New Flemish Approach for Risk Analysis System for Transport of Dangerous goods

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Introduction (1/3)

Who are we ?

- Flemish Government
- Environment, Nature and Energy Department (LNE)
- Environmental, Nature and Energy Policy Unit
- **Safety Reporting Division**
  - Mission: to play the central role in the preparation, optimalization and evaluation of the Flemish External Safety policy, in order to improve external safety and to contribute to risk assessment by implementing this policy
  - 11 experts

Introduction (2/3)

Transport safety ?

- **Risk of the transport of dangerous substances on its surroundings:**
  - **So far not adequately internationally regulated**
  - **No harmonization on EU or UN level**

- **Therefor Flanders has started the development of a new approach of a Risk Analysis System**

Introduction (3/3)

Research projects for External Safety of Transport of dangerous goods

- Phase 1 – **Survey of risk analysis of transport of dangerous substances**
  - **DNV**, finished in 2007
- Phase 2 – **Development of a risk analysis system**
  - **SGS** (+ Ghent University (IDM) and Antwerp University (Argoss)), finished in 2009
- Phase 3 – **New approach of a risk analysis system**
  - **Möbius** Business Redesign (+ Brussels University (MOSI-T) and Safety Advisors), finished in 2010
- Phase 3 Annex - Input data parameters for transport modalities
  - **VITO** (+ MINT), **SGS** (+ GIM + Antwerp University), finished in 2011
- Phase 4 - **Special parts in transport chain** (marshalling yards, tunnels, road parkings, …)
  - **DNV** (+ Arcadis), finished in 2012
- Phase 5 – Validation of assumptions, parameters and approach of risk analysis system
  - **DNV** (+ SGS + GIM), going on in 2013

Flemish approach – Goal settings (1/2)

Primary goals

- To make external risk on an acceptable level for new and existing transport
- To be able to communicate clearly about external risk with the public, proactive to “nimby” syndrome

Secondary goals

- To give risk analysis an adequate place in land use planning
- To do permanent improvements for safety
- Monitoring safety (accidents, casualties, …)
- Cooperation between all parties (federal, regional and local governments, industry and public)

Flemish approach – Goal settings (2/2)

Goals in practice

- Short term = to compare external risks of
  - different segments of a transportation route
  - different transportation routes
  - different transport modes
- Medium and long term = to check external risks to risk acceptance criteria

Principle

Risk Analysis System = Quantitative approach

and

- User-friendly for as well the safety expert as the policy advisor
- Easy to automate
- Validated on the basis of accident data
- Takes specific local circumstances into account

What includes the risk analysis system? (1/2)

General

- **External Safety**
  - Lethal effects
- **Inland transport infrastructure**
  - Modes of inland transport
    - Roads incl. tunnels
    - Railways incl. tunnels
    - Inland waterways and port areas
    - Pipelines and gas pressure reduction stations
  - Routes
  - Segments
- **Dangerous goods**
  - Flammable fluids
  - Flammable gases
  - Toxic fluids
  - Toxic gases

What includes the risk analysis system? (2/2)

Assumptions risk calculation

- **Scenarios**
  - Maximum credible accident
  - Most credible accident
- **Effects**
  - Segments based on smallest effect distance
  - Meteo: D5 en F1,5
  - Effect zone: from 100% to 1% lethal
- **Failure frequencies**
  1. Based on general database
  2. Based on local database
- **Consequences** = human casualties in effect zone
  - All persons in surroundings, inclusive fellow road users
  - Option = specification for vulnerable persons (hospitals, retirement homes, schools)
- **Risks**

Way of working – Scenarios & Effects (1/6)

Transport mode	Type hazardous goods	Maximum credible scenario	Subsequent event	Representative substance	Impact distance (m)
Railway	Flammable liquids	Rupture	Pool fire	Pentane	50
Railway	Toxic liquids	Rupture	Evaporating pool	Acrylonitrile	150
Railway	Toxic gases	Rupture	Toxic cloud	Ammonia	625
Railway	Flammable gases	Rupture	BLEVE (with fireball)	Propane	475

Way of working – Failure frequencies (2/6)

- Two steps

1. General failure frequencies
   - If available, from database accidents in Flanders, or
   - Link with international accident databases

2. Local failure frequencies
   - Related to expert parameters
     - Existing situations: if available, from local accident databases
     - New or planned situations: predictions

Way of working – Local failure frequencies (3/6)

- Local factors will influence failure frequency
  - Infrastructure parameters
  - Traffic parameters

- $P_{local} = P_{general} \cdot C$

  P_{local} = Local frequency

  $P_{general}$ = General frequency

  C = Locality parameter

- $C = A_{loc}.L_{total}/A_{total}.L$

  A_{loc} = number of accidents on segment with length L

  L_{total} = total length of the routes examined in database

  A_{total} = total number of accidents in database

  L = length of the part of route for which C is calculated

Way of working – Expert parameters (4/6)

Roads	Railways	Waterways	Pipelines
Type of road	Signal system	Type of waterway	Diameter of the pipeline
Type of crossings	Switch points and crossings	Crossings, locks and docks	Wall thickness
Accessibility of emergency services	Accessibility of emergency services	Accessibility of emergency services	Accessibility of emergency services
Quality of the road	Hot-box detection	Tank type/ CEMT class	Depth of cover
Local risks (such as sharp bend in the road)	Local risks	Local risks	Construction year
External sources of danger	External sources of danger	External sources odanger	Pipe placed in zone around crossing or within the zone of external sources of danger
Traffic intensity	Traffic intensity	Traffic intensity	Destination of the territory
Intensity/capacity ratio of traffic lane	Crossings and passages	Mix of vessels	Pipe placed in flood plain, water catchment of instable area
Permitted speed	Permitted speed	Permitted speed	Possible external corrosion
Traffic control		Night navigation	Patrol
			Possible internal corrosion
			Incorrect operation

Way of working – Risks (5/6)

- Risk of a segment

$$Risk_s = Frequency_s * Consequence_s$$

- Risk of the route

$$Risk\ route = \sum (Risk_{s1} ; Risk_{s2} ; Risk_{s3} ; \ldots ; Risk_{sN})$$

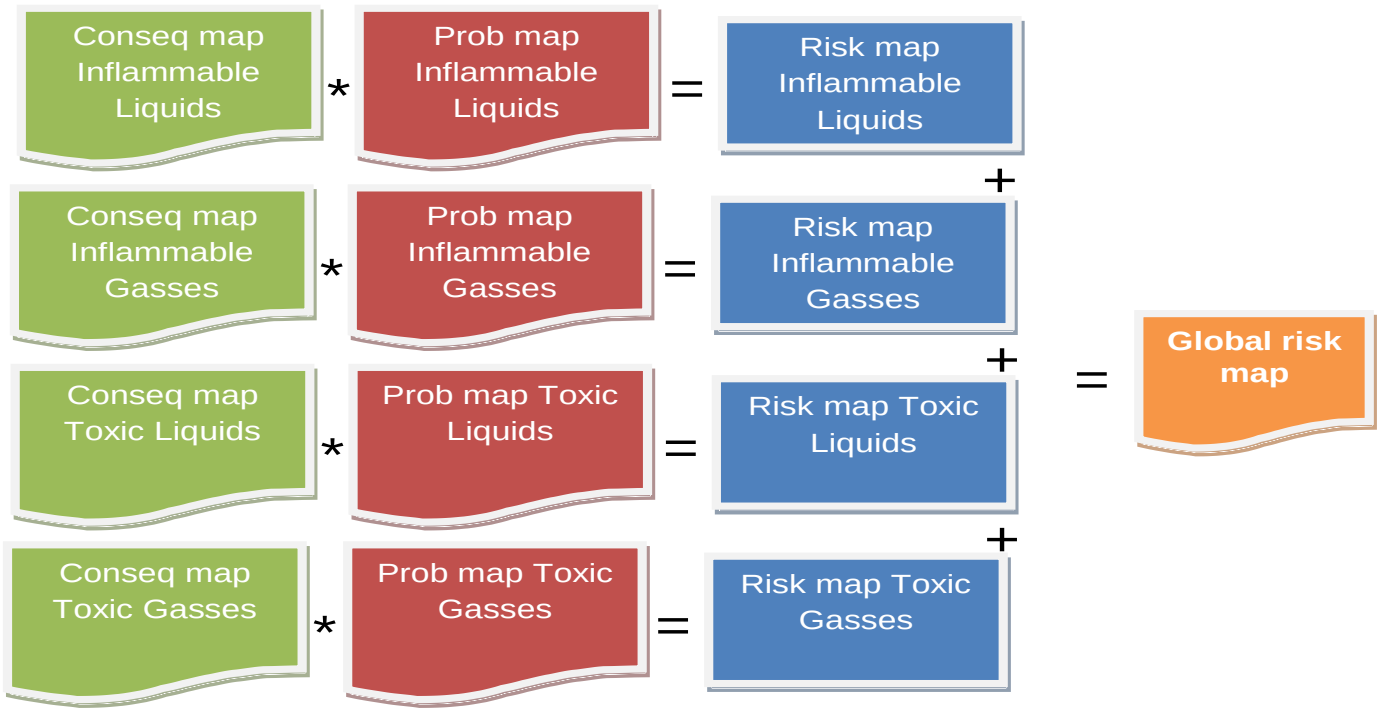
Way of working – Risks (6/6)

- Two steps

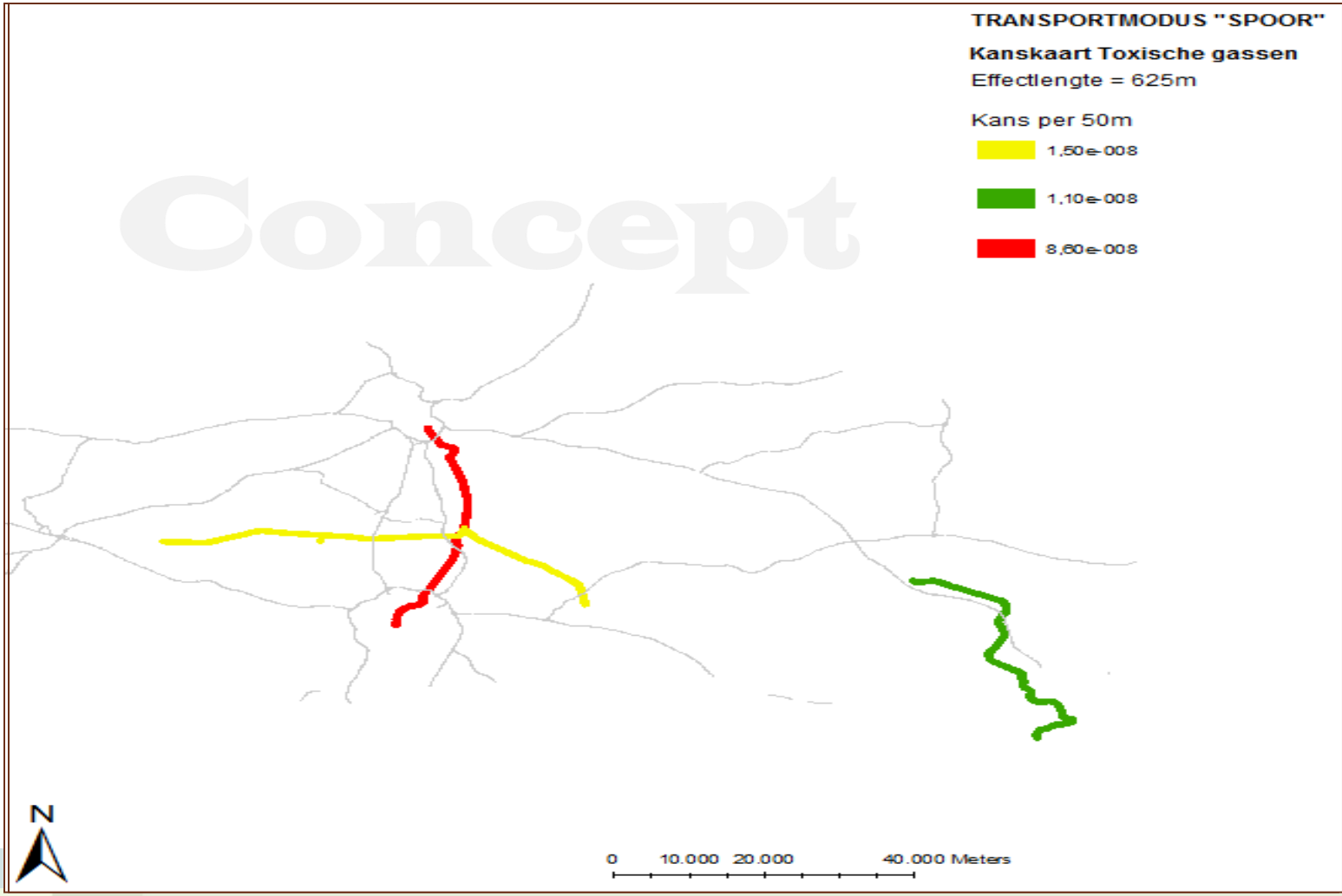
1. General picture of risk
   - Based on general failure frequencies and general effect zone
2. Local picture of risk
   - Based on specific failure frequencies related to expert parameters and general effect zone

Mapping

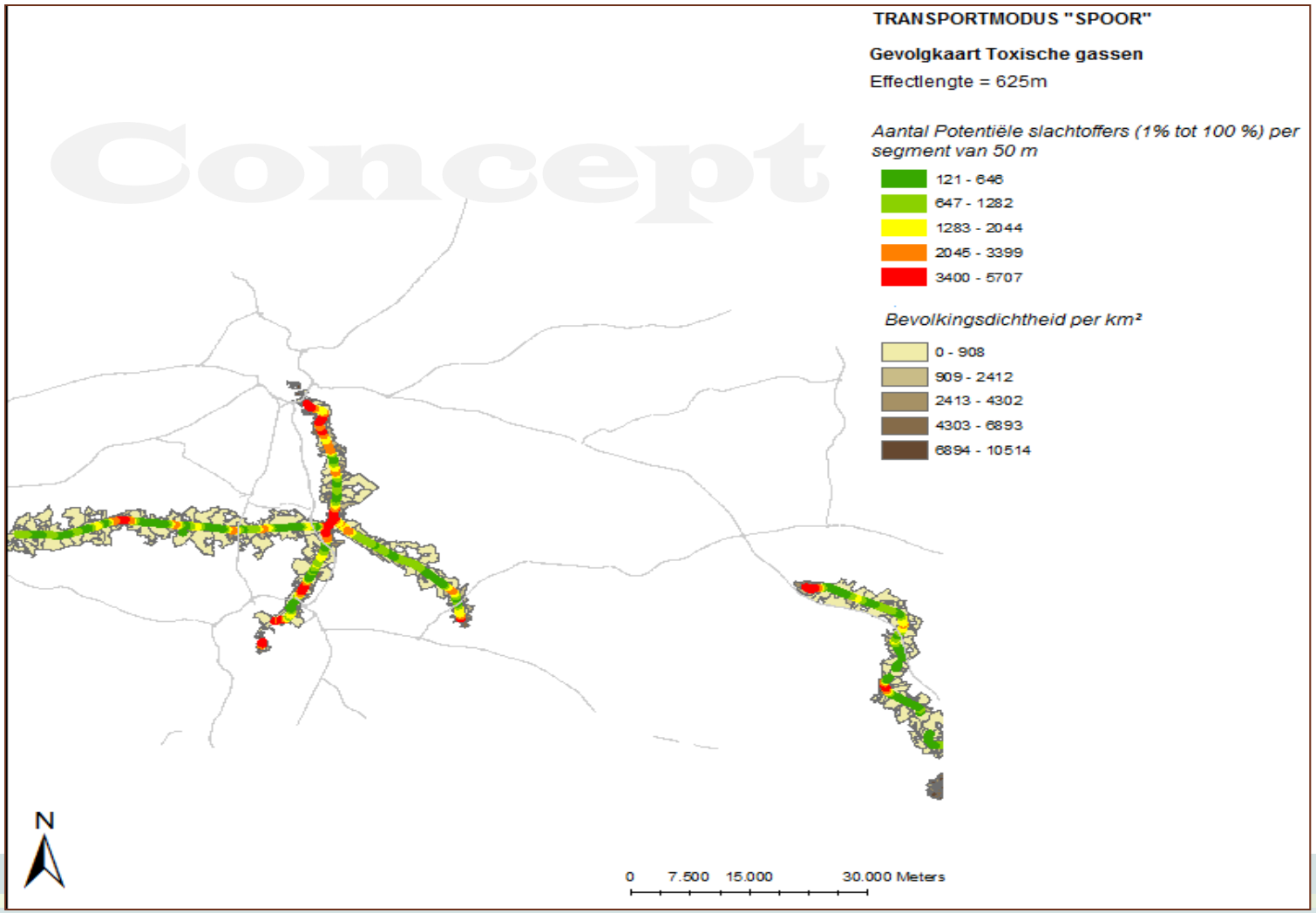
- Risk map is result of failure frequencies and of consequences for the 4 categories of dangerous goods (12 sub maps)



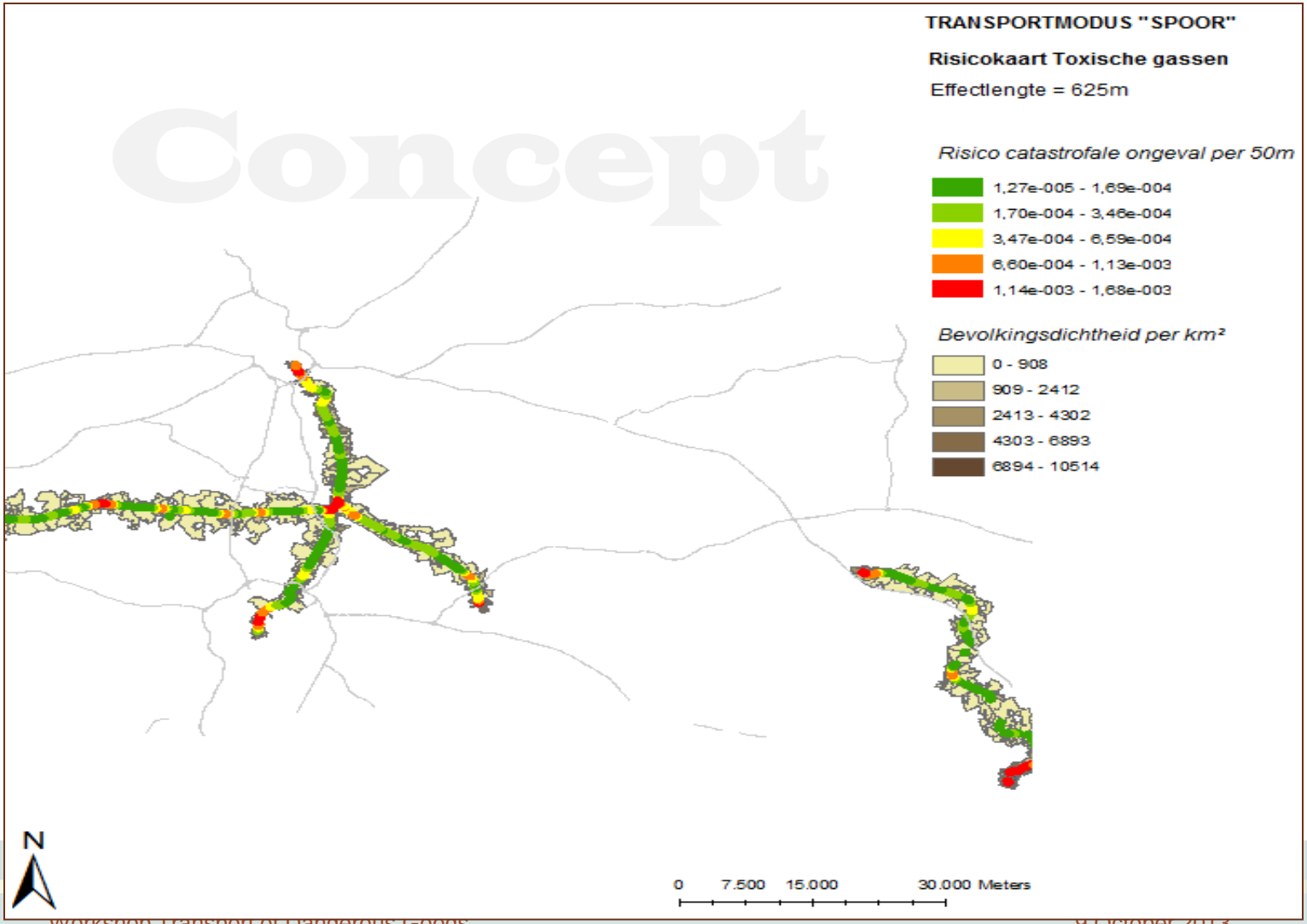
Map failure frequencies toxic gases (example 1)



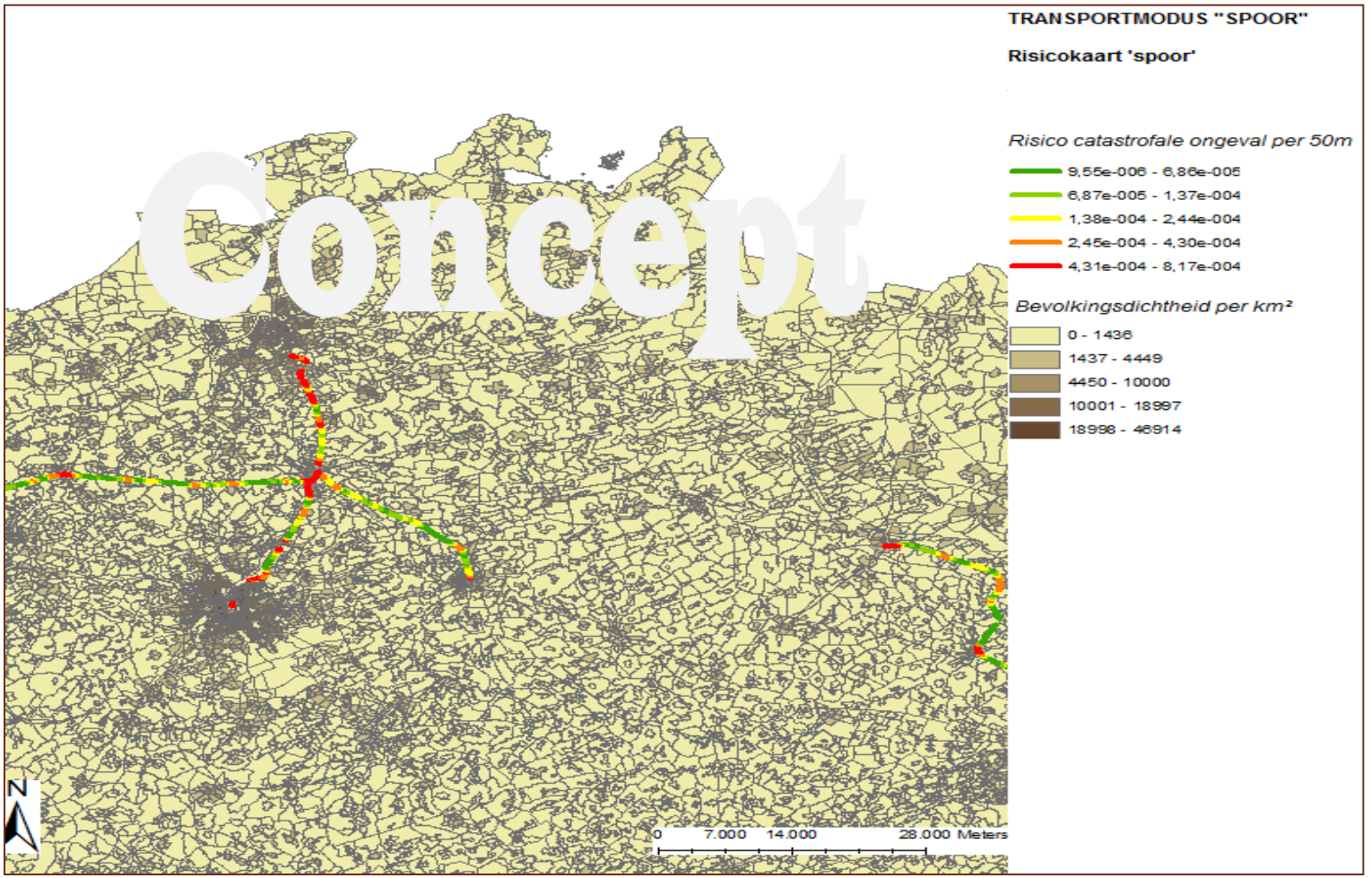
Map consequences toxic gases



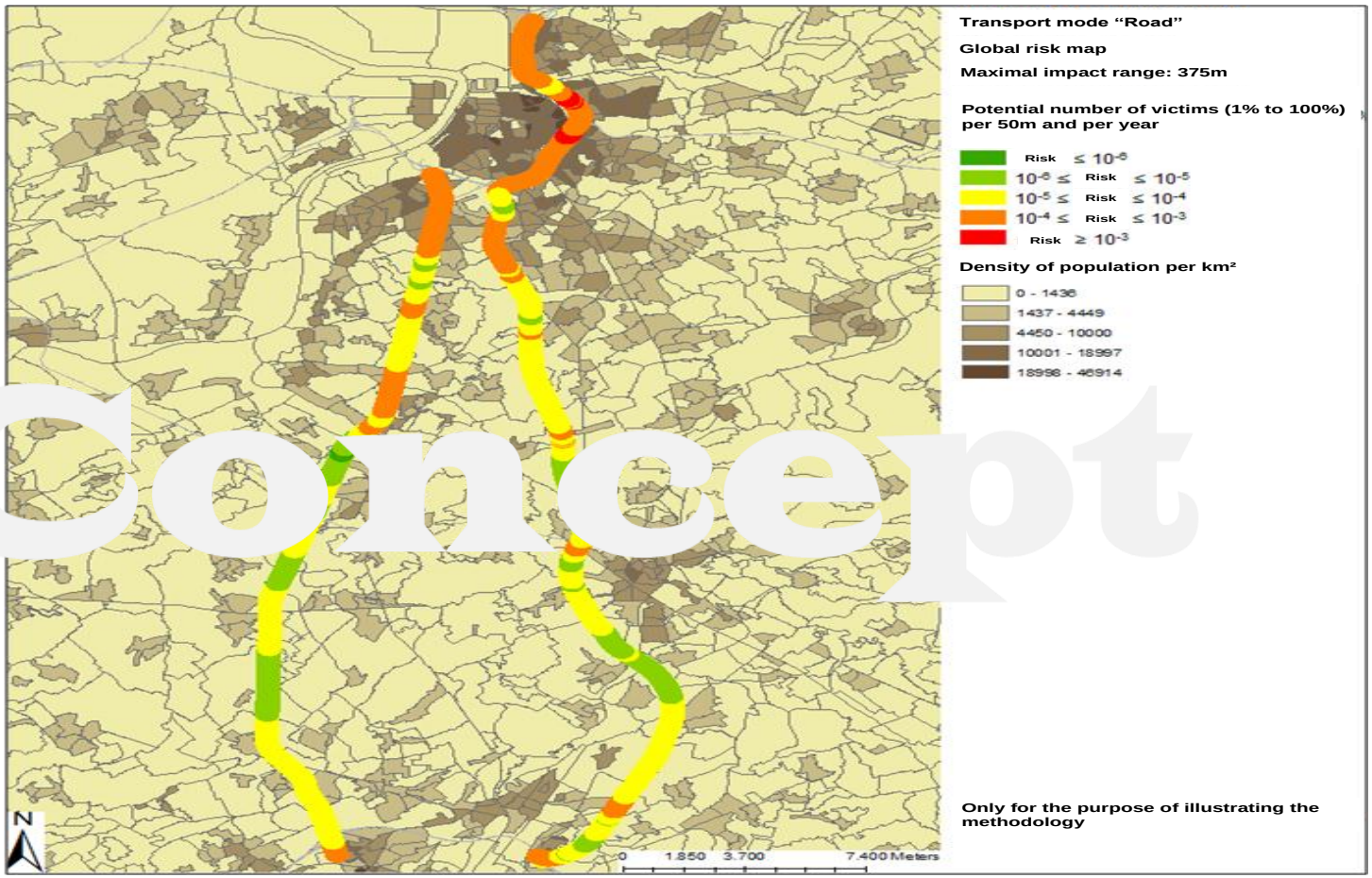
Map risks toxic gases



Map global risks of routes



Map global risks of routes (example 2)



Conclusion

New Flemish approach for Risk Analysis System

- **Allows analysis (of origin) of risks**
  - to obtain acceptable level of risks
  - to make improvements for safety
- **Gives a geographical picture of risks**
  - easy to communicate with the public
  - easy to automate
- **Supports decision making in land use planning**
  - to take into account potential human casualties in the surroundings of transport routes
- **Can be applied in other countries**

Contact & info

- seveso@vlaanderen.be
- Website Safety Reporting Division: www.lne.be/themas/veiligheidsrapportage
- Reference: Chemical Engineering Transactions, Vol. 31, p 19-24, 2013

Questions ?