Introduction and Background

In preparation for the IPCC 5th assessment, the international modeling community is developing four Representative Concentration Paths (RCPs) using scenarios developed by four different Integrated Assessment Models (IAMs). These RCPs will be used as input for model runs by Earth System Models. The diversity of approaches and requirements among both IAMs and ESMs with respect to tracking land-use change presents a challenge for effectively passing data between these communities. In addition, the dependence of model projections on land-use history presents a challenge for smoothly transitioning from the historical estimates in ESMs to the future projections based on IAMs. Motivated by these challenges, we have initiated an interaction between IAMs and ESMs to provide a harmonized record of land-use data.

Prior Work on Global Land-use Modeling

Our previous research activities involved the development of a Global Landuse Model (GLM) to compute fractional landuse and landuse transitions past and future in a degree resolution gridcells, including the extent and spatial distribution of secondary/recovering lands. The model spatially allocates wood harvest and shifting cultivation activities using gridded historical crop and pasture data, national wood harvest demand, and region-based future data from IAM implementations of IPCC SRES scenarios as inputs.

Key findings were:
- 40-60% of the Earth’s surfaces has been modified by human activities.
- Logging and shifting agriculture are primarily responsible for the creation of secondary/recovering lands.
- Showed patterns of wood harvesting, intensity of clearing for agriculture, and residency time of agriculture.
- Priority of primary/secondary/land for harvest.

A sample of our research results, based on the B1 storyline of the SRES scenarios, are shown in the figure below where the increasing area of global secondary lands can clearly be seen. For further details of our modeling approach and results, please refer to Hurtt et al. 2006.

Harmonization Strategy

Based on the potential of our prior work with GLM we are now enhancing our abilities and working directly with IAM and ESM groups to harmonize land-use data between these communities. Our work process is shown in Figure 3 below. Climate and landuse are inherently coupled systems and although our GLM is not fully coupled to the ESM, in future research we plan to use ESM future climate data output in our models.

Figure 3: Flow diagram of work process involved in global landuse harmonization between IAMs and ESMs, using GLM. Note that future climate data output from ESM could be used as inputs into further GLM simulations.

Next Steps

By the early fall we aim to have generated gridded land use and landuse transition data for the years 1500-2300 (at half degree resolution). This data will then be used as inputs to various Earth System Models. Our future projections will be based upon data provided by several IAMs from implementations of the four Representative Concentration Paths. Challenges will involve ensuring that landuse data and landuse categories are consistent between the historical and future data and ensuring a smooth transition between them. The IAM future data can vary between region-based data and geographically explicit information and we will explore how this data can be used as inputs into our grid-based model—the various options available range from grid based anomaly methods to allocation procedures for regional data. In addition, we plan to implement an improved shifting cultivation algorithm, extend our projections to the year 2300, and include urban and plantation forest landuse categories.

Key References

Houghton and Hackler 2000, Global Ecology & Biogeography, Vol. 9
Houghton and Hackler 2003, Global Biogeochemical Cycles, Vol. 17

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