EXPLORING THE LINK BETWEEN URBAN DEVELOPMENT AND WATER DEMAND: THE IMPACT OF WATER-AWARE TECHNOLOGIES AND OPTIONS

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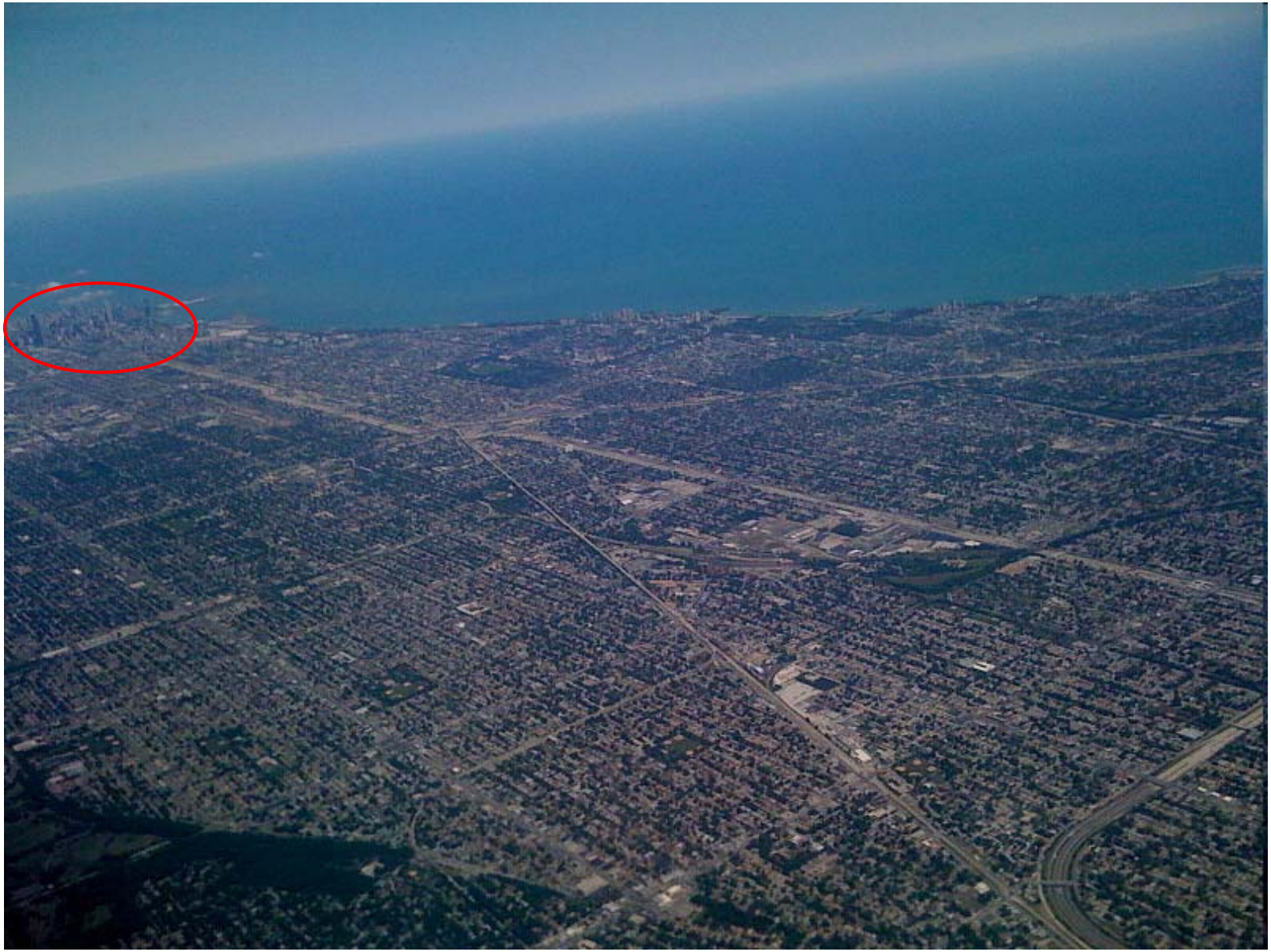
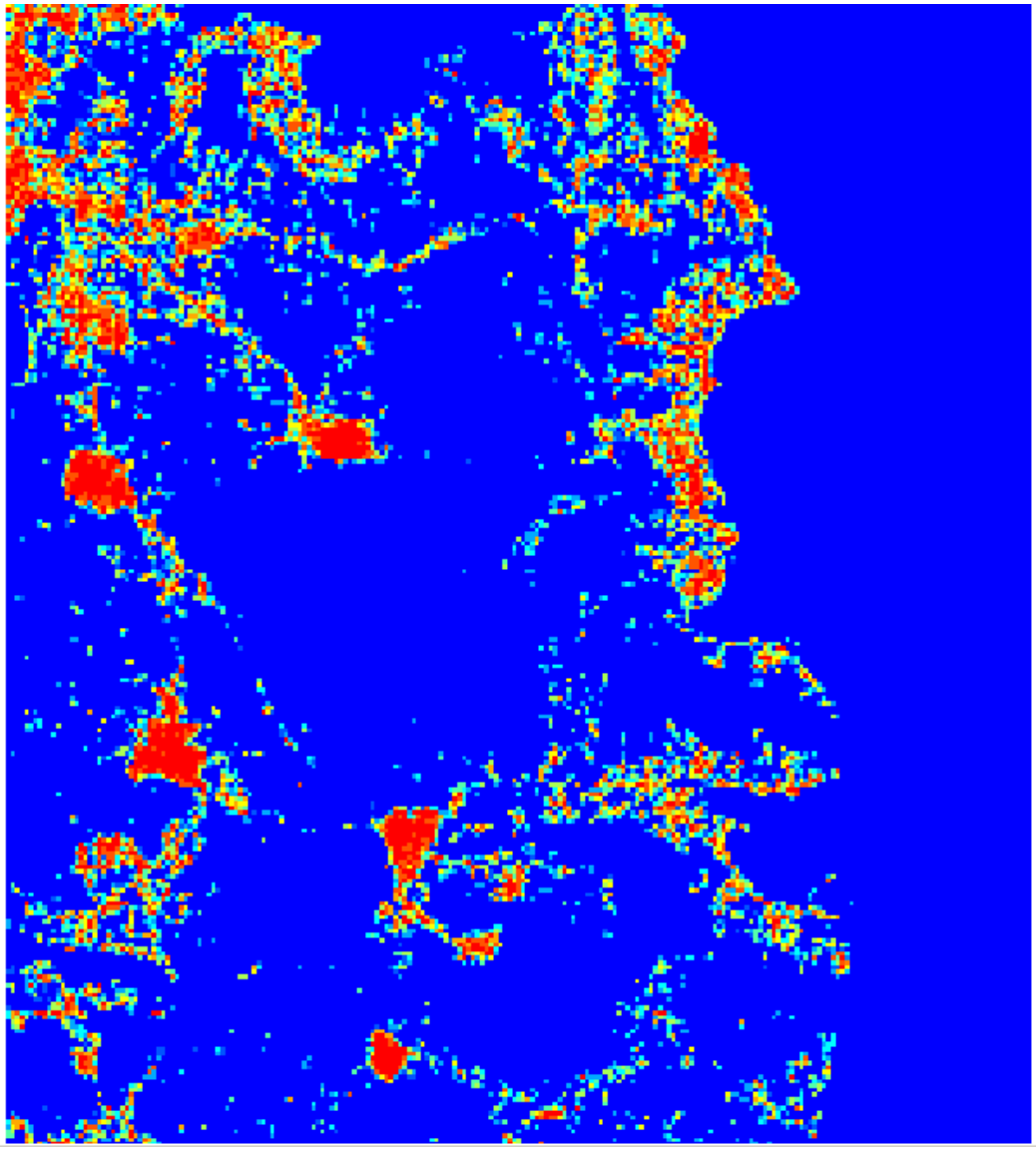
Urban growth



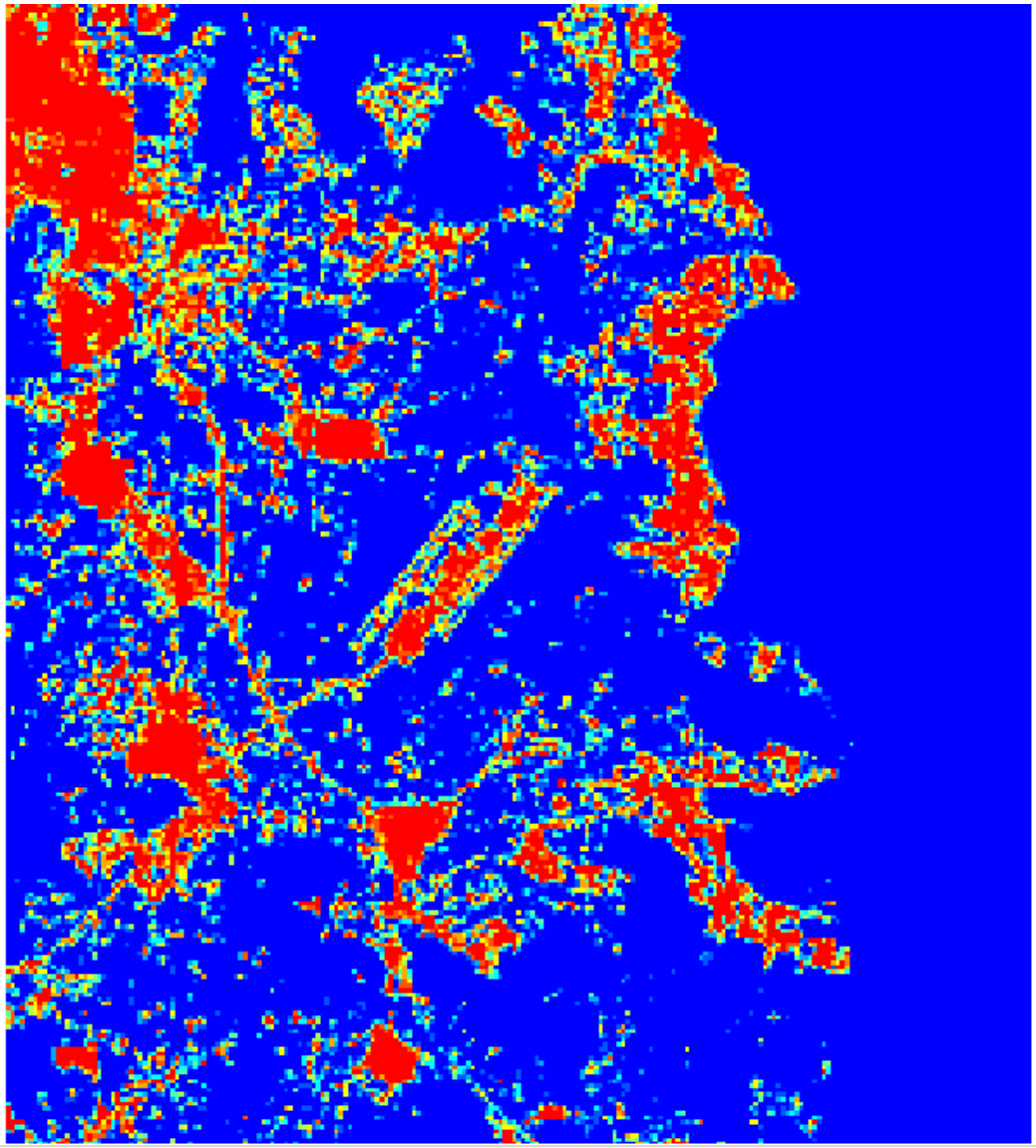
The Chicago metro area (from wikipedia)

Urban growth



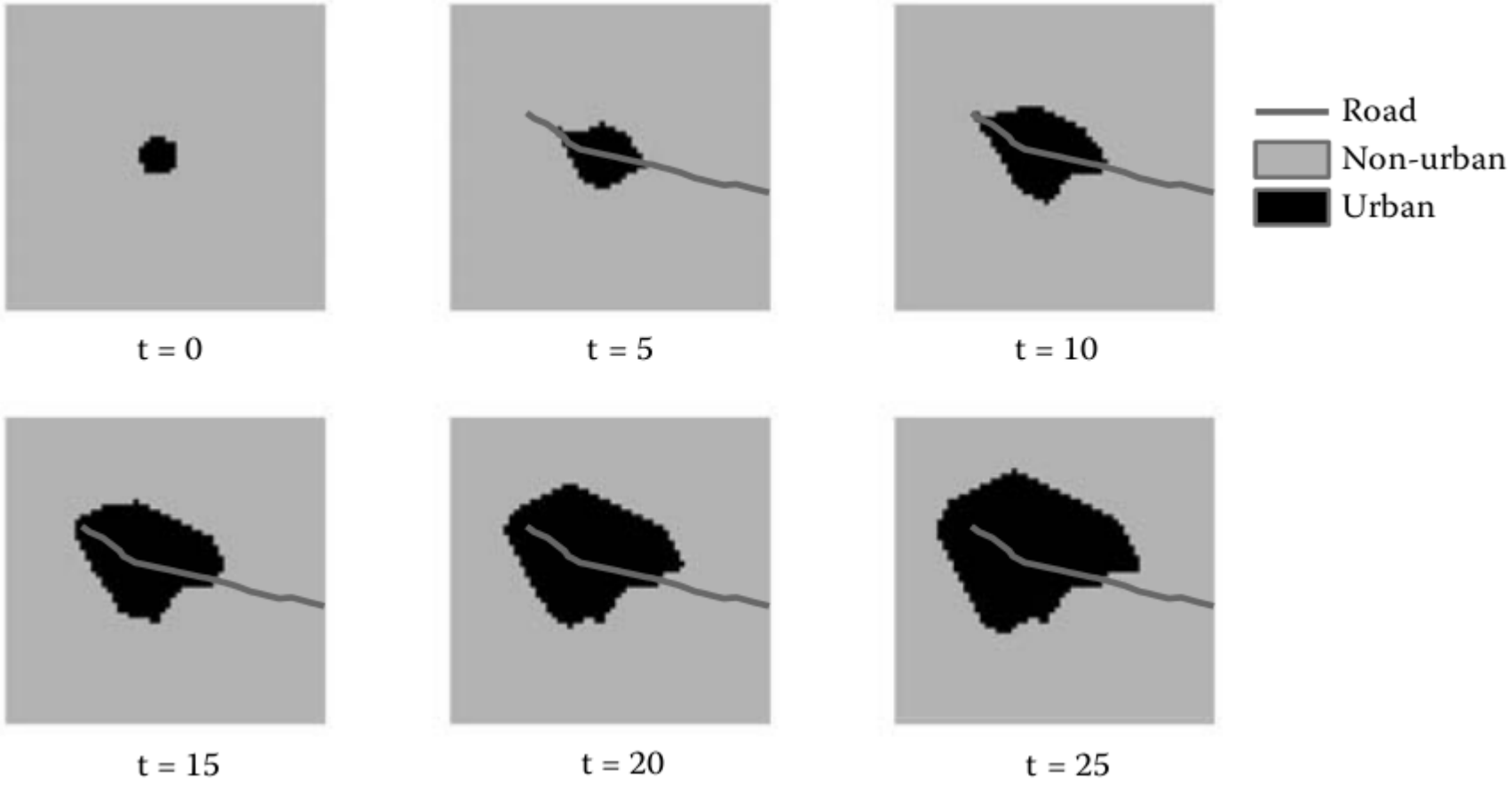
East Athens 1988

Urban growth



East Athens 2007

Typical urban growth pattern



Growth of a hypothetical town (Liu, 2009)

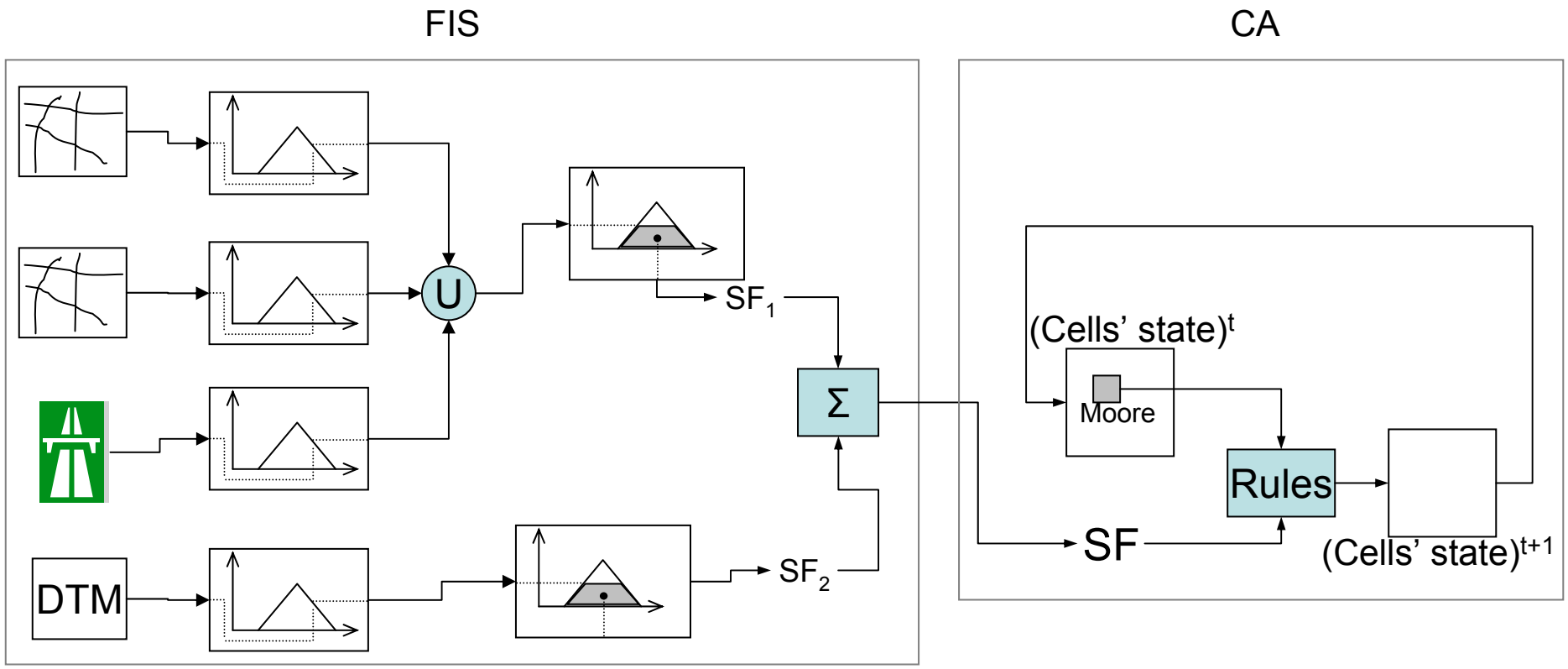
Cellular Automata

Automaton, an entity that has a mechanism for processing information based on its own characteristics.

A cellular automat is characterized by:

- the cell, the basic spatial unit (raster representation).
- the state, which identifies the properties of the cell.
- the neighbourhood of the cell in question.
- the transition rule, which defines how the state changes.
- the time.

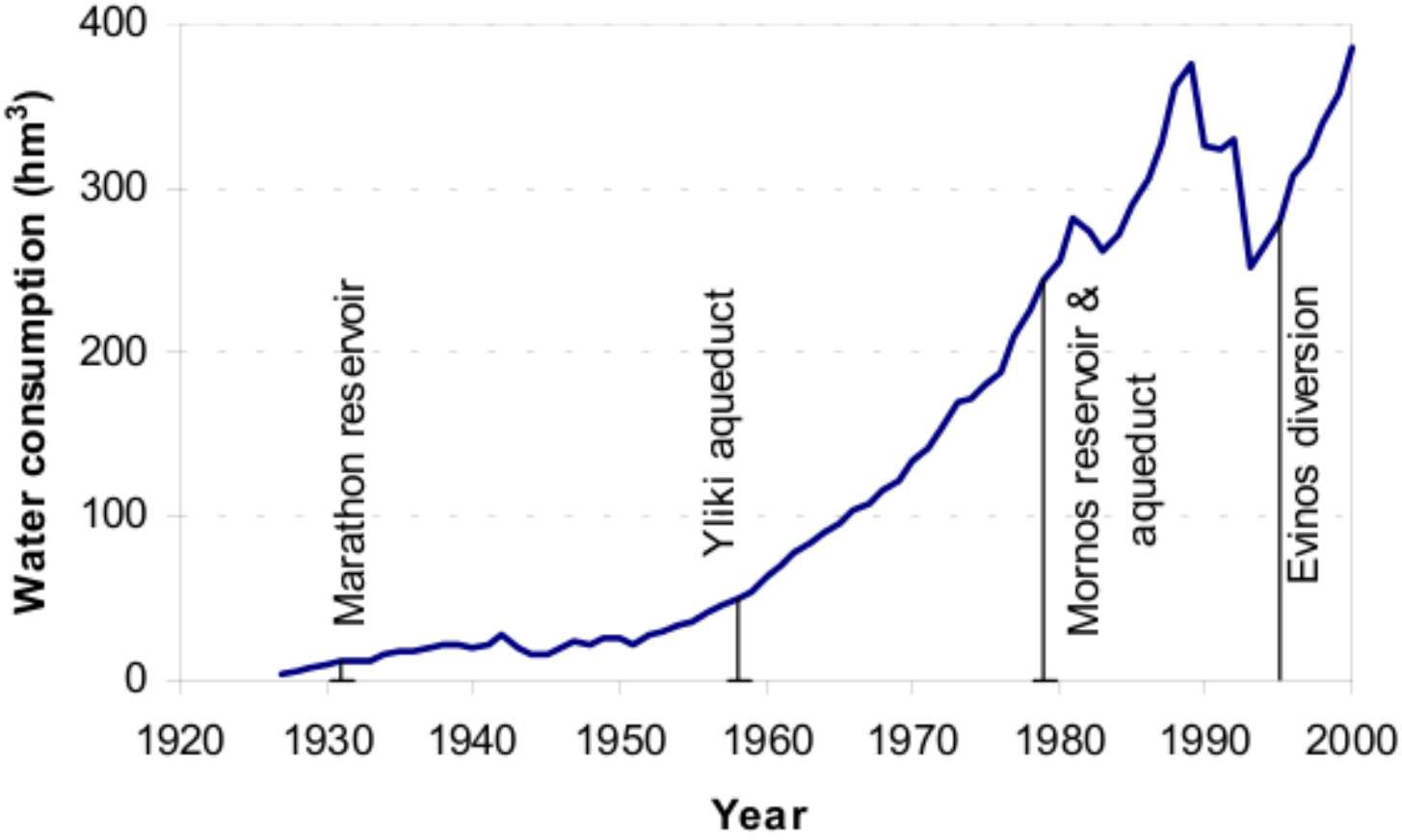
CA and FIS



- Suitability concerning transportation: "*close to primary network* ***and*** *close to secondary network* ***and*** *close to motorway junction*"
- Suitability concerning terrain: "slope is low"

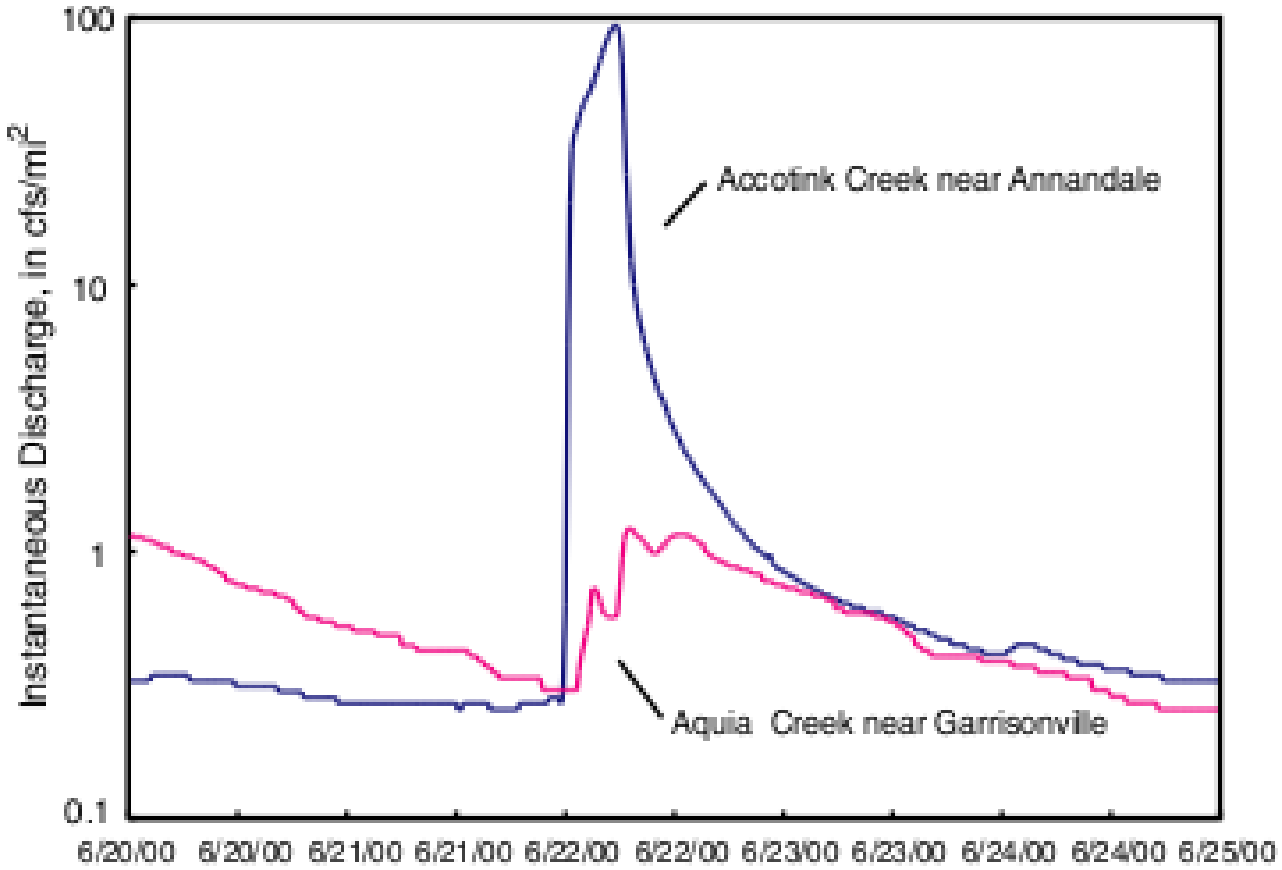
Pressures – increased abstractions

Athens annual water consumption (Xenos et al.,2002)



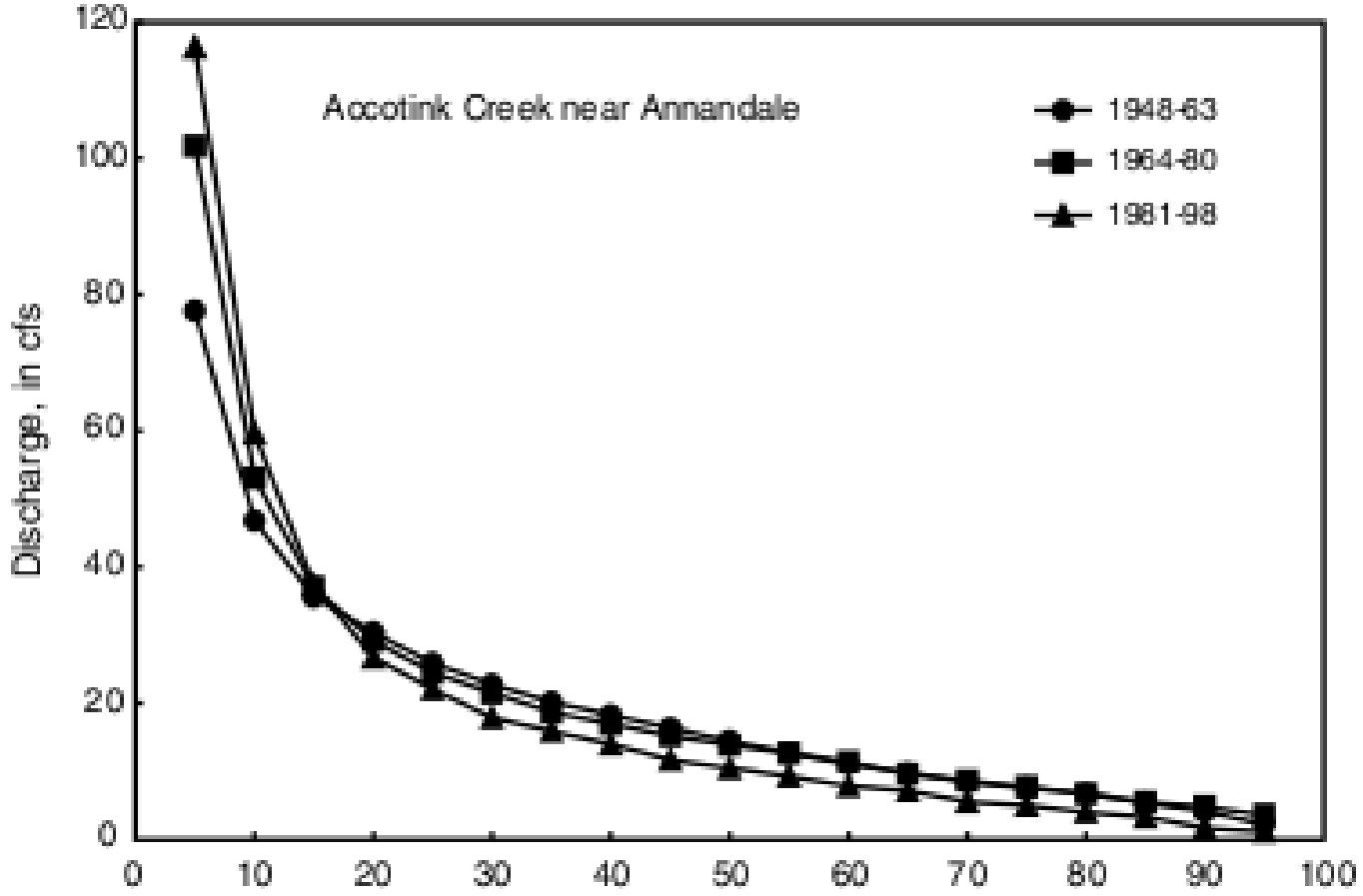
Pressures – increased runoff peaks

Discharge per unit drainage area (USGS, 1999)



Pressures – reduced base flow

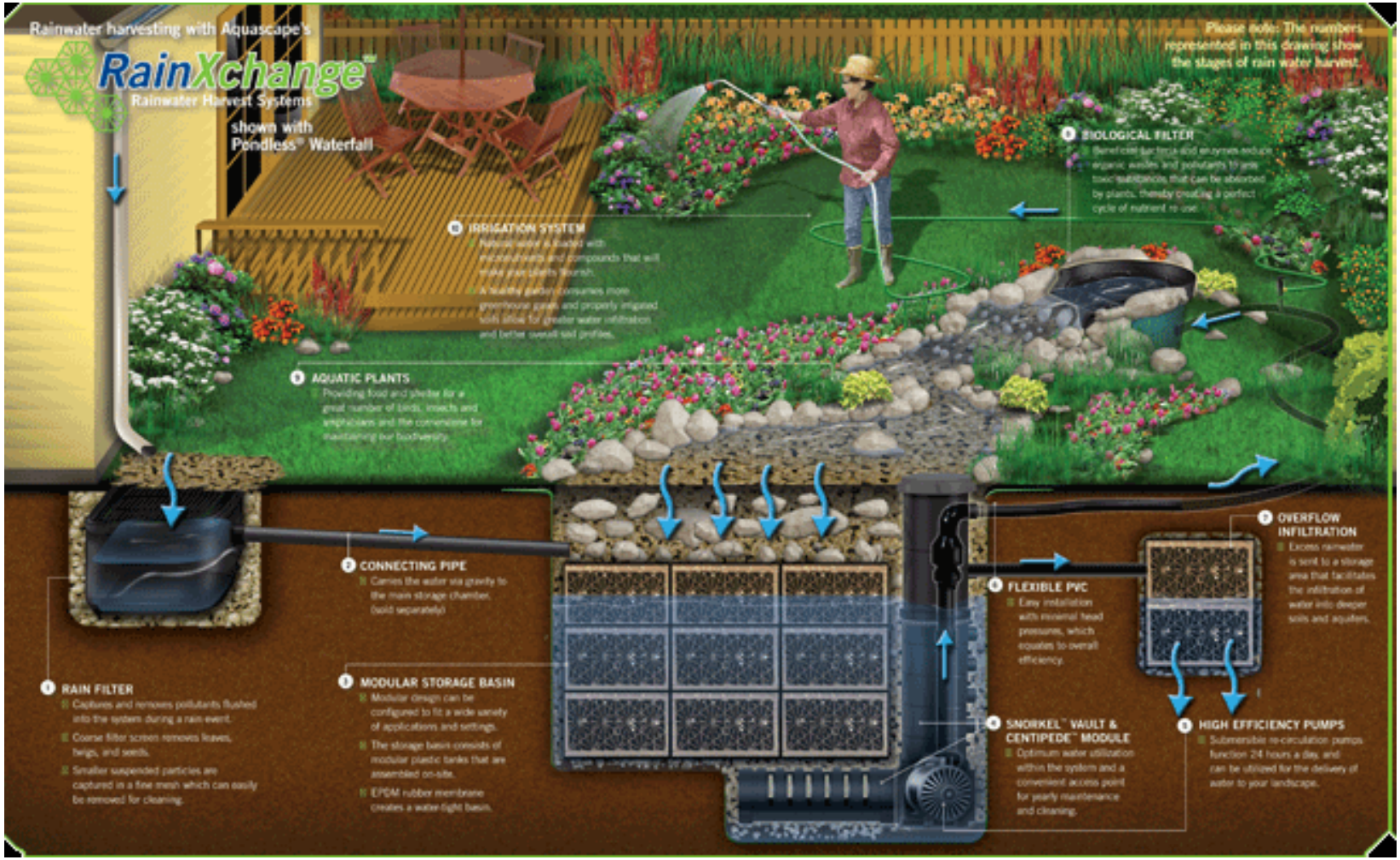
Flow duration curves (USGS, 1999)



New technologies

Greywater recycling: decreases of potable water demand (Hansgrohe int.)

New technologies



Rainwater harvesting: decreases both runoff peak and demand of potable water (RainXchange)

Urban water cycle modelling

Does successful implementation of new technologies requires modelling?

Dynamic system

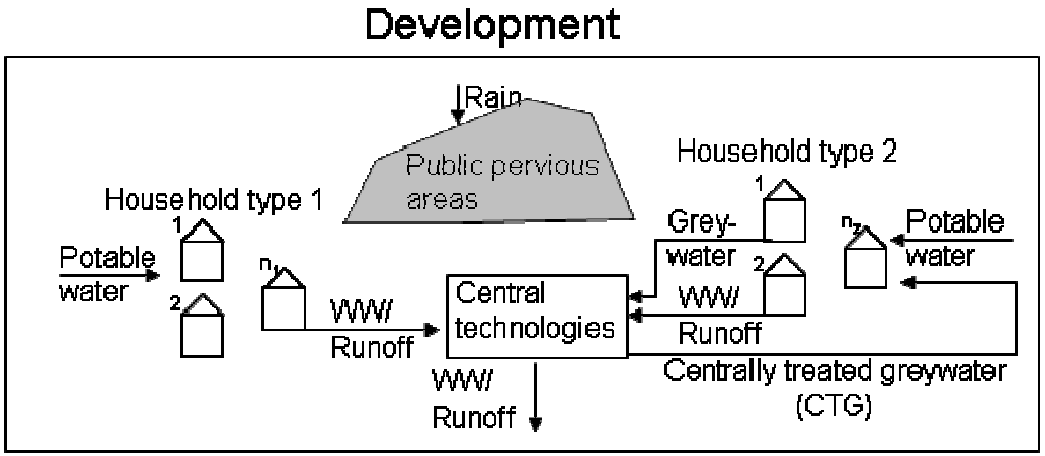
- Rainfall is stochastic
- Demand fluctuates
- System response depends on its present conditions
- Components interaction

Optimization

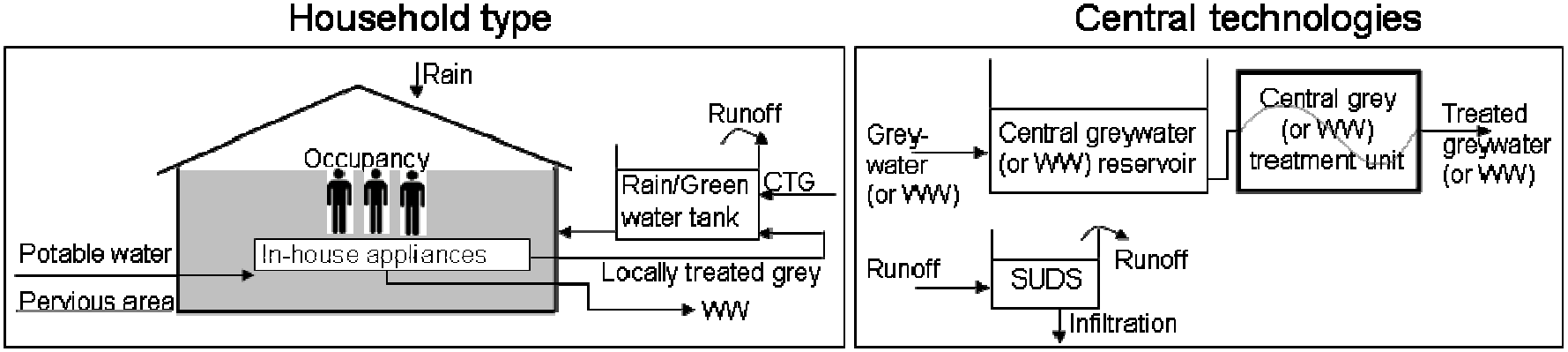
- Parameters, the properties of the system (e.g. capacities, installed appliances)
- State variables, the variables describing the system conditions (e.g. water level of tanks)
- Performance indicators, the aggregation of the system outputs (e.g. potable water demand, costs, energy)

UWOT

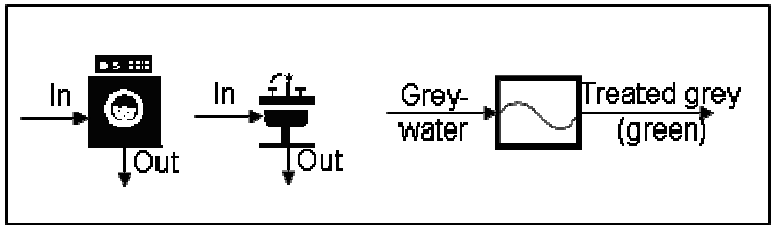
HIGHER LEVEL



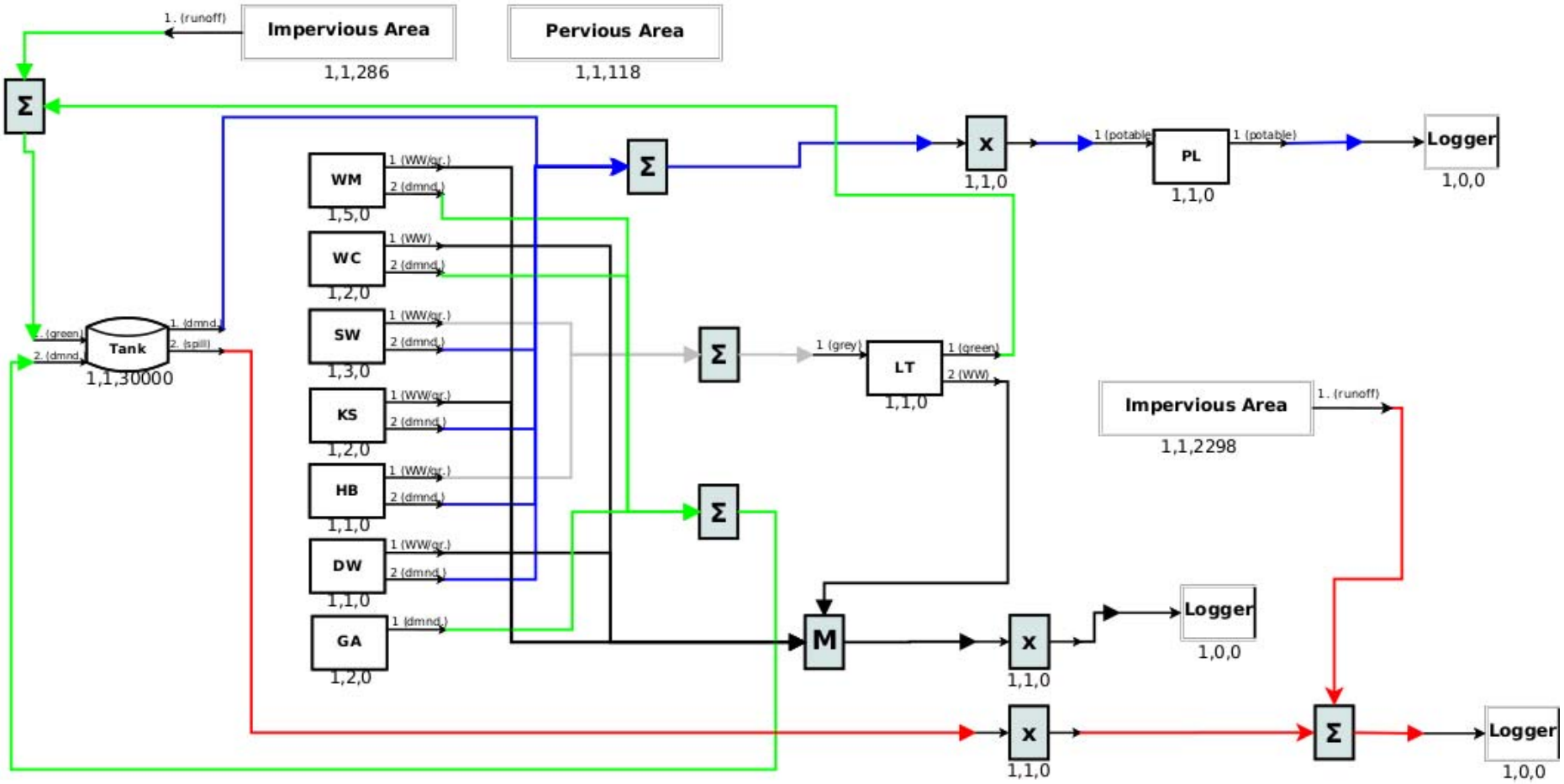
MIDDLE LEVEL



LOWER LEVEL



UWOT


1. (runoff)
Impervious Area
1,1,286
Pervious Area
1,1,118
Σ
WM
1,5,0
WC
1,2,0
SW
1,3,0
KS
1,2,0
HB
1,1,0
DW
1,1,0
GA
1,2,0
1 (WW/gr.)
2 (dmnd.)
1 (WW)
1 (dmnd.)
Tank
1,1,30000
2. (green)
2. (dmnd.)
1. (dmnd.)
2. (spill)
X
1,1,0
1 (potable)
PL
1,1,0
Logger
1,0,0
1 (grey)
LT
1,1,0
1 (green)
2 (WW)
M
Impervious Area
1,1,2298
1. (runoff)

Households of studied area

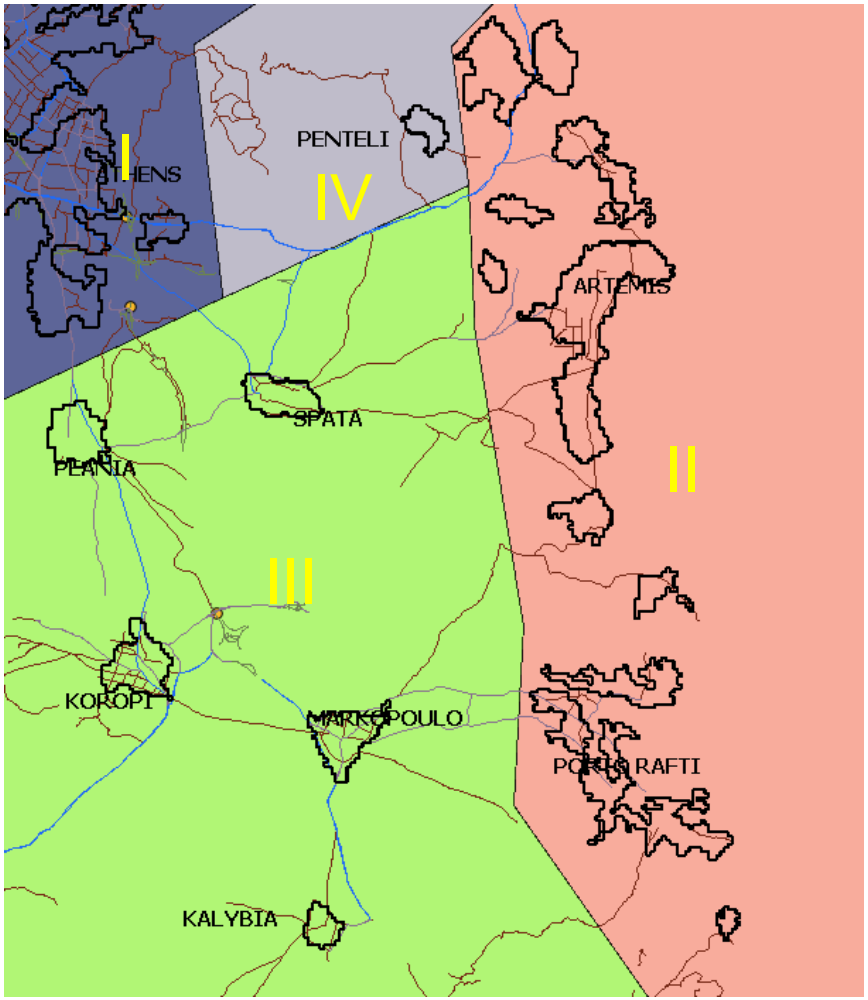
Category I

Category II

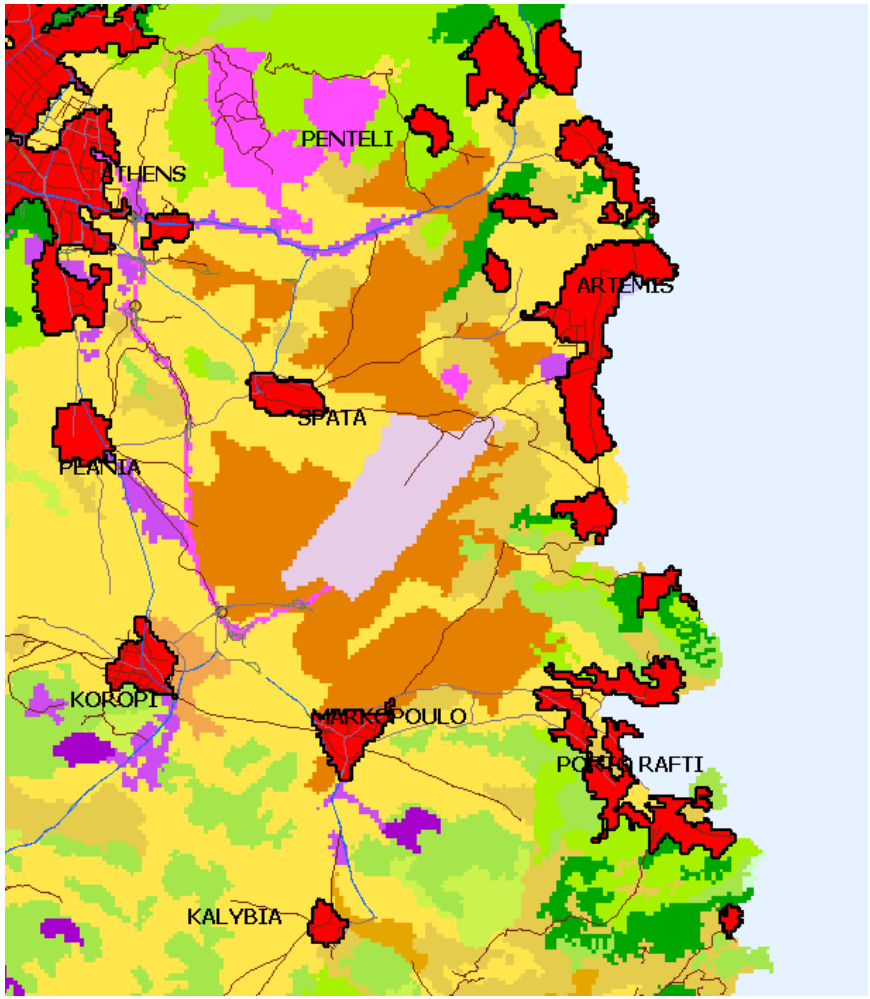
Category III

Category IV

Study area



Dominant categories at studied area



Corine 2000 of studied area

Combination of UWOT with CA

Results of UWOT simulation

		Cat. 1	**Cat. 2**	**Cat. 3**	**Cat. 4**
Potable Demand (L/d)	Innovative	26253	8639	27759	5459
	Conventional	34807	10977	35177	7743
WW Out (L/d)	Innovative	29360	10234	30714	7249
	Conventional	33260	10234	33564	7249
Max Runoff Volume (m^3)	Innovative	650	537	441	681
	Conventional	1037	675	1076	681

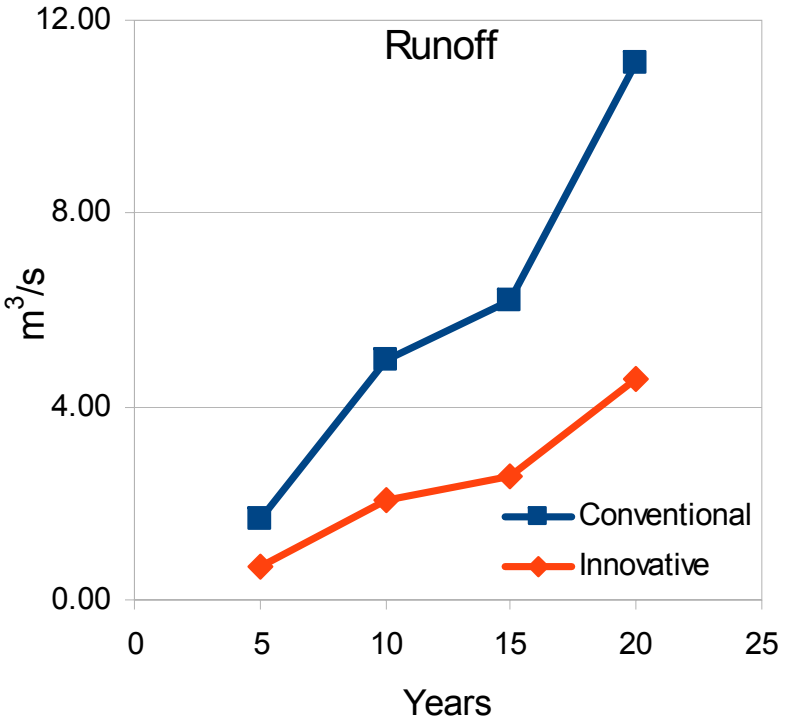
×

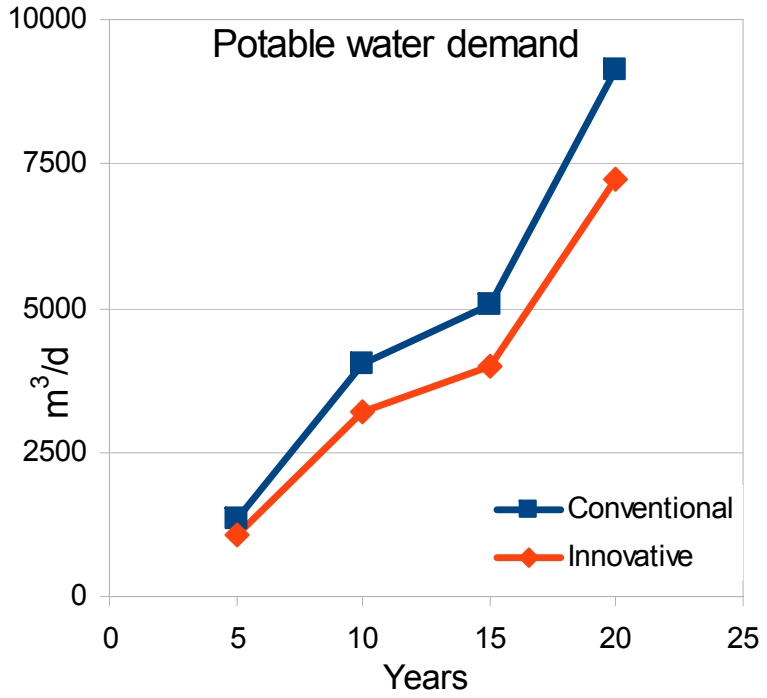
(CA results) ∩ (Municipality boundaries) ∩ (Categories Mask)

	ATHENS	PEANIA	KOROPI	KALYBIA	PENTELI	SPATA	ARTEMIS
Cat. 1	1154	0	0	0	0	0	0
Cat. 2	0	0	0	0	1	1	757
Cat. 3	17	154	260	105	0	135	0
Cat. 4	0	0	0	0	44	0	0

Results/conclusions

Demand forecast for potable water and stormwater drainage for town of Koropi.





Results/conclusions

Runoff peak and the potable water demand can be reduced considerably by a combined scheme that includes rainwater harvesting and local water treatment.

Rainwater harvesting scheme provides considerable reduction of the potable water demand but marginal reduction of the runoff peak

References

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- Xenos, D., I. Passios, S. Georgiades, E. Parlis, and D. Koutsoyiannis, Water demand management and the Athens water supply, *Proceedings of the 7th BNAWQ Scientific and Practical Conference "Water Quality Technologies and Management in Bulgaria"*, Sofia, 44–50, Bulgarian National Association on Water Quality, 2002.