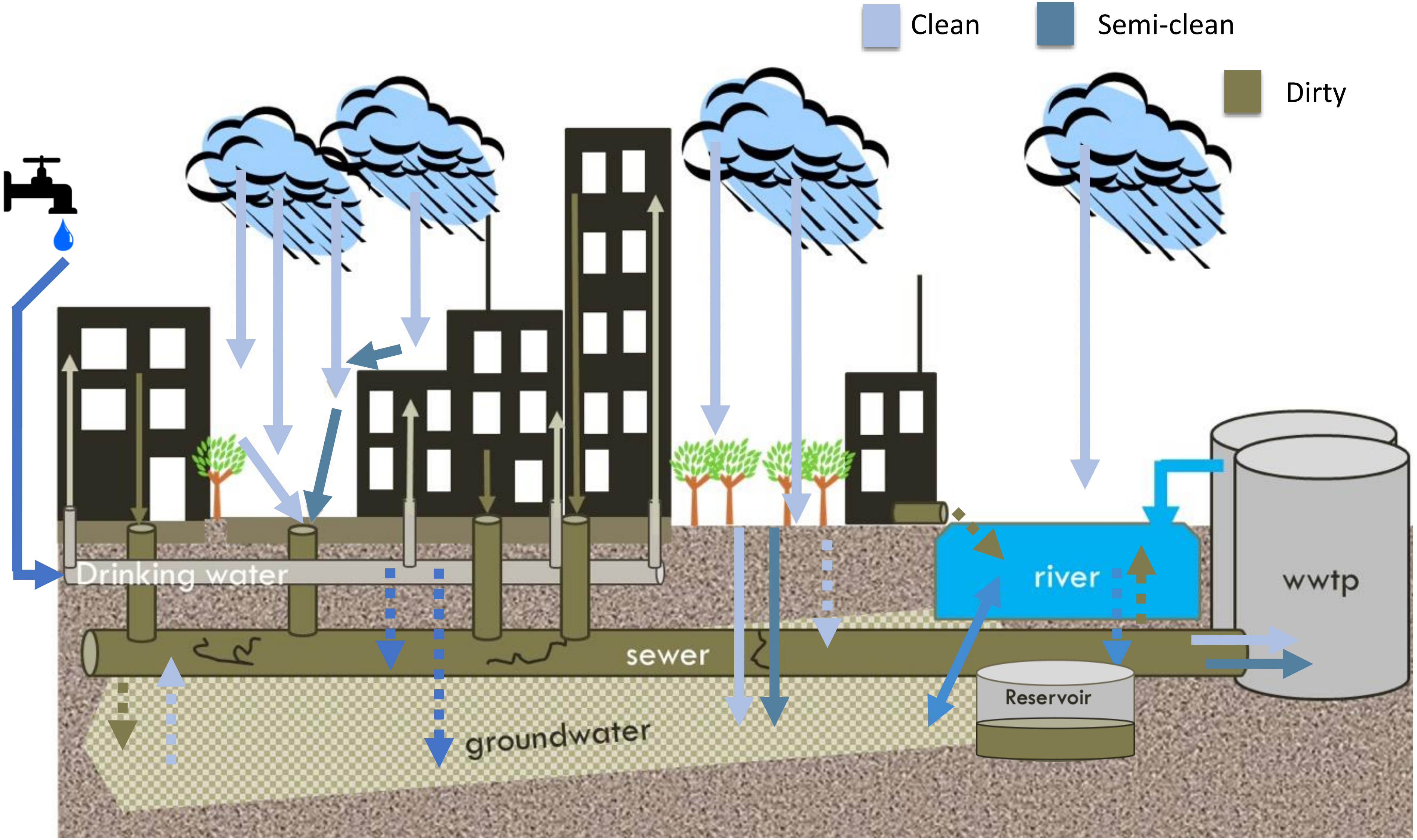
De Morgen 24-07-20[illegible]

Komende twintig jaar moeten vijfhonderd kilometer riool worden gerenoveerd

Een derde Brusselse riolen gebuisd

■ De put in de Henri Jasparlaan (l) is de derde grote wegverzakking in 40 dagen tijd. Oorzaak: de abominabele staat van de verouderde riolen.

Rain water in sewer system, combined sewers in Brussels and hidden connections



$\delta^{18}O$ ($^{18}O/^{16}O$) traces water masses in city (De Bondt et al. 2018)

Isotopic analyses to trace urban waters

Isotopic analyses
$\partial^{18}O$; ∂D; $\partial^{15}N$

CRD Picarro L2130i

$$\partial^{18}O\ ‰ = \frac{(({}^{18}O\ /{}^{16}O)_{Sample} - ({}^{18}O\ /{}^{16}O)_{STD}))}{({}^{18}O\ /{}^{16}O)_{STD}} \times 1000$$

Trace and quantify different water masses: Rain, groundwater, river, domestic, meteoritic water: document the new urban water cycle: GIS system local to regional water management

Ixelles / Le bassin d'orage résiste bien mais la rue Gray est toujours inondée

Le bassin Flagey sous pression

On a un peu l'impression de tourner en rond à Ixelles-Flagey. Non pas autour de la place mais bien dans la gestion de l'eau de pluie. Et c'est de circonstance ces jours-ci, vu les orages. L'occasion aussi de dresser un premier bilan du nouveau bassin d'orage, après les années de travaux qui ont traumatisé les riverains.

Samedi soir, des trombes d'eau se sont abattues sur la capitale. Le bassin d'orage sous Flagey a-t-il rempli son rôle ? Oui, à première vue. Vivaqua le confirme : *« les bassins ont été remplis à moitié ou aux deux tiers. Donc, le système a fonctionné. »*

A d'autres sources on nous confirme que le parking surplombant le bassin d'orage n'a pas été atteint par la montée brutale des flots. Le système fonctionne, alors ? Partiellement. Car il semblerait que le problème se soit reporté sur la rue Gray, en aval. Des caves y ont été inondées. Ce qui suscite des interrogations sur le rôle et le fonctionnement du bassin d'orage, conçu et construit pour répondre au problème des inondations à Flagey et à la rue Gray.

Des vannes posées à la sortie du bassin servent à réguler le niveau d'eau. Mais le délestage se ferait au détriment des riverains de la rue Gray. Apparemment, c'est l'un ou l'autre.

Cela fait grommeler le bourgmestre d'Ixelles qui préconise, depuis des années, une alternative simple : se servir des étangs d'Ixelles comme bassin de sécurisation. Ceux-ci serviraient de tampon entre l'eau dévalant notamment de l'avenue Louise et le bassin d'orage. D'autres alternatives sont aussi envisagées, comme un collecteur reliant ces zones hautes et la fin de la rue Gray, côté place Jourdan.

Pour la ministre régionale en charge des eaux, Evelyne Uyttebroeck (Ecolo), les étangs ne constituent pas une bonne alternative, cela endommagerait les berges et nuirait à la qualité des eaux. Il faut plutôt travailler en amont, en tentant de réduire les eaux de ruissellement. ■ JEAN-PIERRE BORLOO

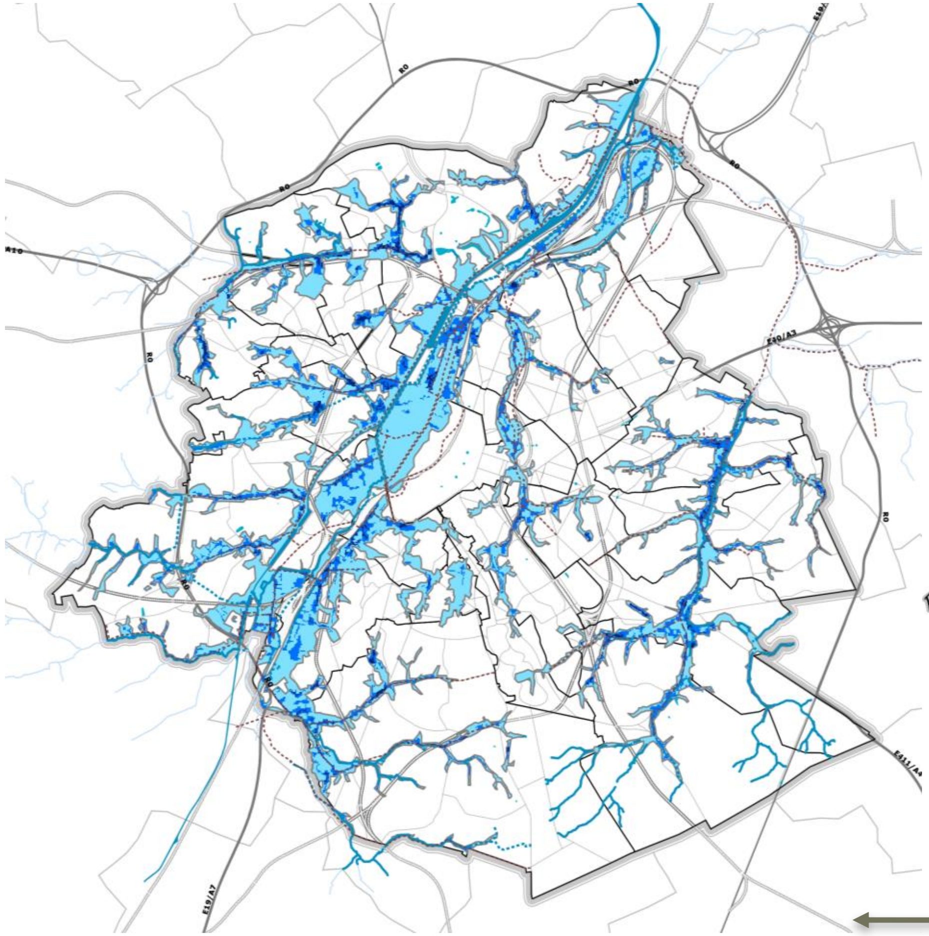
QUELQUE 33.000 M³ D'EAU peuvent être accueillis temporairement sous la place Flagey. © ALAIN DEWEZ

Water management: > storm basins + cleaning stations = G€ + ?

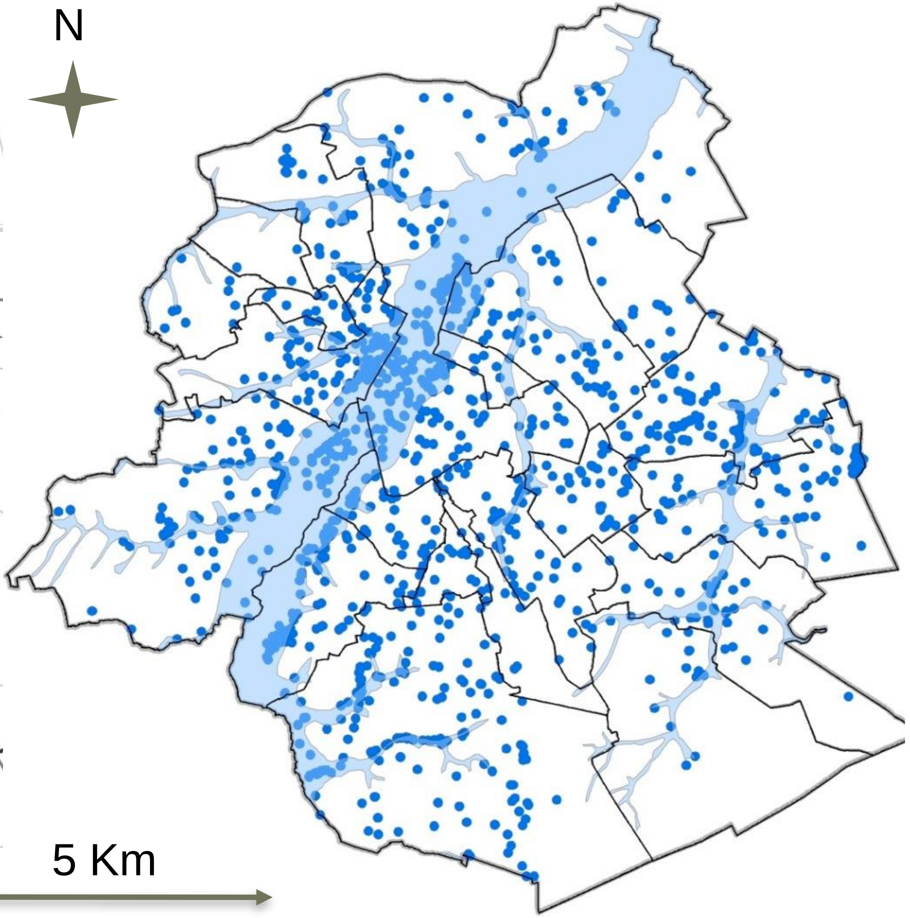
Where does flooding occur ?

IBGE/BIM: flood-risk map

http://geoportal.ibgebim.be/webmap/inondation_carte.phtml



Urgent water interventions (1997-2009, Firefighters data)



N

5 Km

High risk

Moderate risk

Low risk

innudations are not strictly limited to bottom of valleys

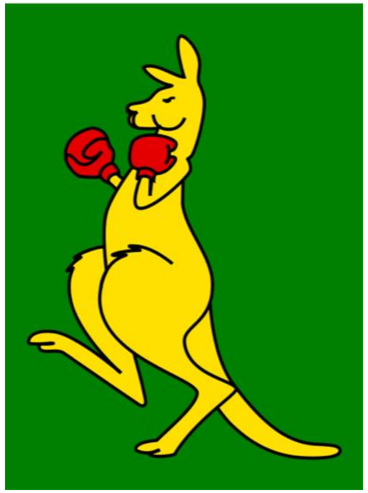
1

Valleys

Too many floods

People
not
happy

Politicians
worried



Problem solved at
local scale ?

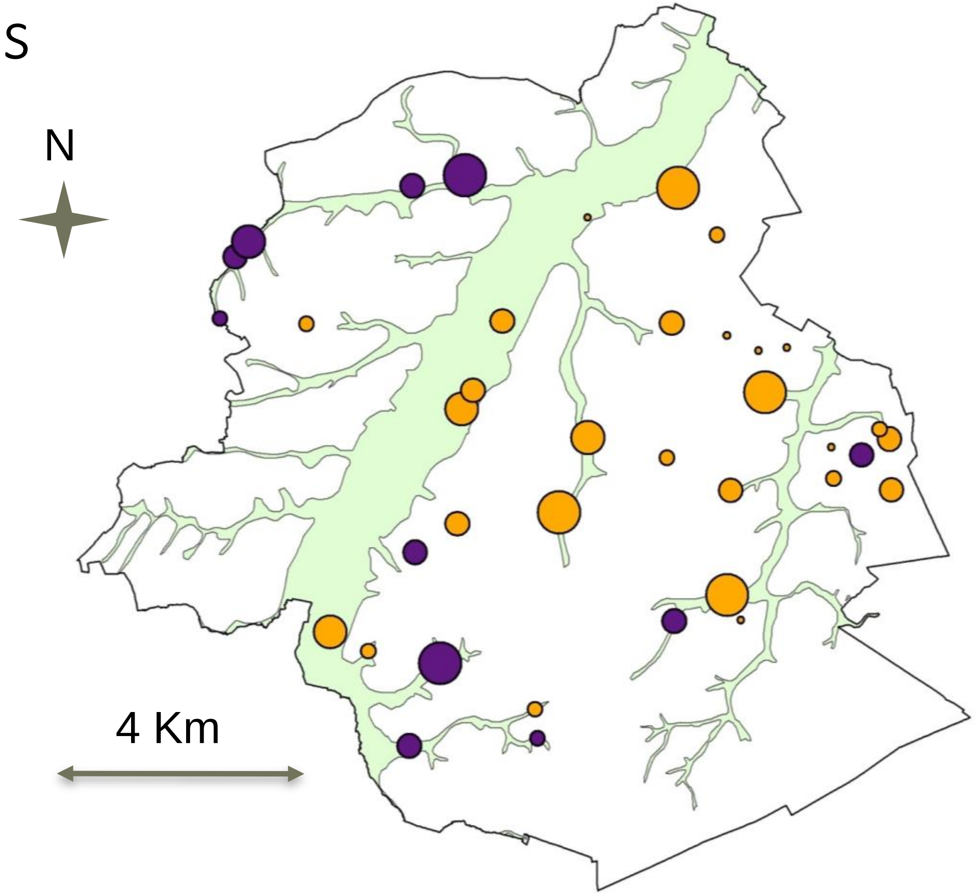
Local
underground
water reservoir

.... next one

Classical solution against floods

Storm water basins = also parking

Repair & increase capacity of sewer system



Large structures at valley bottom (1€/L Forest)

- Basins d'orage en fonction
- Basins d'orage en projet

Smaller structures on elevated topographies: Why ?

What are the (cheaper) alternatives ?

Low Impact Development measures

Alternative solutions exist: LID, BMP, SUDS, WSUD,...

- Restoring natural processes (evaporation, vegetation, soil infiltration)
- Decentralized techniques (where rainwater falls)
- Limiting rainwater flowing to the sewer system

Recent: short track record of planning experience on large scale
Complex: influenced by a variety of *local* parameters
Multidisciplinary: urban planning, geosciences, hydraulics, architects

Their application remains too timid in Brussels

Pit fall: no universal technique: distinct LID measures must be selected & applied to specific locations and scales depending on local / regional physical parameters of the watershed (even in town)

Colateral benefits: cools the city, recreational, ecological, water-saving/recycling, looks good...

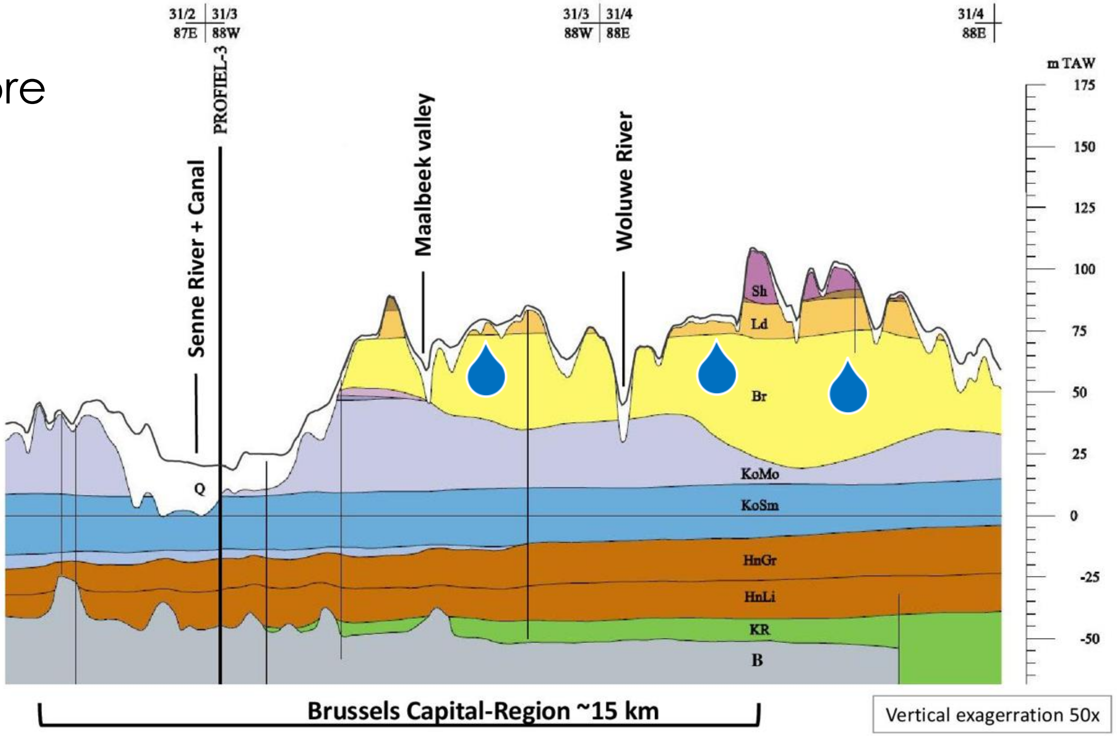
Other approaches sustainable, and probably much cheaper

Restauration of ancien water-ways

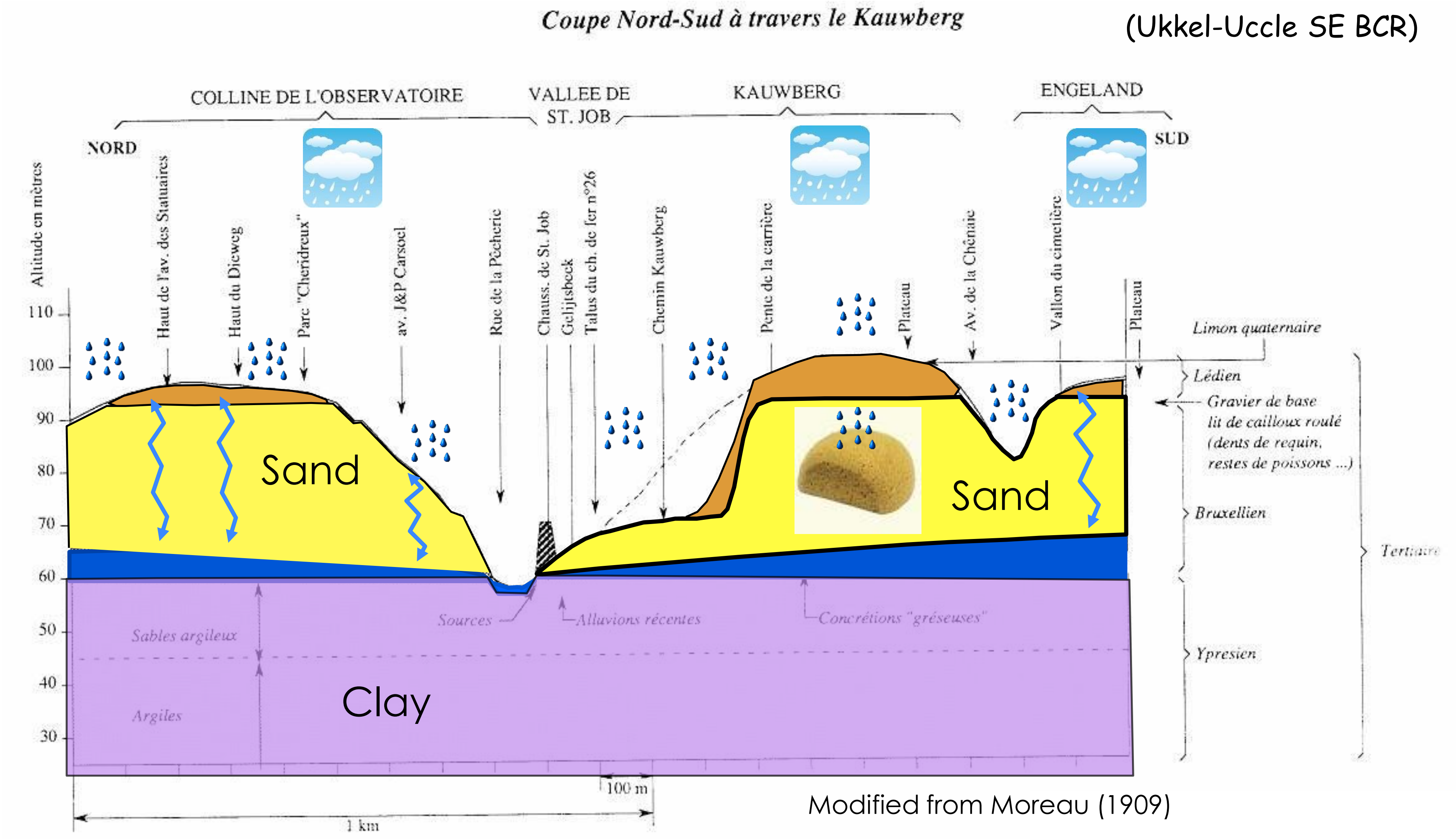
and humid areas

Keep water up-hill before it floods the valleys

In parts of Brussels using porous sands in elevated areas (yellow) : natural storm basin reservoirs.

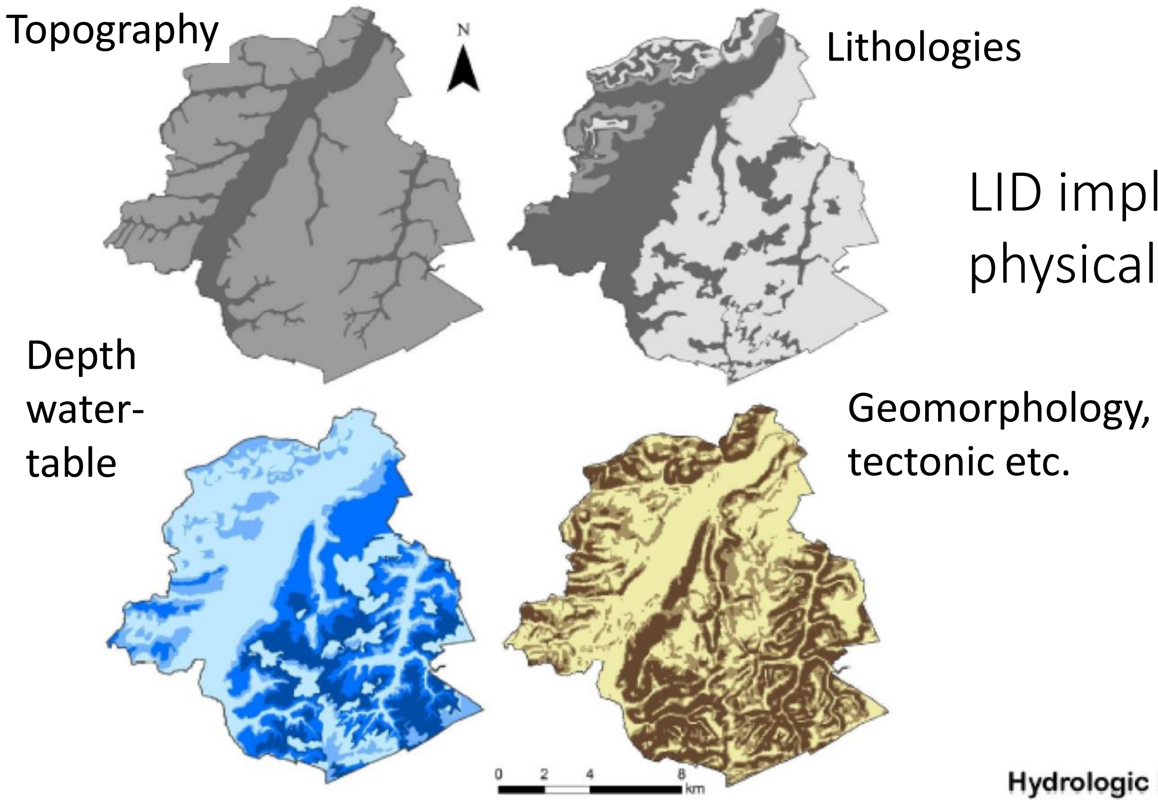


Example: using natural storm-water basins



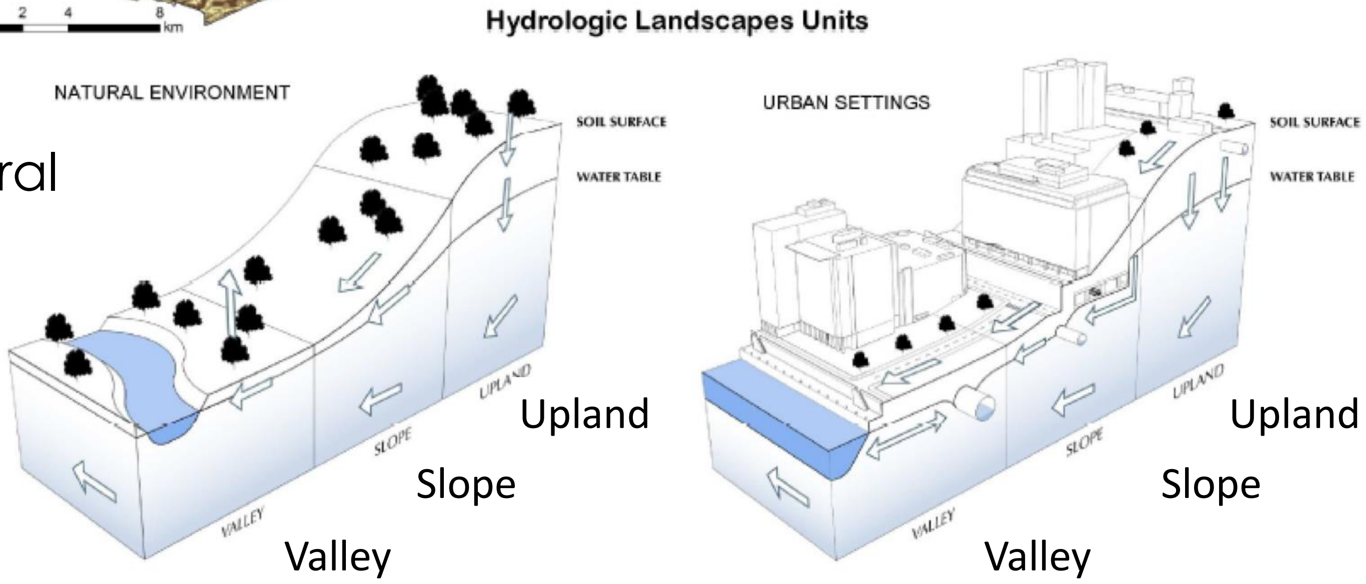
Slow water transit & storage within the sands: Sand = natural (& low cost) storm basin

Impermeabilization induces surface run off along steep slopes & saturation of sewer conduits = *flooding in the valley*

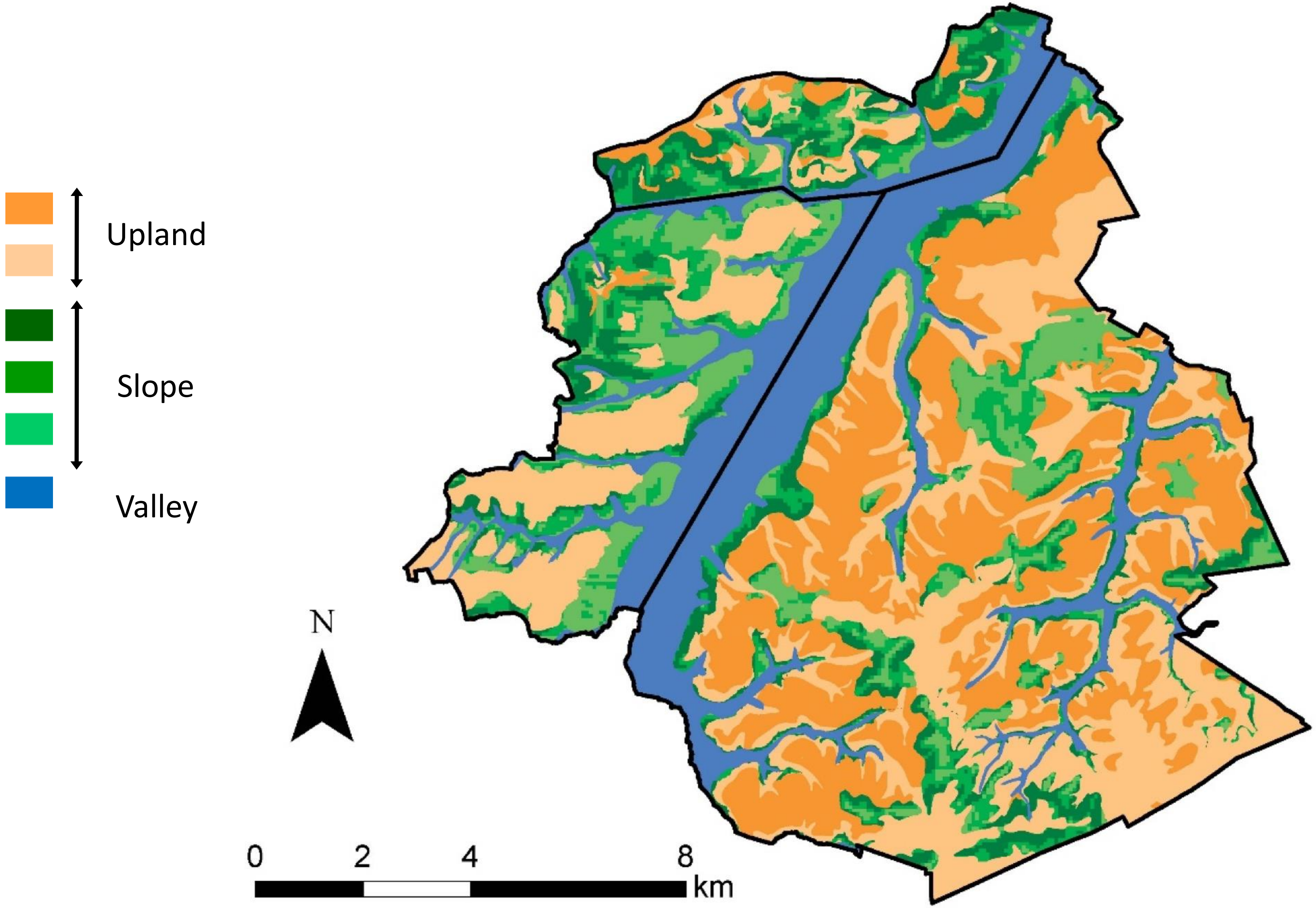


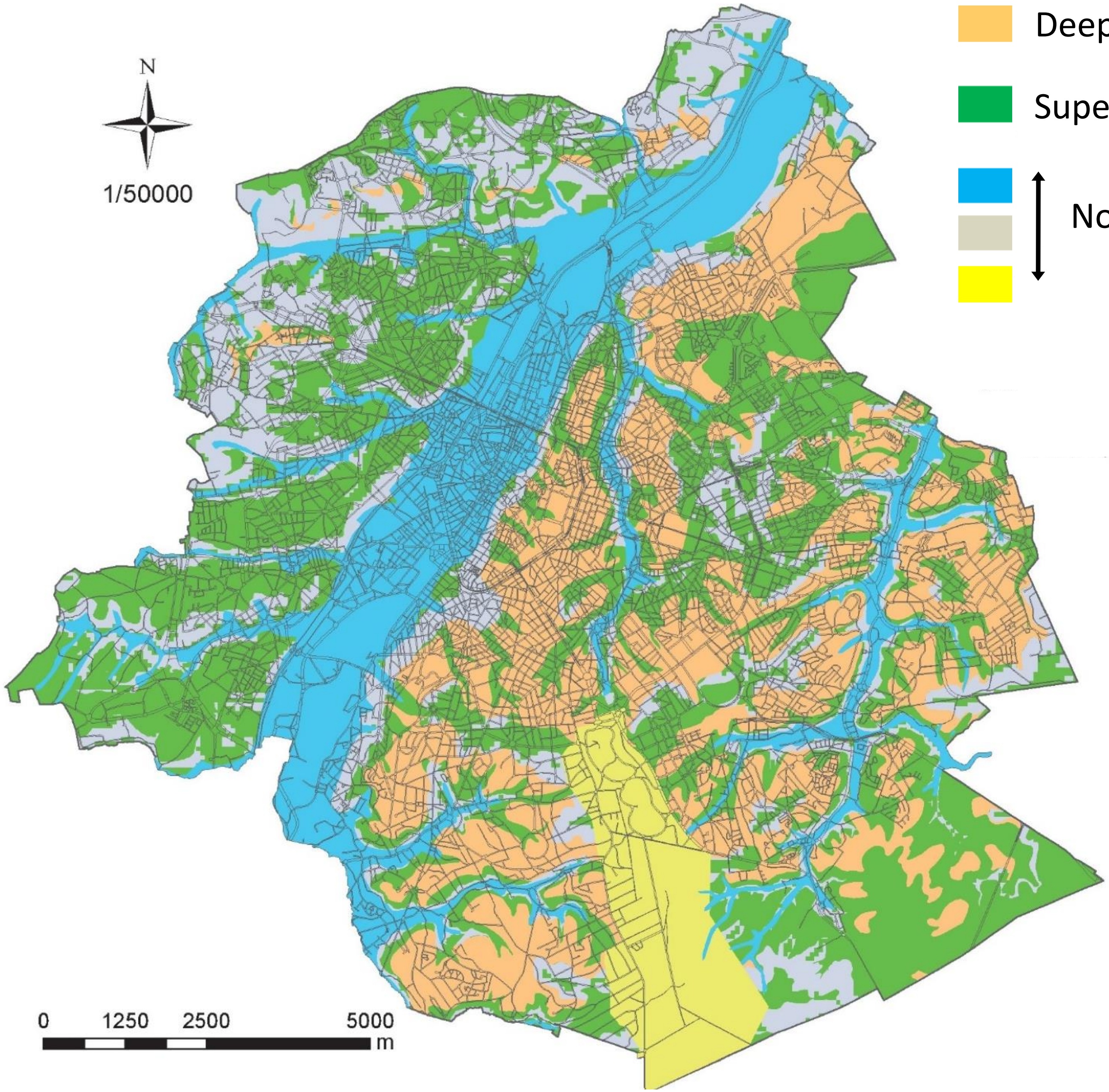
LID imply (good) knowledge of the physical environment in cities

Work based on natural ground principles

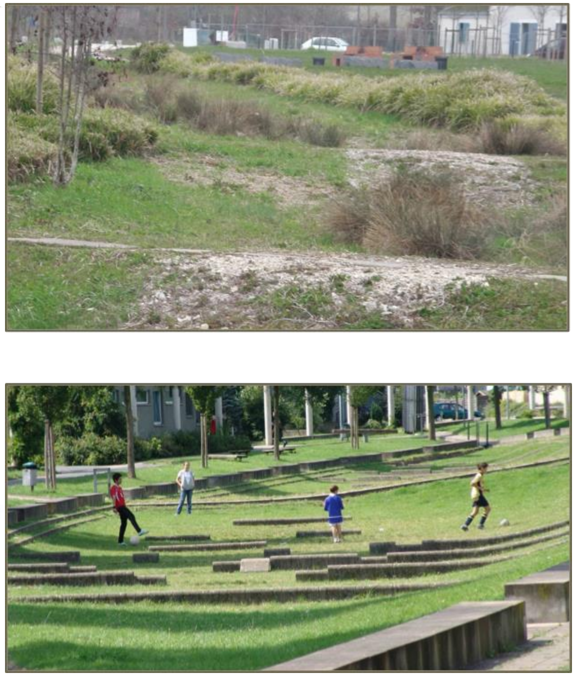


Urban hydrologic landscape map of Brussels





Superficial infiltration

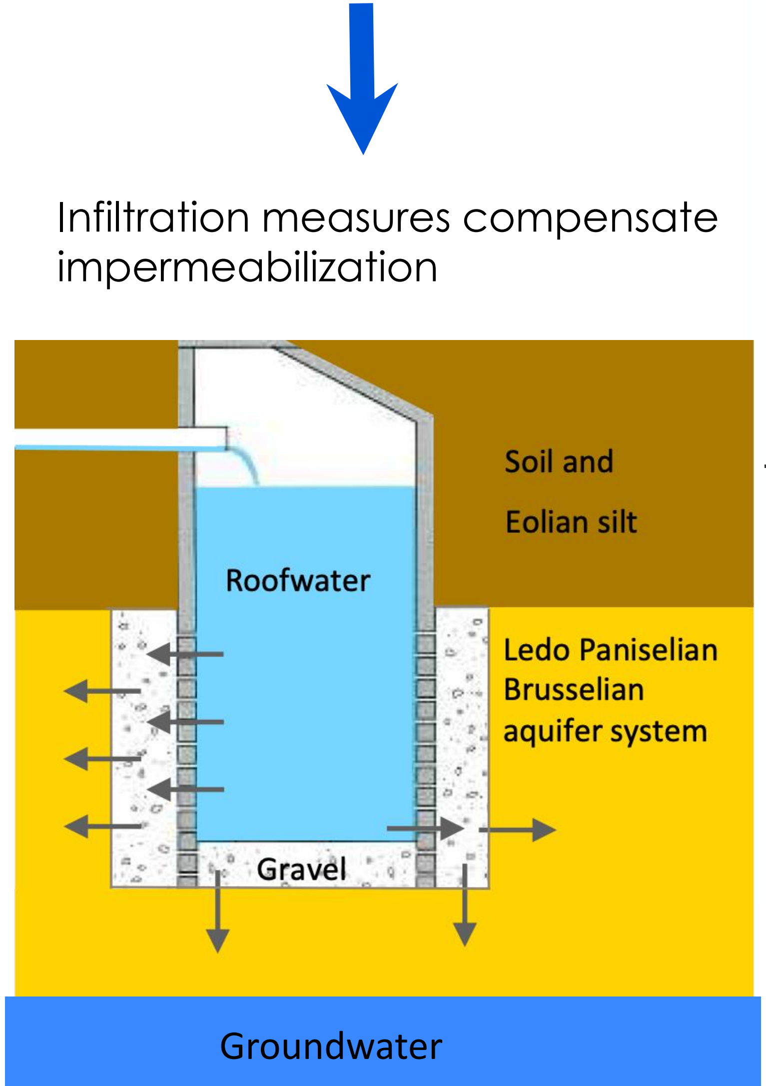


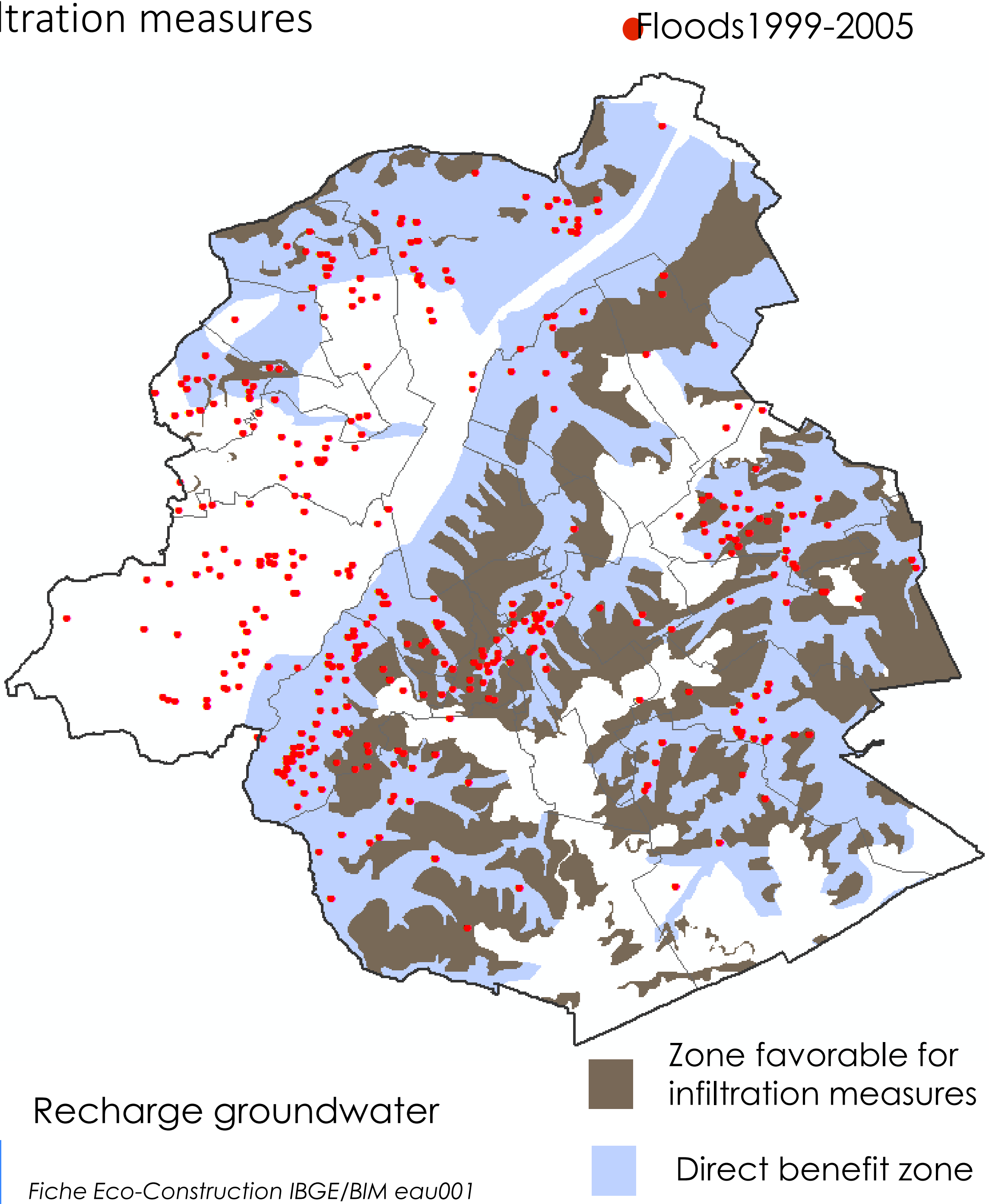
Driven by local physical properties

Infiltration measures

Roofs collect waters

Infiltration measures compensate impermeabilization



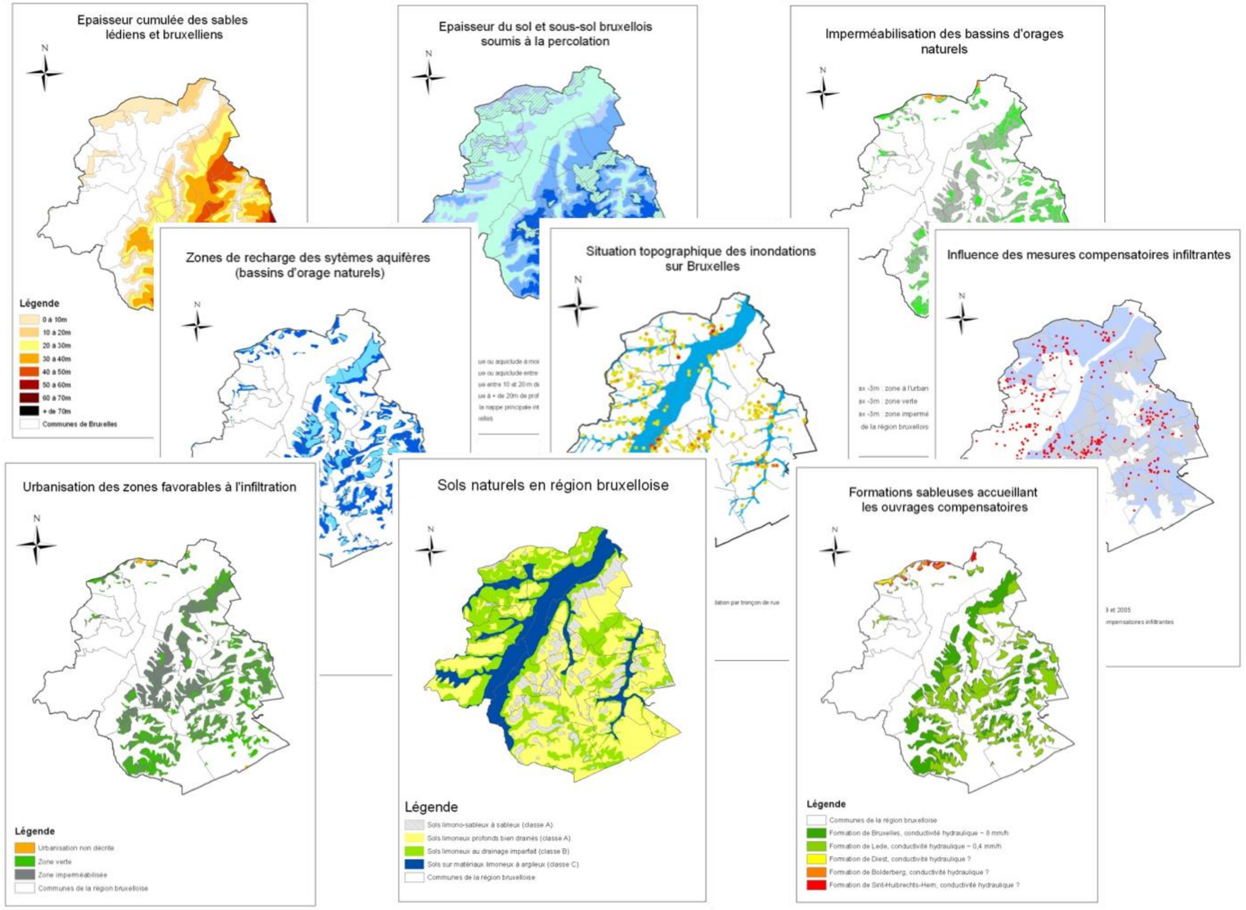


Recharge groundwater

Fiche Eco-Construction IBGE/BIM eau001

Landscape differentiation & production of adapted LID tools for water management at local to regional scale

Available at:
http://we.vub.ac.be/~urbangeo/homeueg.html



The physical environment controls urban water fluxes:
Flooding occurrences & magnitude, soil & lithology, natural infiltration vs induced infiltration, parasitic water in/out sewer, type of infiltration practices depending on topo-geologic environments, level of groundwater, neotectonic…

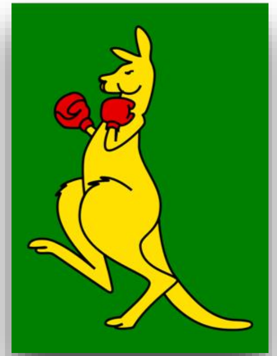
The "natural" hydrologic landscape must be used in urban water management, use of local conditions to maximize LID measure efficiency

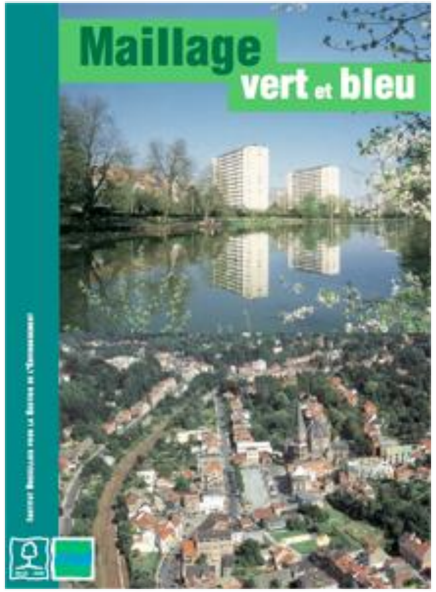
AMGC approach to urban water management

Tai-Chi versus boxing kangaroo

Planned versus ad hoc

Active citizen participation





Limit (+>> €) to "*forced*" engineering solutions: instead favor sustainable approach based on knowledge of urban water cycle
and "*natural*" watershed conditions
Anyone interested ?