



# Economic Modeling of Climate Change and Water scarcity

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# Project description

- This project examines the economic impacts of increasing frequency of water scarcity due to climate change

## WP 5: Economic modeling of Climate change and water scarcity

- Examines the economic impacts of increasing frequency of water scarcity due to climate change
- Models the impacts on the economy as a whole instead of existing partial, sectoral approaches of a reduction of for instance available irrigation water on the agricultural and related sectors
- For this purpose, an Applied General Equilibrium (AGE) model is used ('GTAP') to capture both the direct and indirect effects of water scarcity on economic sectors (agriculture, electricity, navigation, other industry) as the economy (re)adjusts to changing external circumstances

# Introduction

- This project examines the economic impacts of increasing frequency of water scarcity due to climate change
- It models the impacts on the economy as a whole instead of existing partial, sectoral approaches of a reduction of for instance available irrigation water on the agricultural and related sectors
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# Two ways to model water scarcity: focus on the direct and indirect effects



Rest of  
the economy



Demand  
for product



Economic  
sector



Water

**Direct Method** focuses  
on the details of the  
crops dependency on  
water.

It does not include  
economic feedbacks

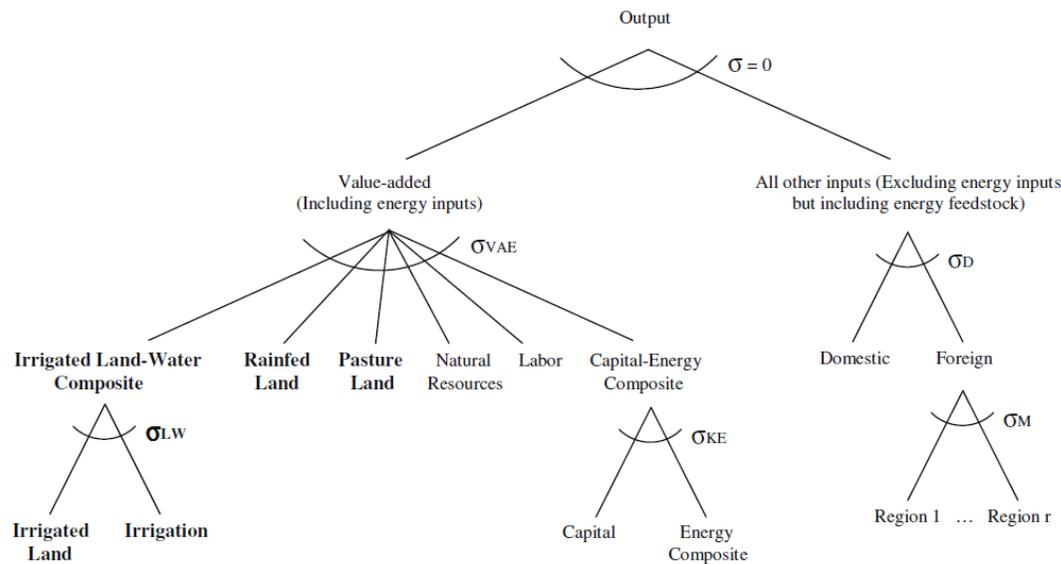


**General Equilibrium**  
method focuses on  
economic feedbacks.

It has a low level of  
detail regarding crop  
dependency on water

# Methodology and Model

- GTAP: A World scale General equilibrium model with a focus on trade
- GTAP-W a recent extension with water explicitly included
- Aggregated to focus on the Rhine and Meuse river basin countries
- Structural reduction of water availability due to climate change
- Medium run equilibrium approx. 5 years.

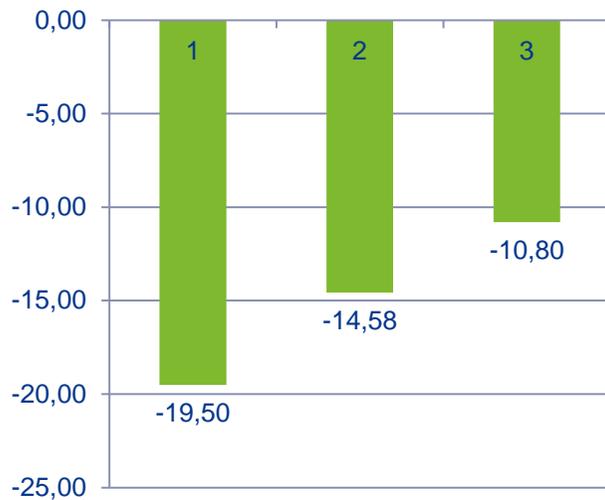


# Data and Direct Results (Deltares)

- Two reports on Climate Change
  - van Velzen et al. 2011
  - van Beek et al. 2008
- Both reports use a collection of models to (among other things) simulate the direct effect of drought and climate change on Dutch agriculture
- Economic feedbacks are not included (prices don't change)
- Specifically they calculate the damage to agriculture that would come from the drought conditions of 76 were they to happen today
- The total additional damage to agriculture from the 76 drought conditions are **1520 Million Euros** or 19.5% of agricultural production.

# GTAP Preliminary Results

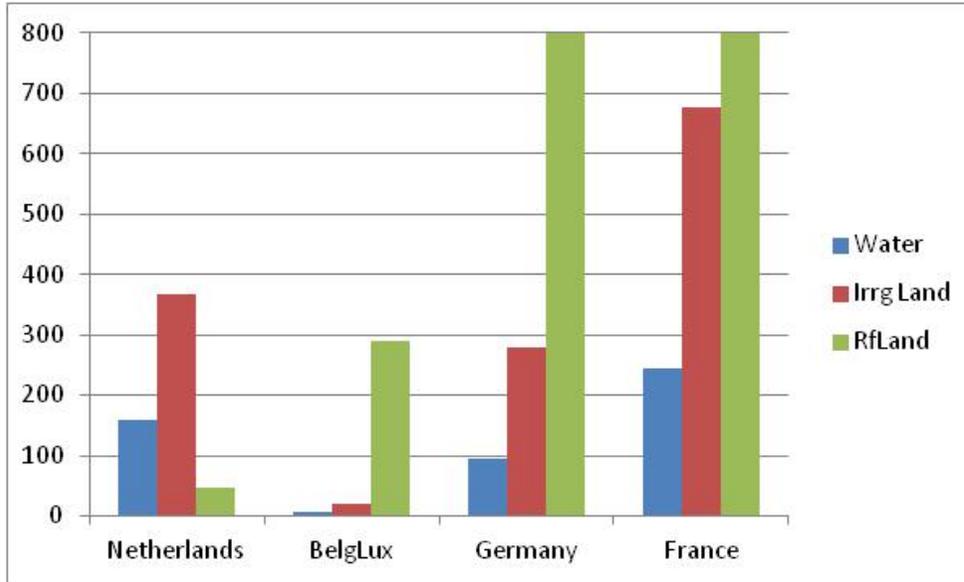
- Using the GTAP model we examine the scenario where the 76 drought conditions become the norm, what would be the effect on the Dutch economy?
- Model was calibrated so that the 76 drought conditions (37% less irrigation water) resulted in a 19.5% agricultural loss at original prices.



Dutch Agricultural Loss in percent change at:

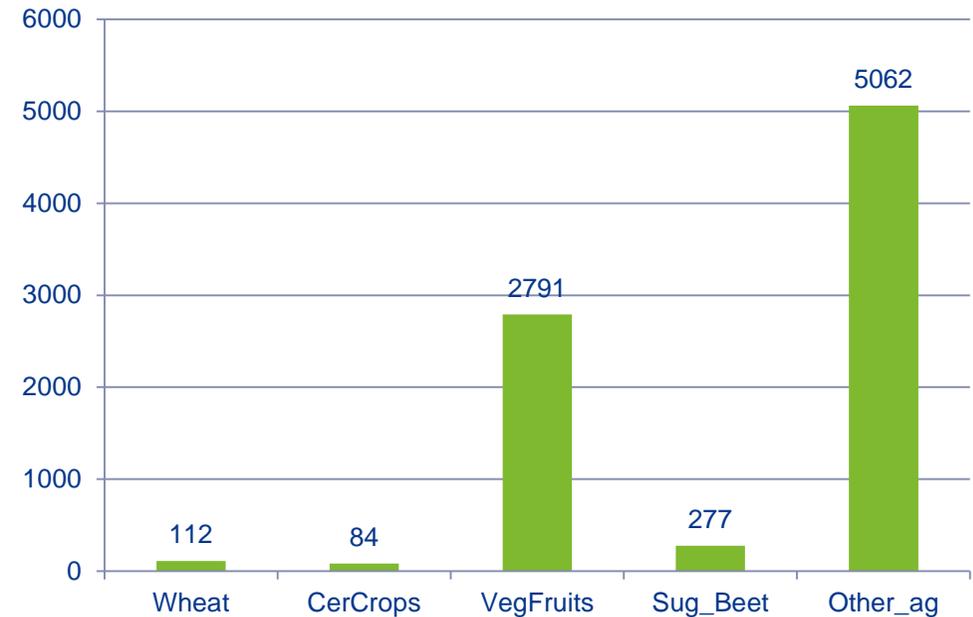
- 1 Original prices
- 2 New equilibrium prices
- 3 If the drought effected the other countries that share the river basin as well

# Sectors and Production factors: initial values



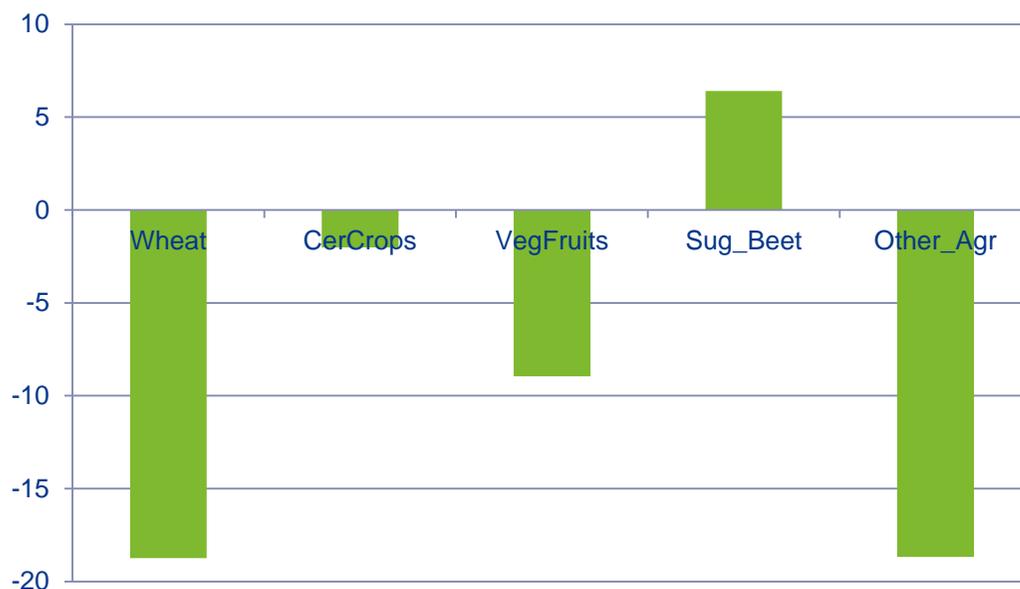
Where Germany and France have a value of rain fed land of 5500 and 5000 respectively

Values in Millions of \$



Dutch Agricultural output

# Agricultural sectors the results

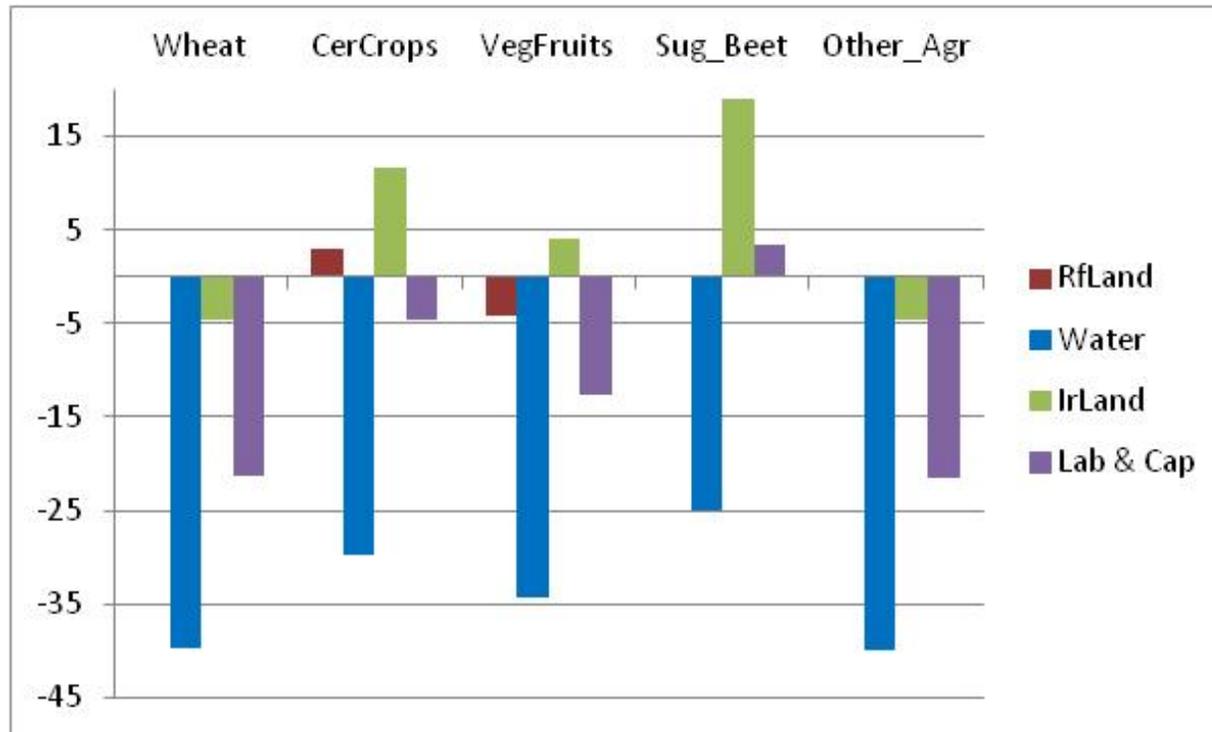


Percent change in value of agricultural sectors as a result of the shock

All sectors have a decrease in physical output

- Half of the drop in exports for the Sugar beet sector is compensated by a increase in domestic consumption from the non-agricultural sectors.
- In Other Agriculture, the fall in exports dominates. This comes primarily from a fall in exports to Germany and the **rest of Europe**

# Percent Change in use of value added agricultural inputs

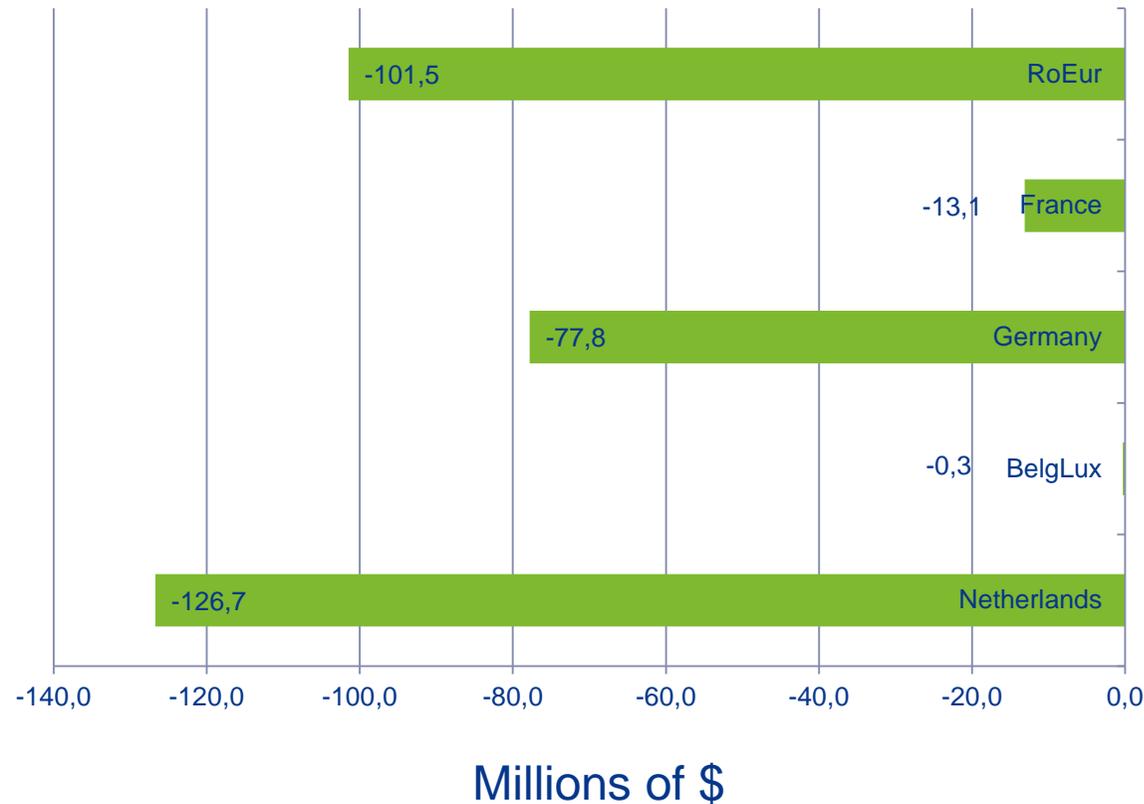


Sectors react differently to water scarcity and change their mix of inputs

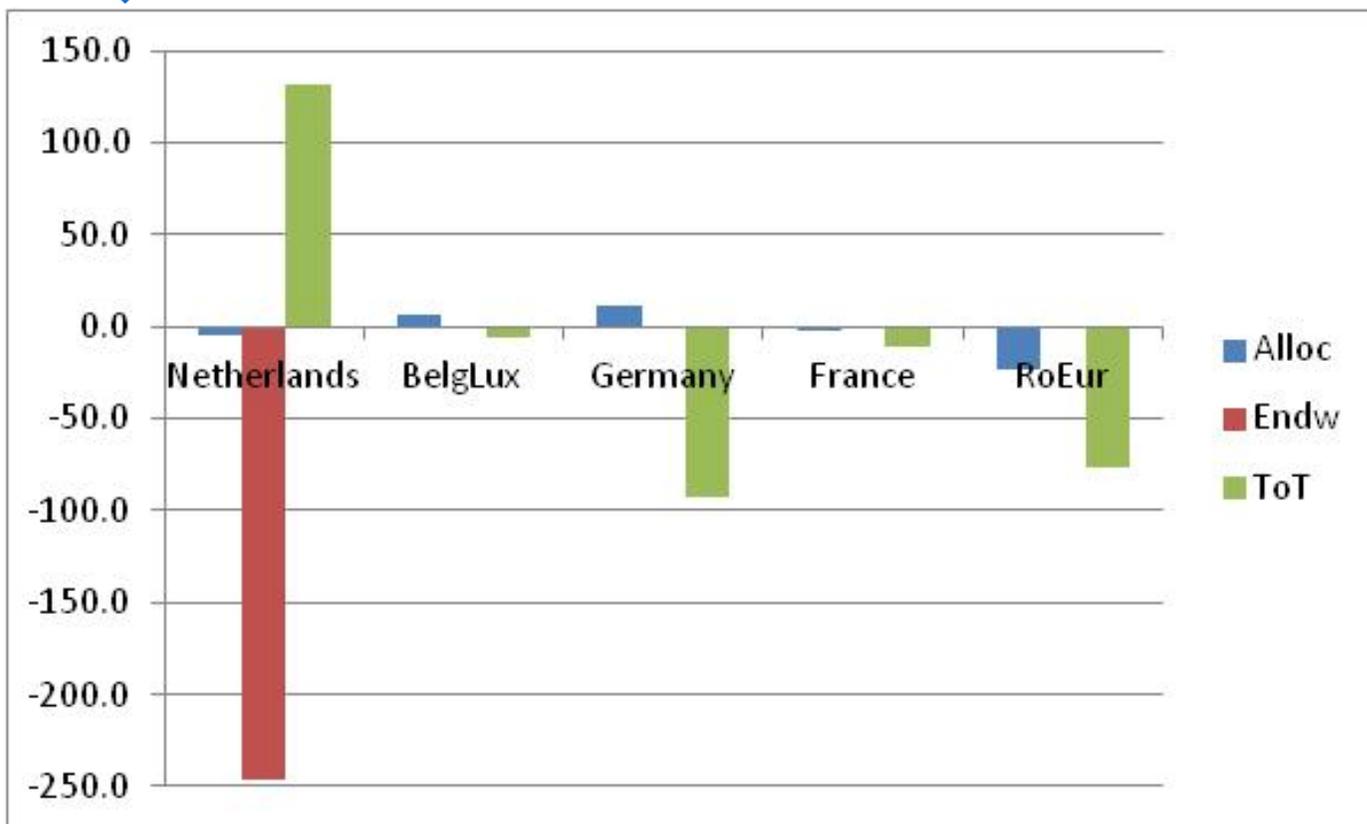
In GTAP-W water, like land, is partially mobile between sectors.  
As a result sectors face slightly different prices for land and water

# How does this effect the consumer? Is the Netherlands worse off? By how much?

GTAP measures utility changes by equivalent variation: how much would the regions be willing to pay to avoid this situation?



# Contribution to Welfare in Miln \$



ToT = Terms of trade

Endw = Loss of endowments (water)

Allocative efficiency = Change in market distortions

Dutch Agricultural exports become more expensive. This allows them to purchase more imports per unit of export good. This affects the importers of these Dutch products

# Conclusions

- A rise in prices partially compensates for a fall in agricultural output
- Heterogeneity in sector response in both the input and output side
- Neighboring countries are affected as well by negative terms of trade leading to possible cooperation on water agreements.

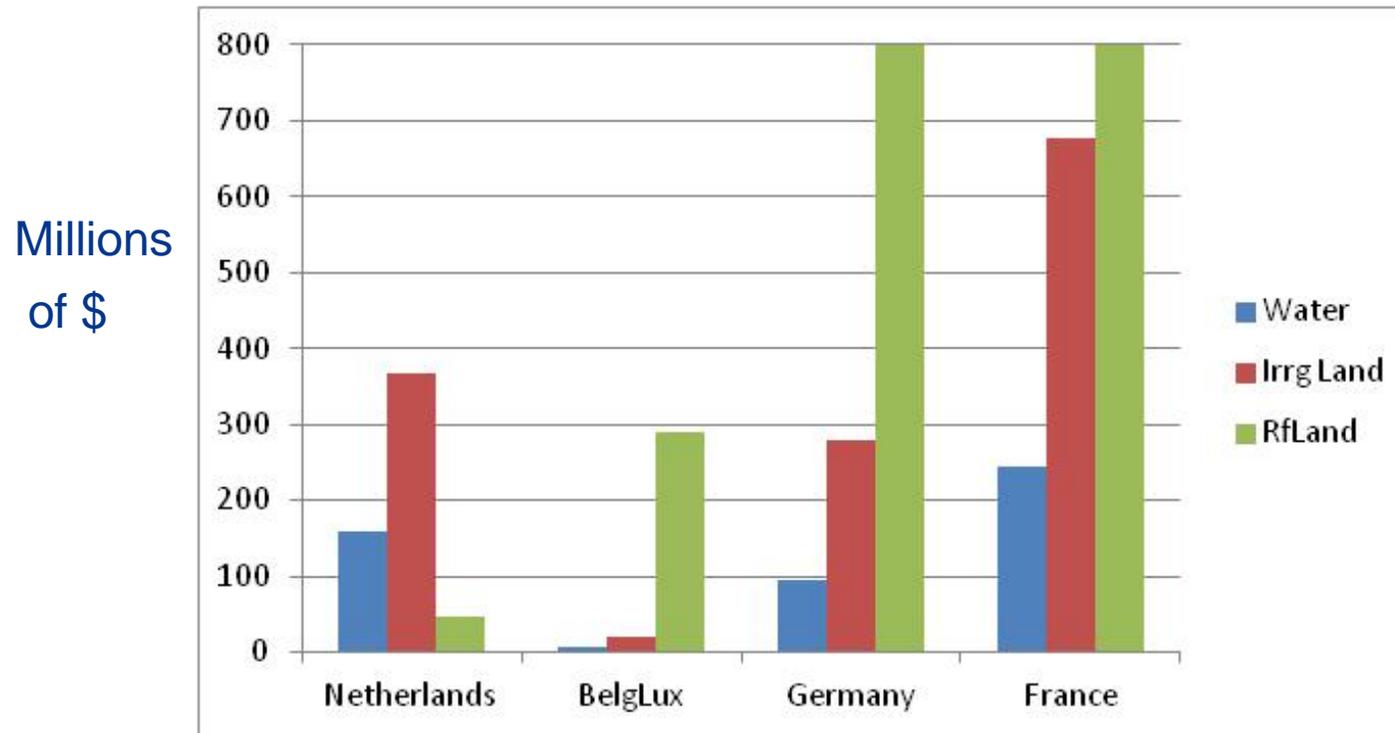
## Further work

- Incorporating explicit water use into other sectors of the economy (specifically energy, transport and industry) and examining possible re-allocation of water between agricultural and non-agricultural sectors
- Distinguishing water and water users by river basin, to examine the attractiveness of inter basin water transfers or international water transfers within the same basin.



**Thank you for your attention**

# Initial values of agricultural inputs



Where Germany and France have a value of rain fed land of 5500 and 5000 respectively

# Agricultural Sectors: Initial output

