A framework for designing Regional Biomass Delivery Chains (Project ME4)

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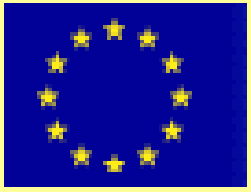
Project Partners

- Wageningen UR
  - AFSG – Valorisation of Plant Production chains
  - AFSG – Biobased Products division
  - ESG – Alterra
- Energy research Centre of the Netherlands (ECN)
- Copernicus Institute Utrecht University
- KEMA
- VU – Amsterdam

Project Details

- official start: January 2007
- duration: 4 years
- budget: 2075 kEuro
- main financer: Climate changes spatial planning

- co-financing: EU, Ministry of Agriculture & Shell



Overall project objective

- to develop an integrated framework to assess and analyse the spatial implications and related opportunities and consequences of an increased implementation of biomass delivery chains for energy and materials at different geographical levels

Start of DEMO

- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
- Compare results

Demo

Biomass chain design & assessment tool

Methodology: modules

- Methodology
- Pre-design
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Main aim of this demo:

1) To illustrate what framework can be developed within the first 2 years of the project
2) To show how the tool can be used:
   - For design of optimal biomass chains (given technological expectations)
   - For spatial implementation of the chains
   - For assessment of spatial and other impacts
   - For comparison of the sustainability-performance of different chains
3) We aim at a tool that will be quick and easy to use
   - This implies that from the complicated models only response functions will be integrated into the tool
4) We will use existing models:
   - their use for assessing biomass chains is sometimes new
   - the integration of the models is most challenging

Methodology: modules

- Methodology — Offers information on the Biomass chain design & assessment tool and a user guide
- Pre-design — Offers the chain designer knowledge on technological expectations and costs (Admire Rebus/BIOTRANS)
- Chain design — Offers a means to design an optimal bio-energy chain In a network structure and by optimalisation (Bioloco)
- Spatial modelling — Finds profitable locations for biomass crops within a radius from specified plants (Biomass allocation model)
- Impact assessment — Computes impacts of land use change on environment, biodiversity, landscape and economy (Miterra, knowledge rules, Bioloco)
- Compare results — Offers the user ways to compare results of different pre-designs, chains designs and different impacts in the form of graphs, maps and tables

- Methodology
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Methodology: core models

Core models:

Admire-Rebus/BIOTRANS

Bio-energy Allocation model

Miterra

KELK

3D visualisation

Biodiversity knowledge rules

- Methodology
- Pre-design
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Methodology: Admire Rebus/BIOTRANS

Input:

1) Biomass potentials (to obtain realistic potential)
2) Costs of (expected) technologies
   - Technology costs (investment and operational costs)
   - Fuel costs (market prices, handling, domestic transport)
   - Lifetime
   - Tax rates
   - Reference electricity price
3) Policy (support) system (e.g. obligation or support system, feed-in tariff, premia)

Calculation:

1) Demand and supply curves for each year

Output:

1) Amount of energy per year at different costs and biomass-technology mixes

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Pre-design: output

	Costs bio-ethanol per GJ			
	Costs bio-electricity per GWh			
Biomass tons DM	Year 2000	Year 2010	Year 2020	Year 2030
1000	K€50	K€50	K€45	K€40
2000	K€100	K€80	K€70	K€65
3000	K€120	K€100	K€100	K€90

Biomass chain design & assessment tool

- Methodology
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Chain design: input

	Costs bio-ethanol per GJ			
	Costs bio-electricity per GWh			
Biomass tons DM	Year 2000	Year 2010	Year 2020	Year 2030
1000	K€50	K€50	K€45	K€40
2000	K€100	K€80	K€70	K€65
3000	K€120	K€100	K€100	K€90

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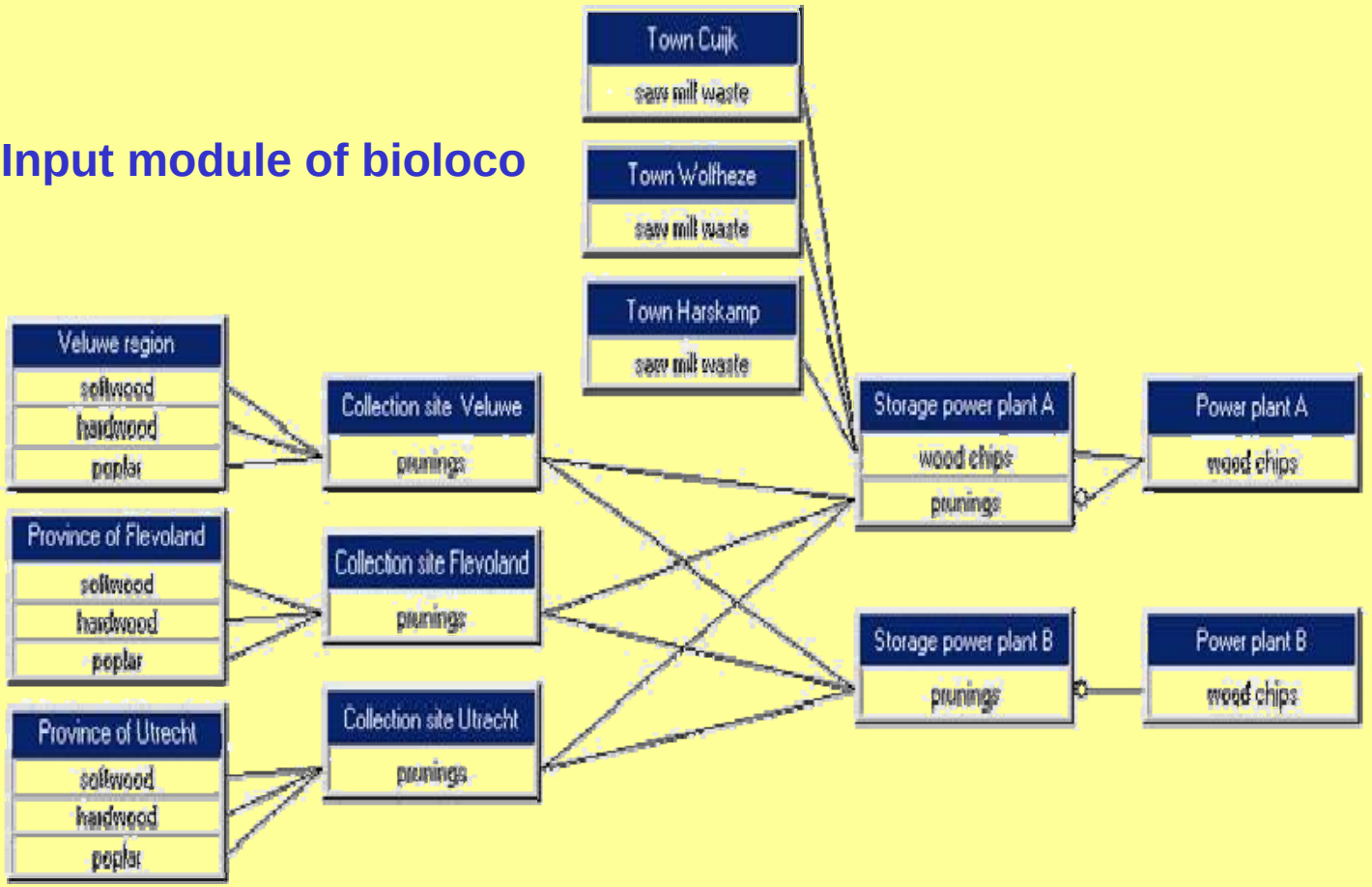
Chain design: network structure

Input module of bioloco



Biomass chain design & assessment tool

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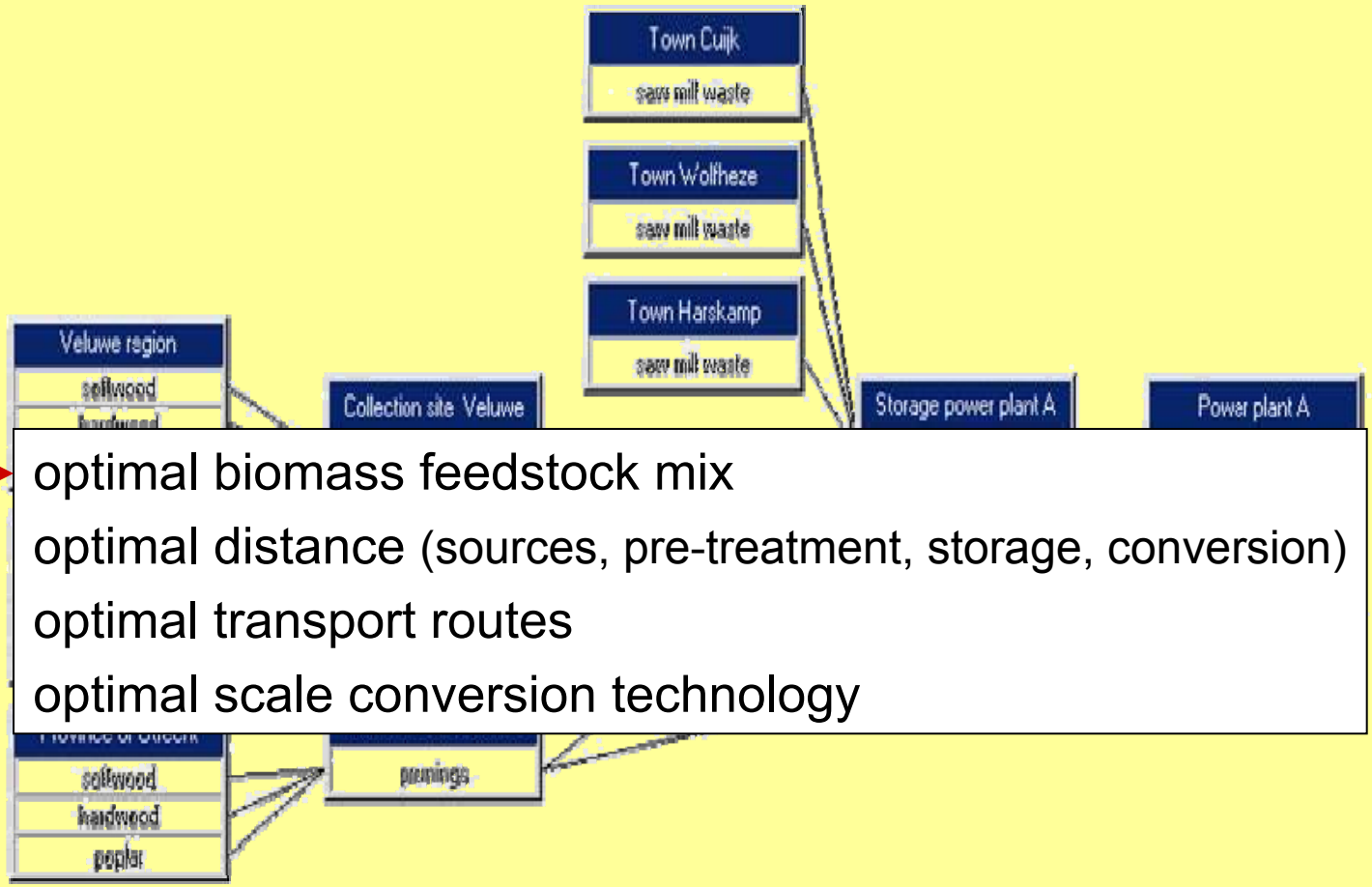
Chain design: output



optimal biomass feedstock mix

optimal distance (sources, pre-treatment, storage, conversion)

optimal transport routes

optimal scale conversion technology

- Methodology
- Pre-design
- Chain design
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Spatial modelling: input 1

optimal biomass feedstock mix

optimal distances (sources, pre-treatment, storage, conversion)

optimal transport routes

optimal scale conversion technology

- Methodology
- Pre-design
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- Impact assessment
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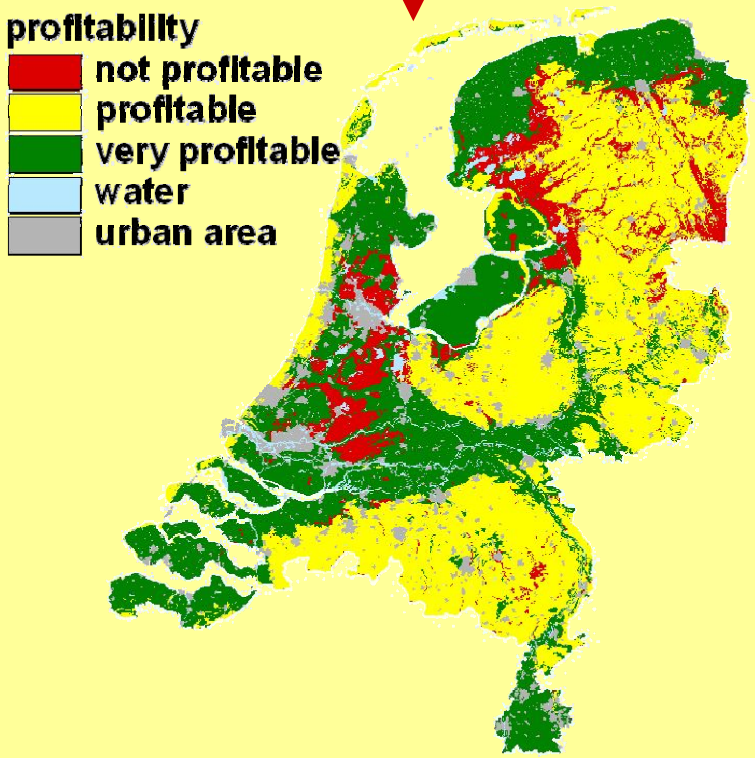
Spatial modelling: input 2

Knowledge input for Spatial modelling:
For each biomass crop a profitability map is derived from average yield levels per soil type (and climate)



- Methodology
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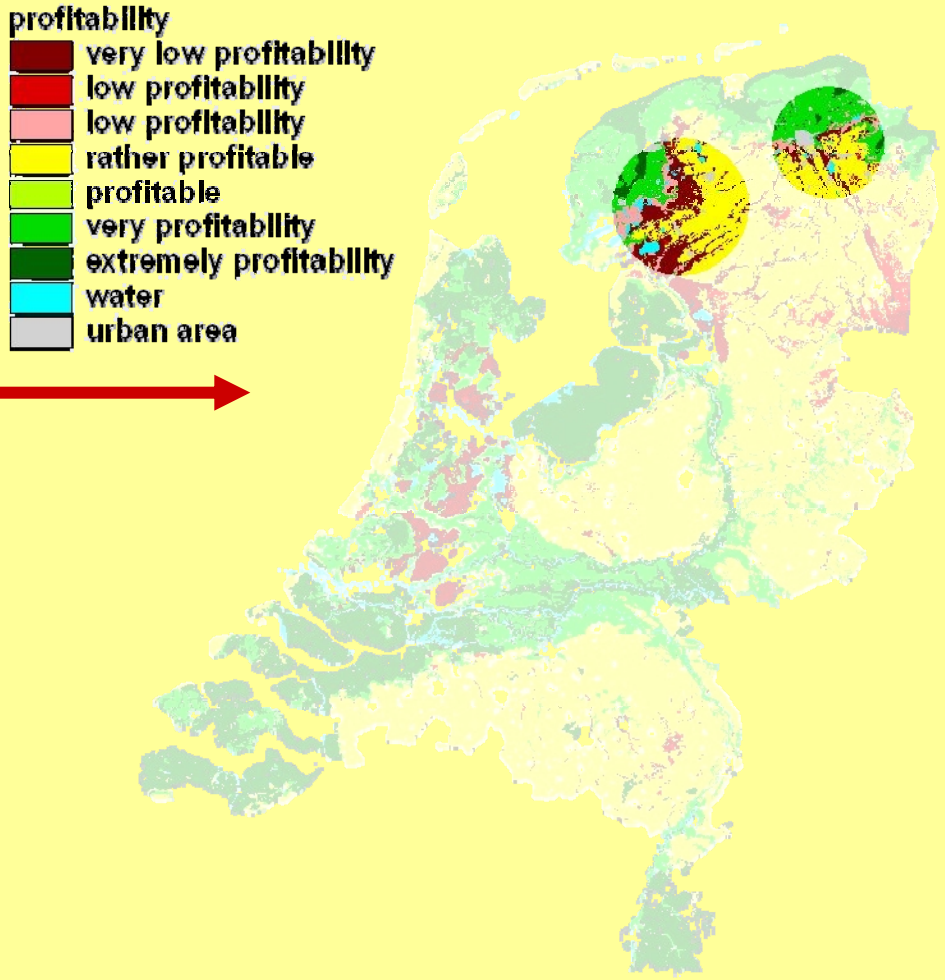
Spatial modelling: calculation

Please wait while financial profit per ha of biomass crop(s) within a radius of plant(s) is being calculated …….

85%

- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
- Compare results

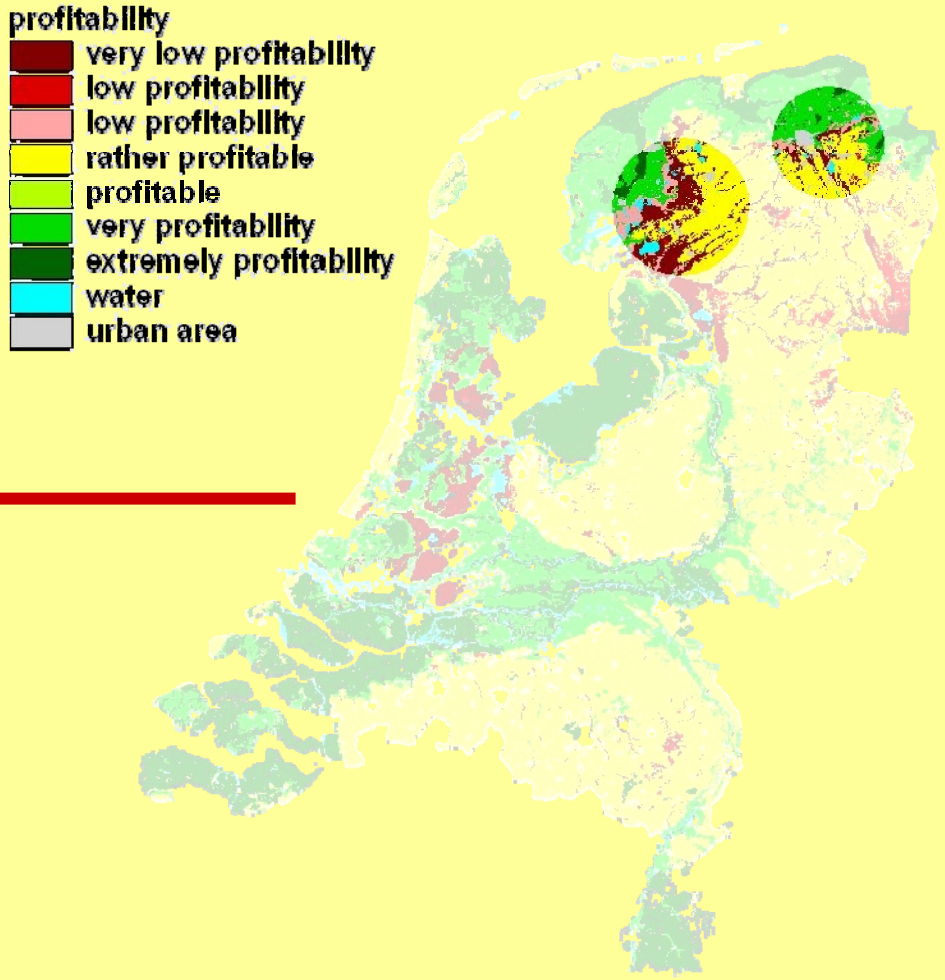
Spatial modelling: output



Impact assessment: input 1

Biomass chain design & assessment tool

- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
  - **Land use**
  - Environment
  - Landscape
  - Biodiversity
- Compare results



Impact assessment: input 2

Biomass chain design & assessment tool

- Methodology
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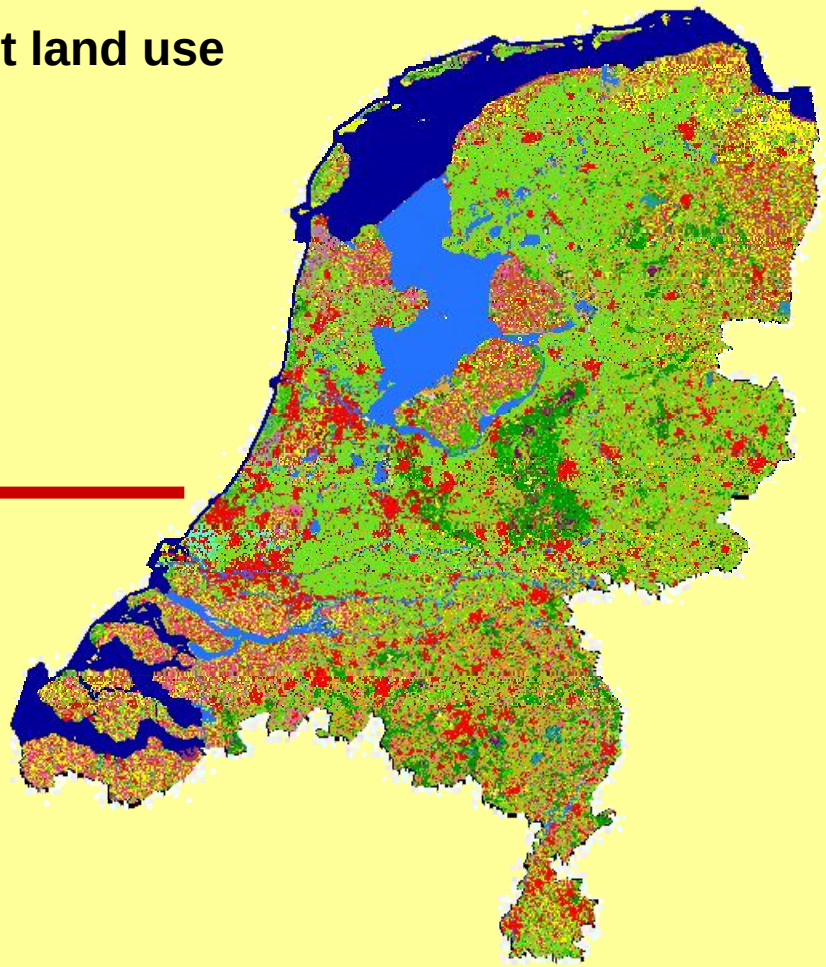
- Compare results

Present land use



Impact assessment land use: output

Biomass chain design & assessment tool

- Methodology
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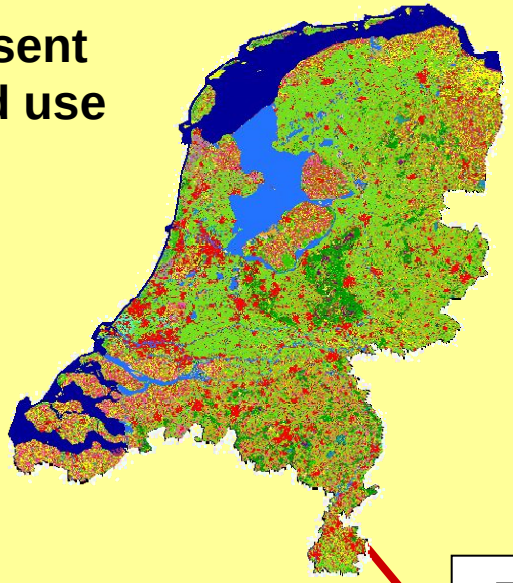
Present land use



Locations of new biomass crops

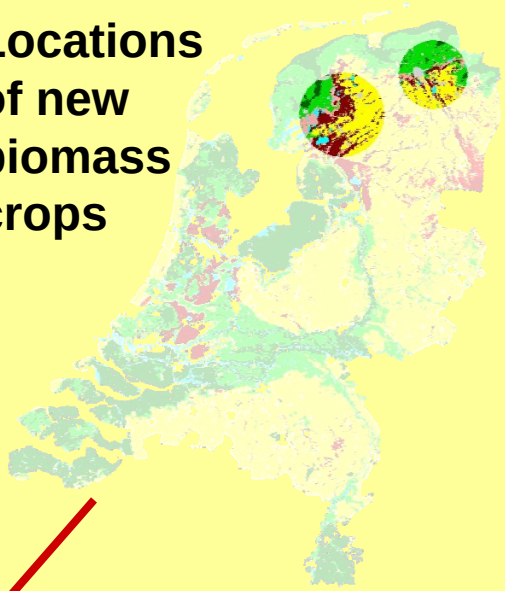


Table of land use change

Please wait while land use change is being calculated

.....

85%

Impact assessment: input

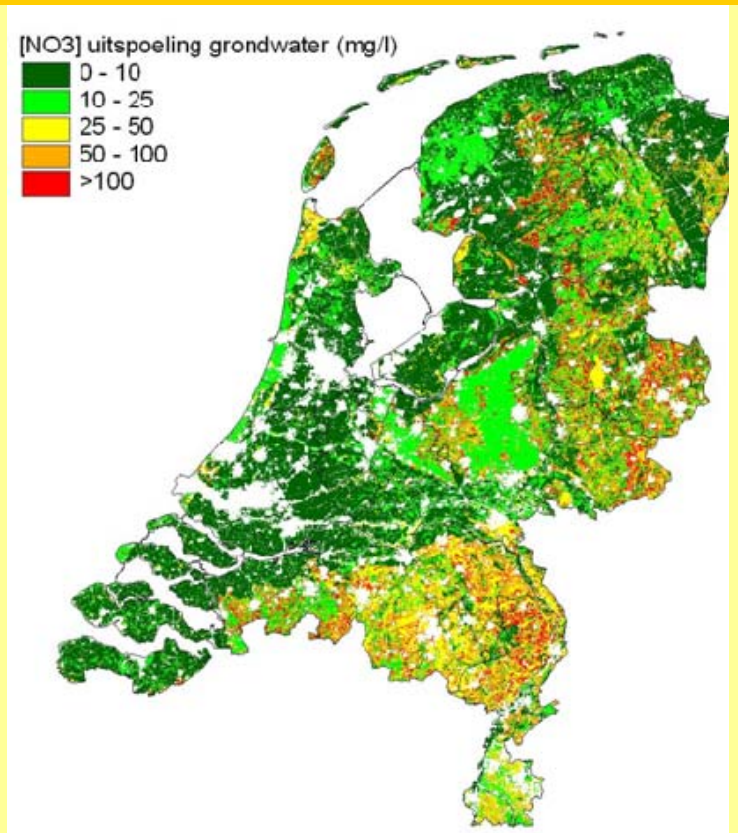
- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
  - Land use
  - **Environment**
  - **Landscape**
  - **Biodiversity**
- Compare results

Table of land use change

Impact assessment environment: output

Biomass chain design & assessment tool

- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
  - Land use
  - **Environment**
  - Landscape
  - Biodiversity
- Compare results



N-, P- and C-balance (soil and ground water)
Leaching and runoff of nitrogen (ground water)
GHG Emission (CO_2, N_2O, CH_4) (air, climate)

Impact assessment biodiversity : input

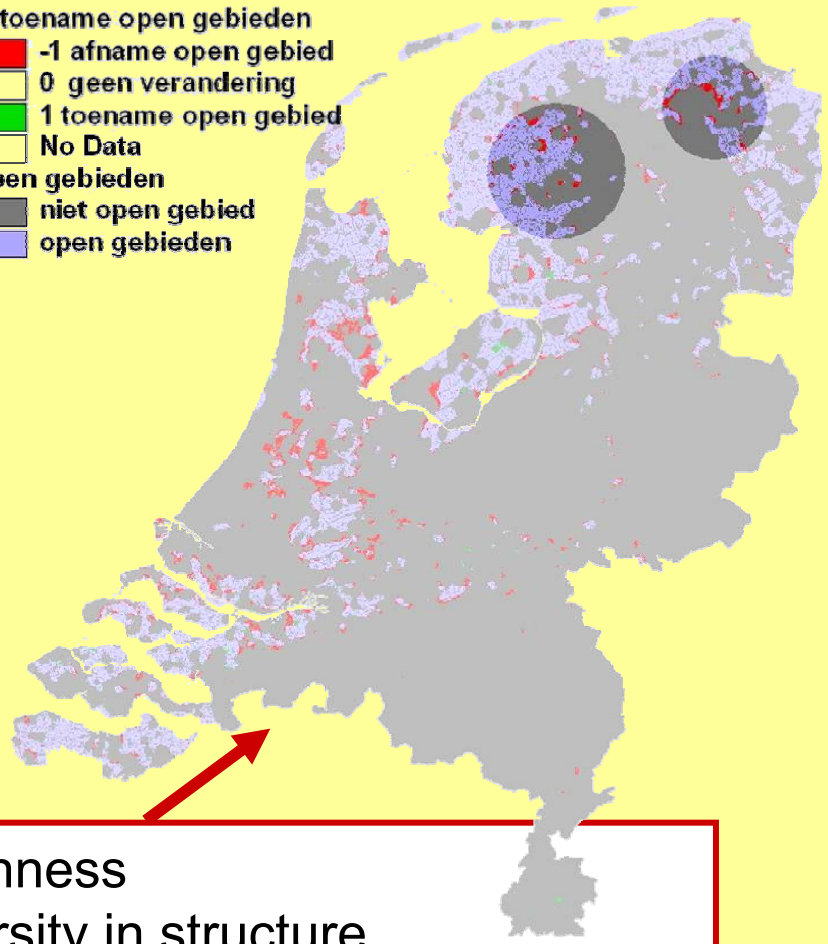
- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
  - Land use
  - Environment
  - Landscape
  - **Biodiversity**
- Compare results

N-, P- and C-balance (soil and ground water)
Leaching and runoff of nitrogen (ground water)
GHG Emission (CO_2, N_2O, CH_4) (air, climate)

Impact assessment landscape : output

Biomass chain design & assessment tool

- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
  - Land use
  - Environment
  - **Landscape**
  - Biodiversity
- Compare results



Change in Openness
Change in Diversity in structure
Change in Size of (semi) natural vegetations

Visual impact

Impact assessment biodiversity: input

- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
  - Land use
  - Environment
  - Landscape
  - **Biodiversity**
- Viewing results

Change in Openness
Change in Diversity in structure
Change in Size of (semi) natural vegetations

- Methodology
- Pre-design
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- Spatial modelling
- Impact assessment
  - Land use
  - Environment
  - Landscape
  - **Biodiversity**
- Compare results

Impact assessment biodiversity: output

Indicators	impact
Soil biodiversity	+
Vegetation	+
Farmland birds	-
Invertebrates	+
Mammals (forest)	-
Mammals (other)	+

Indirect effects through improvement or degradation of environment/habitat (output Miterra) specified for:

- Soil biodiversity
- Vegetation
- Farmland birds
- Invertebrates
- Mammals

Direct effect on biodiversity through changes in land use and landscape structure on:

- Farmland birds and mammals

- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
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  - Environment
  - Landscape
  - **Biodiversity**
- Compare results

Impact assessment biodiversity: methodology

Biomass cropping-drivers	***Pressures (partly from Miterra):***	**Water**	**Soil**	**Soil organism**	**Birds**	**Mammals**	**Inverts**	**Plants**
rotation widening, higher crop diversity	extensification	**+**	+	+	+/-	+	+	+
Clearing abandoned land	Re-using abandoned land, increase landscape diversity	-	-	-	+	+/-	+/-	+/-
Drain land/ bring land under irrigation	Drainage/ irrigation	-	-	-	-	-	-	-
Enlarging plots/ remove hedges, tree lines etc	Habitat fragmentation	**0**	0	0	-	-	-	-
Less tillage/ploughing removal biomass	Less erosion, improvement of soil C	+	+	+	+	+	+	+
Less N-application	Less eutrophication, acidification	+	+	+	+/-	+	+	+
Less pesticides	Improvement of water & soil quality	+	+	+	+	+	+	+

Impact assessment landscape : output

- Methodology
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→

- Change in Openness
- Change in Diversity in structure
- Change in Size of (semi) natural vegetations
- Visual impact

Impact assessment landscape : output

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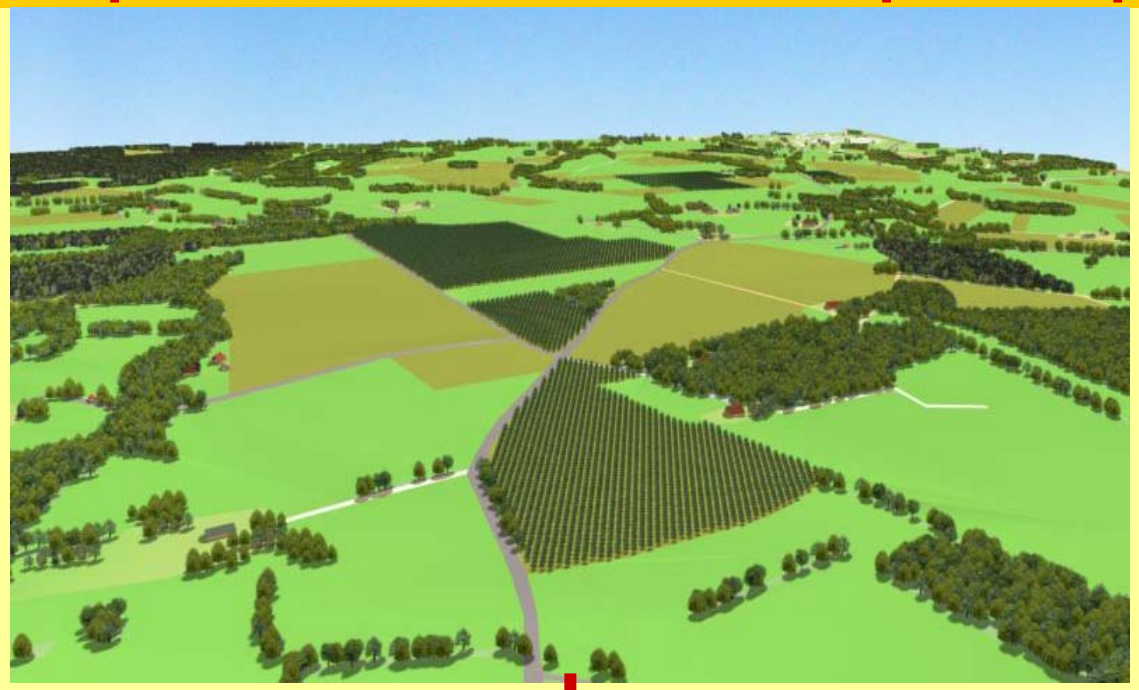

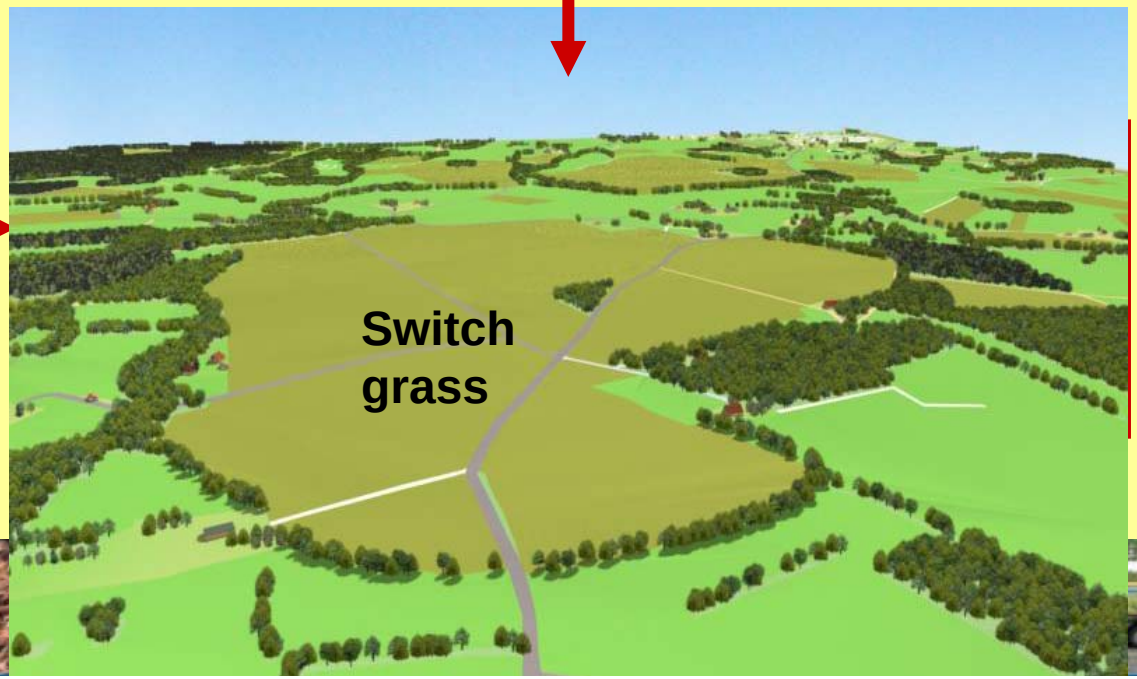

- Methodology
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  - Biodiversity
- Compare results

Impact assessment: economy?

Later in the project:
Economic impacts on **country** level derived from the pre-design?

Later in the project:
Economic impacts on **regional** level derived from the chain design?

Later in the project:
Economic impacts on **farm** level derived from the land use changes?

Biomass chain design & assessment tool

- Methodology
- Pre-design
- Chain design
- Spatial modelling
- Impact assessment
- Compare results
  - **Bar chart**
  - Spider graph
  - Score table
  - Map

Compare results

Select **pre-designs:**
❑2005 ▼

Select results Of pre-designs:
❑Costs bio-elect ▼

Select chains:
❑North-east 200 ▼

Select results of **chain designs**:
❑Price level ▼

Select **Impacts:**
❑Land use ▼
❑Environment ▼
❑Landscape ▼
❑Biodiversity ▼

Select >2 pre-designs if you want to compare results for different pre-designs

Select here the type of results you want to compare for the selected pre-designs

Select >2 chains if you want to compare results for different chains

Select here the type of results you want to compare for the selected chains

Select here the impacts you want to compare for the selected chains

Compare results

Biomass chain design & assessment tool

- Methodology
- Pre-design
- Chain design
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- Impact assessment
- Compare results

  Bar chart
  Spider graph
  Score table
  Map

Select **pre-designs:**

❑2005 ▼

Select results Of pre-designs:

❑Costs bio-elect ▼

Select chains:

■North-east 201 ▼

Select results of **chain designs**:

■Price level ▼

Select **Impacts:**

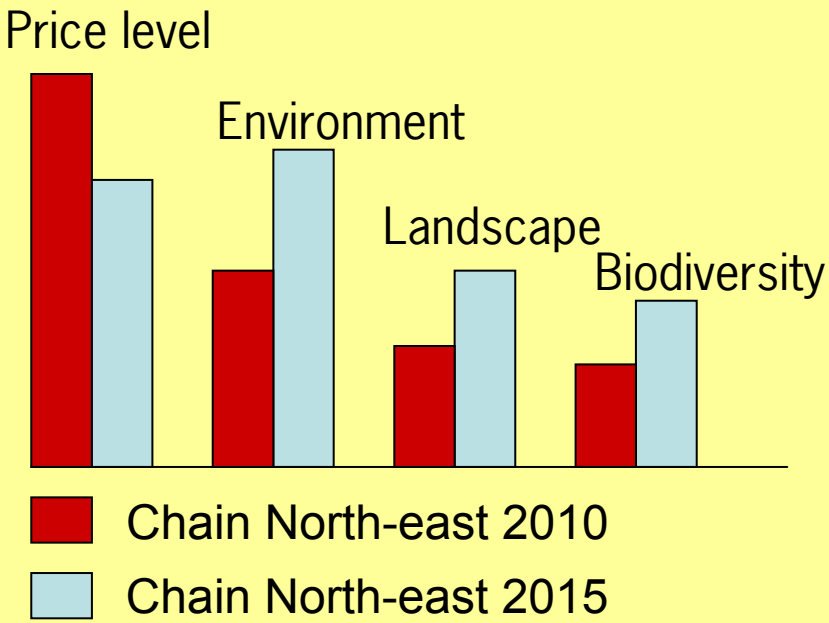
■Land use ▼

■Environment ▼

■Landscape ▼

■Biodiversity ▼

Example of results on aggregated level



Compare results

Biomass chain design & assessment tool

- Methodology
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Select **pre-designs:**

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Select chains:

■North-east 201 ▼

Select results of **chain designs**:

■Price level ▼

Select **Impacts:**

■Land use ▼

■Environment ▼

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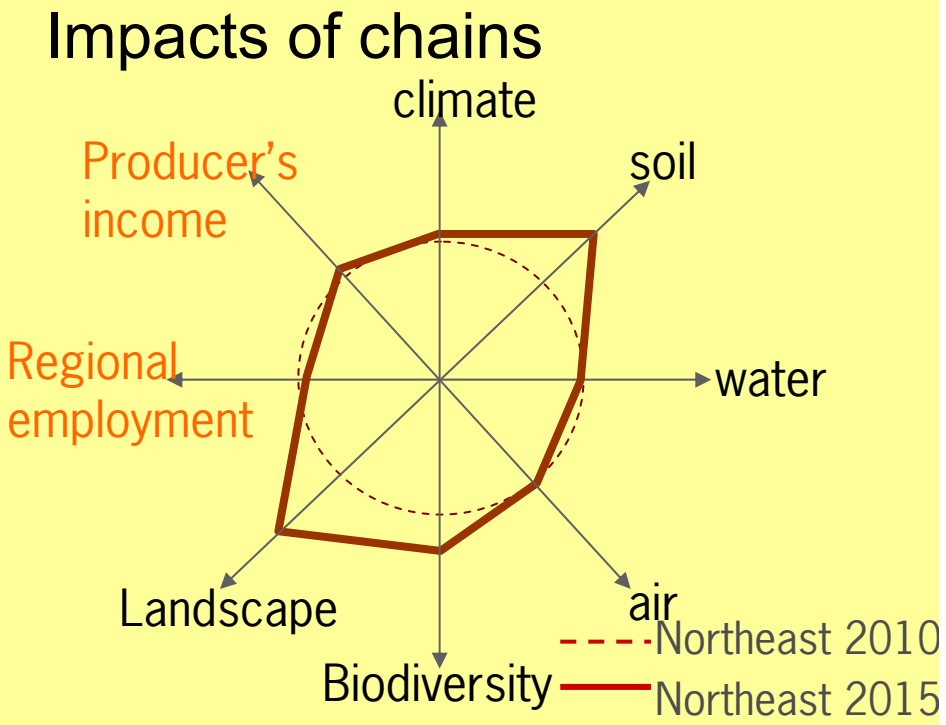

Biomass chain design & assessment tool

- Methodology
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Demo

EXIT