Crisis Simulation in the European Gas Transmission System

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GEmFlow

- Monte-Carlo approach (statistical analysis and/or optimization)
- Time dependency
- Duration and consumption test
- Daily balancing
- Balanced system – disruption – restoring balance
- Inflow: cross-border pipelines, storages, production, LNG
- Outflow: cross-border pipelines, demand - critical consumption [the larger quantity of system operability (e.g. to maintain minimum pressure) and protected consumption needed]

Assumptions & scenarios

- General assumptions
  - extreme (1-in-20 years) weather conditions in the beginning of January at a country level, for all countries
  - cut of the supply from the Ukraine
  - duration 30 days

- Optimizing flows to consumption

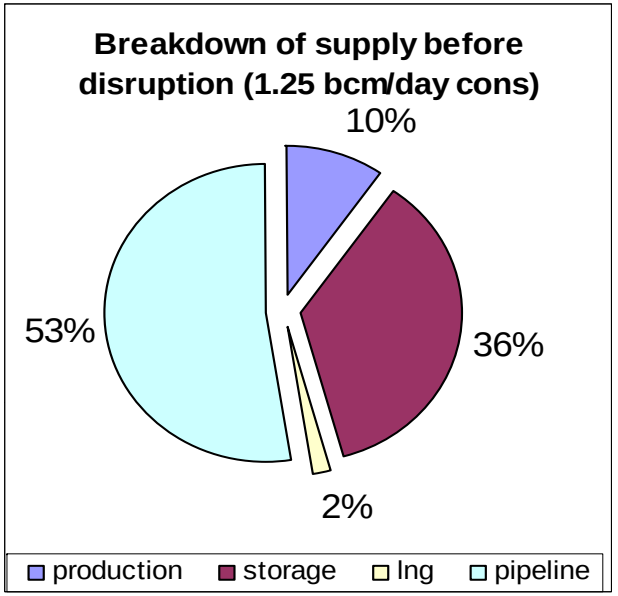
  What is the highest level of consumption for a set period?

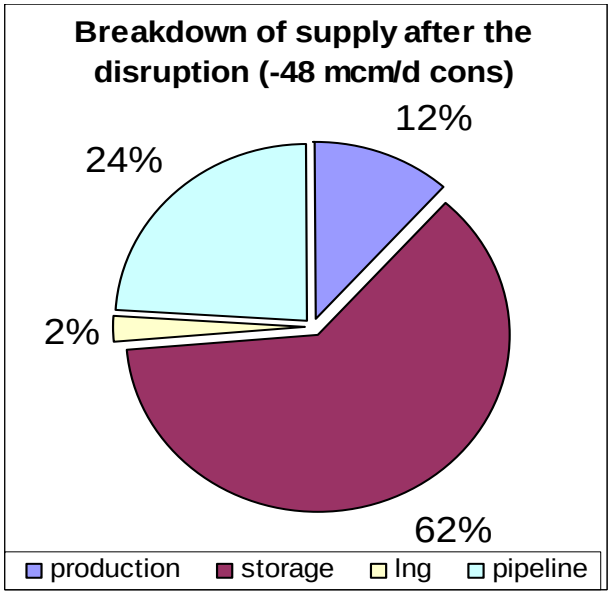
  What is the range of distribution of consumption loss in a set period?

Results – Ukraine

Affected countries: Germany, Poland, Czech Republic, Slovakia, Italy, Slovenia, Austria, Hungary, Romania, Croatia, Bosnia and Herzegovina, Serbia, Bulgaria, Macedonia, Greece

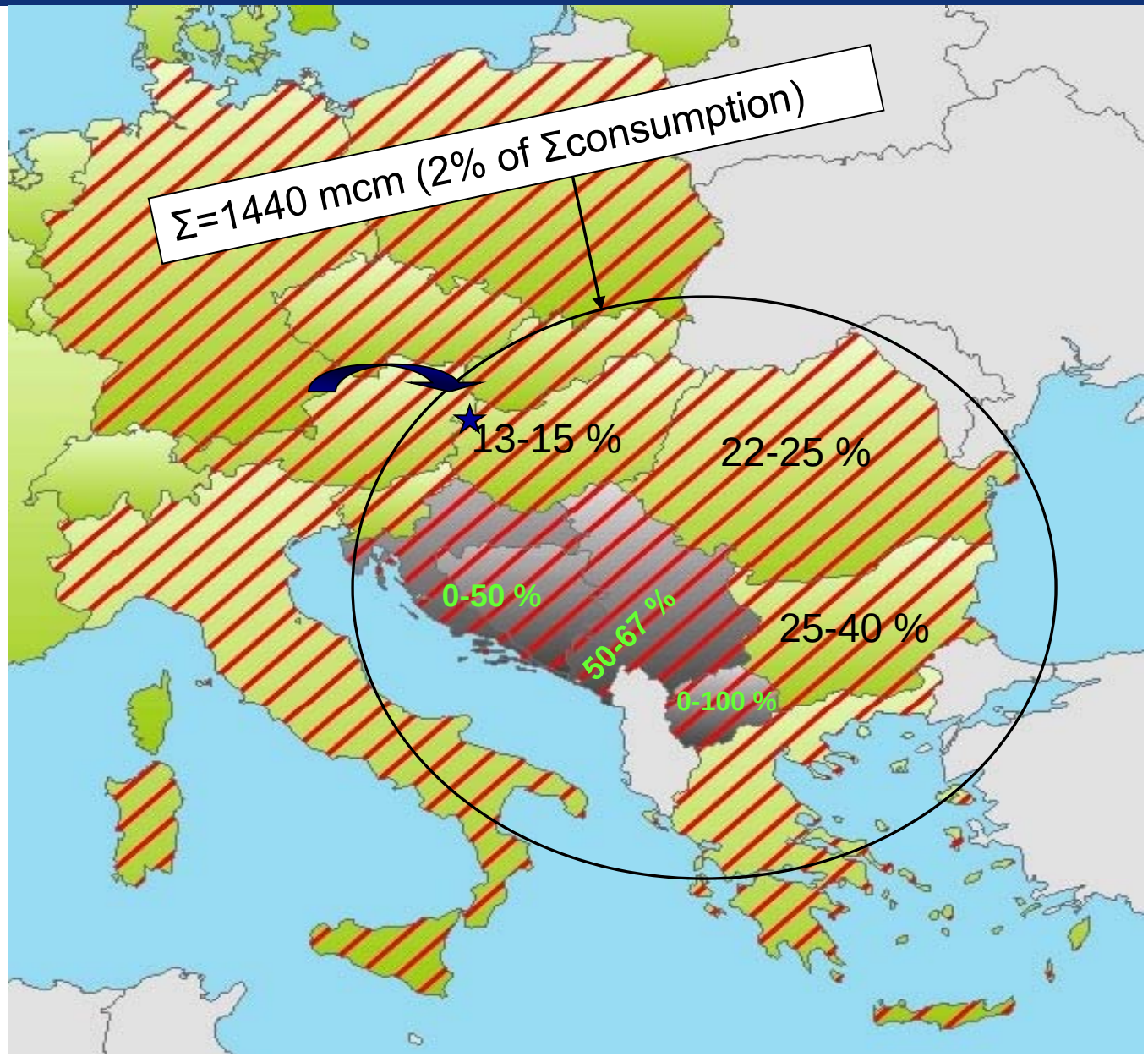
Changes in natural gas balance (mcm/day)					
	consumption	production	storage	lng	pipeline
Austria	0	1.3	17	0	-18
Bulgaria	-5	0	0	0	-5
Czech Republic	0	0	21	0	-21
Germany	0	0	130	0	-130
Greece	0	0	0	3	-3
Hungary	-15	0	15	0	-30
Italy	0	0	104	0	-104
Poland	0	0	4	0	-4
Romania	-18	12	7	0	-37
Slovakia	0	0	2	0	-2
Slovenia	0	0	0	0	0
Bosnia	-1	0	0	0	-1
Serbia	-8	0	0	0	-8
Croatia	0	3	0	0	-3
Macedonia	-1	0	0	0	-1





Results – Ukraine

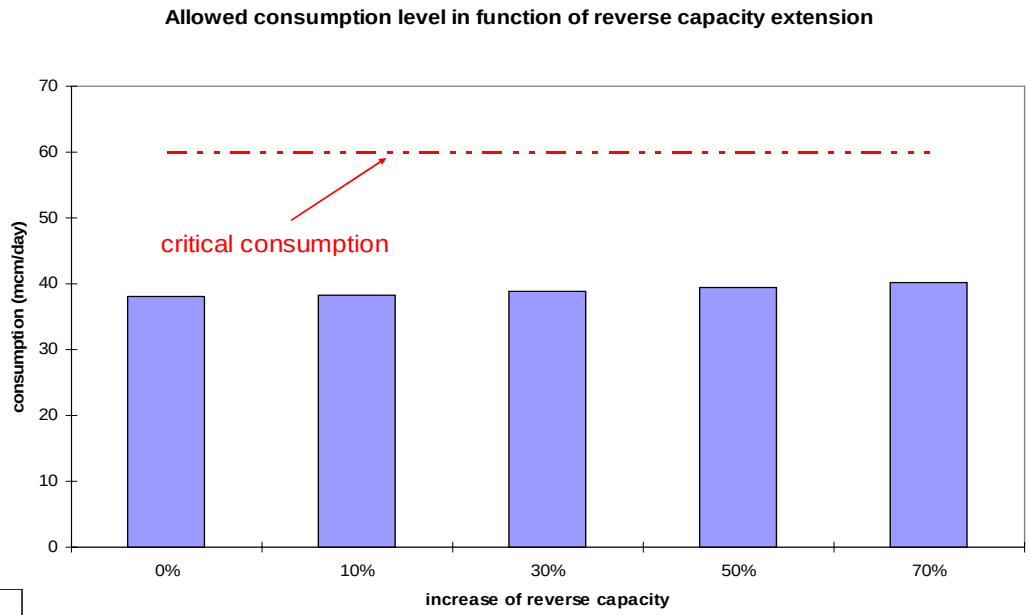
Assumption: -7 mcm/day to the reduced demand of the group of HU, RO, BG, BA, RS, FYROM

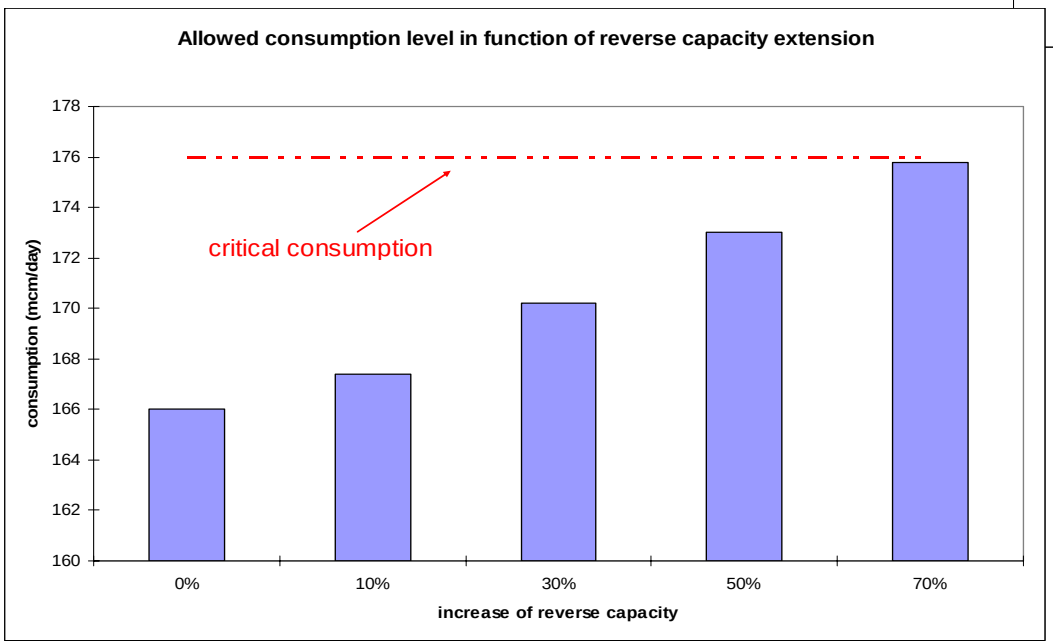


Ukraine & Belarus – reverse flows

1. case

- DE-PL direction
- initial capacity 3 mcm/day
- critical consumption of PL is 60 mcm/day





2. case

- AT-HU direction
- initial capacity 14 mcm/day
- critical consumption of the region is 176 mcm/day

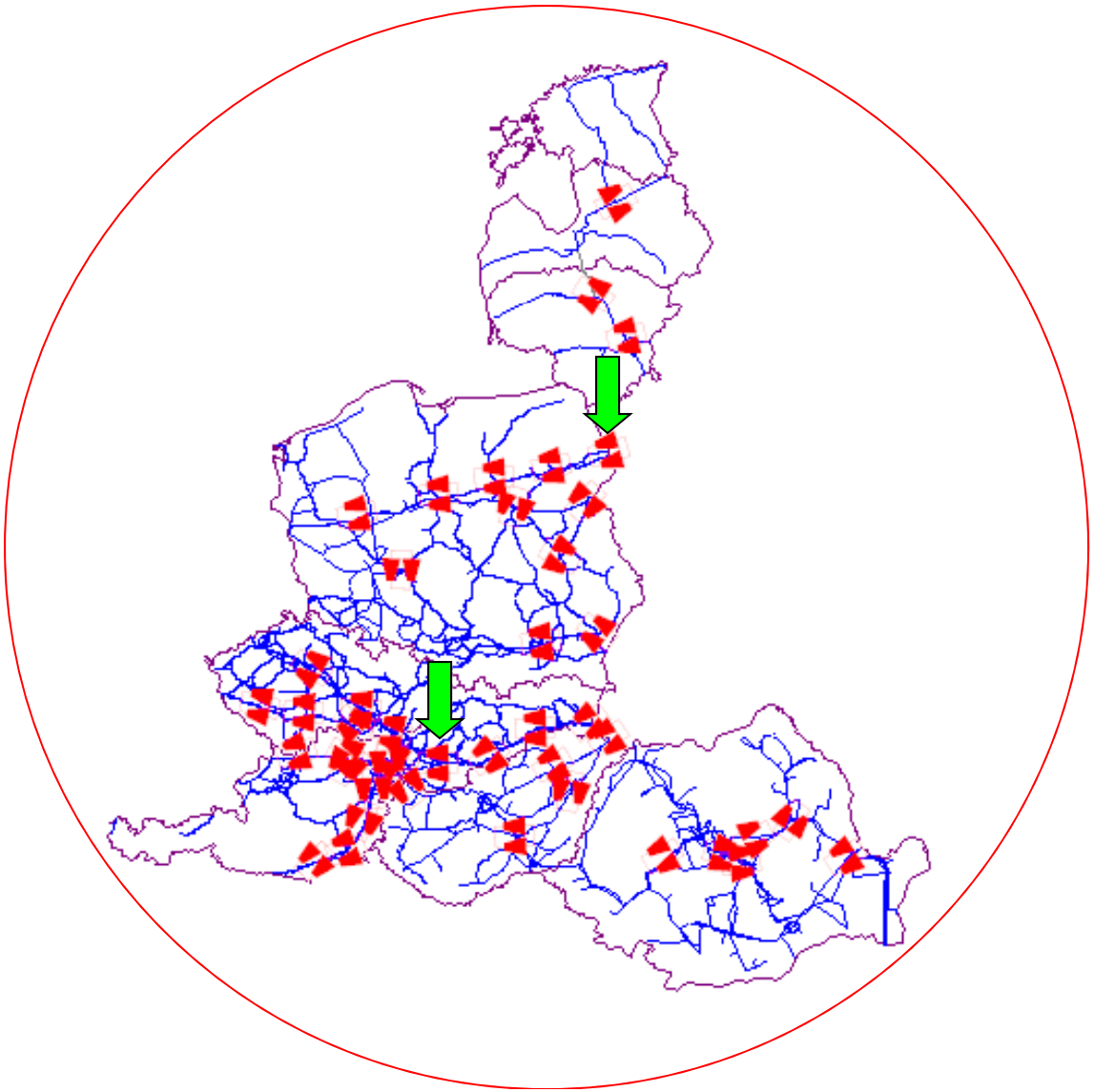
Technical simulations

- Technical (hydraulic) model
- 9 countries' system at present
- Several simulation options
    - Extreme weather conditions
    - Disruptions (technical, political, cyber, etc.)
    - New infrastructures
- Extendable

Methodology

- Focus on the high pressure transportation system and daily balancing
- Demand set to the highest level in the last 20 years
- Construct the baseline (pre-crisis) status of the natural gas system
- Simulate a disruption
- Facilitate possible countermeasures in order to restore balance in the system with the least possible cost

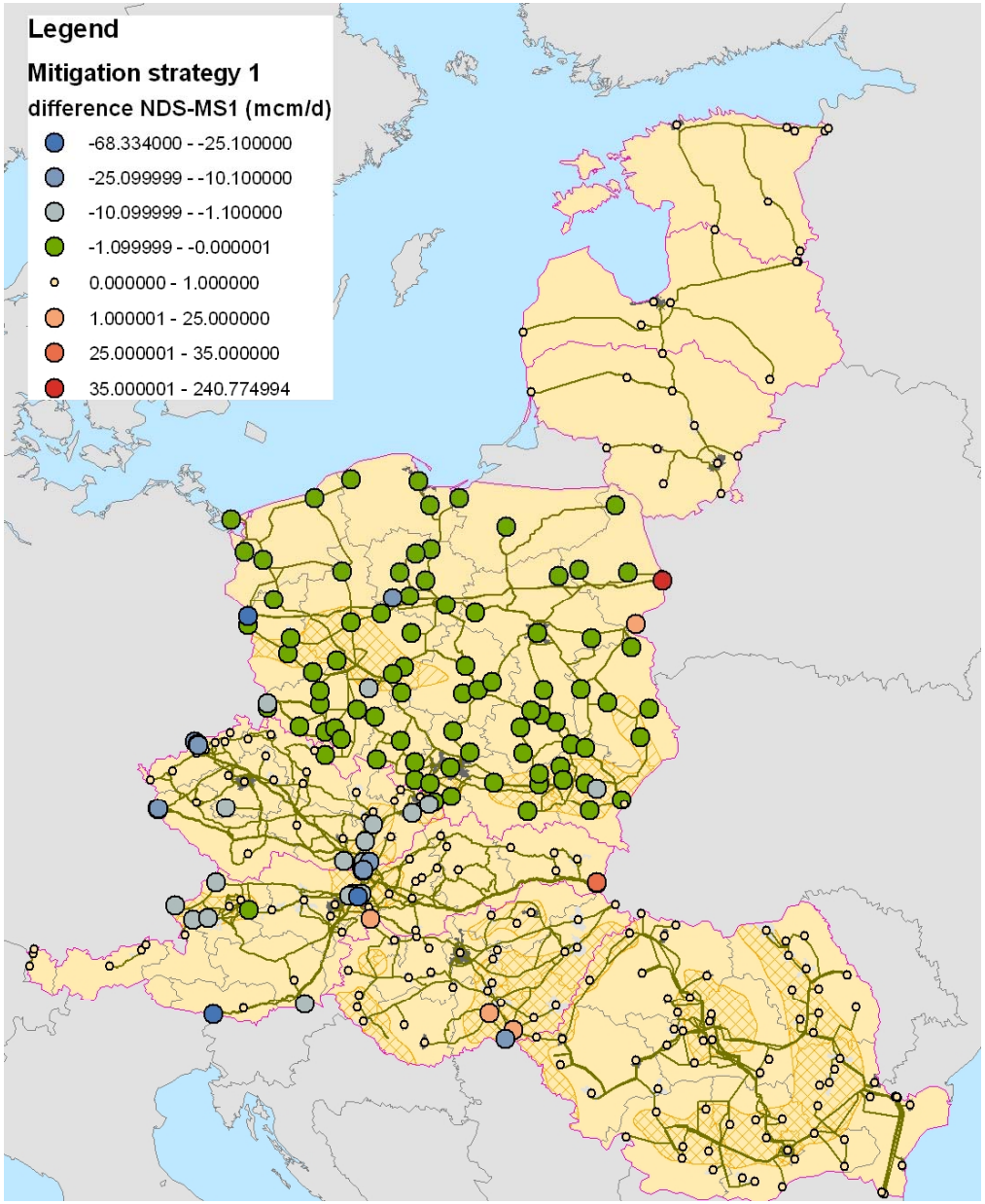
Countermeasures



Location of disruption

Compressor station

Disruption – mitigation strategy 1



Storage use:

PL, CZ, AT = maximum

SK, H = normal peak

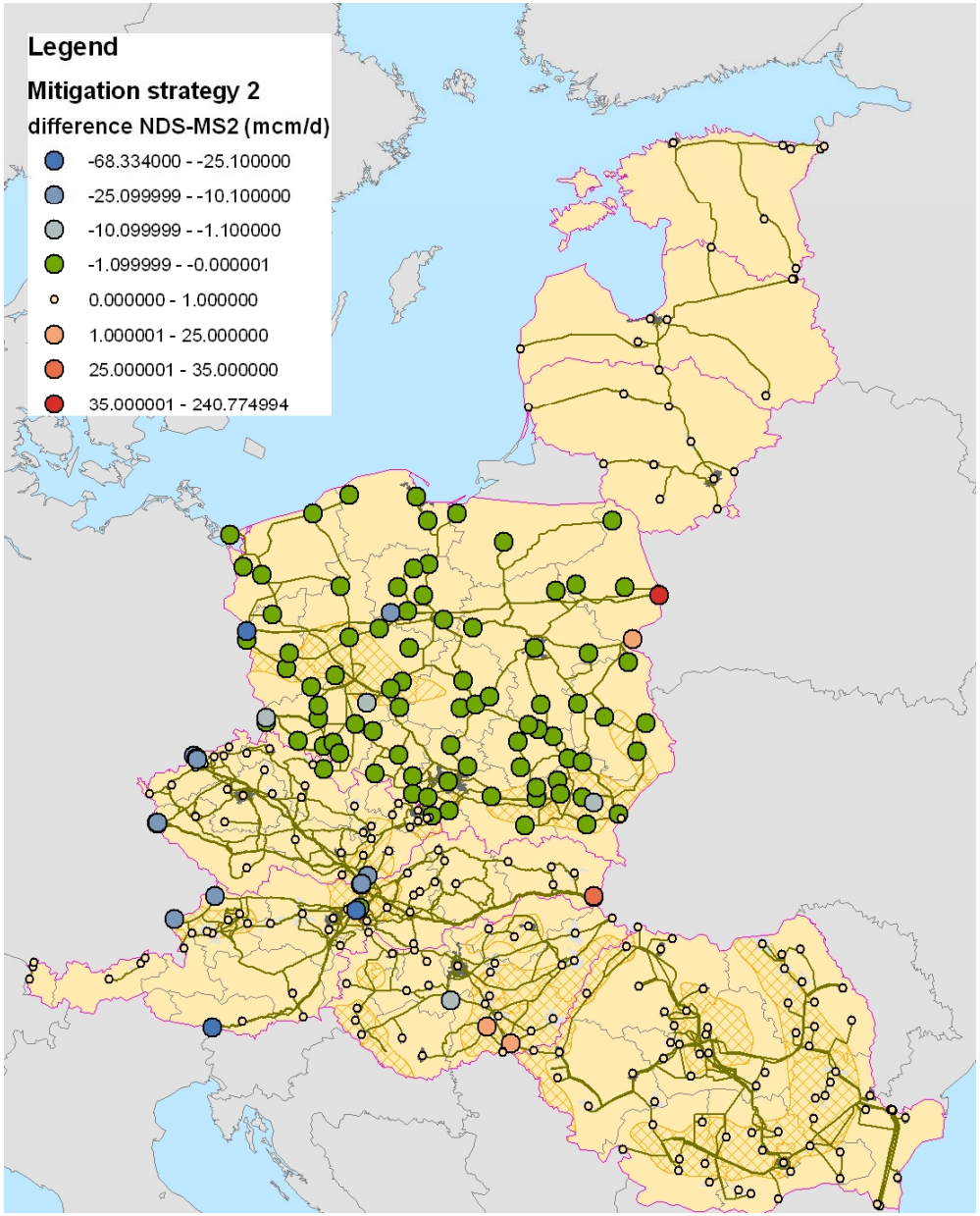
Consumption:

PL = 90 %

CZ, AT, SK, H = normal peak

Disruption – mitigation strategy 2

to restore normal operation



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Disruption – mitigation strategy 2

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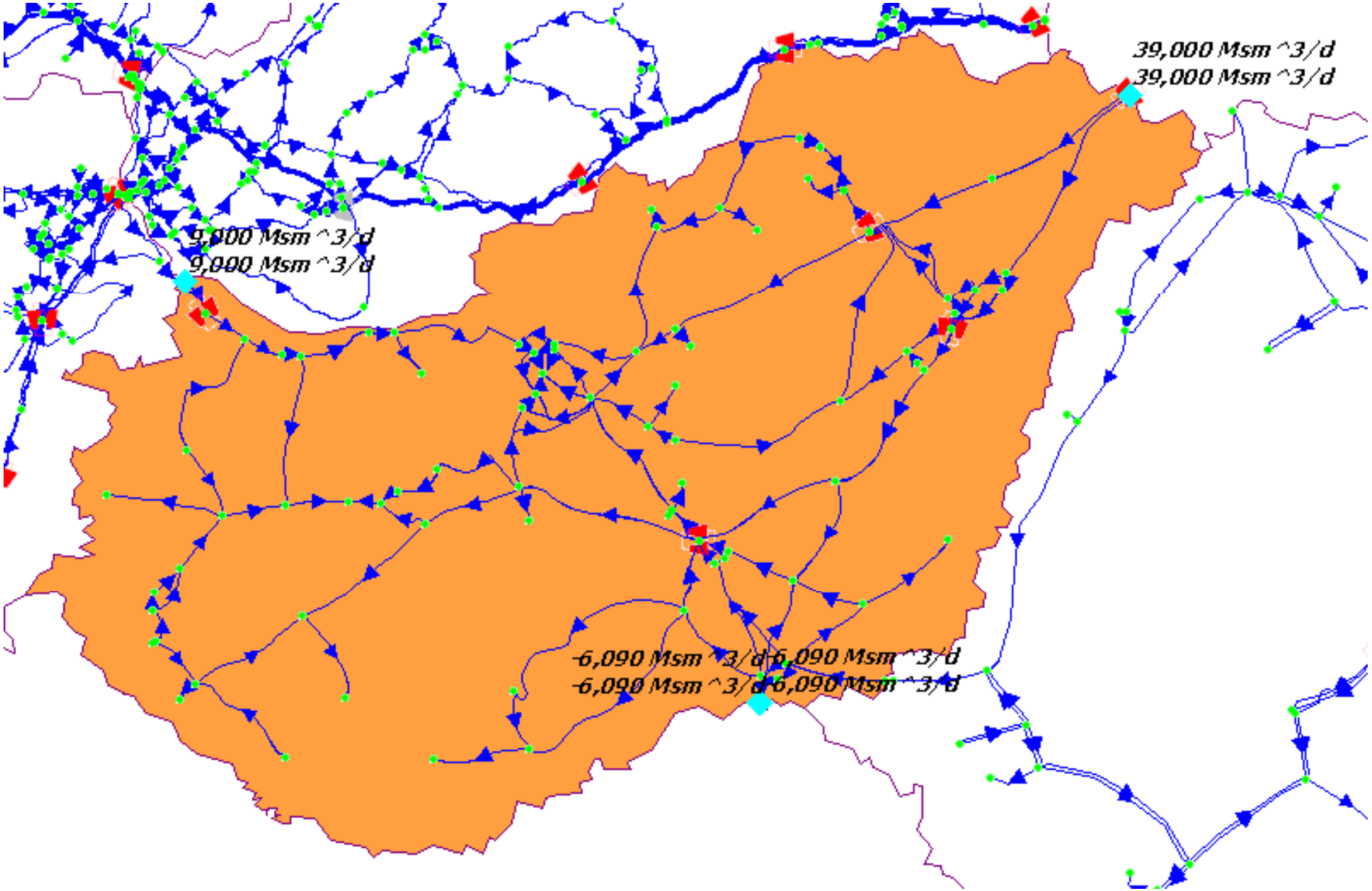

Disruption – mitigation strategy 2

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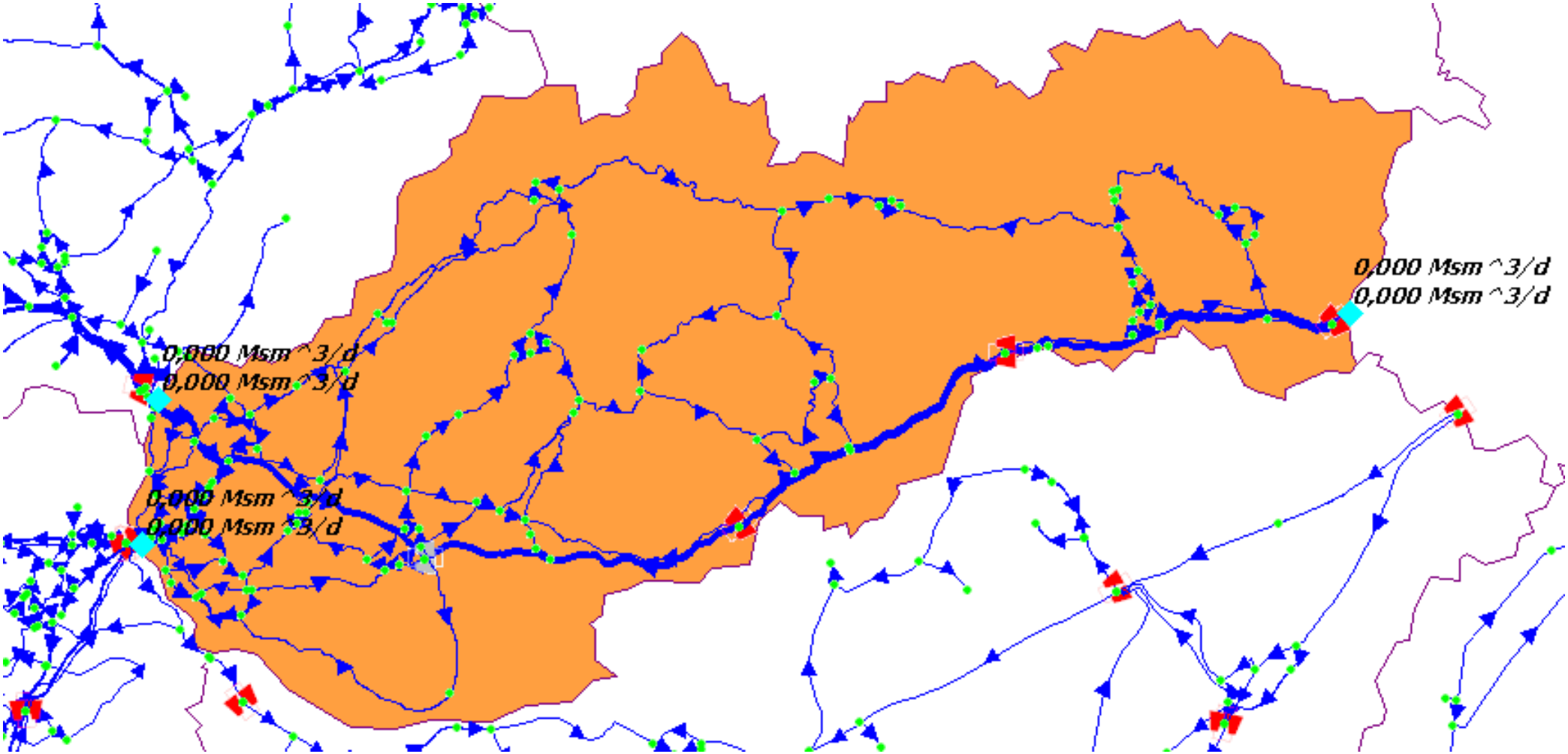

Disruption – mitigation strategy 2

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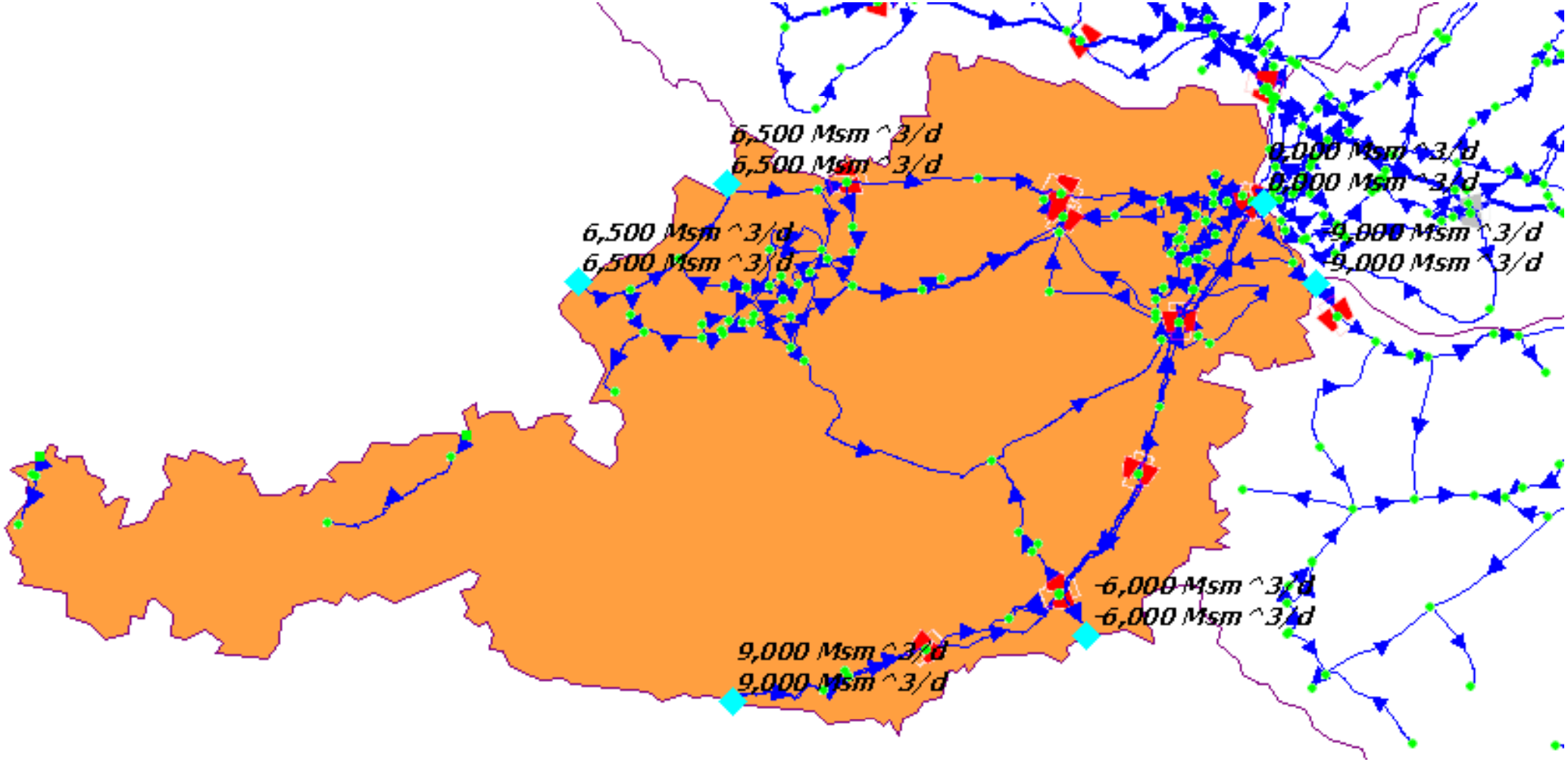

Disruption – mitigation strategy 2

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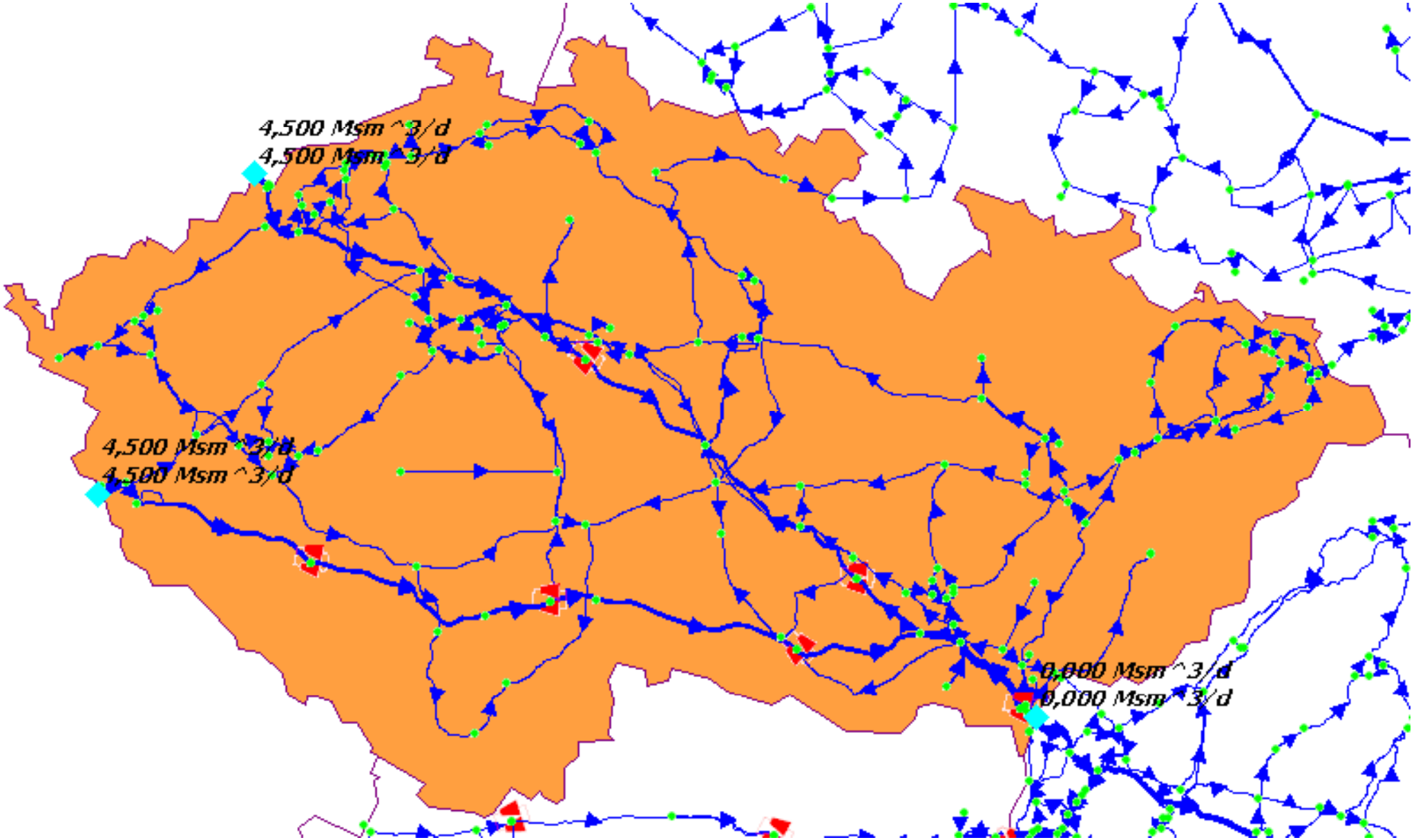
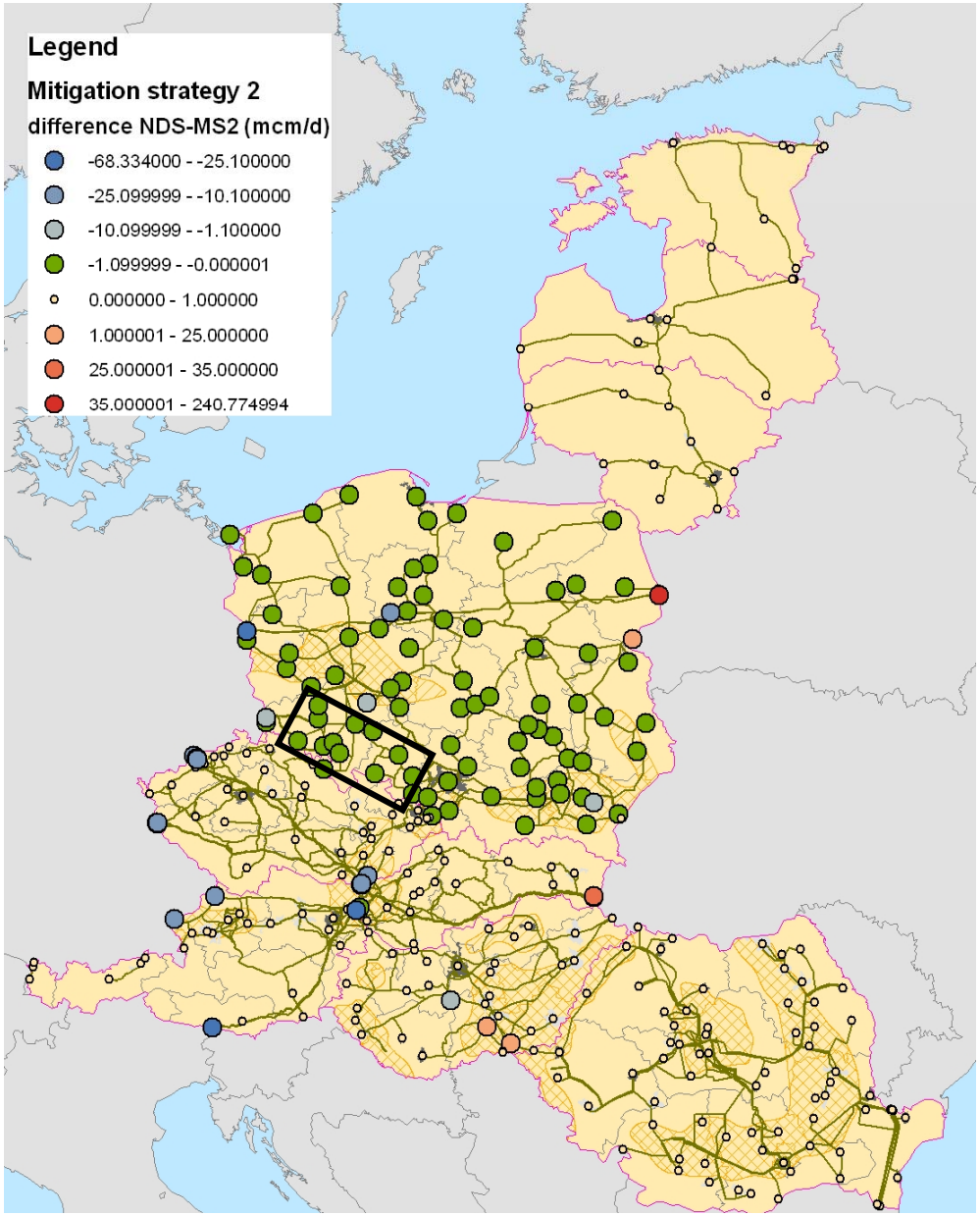
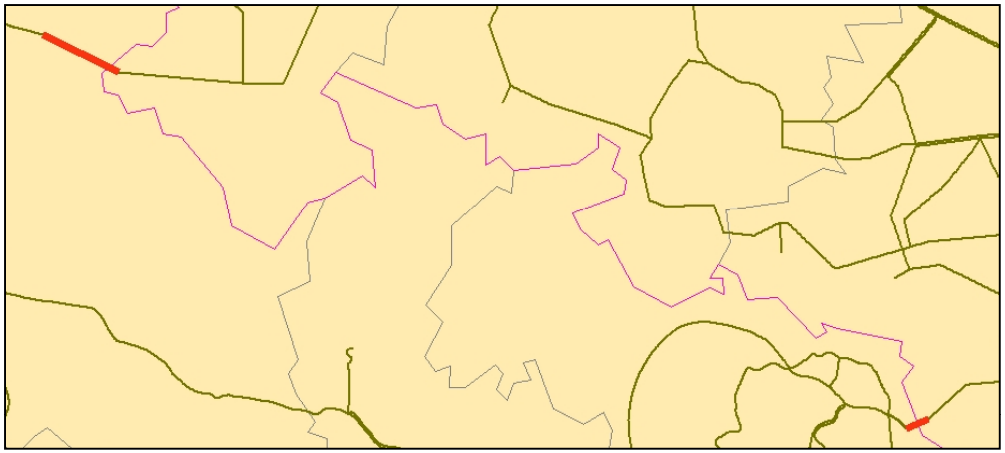


Disruption – mitigation strategy 2

new infrastructure





Storage use:

PL, = maximum

CZ, AT, SK, H = normal peak

Consumption:

PL = 95 %

CZ, AT, SK, H = normal peak

Disruption – mitigation strategy 2

new infrastructure

THANK YOU!