# Climate change impacts and adaptation of agriculture in the Netherlands

Pytrik Reidsma[1], Ben Schaap[2], Maryia Mandryk[1], Argyris Kanellopoulos[1], Joost Wolf[1], Frank Ewert[3], Jan Verhagen[2], Martin van Ittersum[1]

[1]Plant Production Systems group, Wageningen University, The Netherlands
[2]Plant Research International, Wageningen UR, The Netherlands
[3]Institute of Crop Science and Resource Conservation Bonn University, Germany

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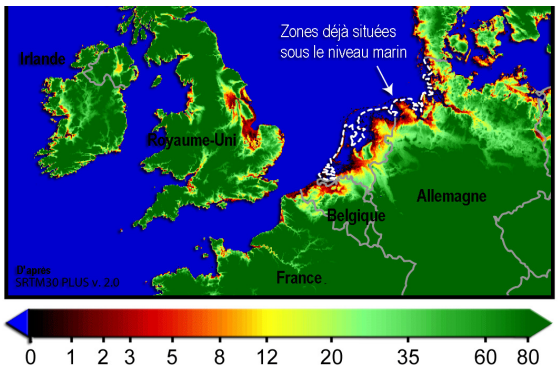
## Introduction: Adaptation in the Netherlands

Aim: "climate proofing" the Netherlands over all sectors including agriculture


Area at risk with potential sea level rise




Source:Wikipedia

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## Region of Flevoland 40 years ago and …. 40 years ahead?

1950 2010


To assess i… pproach

- **Multi…**
- **Multi…** level r… eme events, sea
- **Multi…** global, EU, region, farm, field
- **Multiple methods:** historical analyses, scenarios, models, stakeholder workshops, interviews

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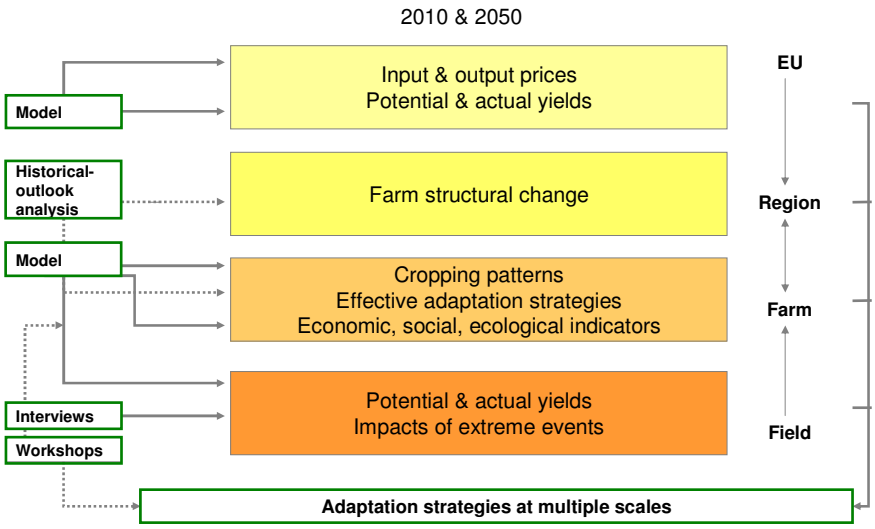
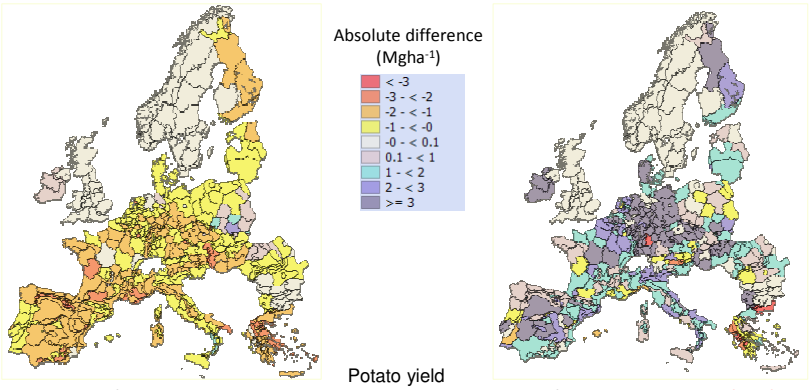
## Integrated approach: scales, SD dimensions, stakeholders



## EU level

| Model | | |
|---|---|---|
| | Market model | Input & output prices: 2010 & 2050 |
| | Cropping system model | Potential yields: 2010, 2050 |
| | Integration climate, technology | Actual yields: 2010, 2050 |

**EU** → **Region**




Climate | Potato yield | Climate + $CO_2$ + Technology

Scenario (15GCM A1B)

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Ewert et al., 2005; Heckelei & Britz, 2001

## Regional level

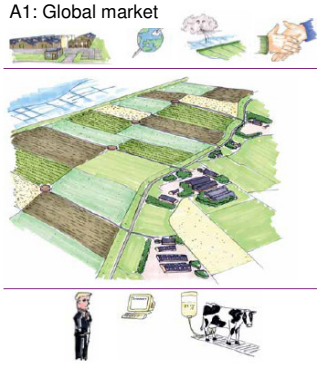
**EU** → **Region** → **Farm**

| Historical analysis & outlook | Scenarios | Farm structural change: 2050 |
|---|---|---|

2010: Mainly production oriented; 40-100 ha; medium intensive; potato, sugar beet, onion, wheat

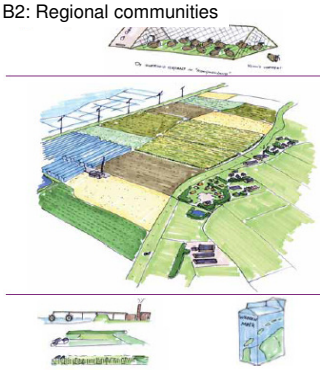
2050

A1: Global market



Production
Size x 2
High intensive
More flowers & vegetables

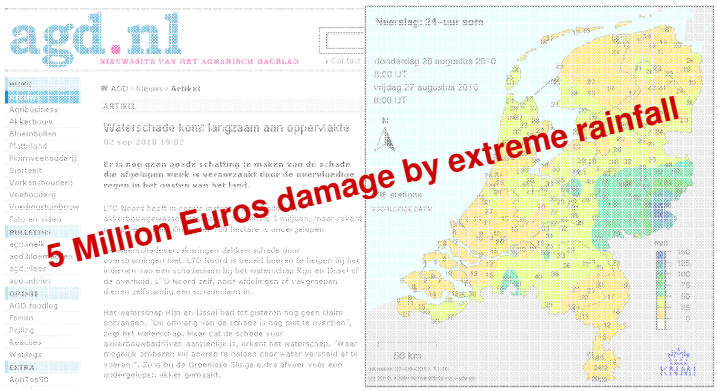
B2: Regional communities



Multifunctional
Size x 1.5
Medium intensive
More diverse crops

Pictures from Van der Kolk et al., 2007

## Field: Crop yields




EU
Region
Farm
Field

Model
Interviews
Workshops

| | |
|---|---|
| Cropping system model | Potential yields: 2010, 2050 |
| Agro Climate Calendar | Impact of extreme events: 2010, 2050 |
| Integration climate, technology | Actual yields: 2010, 2050 |

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## Crop level: crop simulation model

| Crop | Potential yield base yr (t/ha) | Water-limited base yr (t/ha) | **567 ppm and climate change** | **Idem + adaptation** |
|---|---|---|---|---|
| Winter wheat | 10.3 | 9.9 | 9 % | 11 % |
| Potato ware | 15.6 | 12.0 | 9 % | 14 % |
| Potato seed | 11.0 | 9.0 | 9 % | 19 % |
| Sugar beet | 16.9 | 15.9 | 25 % | 25 % |
| Fodder maize | 22.5 | 21.7 | 9 % | 17 % |
| Sunflower | 3.8 | 3.6 | 10 % | 15 % |
| Onions | 13.6 | 11.6 | 21 % | 27 % |
| Tulip | 6.8 | 5.7 | 26 % | 35 % |

Effects of $CO_2$ and climate change (W, +2°) on water-limited yields (Flevoland)
Adaptation: 15 days earlier sowing date and 'more southern' varieties
All +, although for W+ also negative impacts expected

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## Crop level: weather extremes, onion

Define weather events that are harmful to crops
Couple weather events to frequency of occurrence

Frequency of weather events

- reference climate (30 years:1976-2005)
- future climate (30 years: 2026-2055)


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Schaap et al., 2009

## Onion: climate factors harmful to seed onion

| Climate factor | Timing | Impact on crop | Damage |
|---|---|---|---|
| Long dry period in spring | feb-apr | Crop failure | 0-100% |
| Long dry period in summer | june-july | Growth & yield reduction | 30-40% |
| Flooded soil | sept-oct | Harvest not possible; diseases | 0-100% |
| Strong rains | july - aug | Bacteria infections | 10-50% |
| Warm and wet | july - aug | Fungi infect leaves | 50-60% |

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Schaap et al., 2009

## Onion: frequency of climate factors now

**Reference period: 1990 (1976-2005)**

| Climate factor | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Long dry period in spring | | 1 | 0 | 2 | | | | | | | | |
| Long dry period in summer | | | | | | 1 | 3 | | | | | |
| Flooded soil | | | | | | | | | 1 | 0 | | |
| Strong rains | | | | | | | 0 | 1 | | | | |
| Warm and wet | | | | | | 0 | 0 | 1 | | | | |

Daily weather information from weather station Eelde (source: KNMI)

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Schaap et al., 2009

## Onion: frequency change of climate factors

**High emission scenario 2040 (2026-2055, +2°C)**

| Climate factor | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Long dry period in spring | | 0 | 0 | +1 | | | | | | | | |
| **Long dry period in summer** | | | | | | **+2** | **+5** | | | | | |
| Flooded soil | | | | | | | | | -1 | 0 | | |
| Strong rains | | | | | | | 0 | +1 | | | | |
| **Warm and wet** | | | | | | **+5** | **+6** | **+6** | | | | |

Next step: define adaptation strategies for major climate risks

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Schaap et al., 2009

## Adaptation workshops with stakeholders

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## Adaptation strategies for onion

| Climate factor | Adaptation strategy | Level | Yearly costs | Investment |
|---|---|---|---|---|
| Long dry period in summer (crop failure) | Irrigation | Farm | Medium | High |
| | Regional water management | Region | - | Very high |
| | Re-sowing | Crop | Low | - |
| | Sowing at higher density | Crop | Low | - |
| Warm and wet (fungi) | Chemical protection | Crop | Medium | - |
| | UV protection | Crop | Medium | Low |
| | Develop resistant varieties | Sector | - | Very high |

Cost-effectiveness:
damage <->
costs + investment

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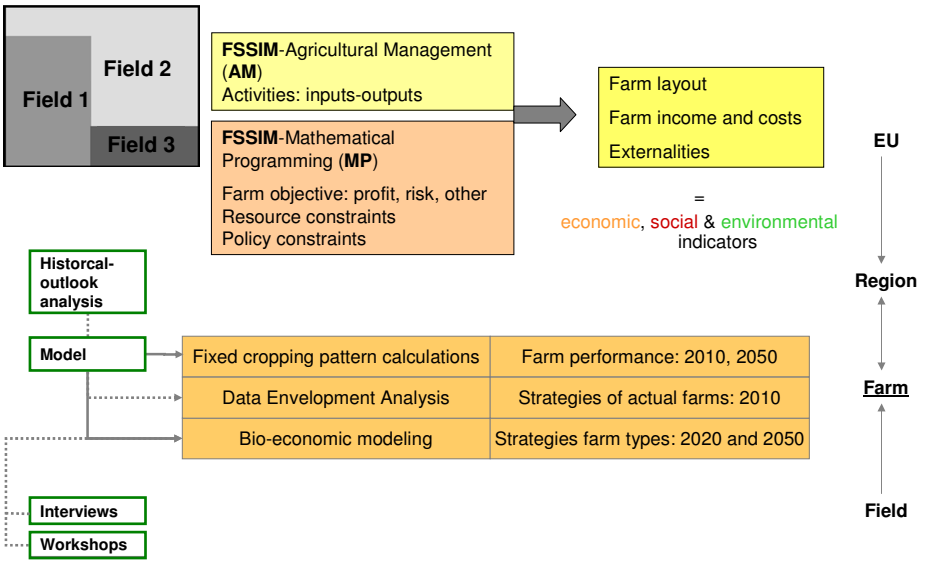
## Farm level: Bio-economic farm modelling

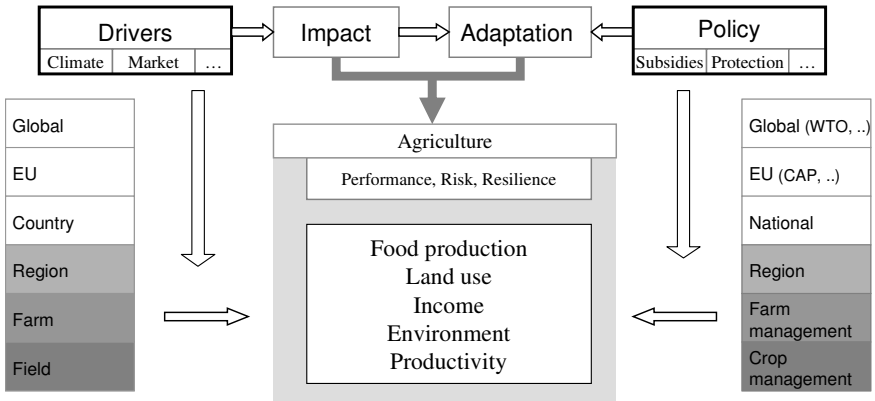



Louhichi et al., 2010, Kanellopoulos et al., 2010

## Integrated assessment of adaptation strategies

SEAMLESS

Scale dependent responses

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Van Ittersum et al., 2008

## Concluding remarks

- For adequate adaptation we have to answer multiple questions on impacts and adaptation at multiple scales
- Context of future farms is needed to assess impacts and evaluate adaptation: towards multifunctional agriculture
- Adaptation has impact on economic, social and environmental indicators
- Climatic extremes are not well captured in crop models
- Adaptation is dynamic, scale dependent and driven by stakeholders
- Use of methods from SEAMLESS Integrated Framework to assess impact and adaptation

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climate changes spatial planning

## Thank you for your attention

Pytrik Reidsma pytrik.reidsma@wur.nl

*Plant Production Systems, Wageningen UR, The Netherlands*

www.klimaatenlandbouw.wur.nl

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