Vulnerability to a large scale flooding

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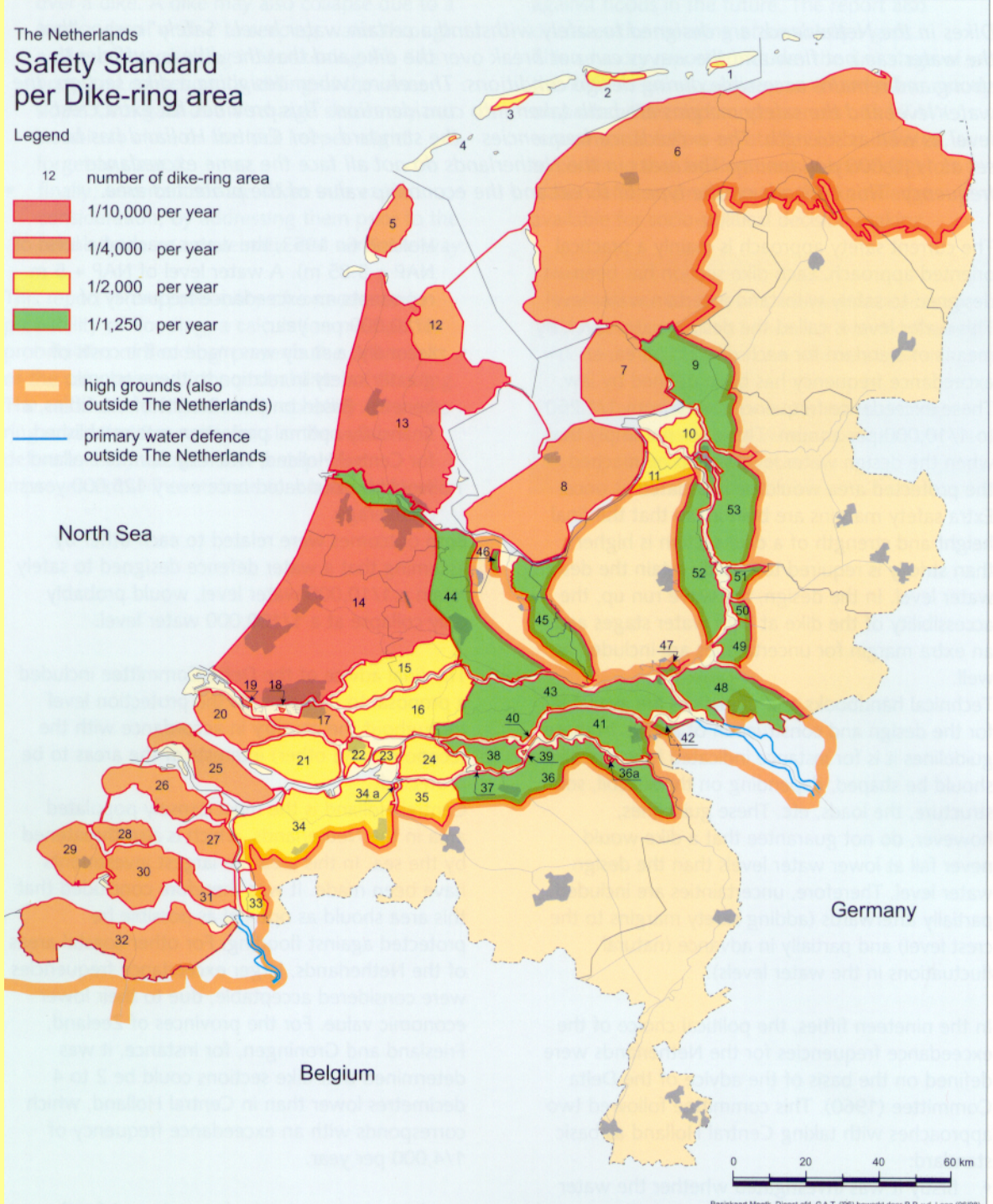
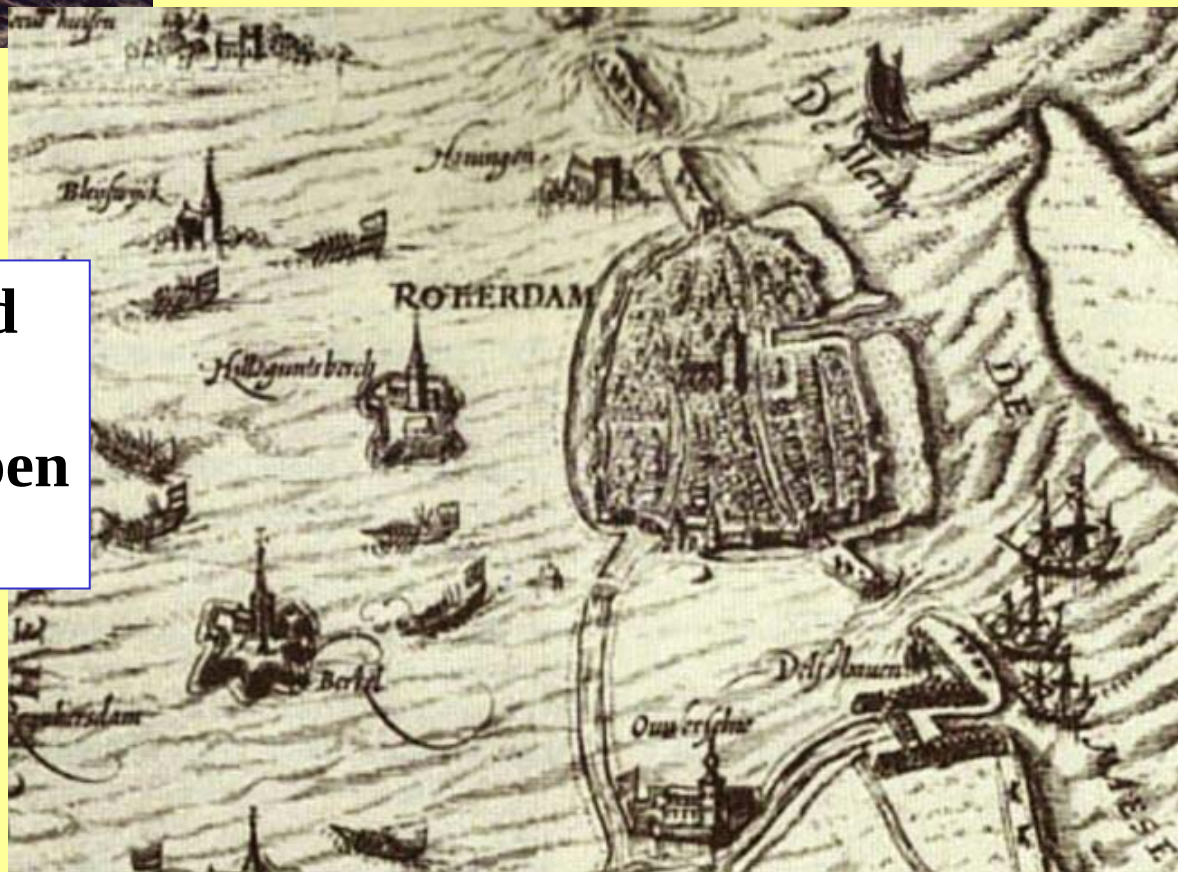
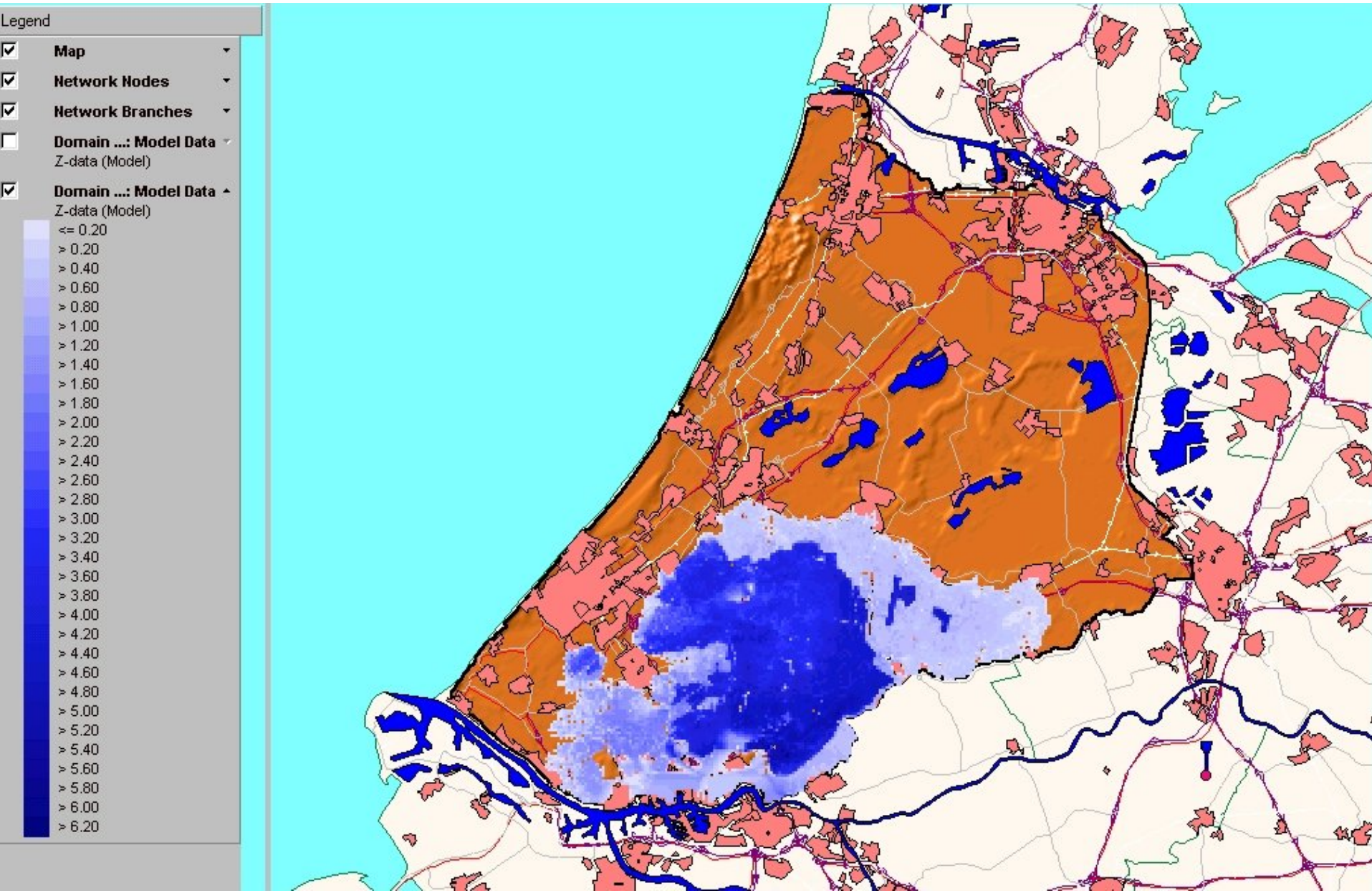
- **Dike rings**


The Netherlands
Safety Standard
per Dike-ring area
Legend
12 number of dike-ring area
1/10,000 per year
1/4,000 per year
1/2,000 per year
1/1,250 per year
high grounds (also outside The Netherlands)
primary water defence outside The Netherlands
North Sea
Germany
Belgium
0 20 40 60 km

1421 - St Elizabeth flood
1717 – Christmas floods
1953 – Randstad, Krimpen



Water depth


Legend
Map
Network Nodes
Network Branches
Domain ...: Model Data
Z-data (Model)
Domain ...: Model Data
Z-data (Model)
<= 0.20
> 0.20
> 0.40
> 0.60
> 0.80
> 1.00
> 1.20
> 1.40
> 1.60
> 1.80
> 2.00
> 2.20
> 2.40
> 2.60
> 2.80
> 3.00
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> 5.80
> 6.00
> 6.20

Risk

- RISK = P * Effect

- Questions
- What to do with low probabilities and big consequences
- How vulnerable are we?

Some definitions

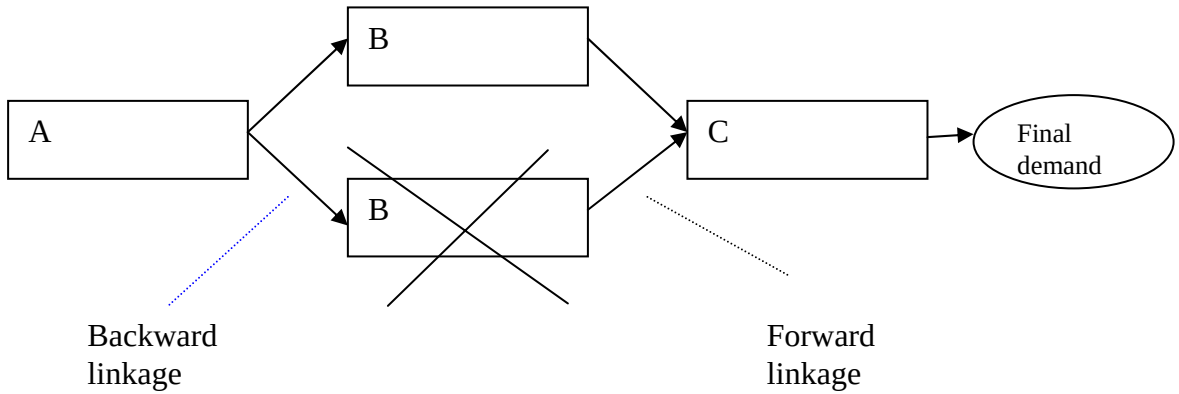
- Vulnerability
  - Time varying status of some (desirable or undesirable) characteristic of the system: value added, employment, pollution
- Resilience
  - Dynamic response of vulnerability to perturbations
    - Not by definition stable (e.g. an estuary)
    - And not by definition positive
    - A resilient system is a one which bends under stress but does not break;
    - Note: we measure resilience via the status of vulnerability

Vulnerability to disasters

- V = f (susceptibility, dependency, transferability)
- Geophysical aspects
- How dependent are we upon business disruption?
- Transferability, *the ability of an activity to respond to a disruptive threat by deferring or using substitutes or relocating*
  - Note 1: concept of economic cost in a CBA:
    - Accounting for adaptations in an economy
    - However, does recovery fit into this concept?
  - Note 2: resiliency is the combination of dependency and transferability

- ***How to visualise vulnerability? GIS***

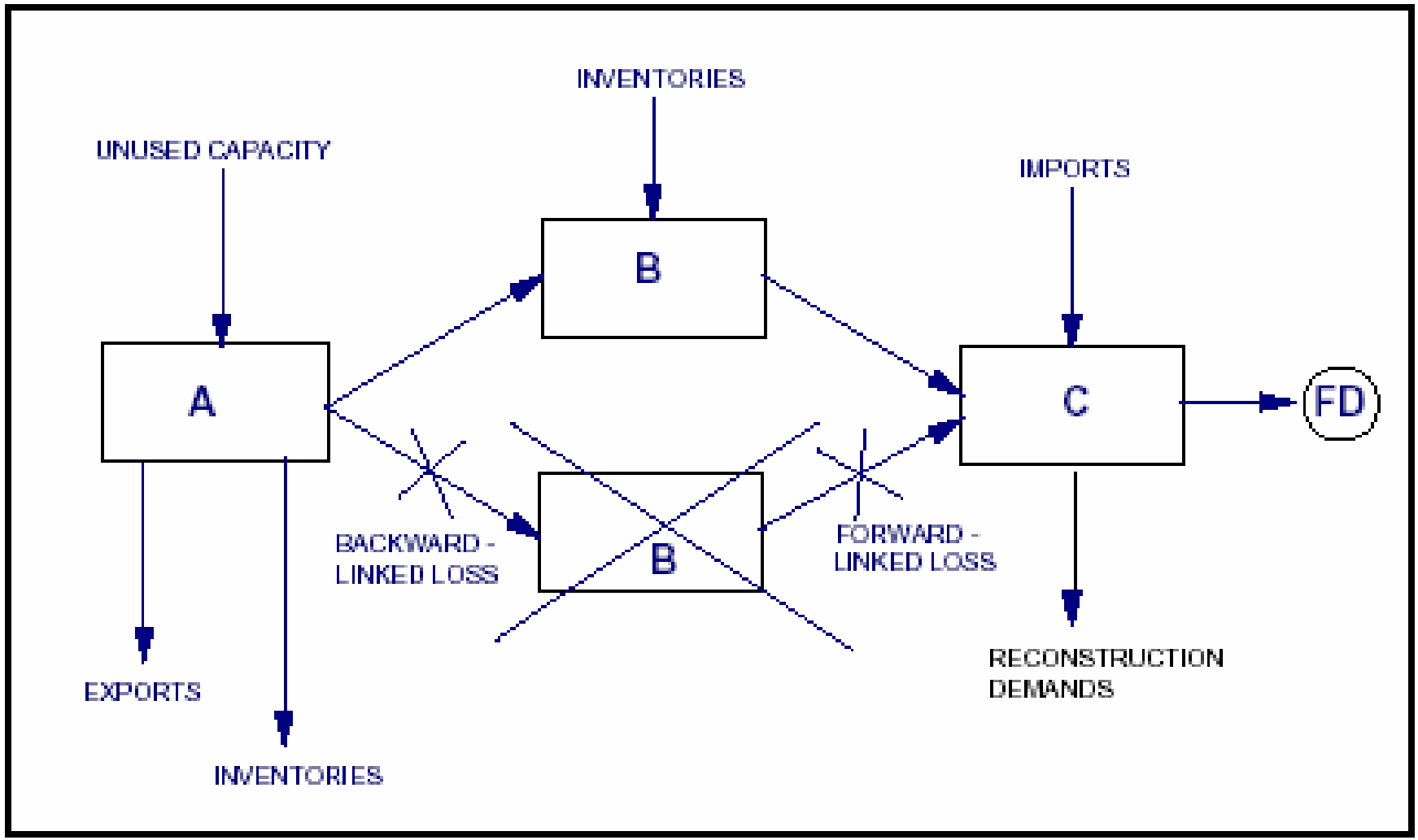
Forward and Backward Linkages in an Economy, when Factory B is Damaged



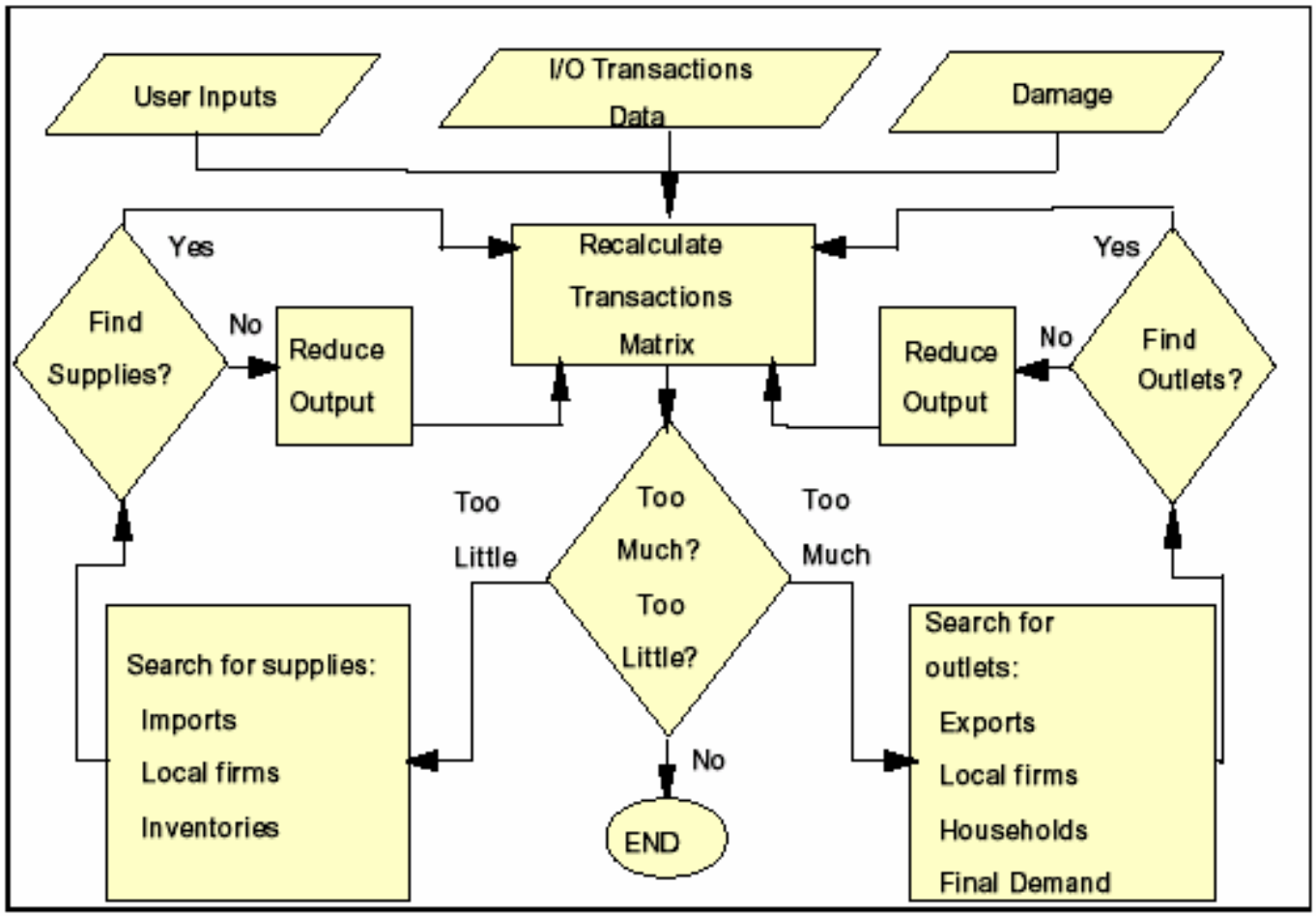
Dependency:

- Input output analysis
- Indirect economic effects of a disaster
  - Multipliers
    - production

Transferability

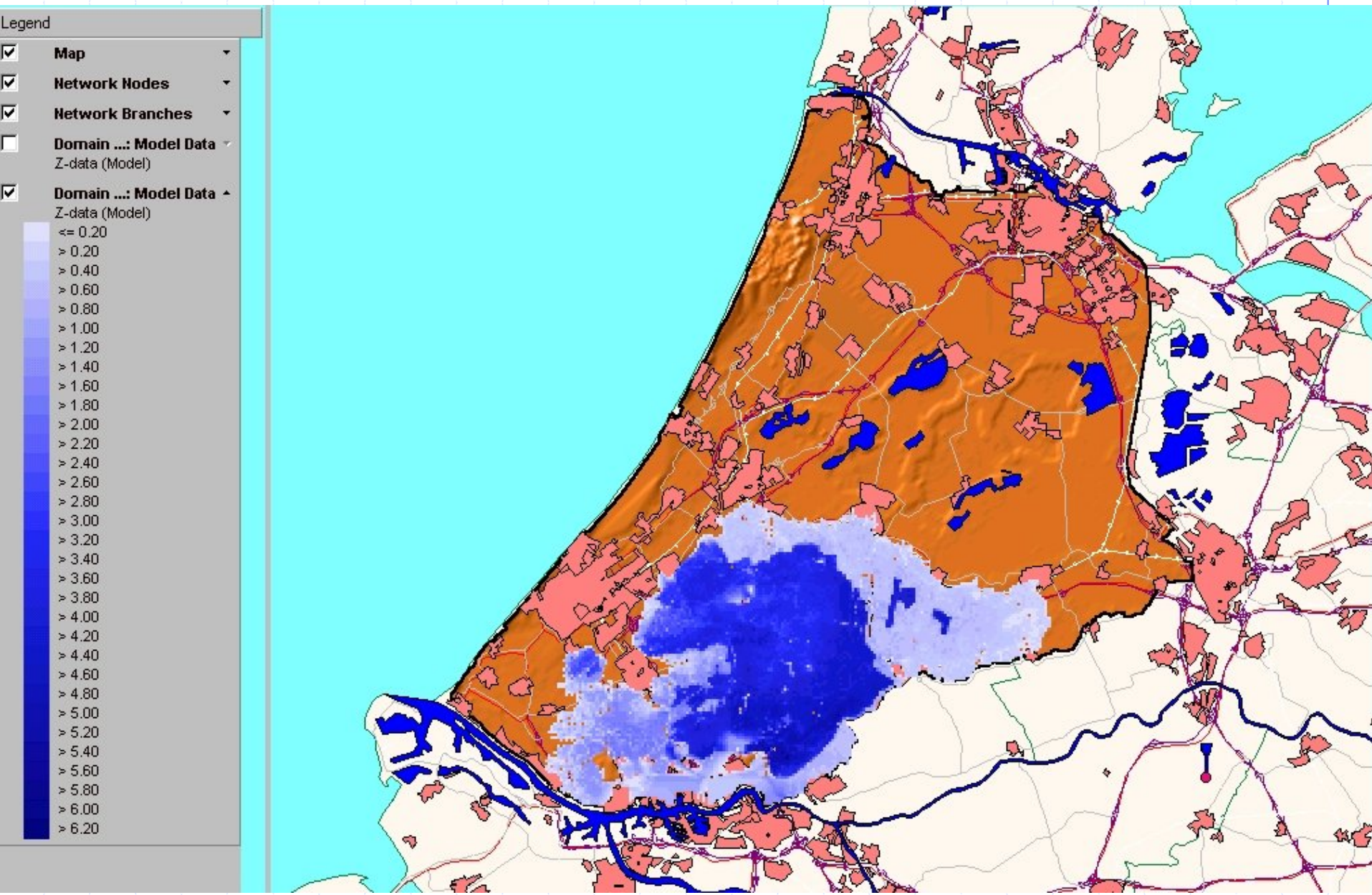


Transferability: the choices



Source: FEMA

Water depth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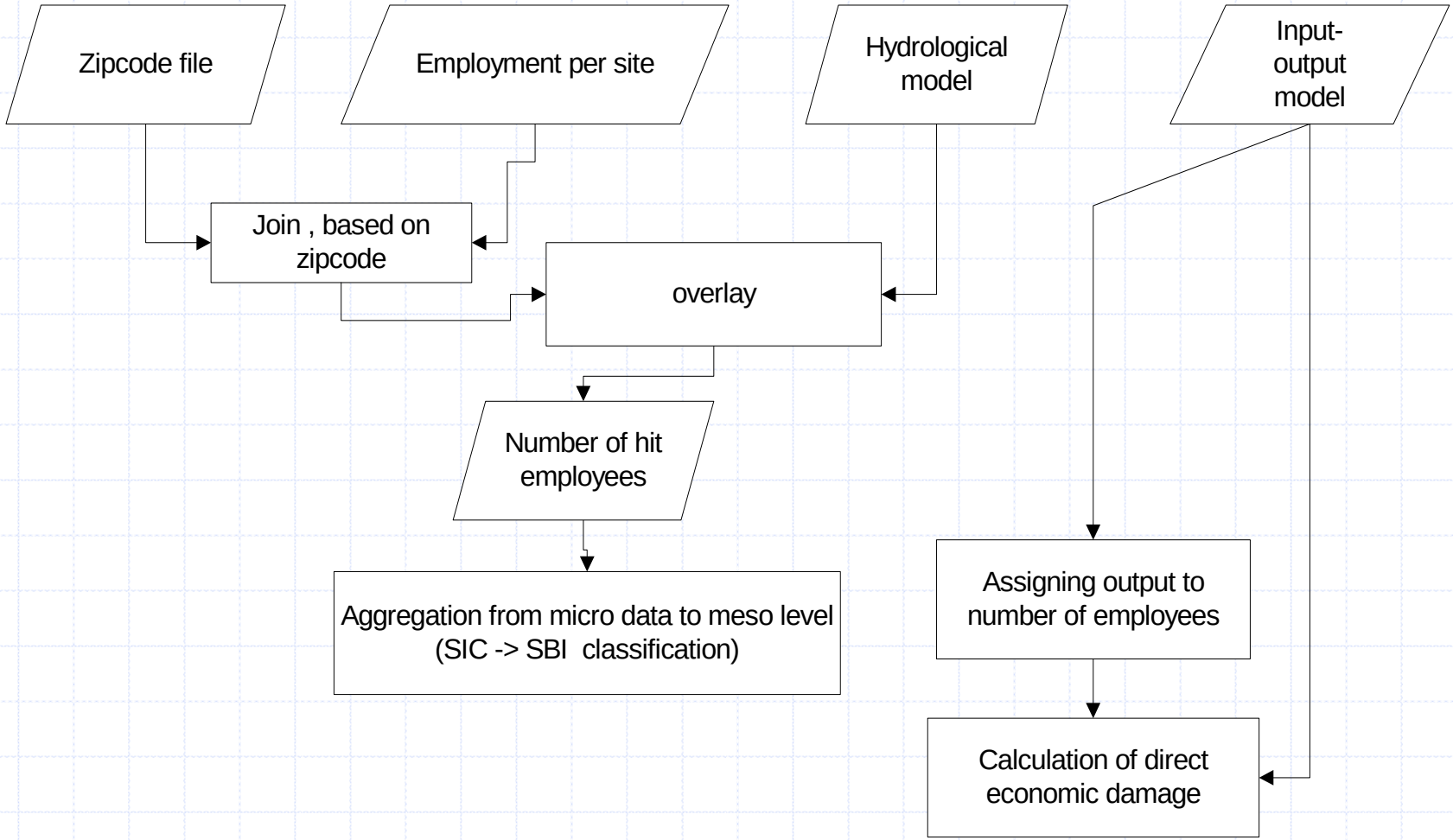
Case: Krimpen dike breakage

- No data available comparable to FEMA
- Aim: defining hot spots
- Vehicle: GIS data base
- Relation with Input-Output analysis
  - Bi-regional IO table; 28 sectors

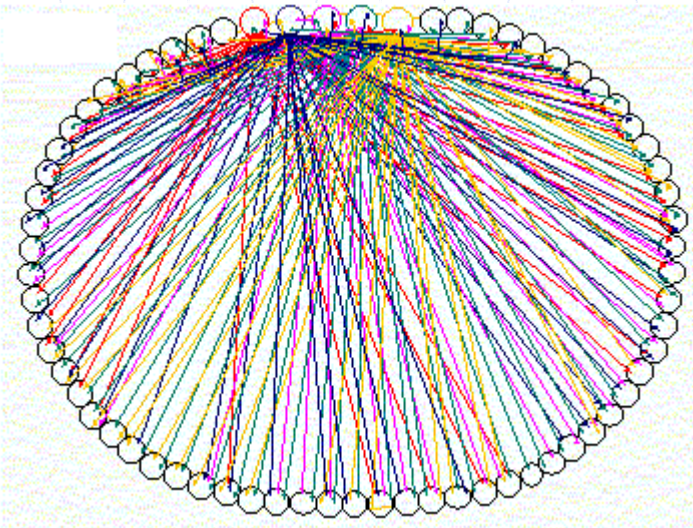
The data: GIS and IO tables



Dependency

- Covered by multipliers in the network of economic interactions

Transferability: a network approach



Transferability cont'd

- The more central a firm operates in a network, the more difficult it is to replace production in the Rest of the Netherlands
- Transactions in a I-O Matrix: a network

Transferability cont'd

- Centrality measures:
  - Betweenes: what proportion of indirect contacts between actors runs via a certain actor
  - Degree: the number of direct contacts with other actors (popularity…)
  - Closeness: measuring paths and distances
- A measure of centrality of an economic sector in a province, compared to the same indicator in the Rest of the Netherlands

Visualising vulnerability

- Hotspots:
  - Concentrations of incidents over time
- Examples in the literature:
  - Crime
  - Town centres
- Software: Crimestat

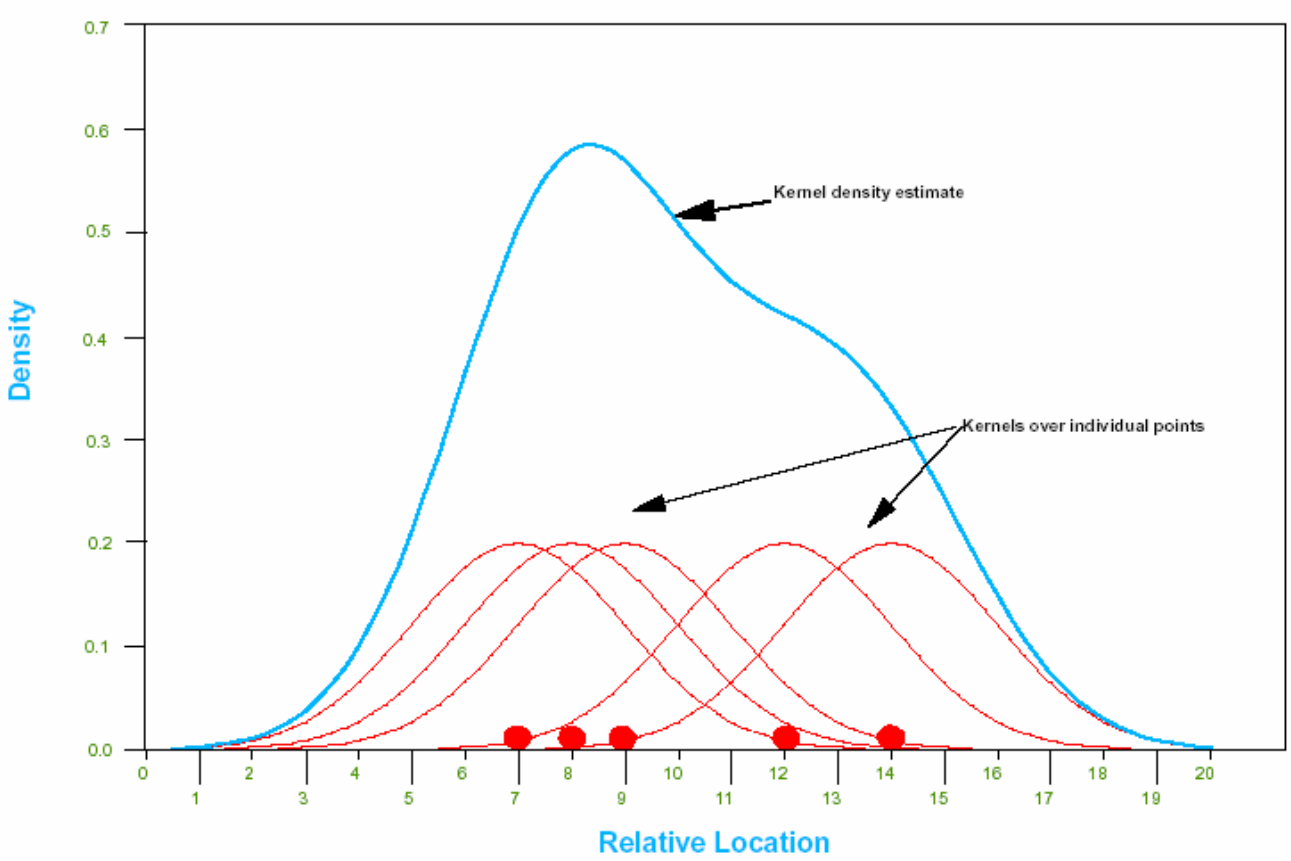
Spatial clustering techniques:

- Point
- Hierarchy
- Partition
- Density: measuring density of concentrations of points
- Clumping
- Risk based

Kernel density estimation

Source: CASA

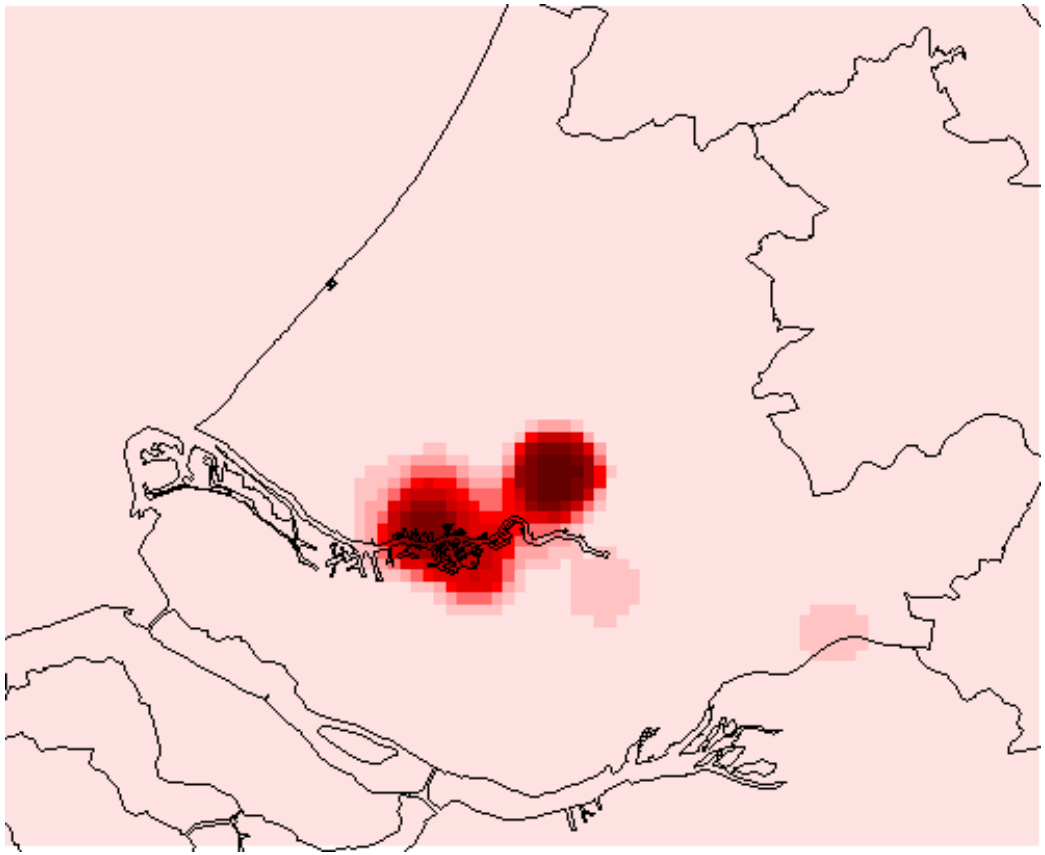
Kernel density



Kernel density

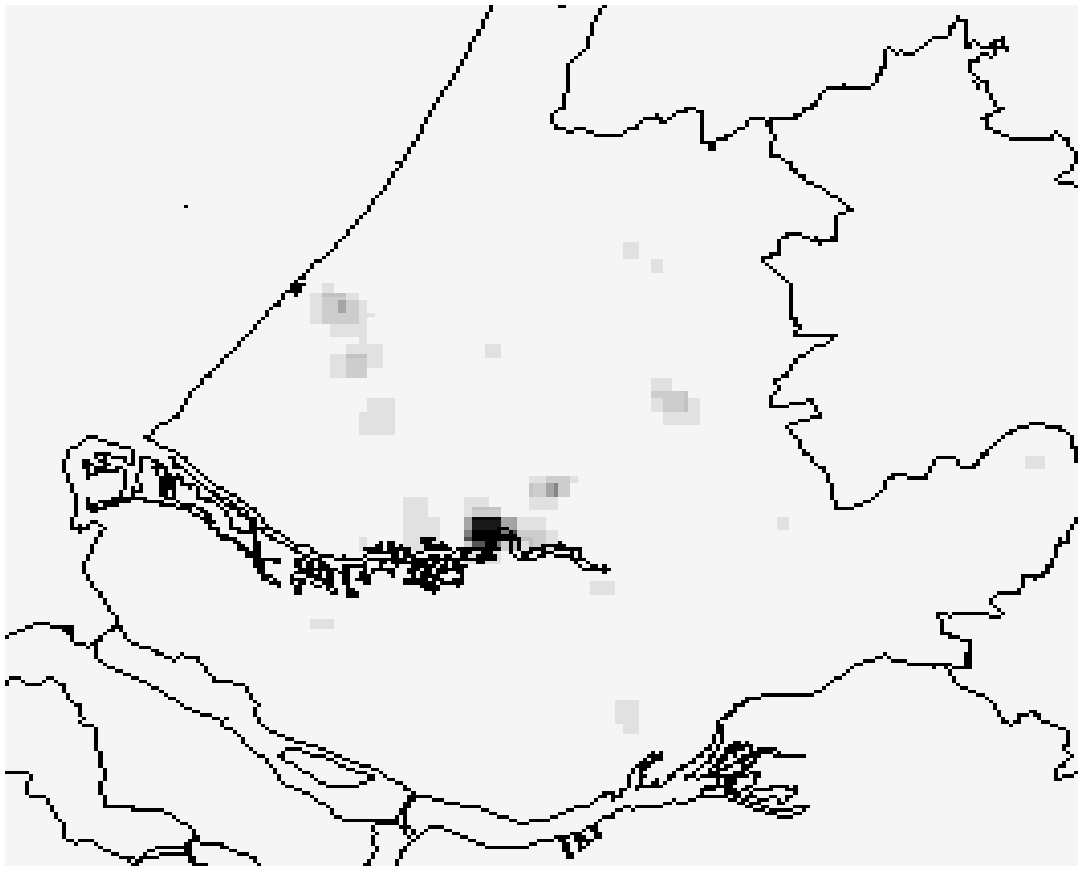
Problem: what is the bandwidth

Petroleum industry in the province of South Holland



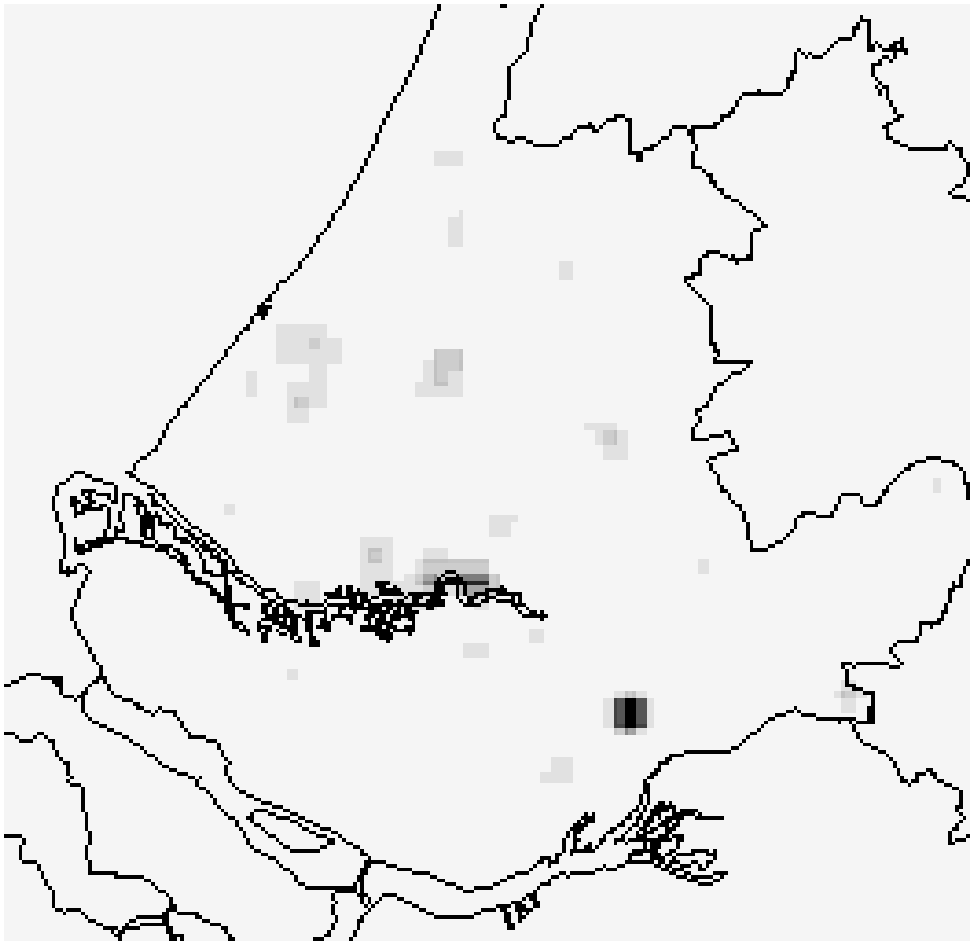
Bandwidth 5000 m

Combining information for 28 sectors in the province of South-Holland: no weights

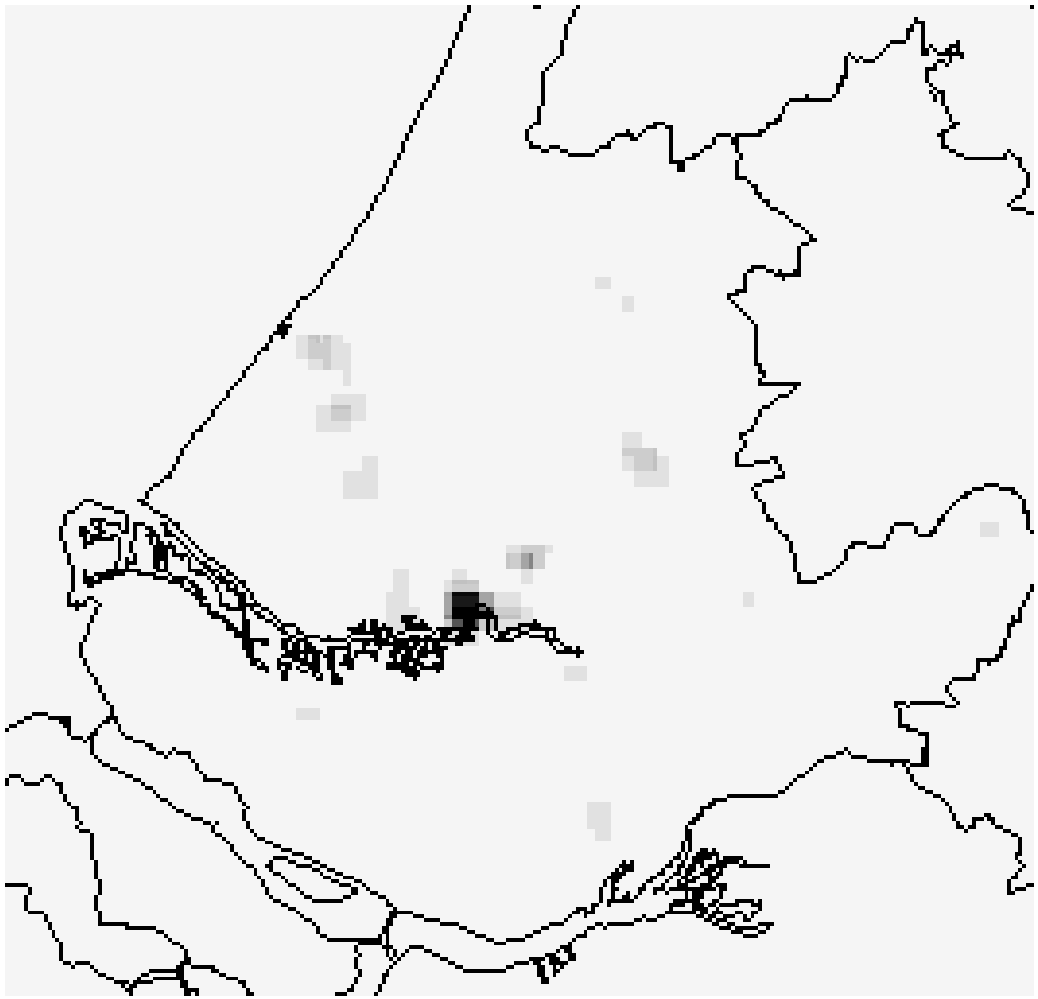


Bandwidth 2000 m

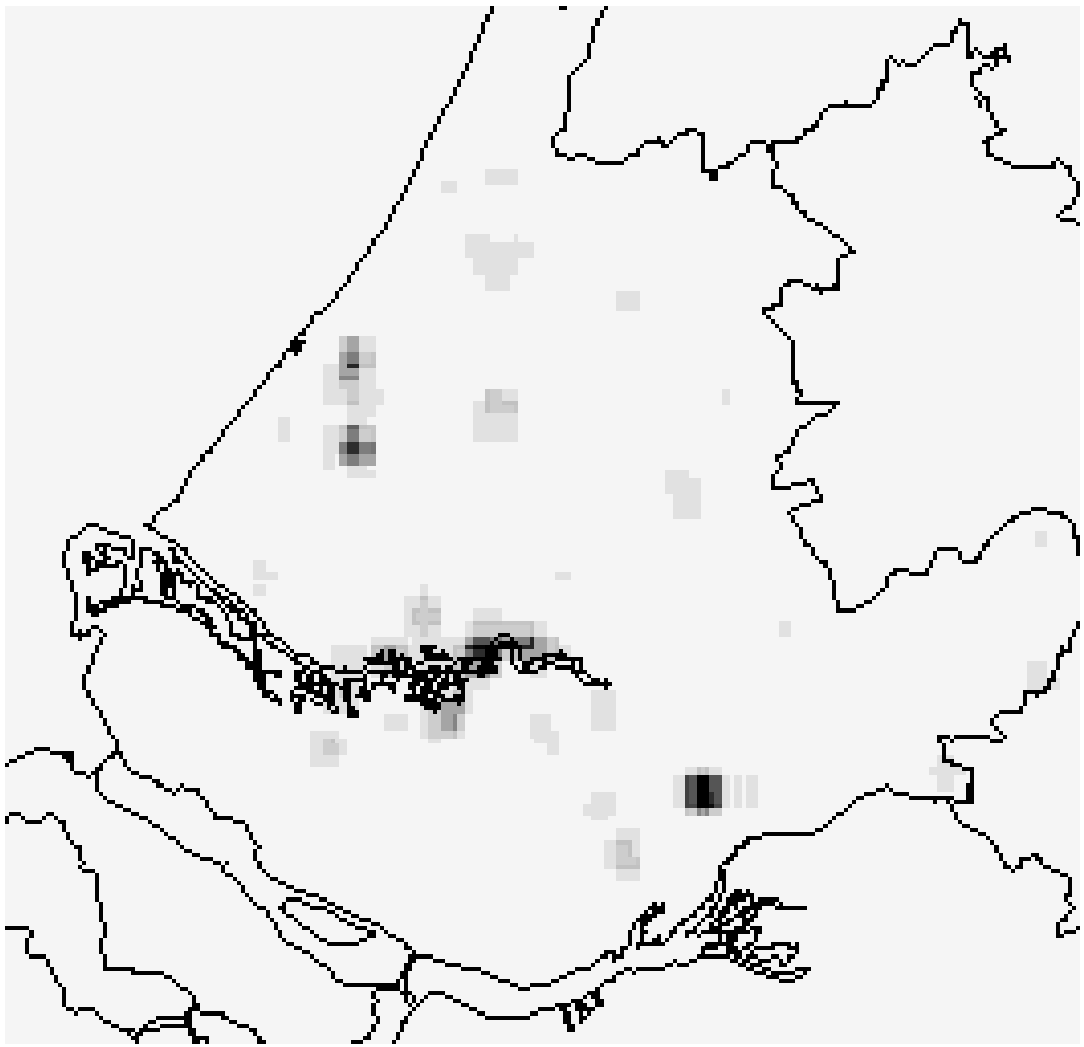
Multipliers as weights in an overlay procedure



Transferability as weights



Multipliers and transferability indicators as weights



Hotspots methodology

- Lots of painful assumptions:
  - Design of transferability (theory ?)
  - Bandwidth
  - Weights in an overlay procedure
  - Combine dependency and transferability

  - But most importantly: I overlooked the role of infrastructure

Final: inundation in the province of South Holland: the role of infrastructure in defining hotspots