Supporting information for Hurtt *et al*. (2002) *Proc. Natl. Acad. Sci. USA* **99** (3), 1389–1394. (10.1073/pnas.012249999)

Appendix 2

To simulate the effects of land-use history on ecosystem structure and carbon fluxes, we constructed a gridded land-use history product to force our ecosystem models. The Land Use Change Hypothesis (LUCY) tracks the area of land from 1700 to 1990 in five land-use categories (crop, pasture, secondary, plantation, and natural vegetation) and the associated land-use transition rates at 1×1 degree resolution. LUCY also includes estimates of stand-age specific harvesting rates on secondary and plantation forests. The methods used to construct LUCY are based largely on those used previously to construct regional land-use history products (e.g., ref. 1). The most fundamental difference here is that these methods have been extended to produce a spatially gridded (1×1 degree) product.

The core component of LUCY are the land-use transition rates. There are $N_l*N_l*N_c*T$ potential land-use transition rates, where N_l is the number of land use classes, N_c is the number of grid cells in the spatial domain, and T is the number of years in the land-use history. In this reconstruction, $N_l = 5$, $N_c = 811$, and $T = 290$. To estimate values for these unknowns, we combined several sources of data and made several simplifying assumptions. The key data sources are:

- Houghton *et al.* (1) regional land-use data through time including area of cropland, pasture, and forest harvested from 1700 to 1990.
- Ramankutty and Foley (2) gridded map of area of cropland at through time at 1×1 degree resolution from 1700 to1990.
- Ramankutty and Foley (2) gridded map of potential vegetation at 1×1 degree resolution.
- U.S. Forest Inventory Analysis data including stand-age distribution data.

The most important simplifying assumption used in calculating the transition rates is that of minimum flows, used in other land-use history reconstruction studies (1). This assumption greatly reduces the number of unknowns by seeking the minimum land-use transitions necessary to satisfy successive proportions of land in each land-use state. Equations for the unknowns are also governed by the following constraints.

All land in LUCY starts out classified as natural vegetation in 1700. The regional land-use history of Houghton *et al.* (1) provides the area of cropland, pasture, and forest harvested through time for each of seven large regions in the coterminous U.S. (e.g., Northeast, Southeast, Pacific, Mountain, East North Central, West North Central, and Southern Plains). To create a spatially gridded version (1×1 degree) consistent with this regional data, we added two gridded data sets normalized to the Houghton historical data as inputs. The first is 1×1 degree map of potential forest from Ramankutty and Foley (2) that specifies the grid cells with potential vegetation classified as forest, and thus which grid cells potentially undergo forest harvesting. Grid cells with potential vegetation that is nonforested never have forest harvesting. The second spatial data set is the 1×1 degree estimate of cropland area in each grid cell through time from Ramankutty and Foley (2). This product localizes where the cropland activity occurs within each region. We assumed that pasture dynamics are related spatially to cropland dynamics. Natural land is transformed to secondary, crop, or pasture when required to match estimates of those land uses. Once land is used, it never returns to the "natural" classification. The age-specific forest harvesting rates within each region were inferred from the distributions of forest stand-age in U.S. Forest Inventory Analysis (FIA) data (J. Caspersen, unpublished work). FIA data were also used to calculate the area of plantations for each region. Land-use transition rates in and out of plantations were assumed proportional to those of secondary forests.

Additional access to the model products will be made available at http://www.esip.unh.edu.

1. Houghton, R. A., Hackler, J. L. & Lawrence, K. T. (1999) *Science* **285**, 574–578.

2. Ramankutty, N. & Foley, J. A. (1999) *Global Biogeochem. Cycles* **4,** 997–1027.