Urban Water Management

Within the module:
Ecology and Water Resources
Summer 2012

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Institut für Wasserwirtschaft,
Hydrologie und
landwirtschaftlichen Wasserbau
Leibniz Universität Hannover

Part 6

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Overview

Contents today: Real time control

- basics
- example

Integrated management and control

- Real time control
  - utilise storage capacity to reduce flooding and pollution
  - operate regulators in real time
  - decision finding needs forecast of rainfall and runoff
    - ⇦ radar data
    - ⇦ measurements (water levels and flow data)
    - ⇦ hydrodynamic modelling for the actual and future states of the system
    - ⇦ automatic computer aided decision finding

- But:
  - potential users are still sceptic
  - depends on available storage capacity
  - needs well defined objectives and priorities

Integrated management and control

Control of urban drainage systems

- static control
  - structural
  - passive
- real time control
  - local
  - global
  - pro-active instead of re-active

    → forecast needed
- forecast
  - rainfall → radar
  - runoff → simulation
  - → flow into the system

Control Concept

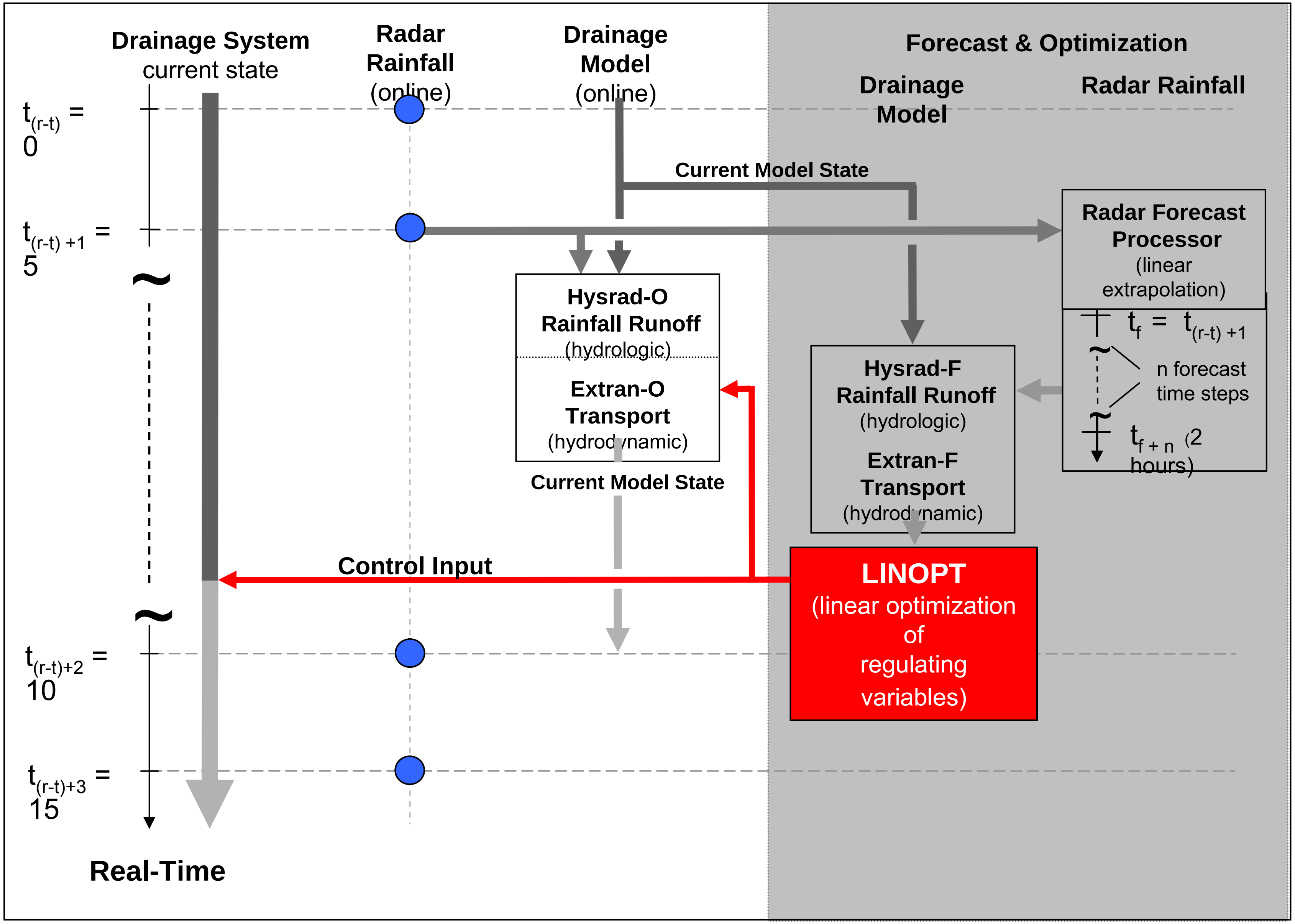
Radar measurement and forecast (nowcasting)

Rainfall runoff simulation - current

- forecast

Decision finding

Control Concept



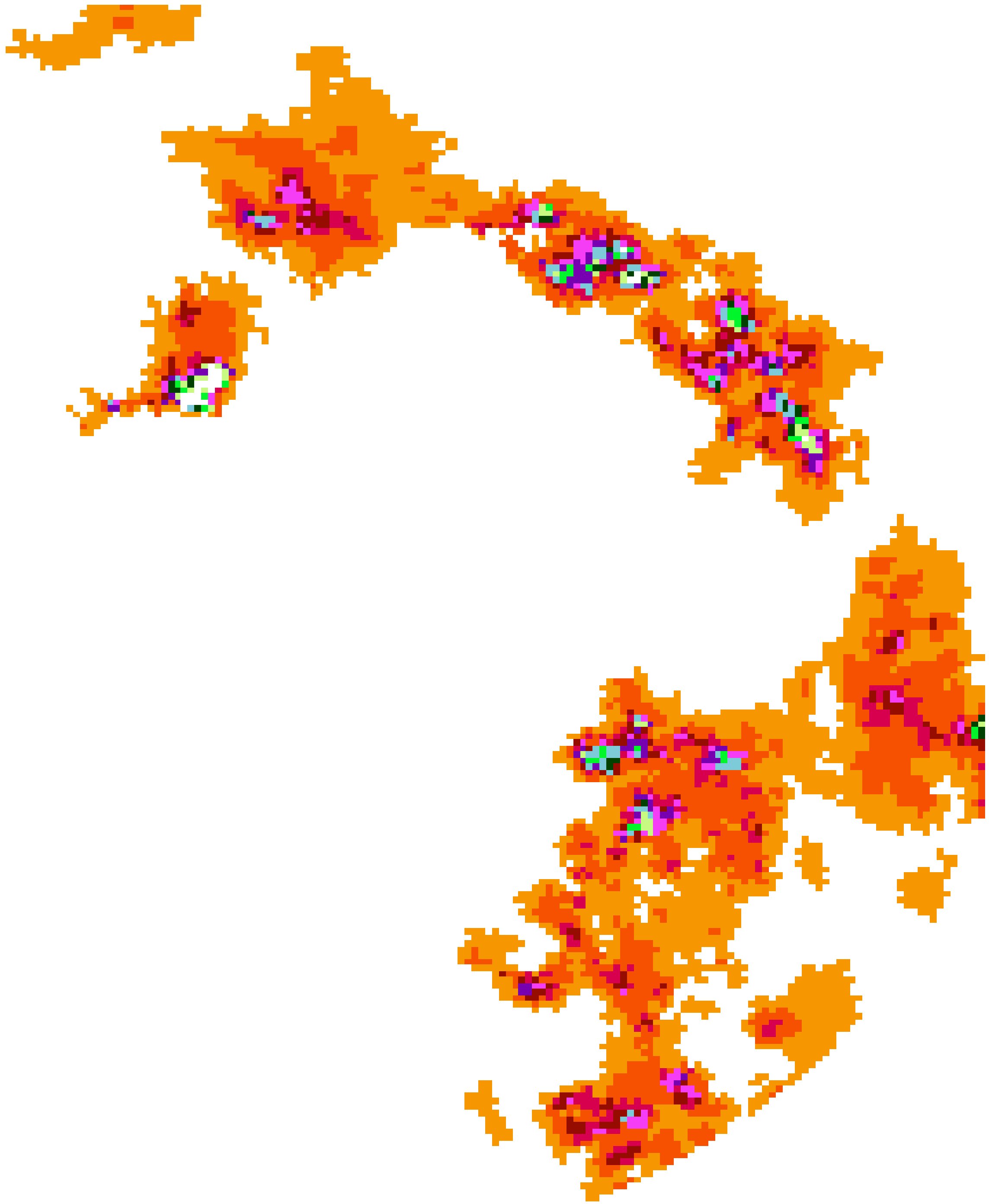
The Radar Rainfall Forecast Processor

Definition of individual storm cells

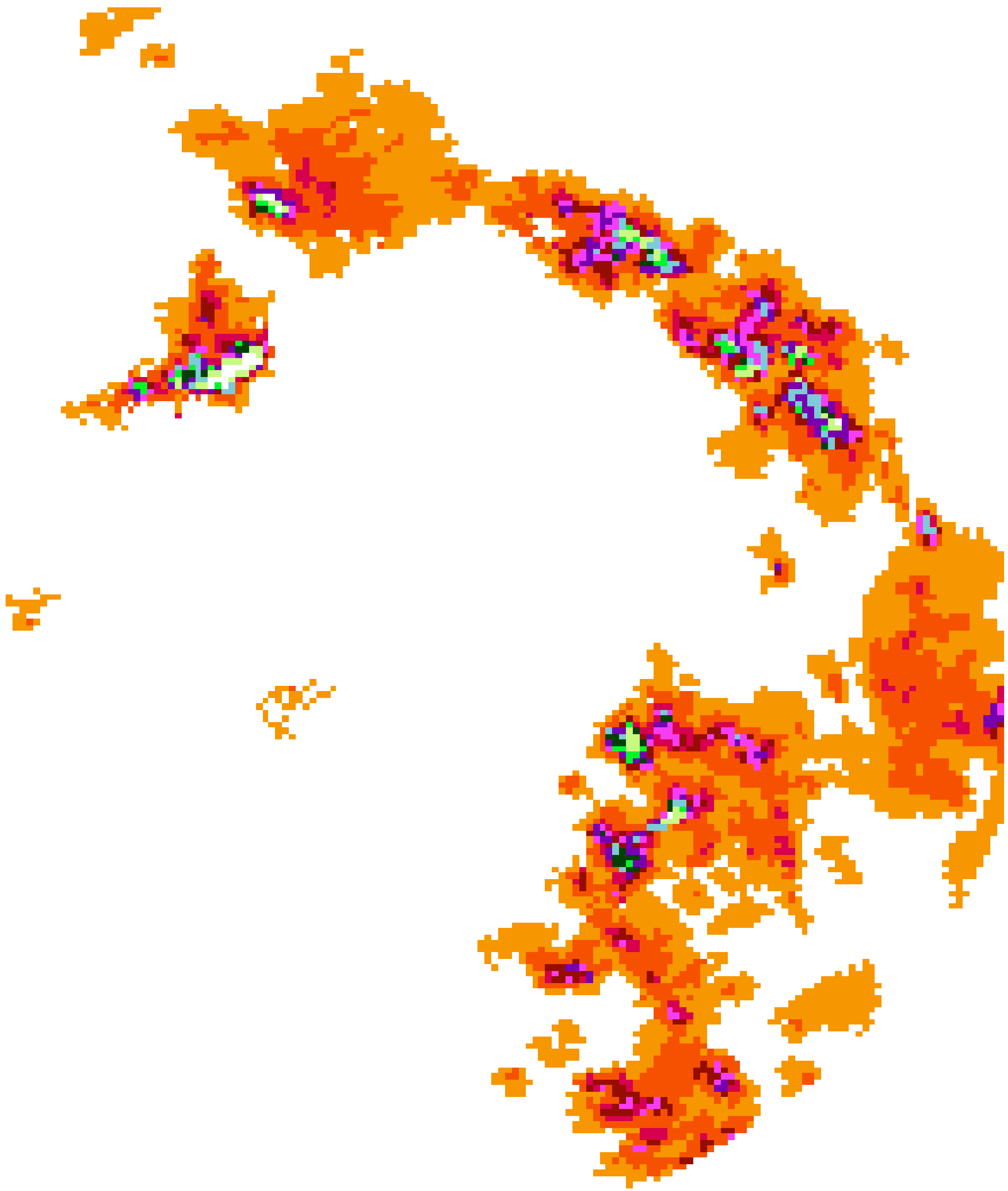
Recognition of individual storm cells in subsequent radar pictures

Calculation of local speed vectors and linear extrapolation

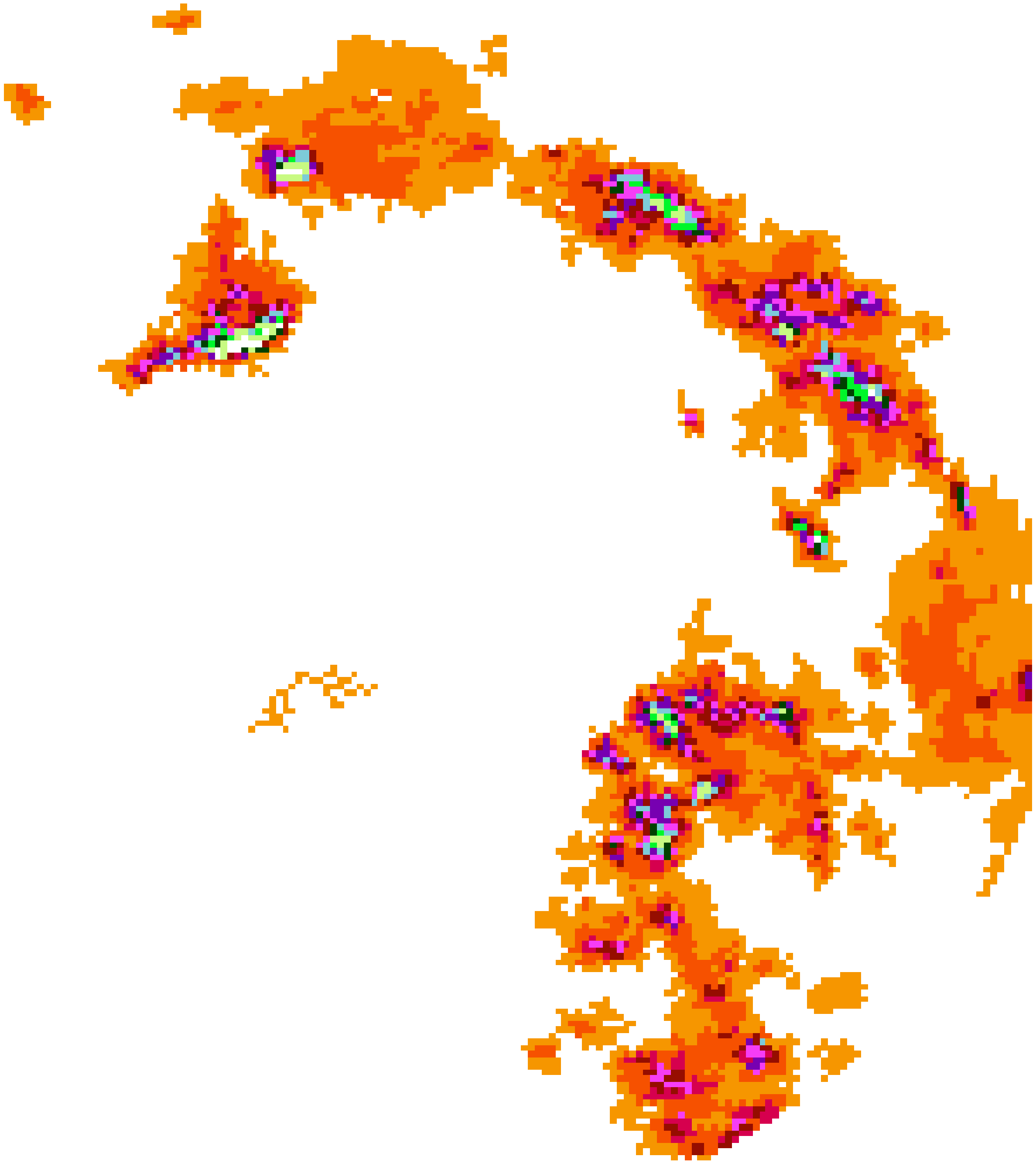
Measurement t - 25’



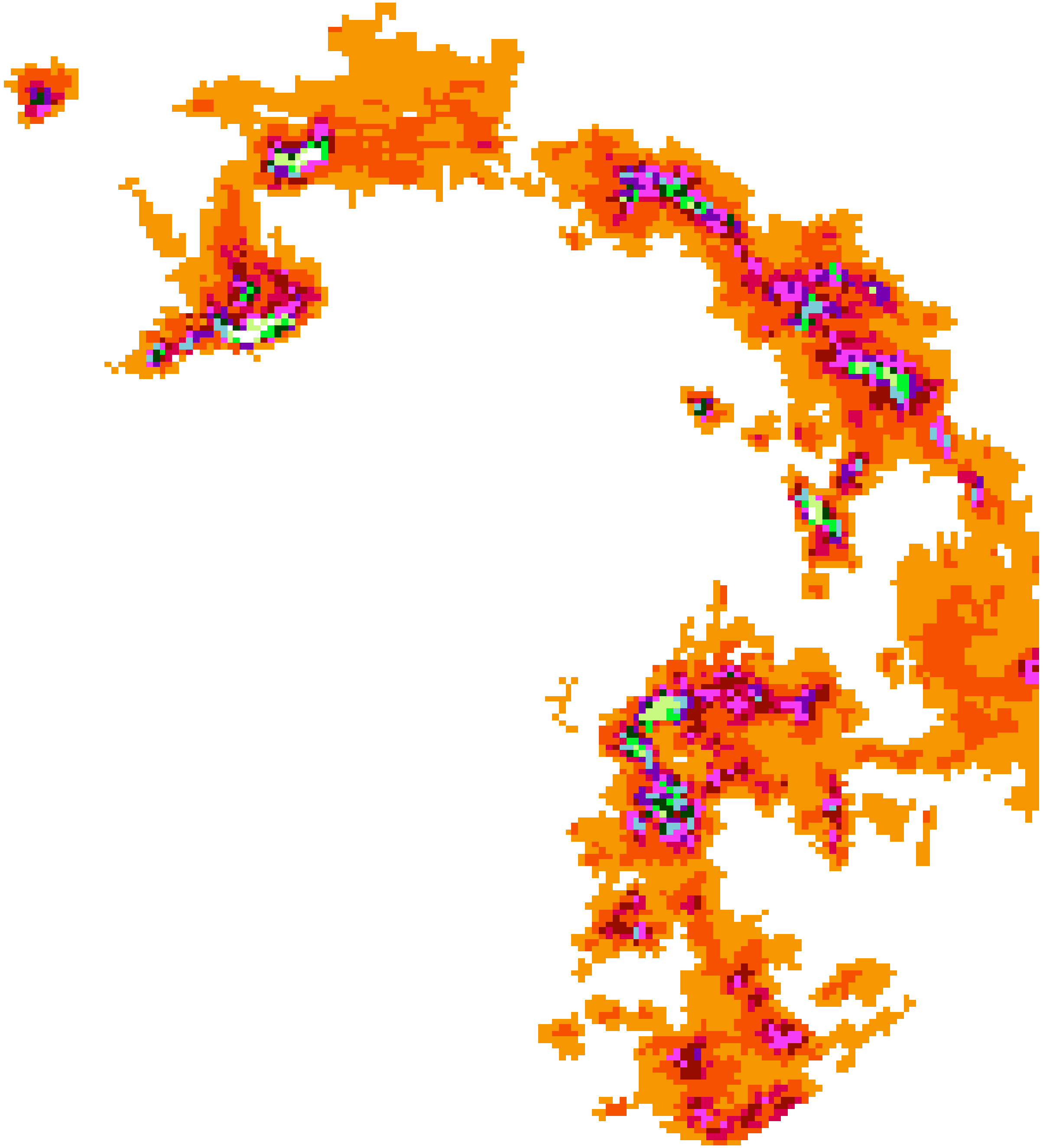
Measurement t - 20’



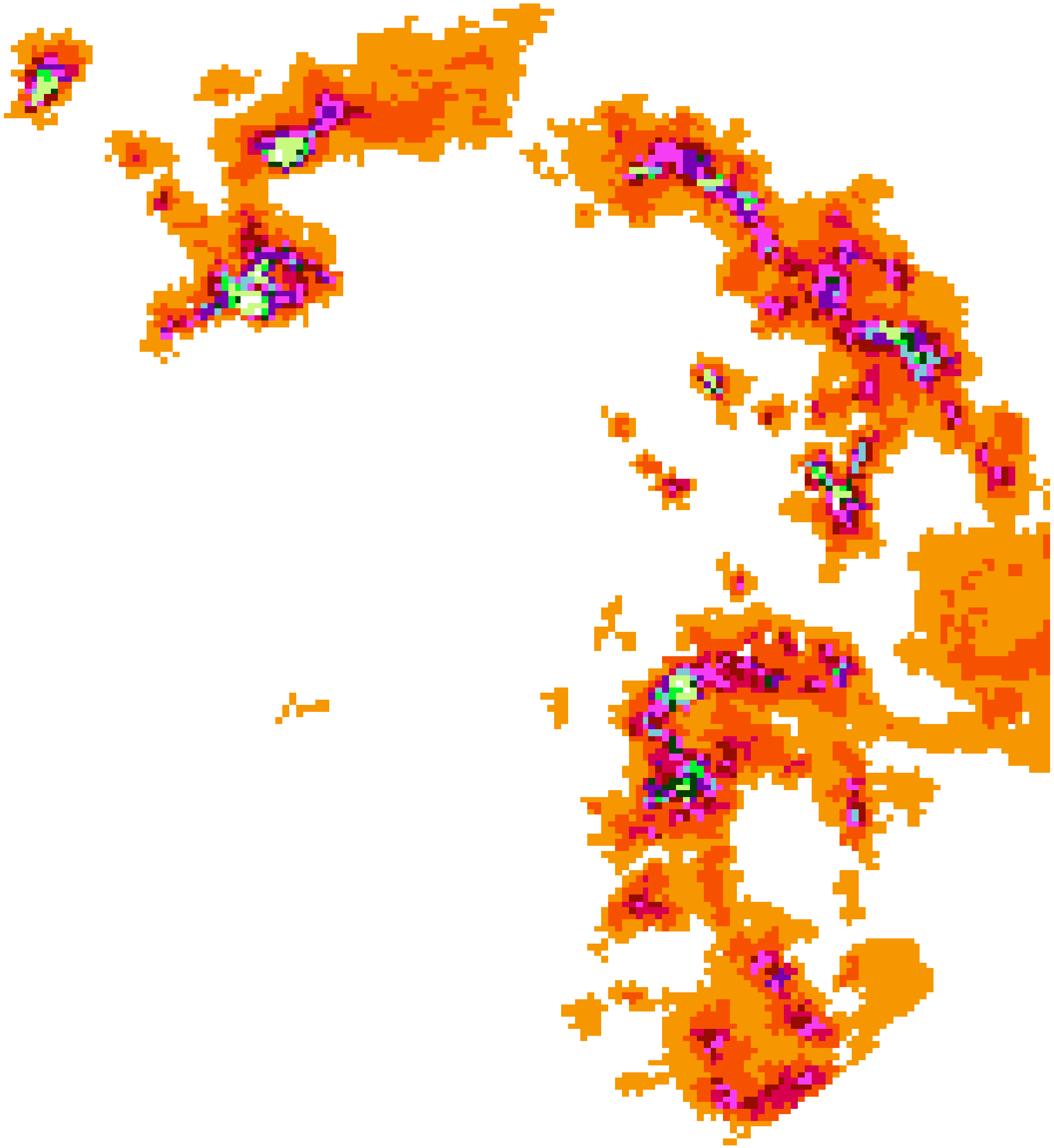
Measurement t - 15’



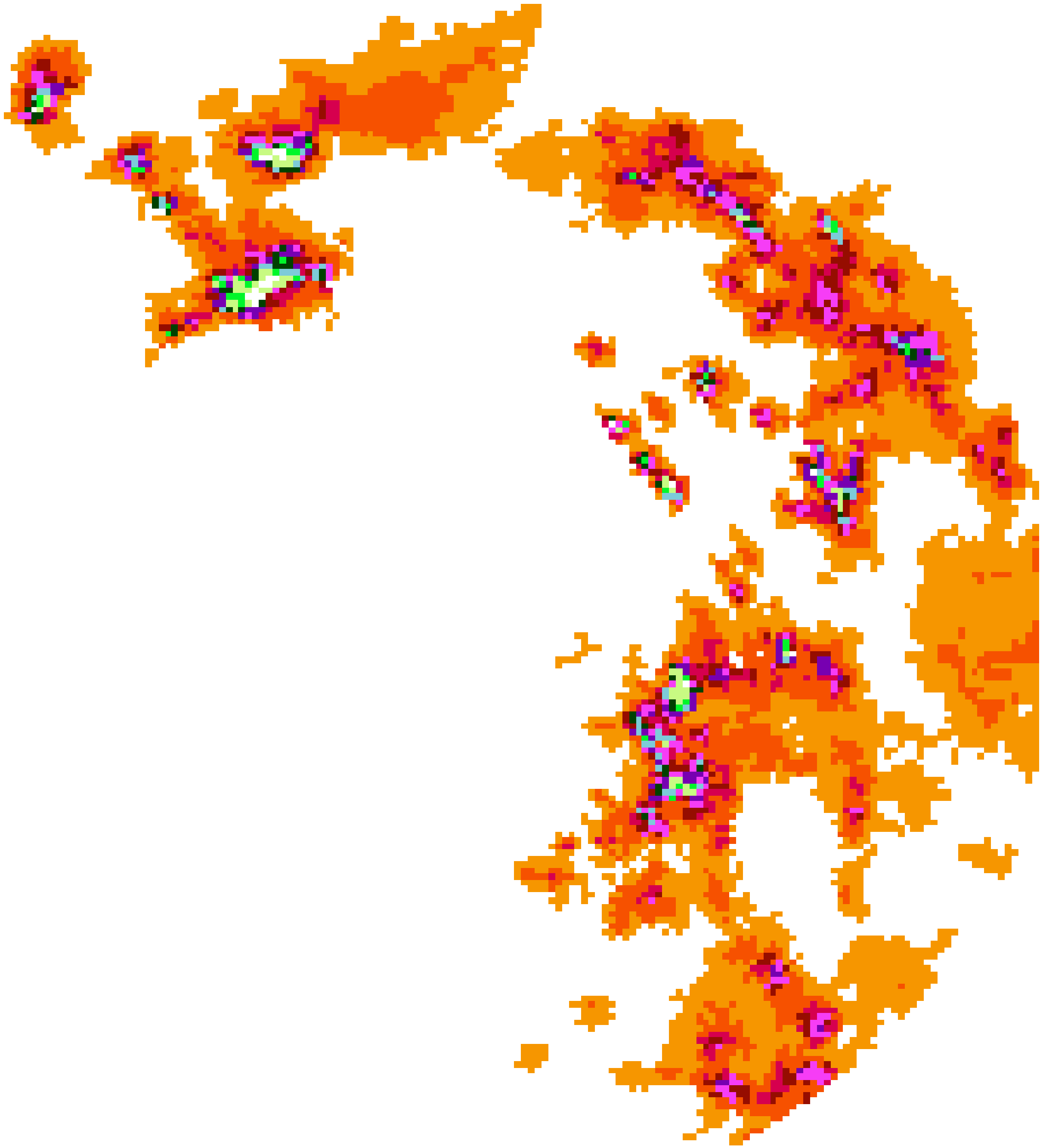
Measurement t - 10'

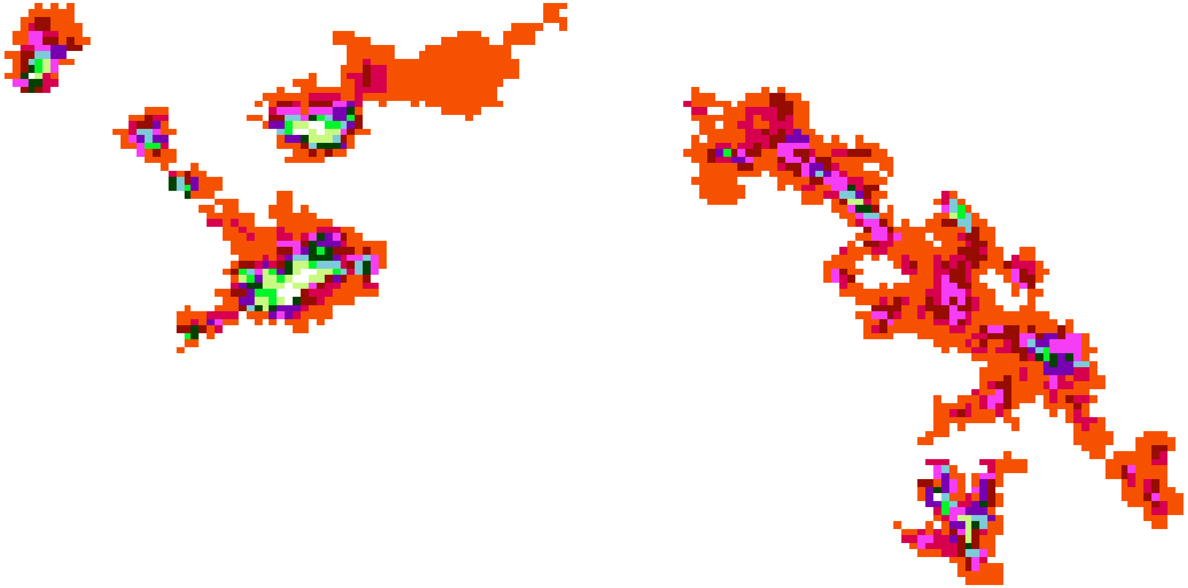


Measurement t - 05’

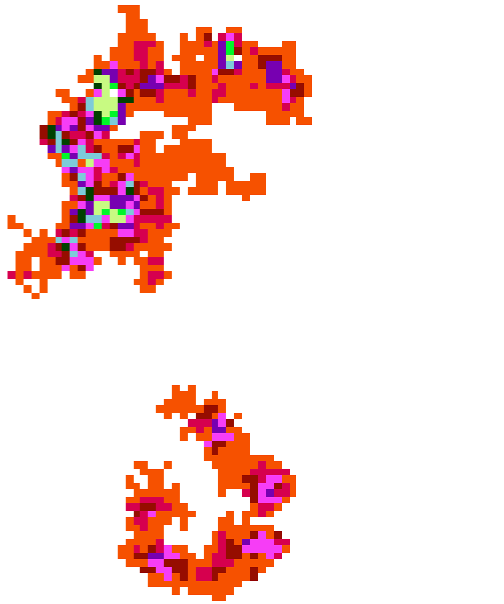


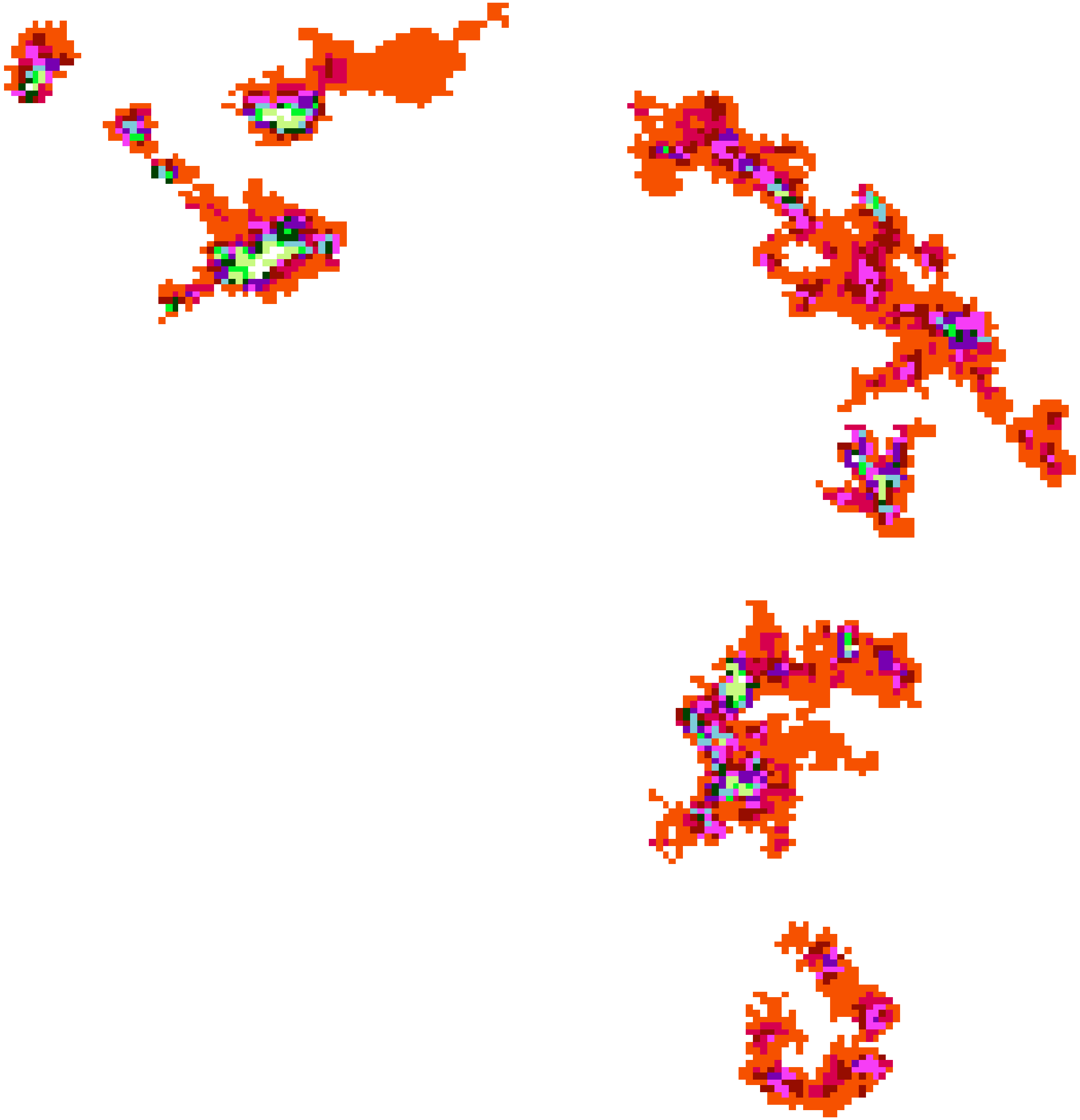
Measurement   t - 00’





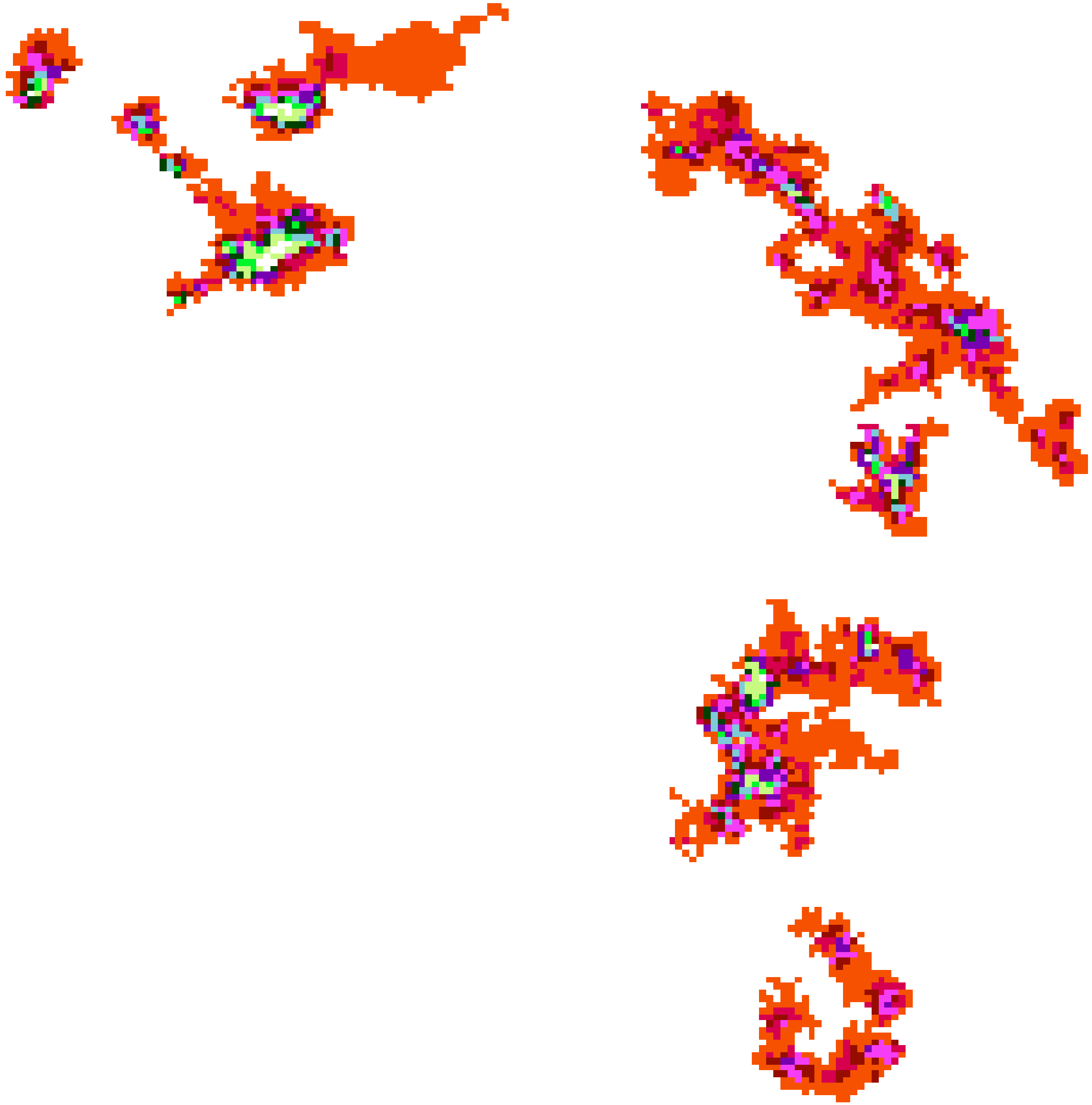
Cell definition t - 00’



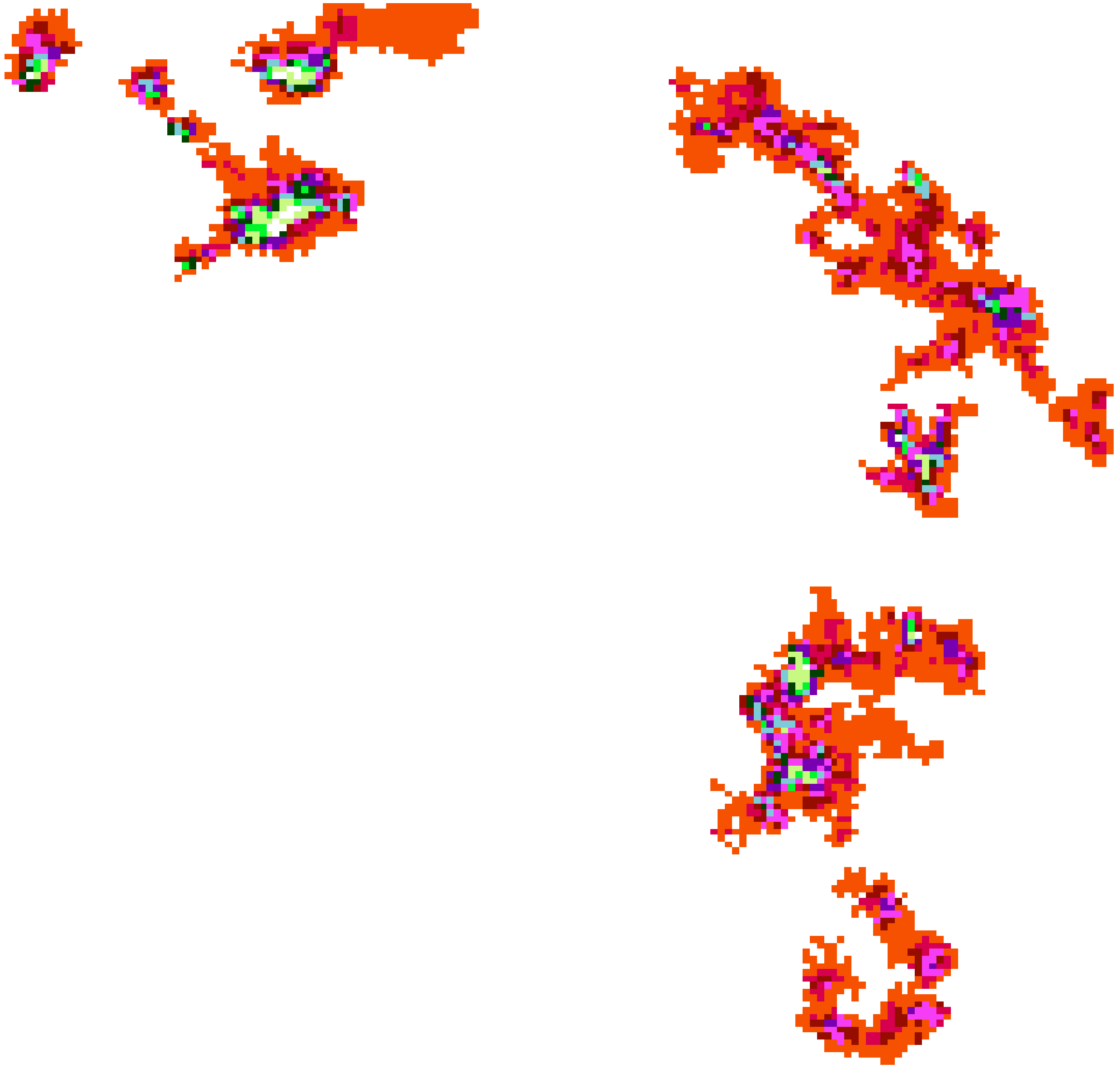


Prognosis t + 05’

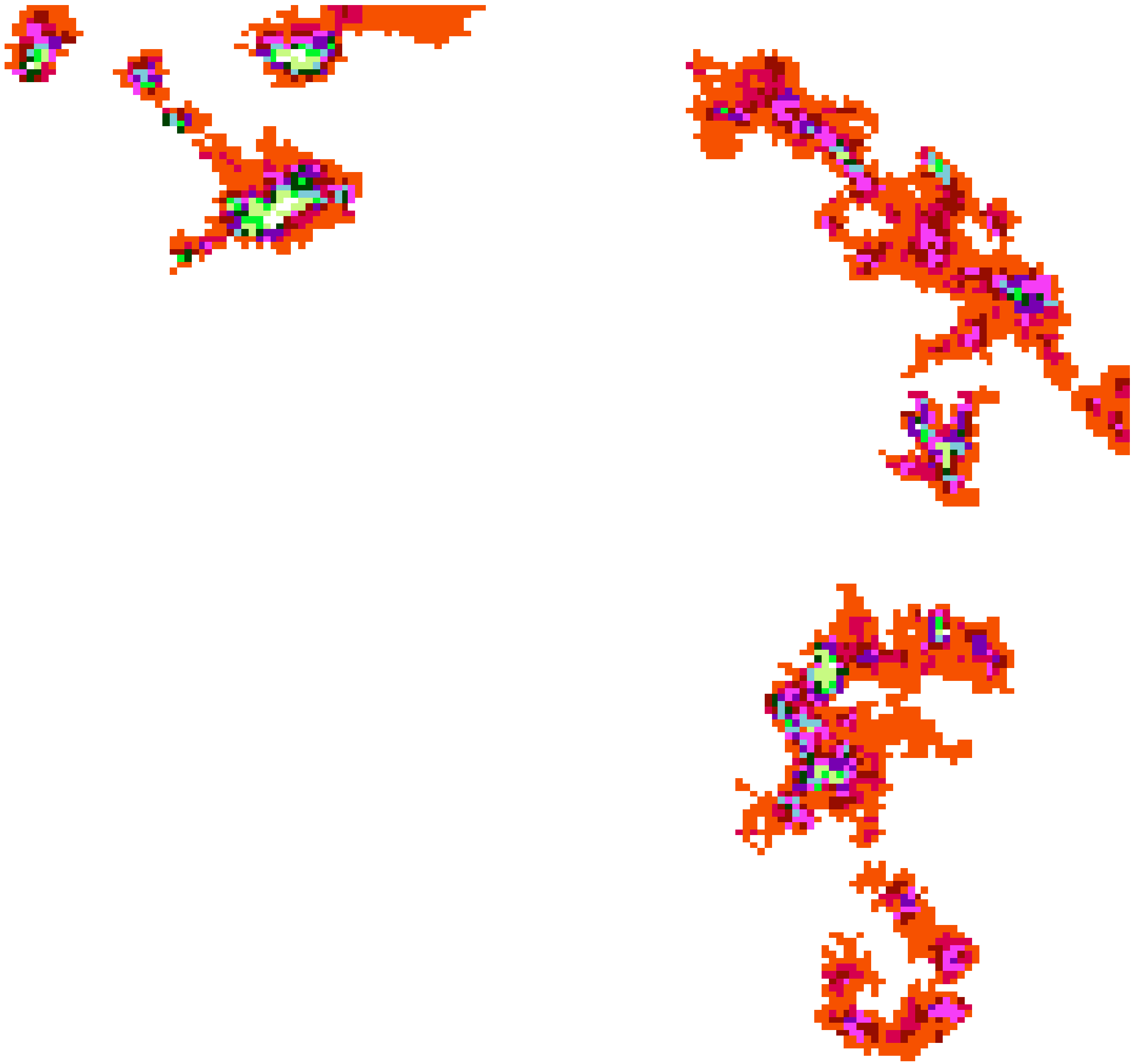
Prognosis t + 10’

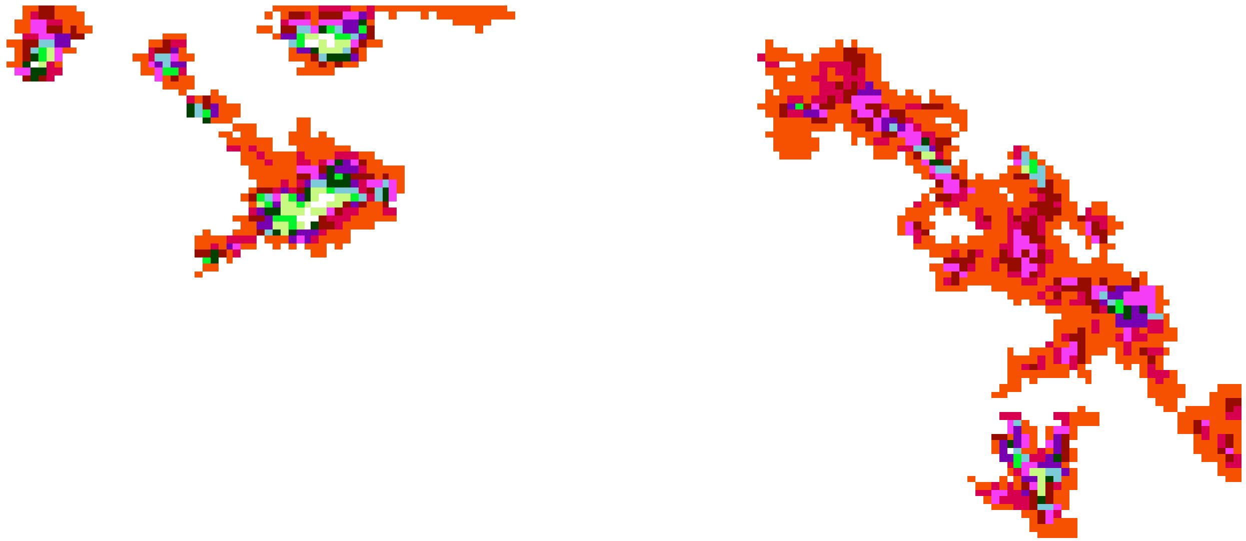


Prognosis t + 15’

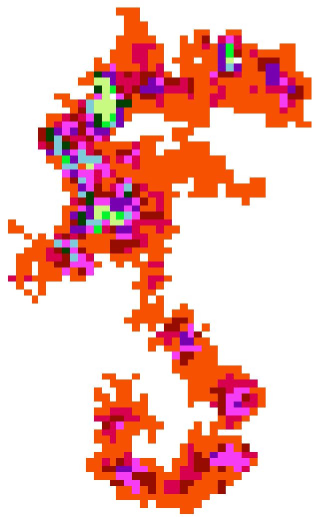


Prognosis t + 20’





Prognosis t + 25’

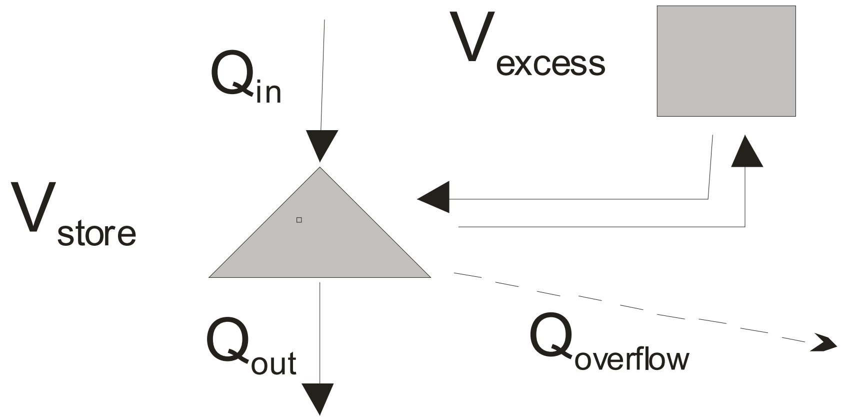


etc …

Decision finding with LINOPT

$$\min \sum_{t=1}^{n} \sum_{k=1}^{m} c_k \cdot V(\text{element}_k)_t$$

with t =1..n forecast horizon
k=1..m system elements



The capacity constraints may be given as Q_{out} = 3,5 m³/s ; V_{store} = 9800 m³ ; V_{excess} = unlimited.

The dynamic constraint or node equation is

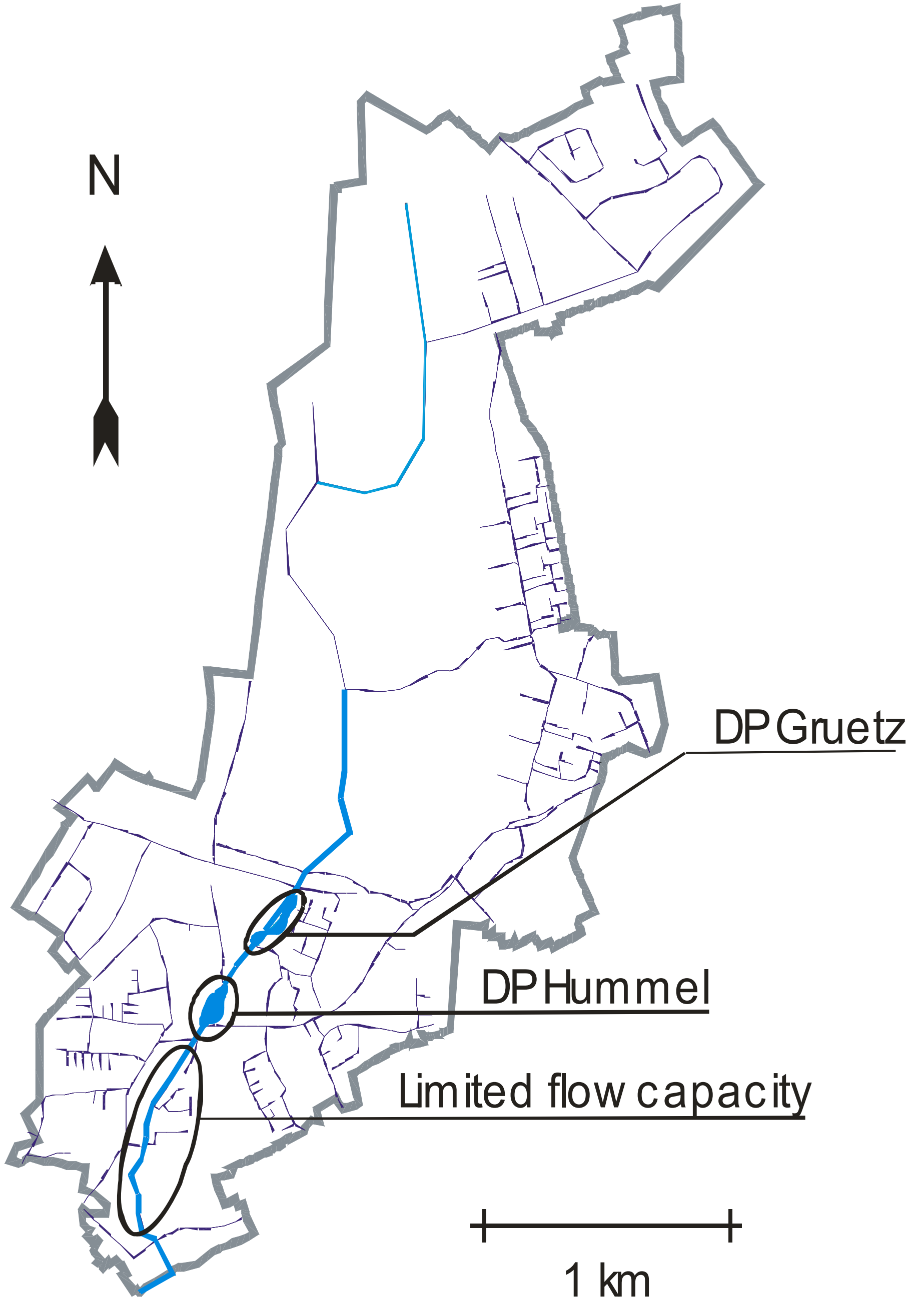
$$V_{store,t} - V_{store,t-1} + V_{excess,t} - V_{excess,t-1} + \left(Q_{out} - Q_{in} \cdot \{+ Q_{overflow}\}\right) \cdot \Delta t = 0$$

The Catchment

Natural creek
(dry weather flow ~50 l/s)

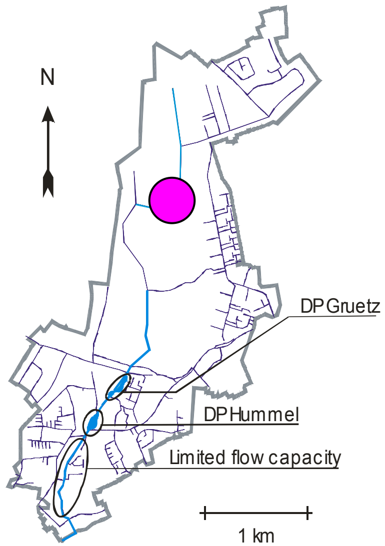
receiving storm sewer runoff

Total area	620 ha
Sewered area	383 ha
Impervious	152 ha

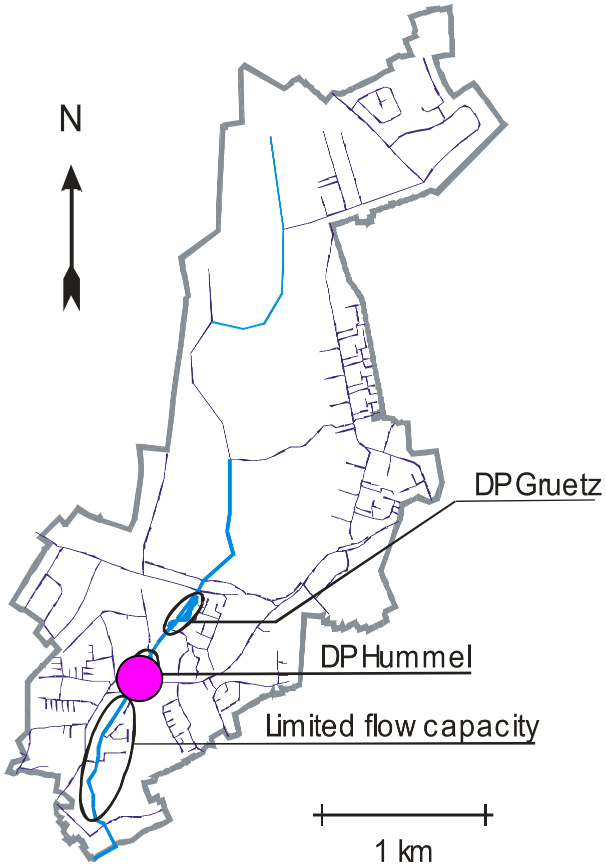


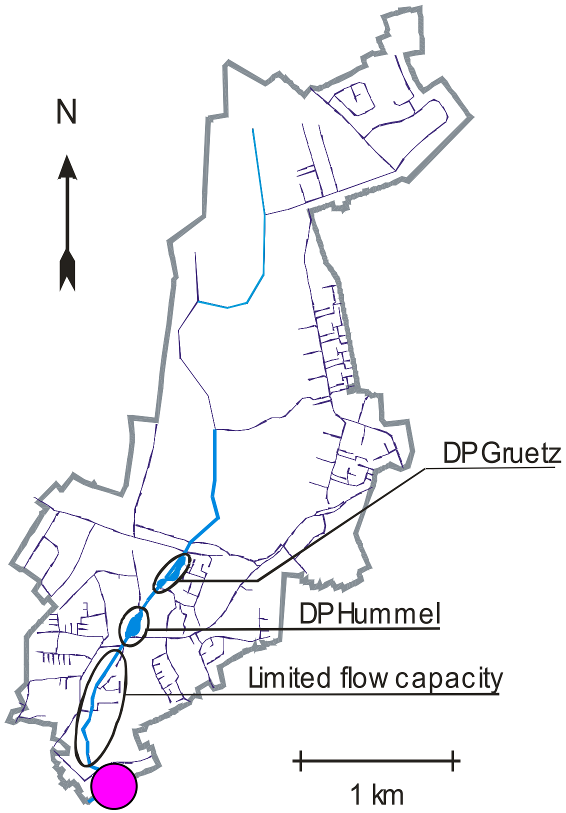

N
DP Gruetz
DP Hummel
Limited flow capacity
1 km


N
DP Gruetz
DP Hummel
Limited flow capacity
1 km

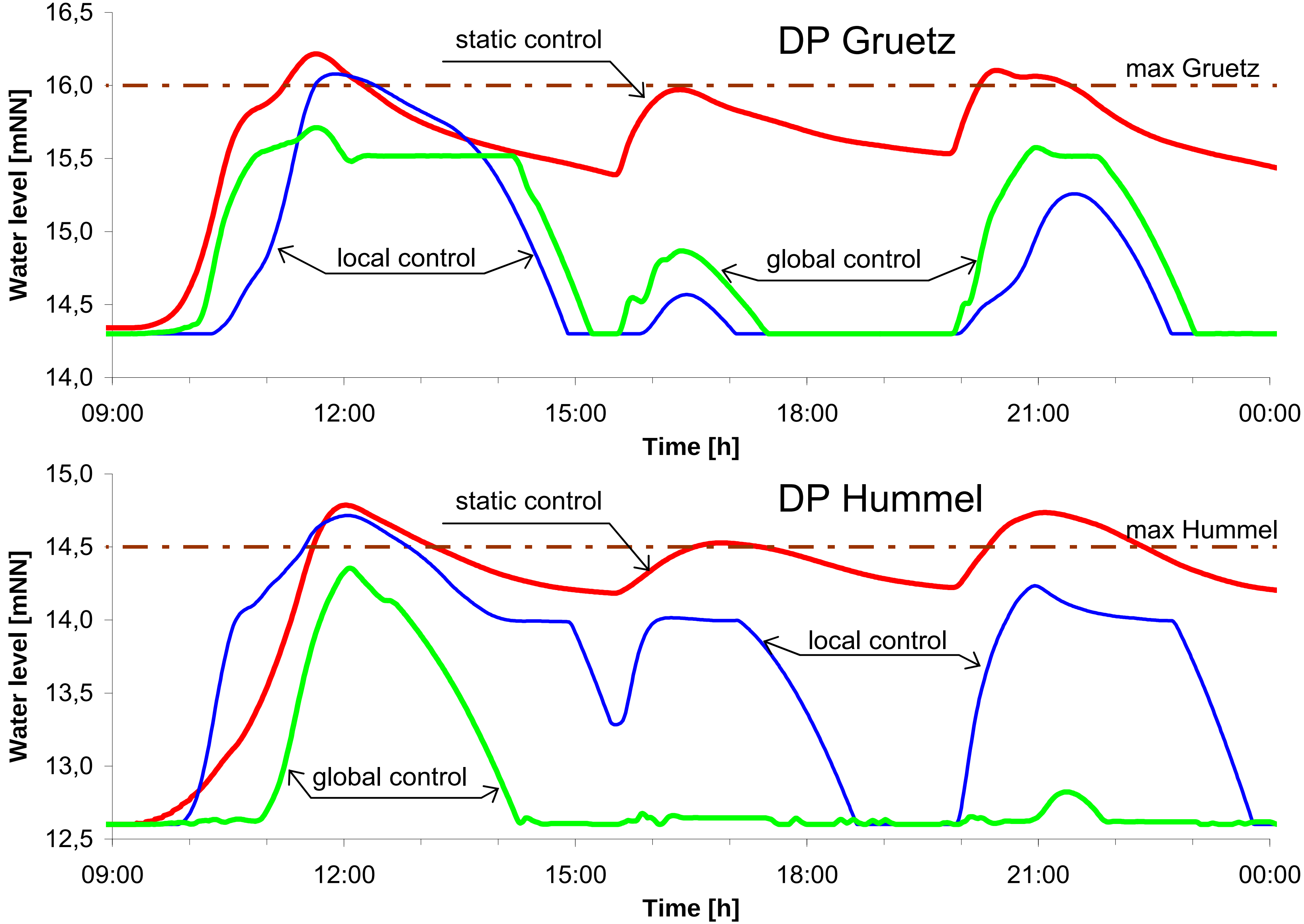


N
DP Gruetz
DP Hummel
Limited flow capacity
1 km

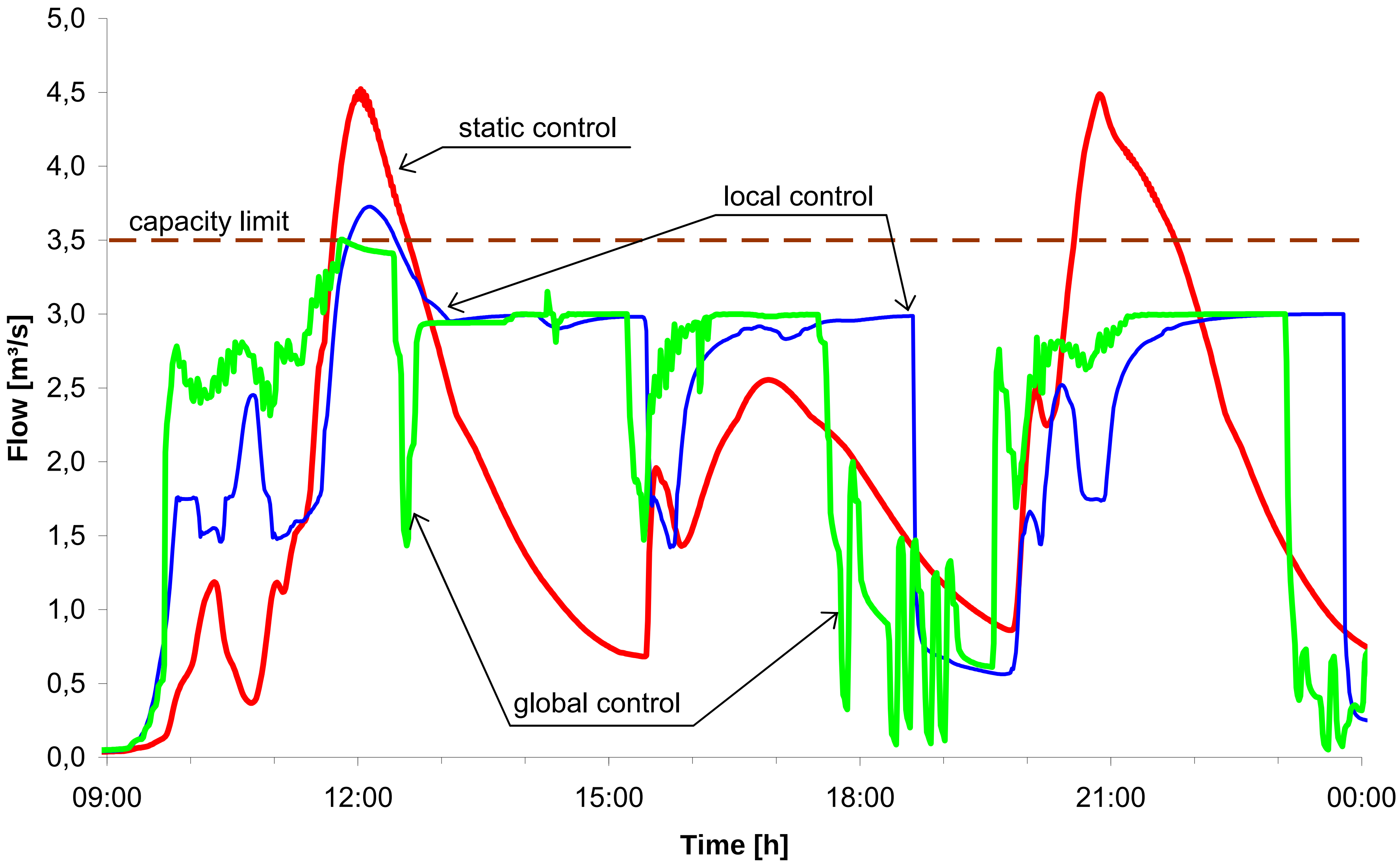

N
DP Gruetz
DP Hummel
Limited flow capacity
1 km

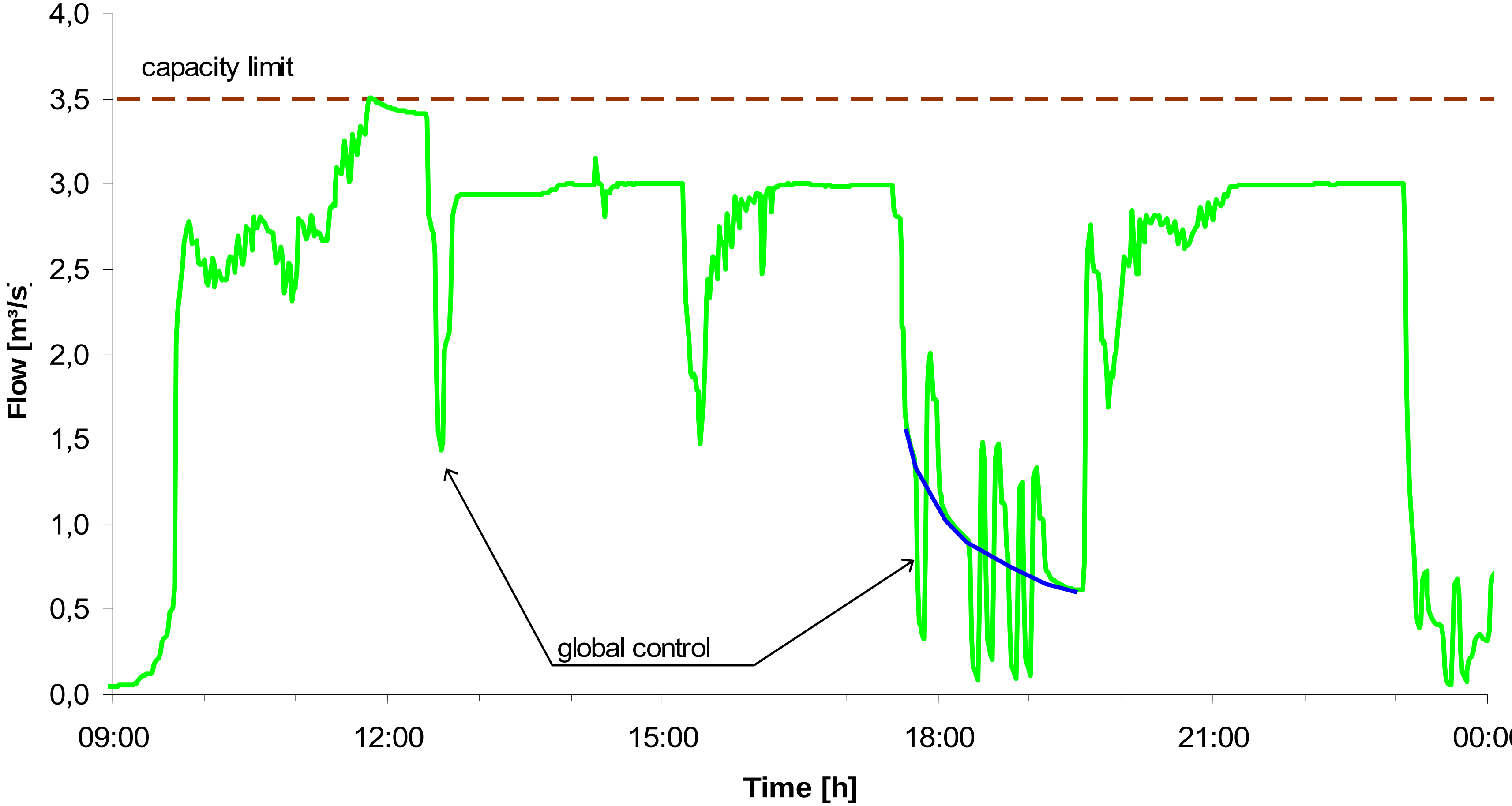

N
DP Gruetz
DP Hummel
Limited flow capacity
1 km

Water Levels for Control Types



Flow below DP Hummel





4,0
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0,0
capacity limit
Flow [m³/s]
global control
09:00
12:00
15:00
18:00
21:00
00:00
Time [h]

Conclusions

The advantage of global control is evident

Oscillations of the set points

→ are due to linear/hydrodynamic modelling

→ should be dampened

Control strategy depends on cost factors

e.g. priorities for DPs Gruetz and Hummel

Further improvement is expected
by coupling with a knowledge based system