Drought and water management in the German agricultural sector - a participatory system dynamics approach

Rodrigo Valencia Cotera

The Study Region

Lower Saxony is the state in Germany with the largest irrigated agricultural land with 8,5 % [1]. During the 2018 drought, Lower Saxony was the third most affected state, with a reduction of 26 % in grain yields [2]. North East Lower Saxony (NELS) is an important agricultural area with 47 % of its land used for agriculture [3]. The NELS is heavily dependent on irrigation due to lower precipitation, sandy soils and water demanding crops [4]. Based on climate projections, the area might be at risk of water shortage due to climate change, as rain patterns, ground water recharge and soil moisture content may change. Despite the increasing risk of droughts, the region has neither a Drought Management Plan nor drought insurance policies.

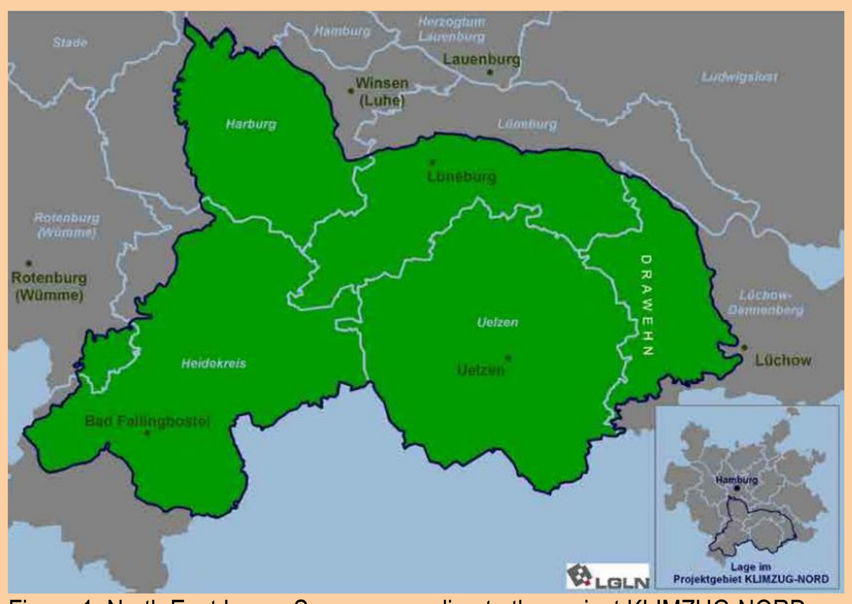

Figure 1: North East Lower Saxony according to the project KLIMZUG-NORD

Objective

Increasing agricultural resilience to drought and water scarcity under climate change conditions, without compromising water resources and without increasing emissions.

Research based on

- System Dynamics (SD)
- Multidisciplinary and participatory approach
- Climate Data
- Conjunctive Water Use (CWU)
- Drought Management

Project description

The project is focused on building a **SD** model based on the actual situation of agricultural systems in NELS. The model building and development is based on a multidisciplinary and **participatory approach**.

The objective of developing a **SD** model is to:

(1) Understand the current and possible future situations of agriculture and its relation to water in NELS.
(2) Identify the stakeholder's needs.
(3) Identify the risks and weaknesses of the system.
(4) Model possible scenarios under climate change conditions.
(5) Use the model to analyze and rank adaptation and management strategies.

Research questions

- How does agriculture in NELS use and manage its water sources?
- What are the stakeholder's needs in NELS?
- How vulnerable is the region to suffer climate change induced drought?
- Which measures can help adapt to climate change?
- How will the implementation of CWU reduce the economic impact of drought or water scarcity in the region?
- Which governance structures are needed to support the implementation of drought management practices?

For more information please visit:
https://www.hicss-hamburg.de

Workflow

Field research and model building

1. Individual interviews with stakeholders to design and build a qualitative model (Figure 2).
2. Group workshop with all stakeholders to build and validate a group model.
3. Development of a quantitative model based on the qualitative group model.
4. Quantify the model processes and feed it with climate data.

Policy Analysis

5. Analysis of the water availability based on climate scenarios with the SD model.
6. Evaluate the possible implementation of CWU and other adaptation measures.

Challenges

1. Finding and getting all main stakeholders to participate.
2. Development of a model which accurately represents reality.
3. Quantification of all the model's processes.
4. Acquire data to calibrate de model.

Results

1. The system is vulnerable to climate change as it has the potential to drastically increase the water demand.
2. Increase in irrigation water demand could lead to water conflicts.
3. Irrigation efficiency could be increased to reduce water and energy demand.
4. Changing crops might be difficult as the whole economical structure of the system is based on them (factories and biogas plants).
5. Improving soil quality might be an essential climate change adaptation measure.
6. New water management strategies are a necessity to adapt to climate change.
7. The region shows promising signs of CWU.

Next steps

1. Quantification of the model and coupling with climate data.
2. Analysis of climate change adaptation measures (crop change, humification, increase irrigation efficiency).
3. Model the effectiveness and viability of conjunctive water use to deal with climate change induced drought.
4. Determine the political and social structured needed to support conjunctive water use.

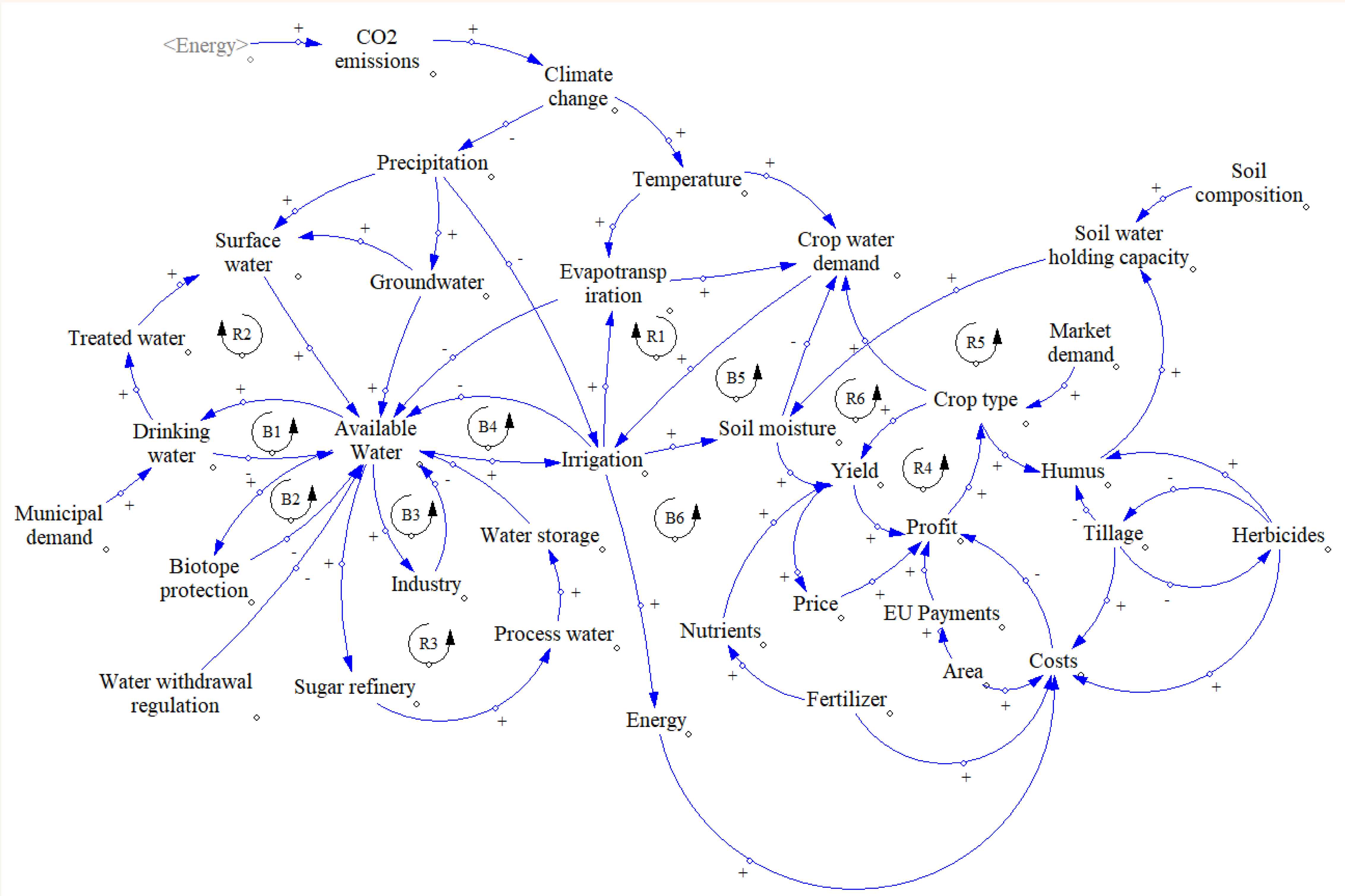

Figure 2:The QSDM representing the relationship between the water resources of the region and agriculture

1. Statistische Ämter des Bundes und der Länder. (2010). Agrarstrukturen in Deutschland Einheit in Vielfalt. Stuttgart. Retrieved from https://www.destatis.de/DE/Publikationen/Thematisch/LandForstwirtschaft/Landwirtschaftzaehlung/Agrarstrukt ureninDeutschland5411203109004.pdf
2. Bundesministerium für Enrnährung und Landwirtschaft. (2018). Trockenheit und Dürre – Überblick über Maßnahmen. Retrieved October 9, 2018, from https://www.bmel.de/DE/Landwirtschaft/Nachhaltige-Landnutzung/Klimawandel/_Texte/Extremwetterlagen-Zustaendigkeiten.html
3. Grocholl, J. (2011). Effiziente Wassernutzung im Ackerbau Nord-Ost-Niedersachsens : Möglichkeiten zur Anpassung an den prognostizierten Klimawandel. Uelzene. Retrieved from https://www.lwk-niedersachsen.de/index.cfm/portal/6/nav/203/article/16132.html
4. Landwirtschaftskammer Niedersachsen. (2012b). AQUARIUS – Dem Wasser kluge Wege ebnen! Projektbericht - Kurzfassung. Uelzen. Retrieved from https://www.lwk-niedersachsen.de/index.cfm/portal/6/nav/203/article/12396.htm?__blob=publicationFile

GERICS Climate Service Center Germany — An institution of Helmholtz-Zentrum Geesthacht
HICSS HELMHOLTZ INSTITUTE FOR CLIMATE SERVICE SCIENCE
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research
Universität Hamburg — DER FORSCHUNG | DER LEHRE | DER BILDUNG