IM3 INTEGRATED MULTISECTOR MULTISCALE MODELING

EVALUATION OF FUTURE URBAN LAND EXPANSION USING A GLOBAL MULTISECTOR DYNAMICS MODEL

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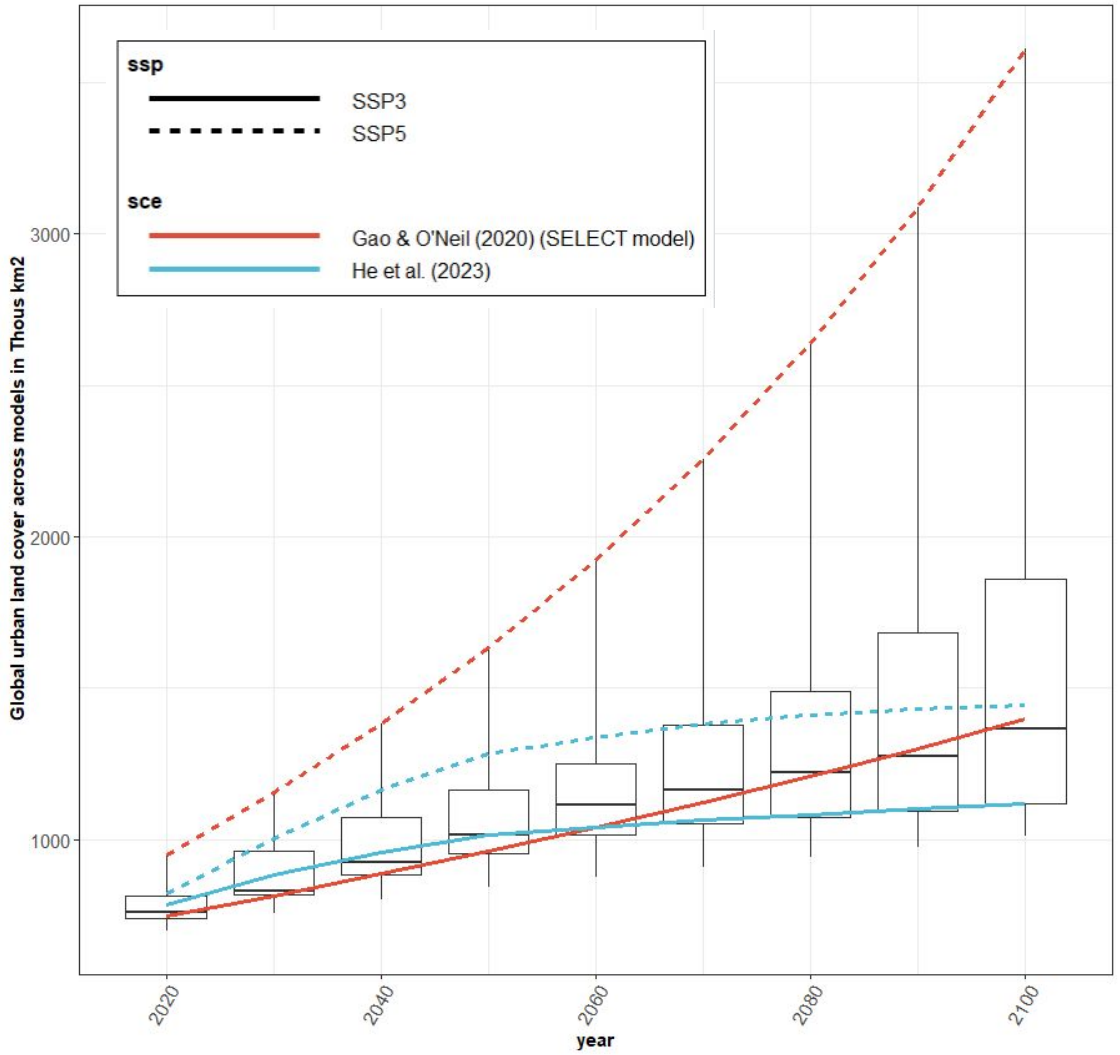
INTRODUCTION

- MSD and human-earth system models have mostly ignored future urban land increase. (e.g. Most models just hold urban land constant)
- However, Urban land is projected to increase significantly by 2100 (Highest being 3.5 million km2 by 2100)
- This makes it difficult to evaluate how future urban expansion may affect food crop, biomass prices in MSD models
- ***Here we implement a dynamic urbanization model in a MSD model , namely GCAM***

Global urban land cover projections under alternative models

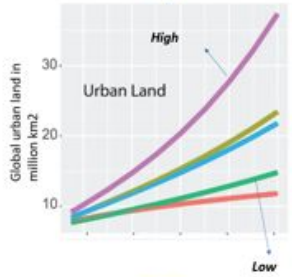


METHODS

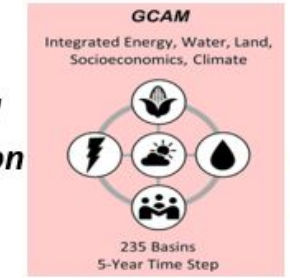
A) Our approach

1. ***Urbanization projections from fine resolution urbanization models***

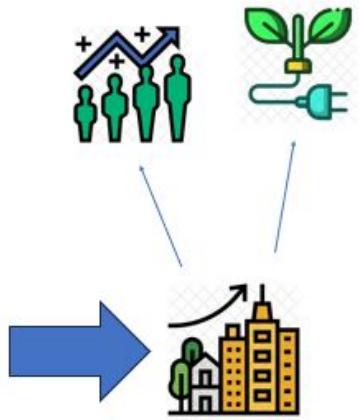
2. ***Define alternative scenarios of urban land demand (e.g. High urban vs low urban)***



3. ***Land supply for urbanization is determined by endogenous urbanization model in GCAM based on land competition***



4. ***GCAM determines effects on urban land value and effects on other sectors under alternative socioeconomic and bioenergy pathways***



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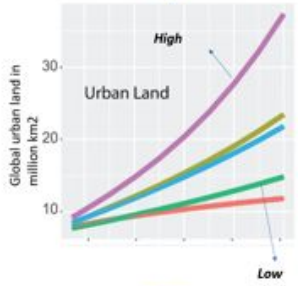

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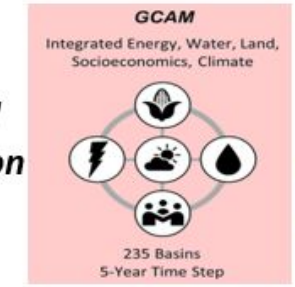

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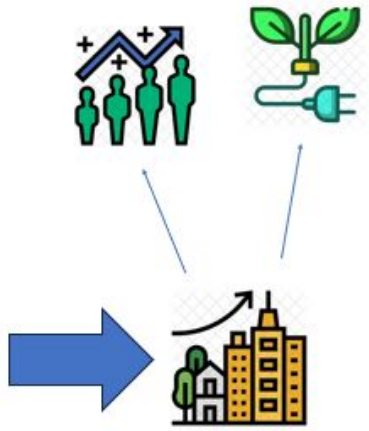
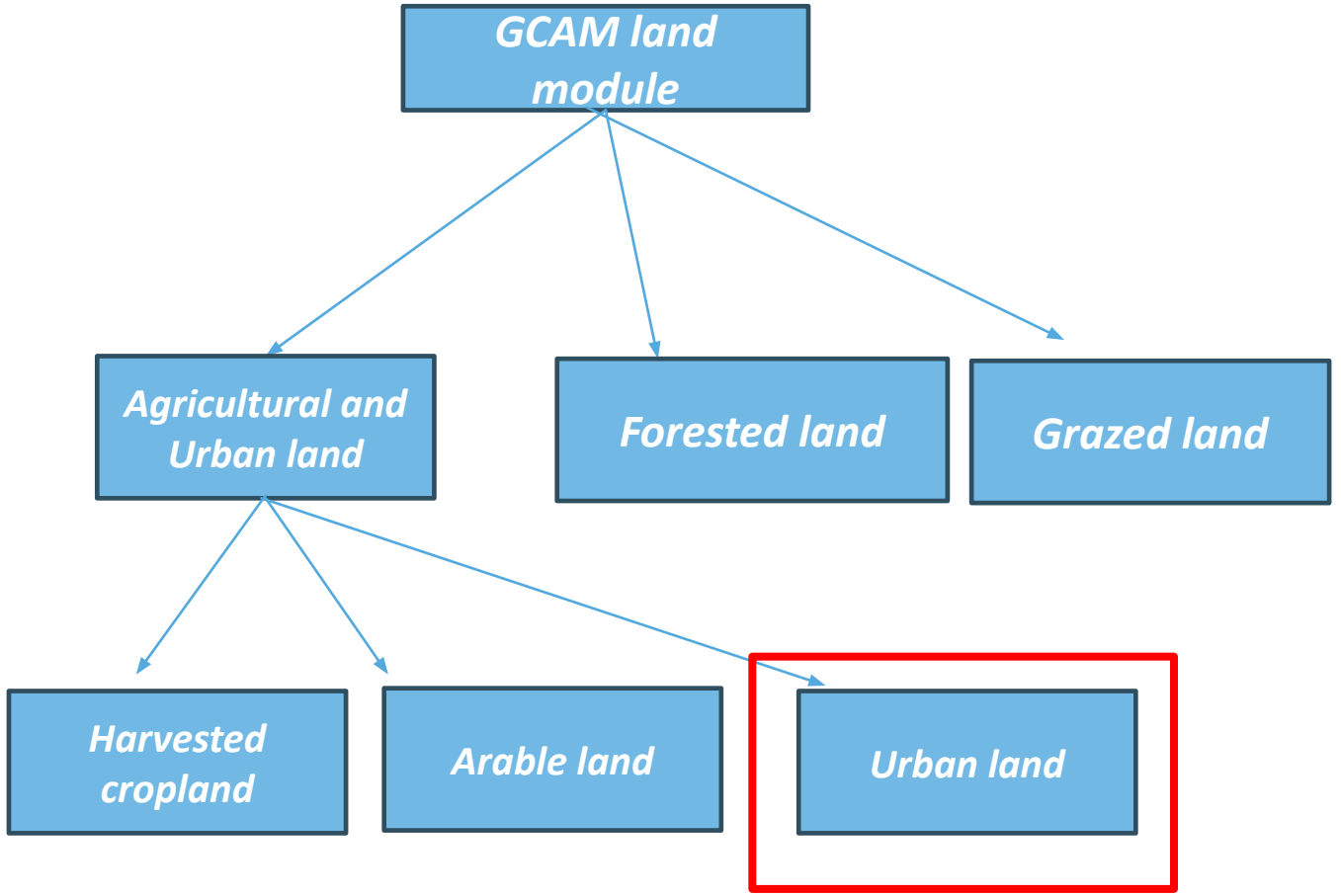


B) Endogenous land competition in GCAM



Based on land competition the model calculates values of urban land in $/thous km2

SCENARIOS

We implement two urbanization pathways-

A) Expanding urbanization- SELECT model
B) Saturating urbanization- He et al (2023)

These are implemented for two socioeconomic scenarios-

A) SSP3
B) SSP5

And we also implement two types of energy transitions

A) Baseline
B) High Bioenergy

Urban model (n=2) X Socio economic scenarios (SSP) (n=2) X Energy transition (Baseline or High bioenergy) (n=2)

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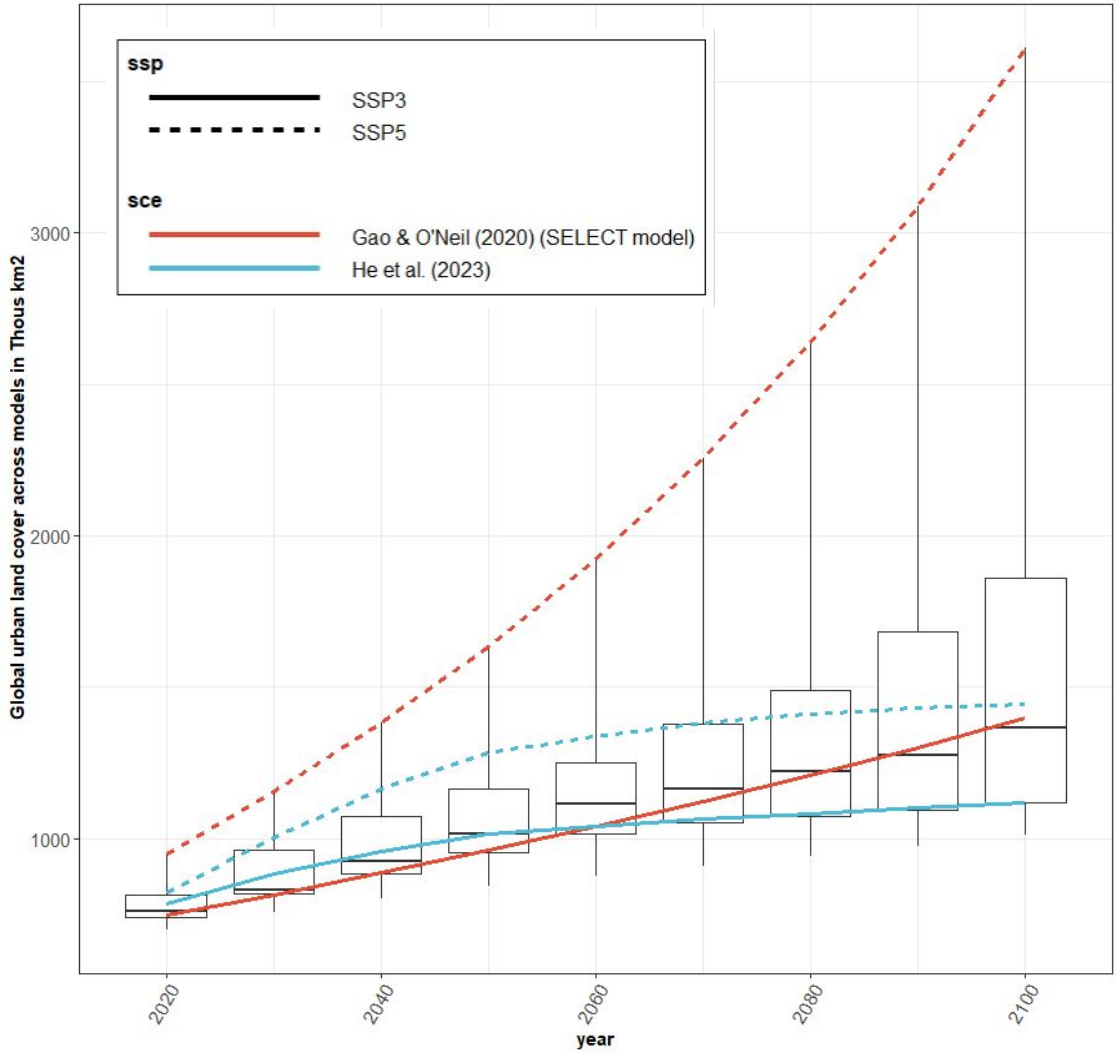
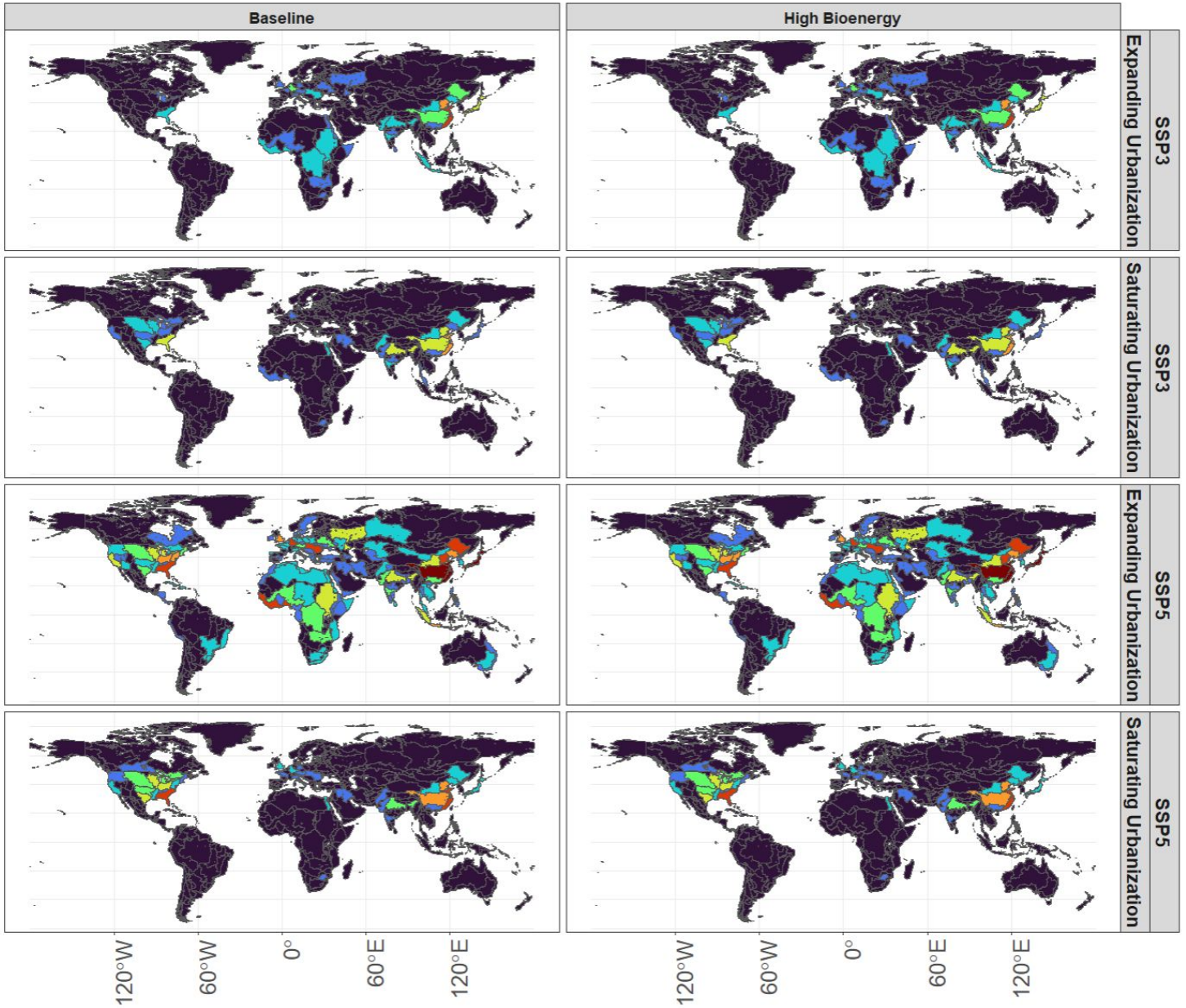
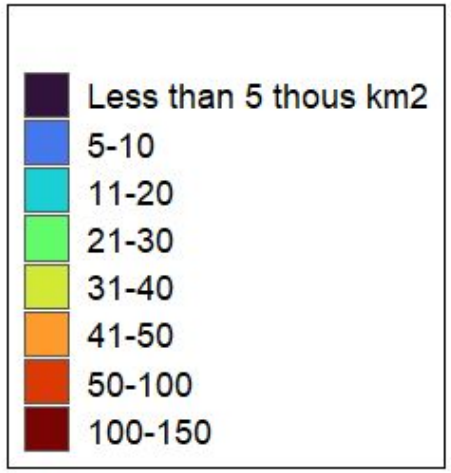


INCREASE IN URBAN LAND AT THE BASIN SCALE IN 2100



Increase in urban land cover by 2100 in thousand km2



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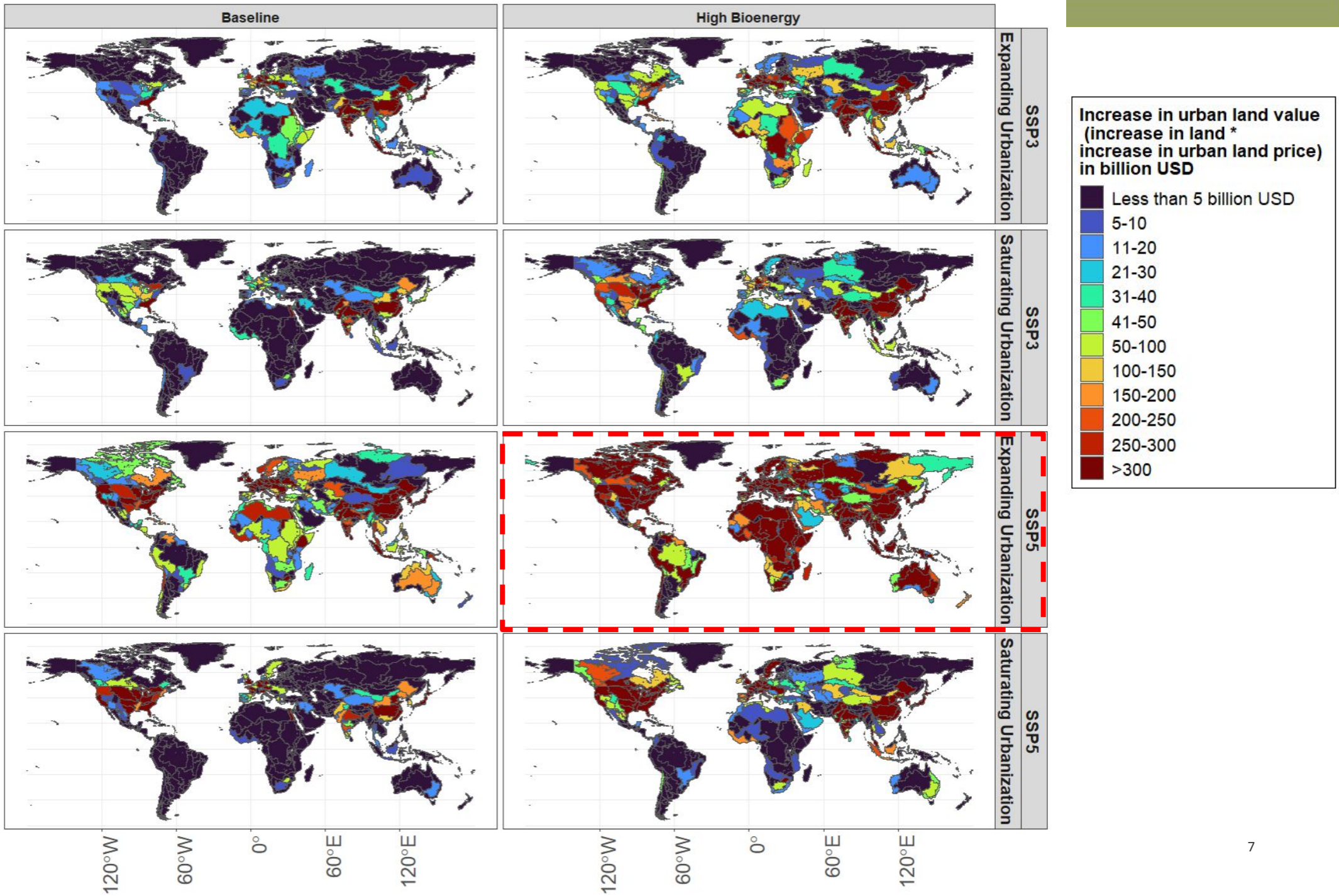
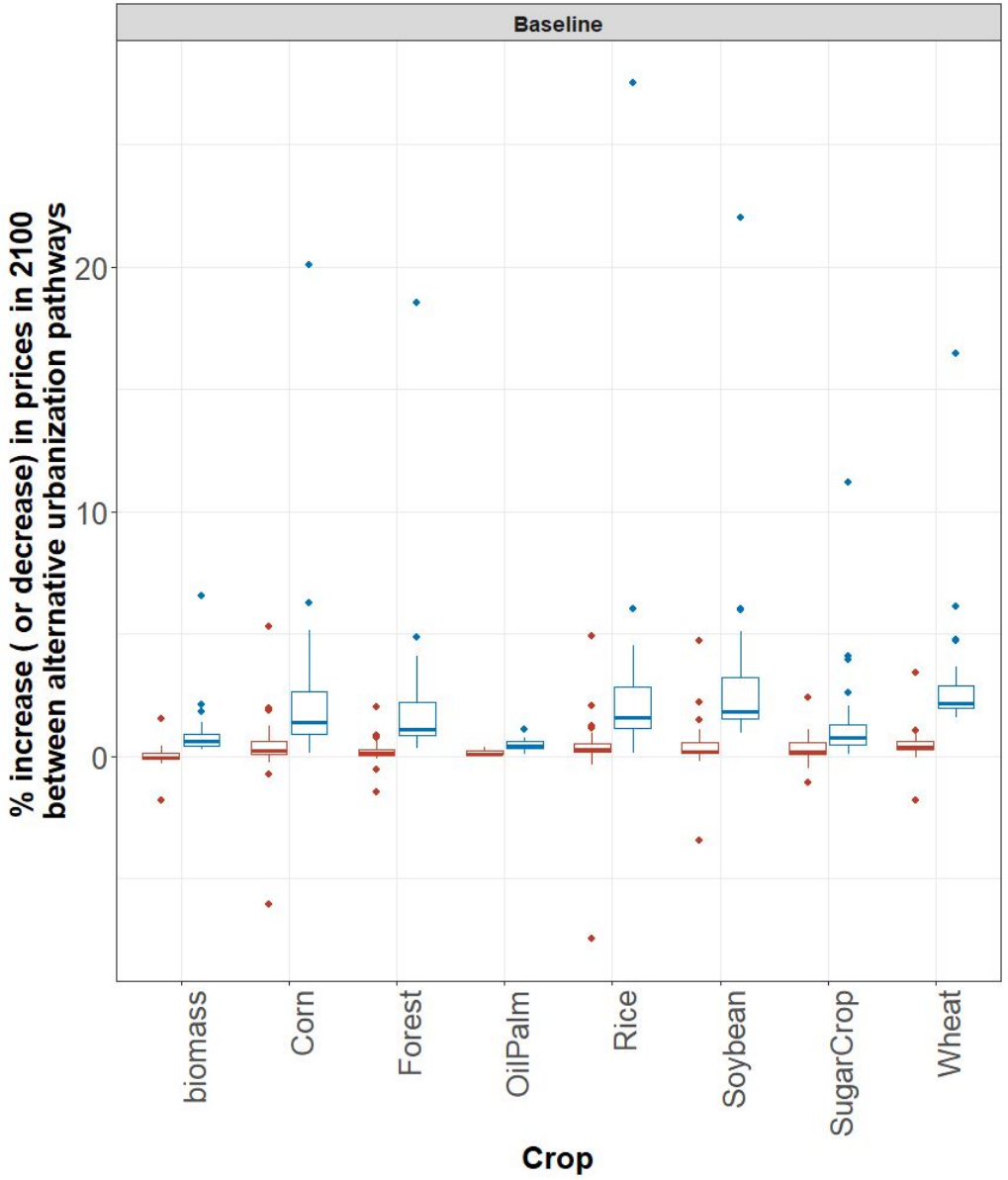
Since GCAM can now produce a projection of increase in the value of urban land based on land competition, we can evaluate total increase in urban land value at the basin scale



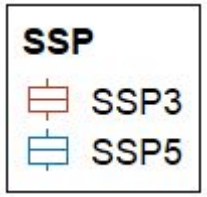
WHAT EFFECT DOES CHANGING URBANIZATION HAVE ON OTHER SECTORS?

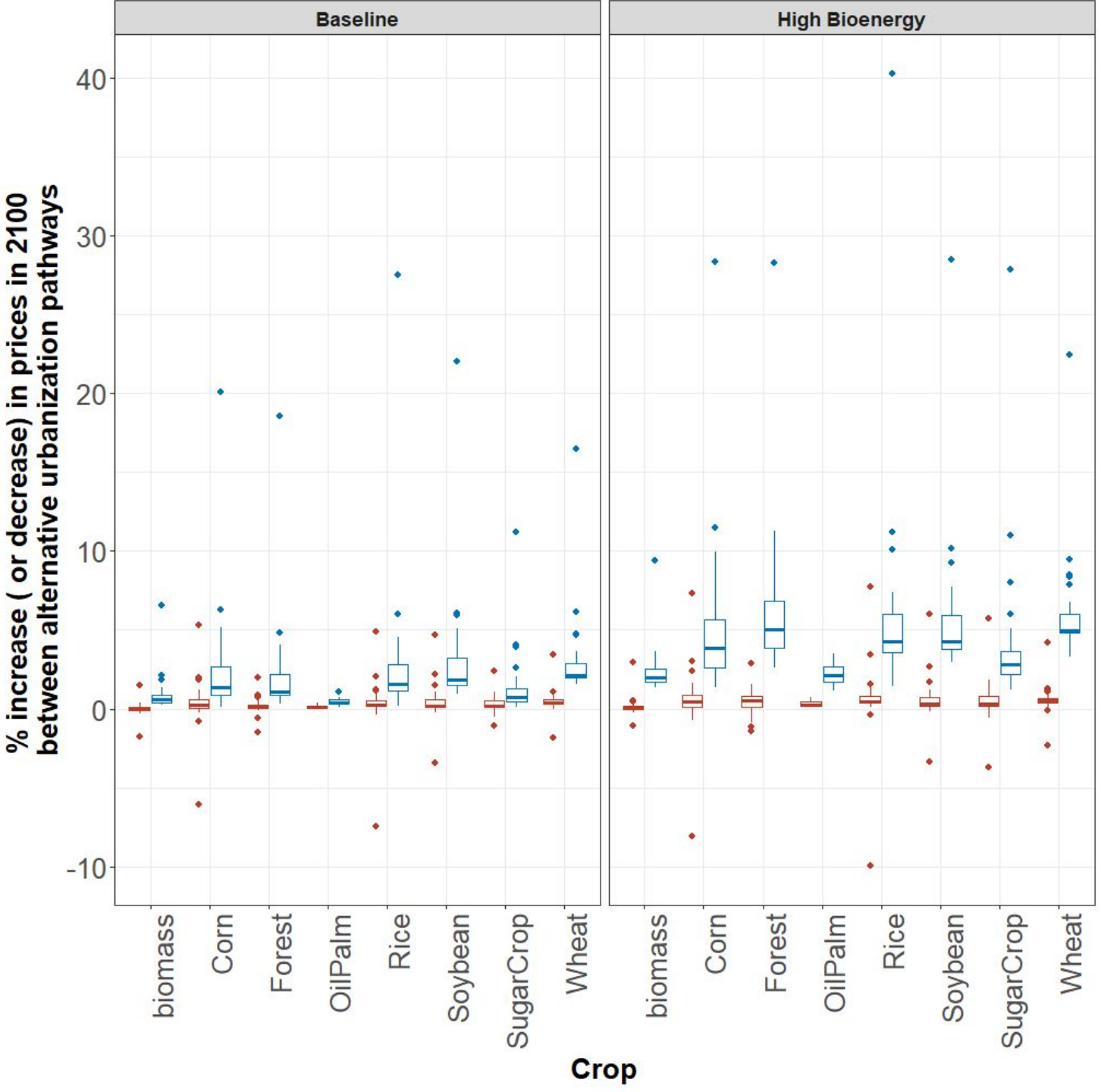


Here we compute the difference in crop prices between expanding and saturating urbanization scenarios for every GCAM region in 2100

Boxplot= distribution of differences across regions

Color= SSP





High bioenergy deployment combined with high socioeconomic pressures from SSP5, produce the largest effects when comparing urbanization scenarios

SUMMARY AND NEXT STEPS

- We have found that alternative urbanization scenarios can produce large effects on the human system and urban prices themselves.
- This is especially the case under scenarios where there is high bioenergy deployment
- Results are regionally and sub-regionally heterogeneous. No linear relationship between the amount of future urbanization and increase in urban land value. Some basins always have high impacts regardless of the level of urbanization
- There are several areas to improve this work-

A) Increasing urbanization scenarios (more than the two we currently use)

B) Downscaling these results with tools such as demeter to enable more comprehensive evaluation by other teams

C) Also implementing “endogenous demand” for urban land and coupling that with the energy model

THANK YOU!

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