Developing and Implementing Land Use and Food Conservation Interventions to Inform China's Carbon Neutrality Transition

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Introduction

Research Aims

By exploring the impact of changes in **land use**, **daily diet** and **biomass energy sources** on China's carbon emissions, this research proposes **four models** to develop a robust theoretical and methodological basis to support the decision-making and national policy development for China to achieve carbon neutrality, and to provide advice for potential policy and technological interventions for China in support of its carbon neutrality targets and the Global 1.5℃ target.

Research Objectives

1. Upgrade Biomass Landuse Change model. Explore the impact of **international trade** on land use and climate change.
2. Create the China Energy Starter Data Kits. Provide data for the China 2050 calculator and also create a simple **zero-level energy system model** for China.
3. Update the existing China 2050 Calculator to the UK MacKay Calculator template. Add the **land use, food, and diet** modules to the China 2050 Calculator to evaluate the impact of land use, food production and provision, and diet on greenhouse gas emissions.
4. Develop China Land Use Future model. Based on the new China 2050 Calculator, link with the system dynamics, understand the **broader dynamic interactions** between food, land use and greenhouse gas emissions.

Methodology

There are **four research questions** in this study, which uses **four quantitative models** to solve them as shown schematically (Fig.1).

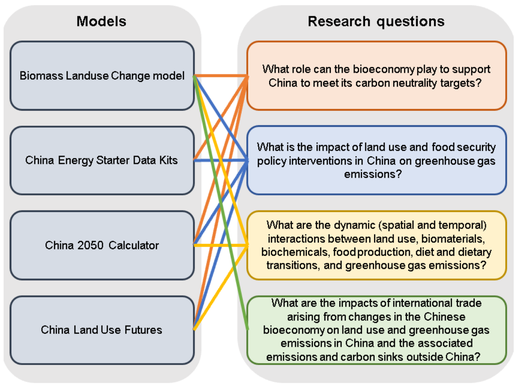


Fig.1 Interlinked maps of models and research questions

Biomass Landuse Change model (BioLUC)

Overview

The BioLUC improves the understanding of **global LUC drivers and dynamics** by allowing examination of global LUC under diverse scenarios and varying model assumptions.

Method

The BioLUC uses a **system dynamics** modeling framework to model (on a global basis) demand for food commodities in response to exogenous biofuel scenarios (Fig.2).

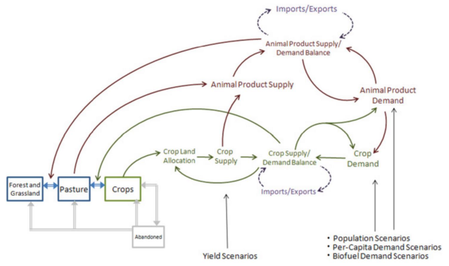


Fig.2 Illustrative influence diagram (Warner et al.,2013)

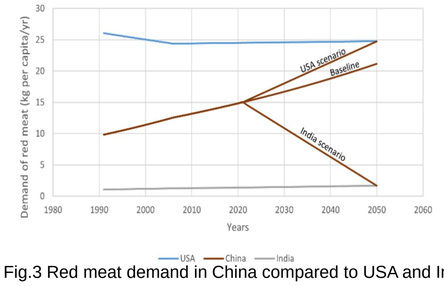
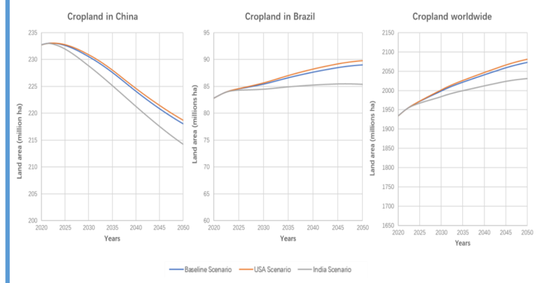


Fig.3 Red meat demand in China compared to USA and India



4a. Change in China 4b. Change in Brazil 4c. Global change

Fig.4 Red meat demand in China compared to USA and India

Example Results

Chinese per capita red meat demand in 2050 is set to (1) USA levels; (2) India levels (Fig.3).

Fig. 4a shows how cropland use in China has changed as a result of changing dietary behaviour.

Fig. 4b shows a reduction in imported forage would have a clear impact on land use in Brazil due to land availability.

Fig. 4c shows how changes in China's diet could impact land use in other parts of the world.

China 2050 Calculator

Overview

The China 2050 Calculator provides a model of the **China energy system to explore pathways to decarbonisation**, including net zero by 2050.

Method

The China 2050 Calculator is developed on the basis of China 2050 Pathway. This calculator adds Land use& Biofuel module and uses Anvil to create the web interphase.

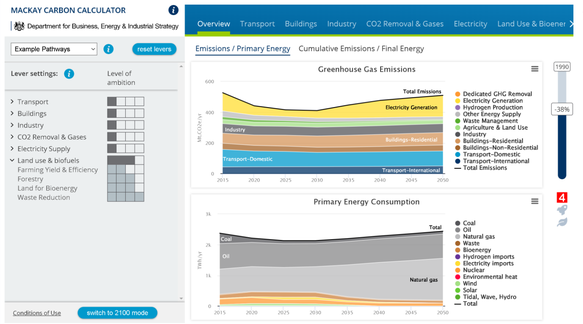


Fig.7 China 2050 Calculator references to UK MacKay Carbon Calculator

Expected Results

The China 2050 Calculator (Fig.7) will be developed and used to analyze the impact of different lever settings on China's GHG emissions and their influence on global climate change. For example: under the Land use & Biofuel module, the impact of changes in Crop Yields & Resource Use Efficiency, Forestry productivity, and Land Use for Bioenergy in China will be estimated.

China Energy Starter Data Kits

Overview

Energy system modelling can be used to develop **internally consistent quantified scenarios**. These provide key insights needed to mobilize finance, understand market development, infrastructure deployment, and support policymaking.

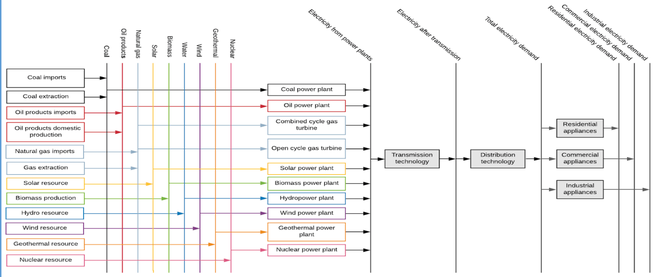


Fig.5 Reference Energy System (Allington et al.,2022)

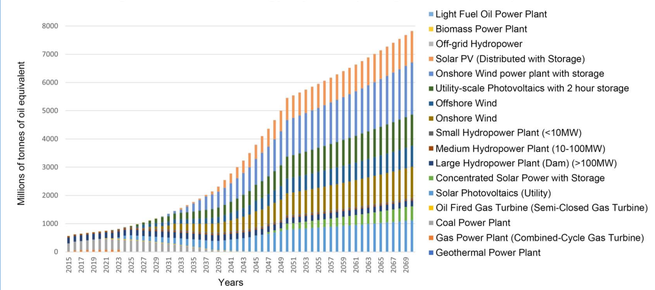


Fig.6 China Annual Electricity Production under Net Zero scenario*

Method

China Energy Starter Data Kits set **three stylized scenarios** (Fossil Future, Least Cost and Net Zero by 2050). Reference Energy System (RES) is a conventional aggregated representation of a real energy system (Fig.5).

Example Results

The Net Zero scenario simulates the annual sources of electricity production where China achieves Net Zero by 2050. Wind, solar and hydro power will be the main sources of electricity production (Fig.6).

*Biomass Power Plant's data is still being collected and the results are subject to adjustment.

China Land Use Futures (CNLUF)

Overview

The CNLUF model evaluates the scope and potential of Chinese land as a temporally and spatially dynamic tool for climate mitigation. Based on the land use methodology and approach developed by the Global Calculator and EU Land Use Future model (Strapasson et al.,2020).

Method

The CNLUF uses a **system dynamics** model to simulate the relationship among land resources, land use futures, related greenhouse gas emissions, and mitigation strategies in China.

Expected Results

The CNLUF model will be developed to assess the GHG emissions impacts arising from a wide range of possible interventions/action points, the 'levers' that drive land use change.

Conclusion

This research is designed to support policy makers in China in developing **land management policies** based on the model's simulation results to help achieve **carbon neutrality** targets through an enhanced **bioeconomy**.

References

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