DESIGNING HISTORICAL AND FUTURE LAND-COVER MAPS AT THE GLOBAL SCALE FOR CLIMATE STUDIES

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We have combined published maps of historical and future crop and pasture extent and derived continuous yearly gridded data sets, at 0.5°*0.5°, from year 1700 till 2100. These datasets are meant to be used by global land-atmosphere-ocean general circulation models to study the impact of land-use induced land-cover changes on climate, or by dynamic global vegetation models to analyze the consequences of land-use on carbon and water fluxes and storage. The datasets differ in their projections of future vegetation distribution, and result from the SRES scenario chosen (e.g. A1b, A2, …). For this specific use within the European ENSEMBLES project, scenario A1b has been chosen. The datasets are of free access on a dods server (http://dods.extra.cea.fr/data/p25nath/DIVA/ForcingData/Vegetation), and quite soon the tools necessary to combine these crop and pasture extents with one's specific present-day land-cover map will also be made available.

1. DATA SETS CHOSEN

Historical croplands have been reconstructed by {Ramankutty, 1999 #339} (hereafter RF99) from 1700 till 1992. Spatial resolution is 0.5° latitude by 0.5° longitude, temporal resolution is yearly. Information provided is the percent area of each grid-cell covered with crops.

Historical pasture has been reconstructed by {Goldewijk, 2001 #340} (hereafter G01) from 1700 till 1990. Spatial resolution is 0.5° latitude by 0.5° longitude, while temporal resolution is every 50 years from 1700 till 1950, and every 20 years afterwards. Information provided is absence (0%) or presence (100%) of pasture.

Future maps of crop and pasture extent result from integrations of the IMAGE 2.2 scenarios (http://www.mnp.nl/image/image_products/, {The-IMAGE-Project, 1998 #281}, hereafter FUTU). Spatial resolution is 0.5° latitude by 0.5° longitude, while temporal resolution is every 10 years from 1990 till 2100. Information provided is absence (0%) or presence (100%) of either crop or pasture. Only one vegetation type can occupy a grid-cell at a given time (no mosaic vegetation).

2. COMBINING CHANGES IN CROP AND PASTURE EXTENT

For the historical maps (1700 till 1990), *if only crops* are found in a given grid-cell, then the *extent provided by RF98* is kept. *If only pasture* is found then *its extent is set to 100%* and no other vegetation type can share the cell. *If both crops and pasture* co-exist within the same grid-cell, then *the extent covered with pasture* is restricted to the part of the grid-cell not covered with crops (*100%-crop extent*). If the crop extent in RF98 exceeds 50%, then the extents of both crop and pasture are set to 50%. These analyses are done for the specific years

provided in the G01 dataset. *A linear interpolation is then carried out for the pasture extent*, *to extrapolate yearly values* at each grid-cell.

A final test is then carried out for each specific year to make sure the sum of crop and pasture extents does not exceed 100%, otherwise they are both restricted to 50%.

Changes in future crop and pasture extent is derived from the IMAGE 2.2 scenarios and *we use an anomaly procedure to ensure consistency between past and future changes*. Every 10 years, starting year 2000, we examine the changes predicted in FUTU between the specific decade under consideration and the previous one. The IMAGE scenarios only provide us with presence or absence of a given vegetation type, *the increase in either crop or pasture is then always done at the expense of natural vegetation* that disappears completely from the grid cell (i.e. crop + pasture extent = 100%). If no change is found, then the extent of crop and/or pasture of the decade is set equal to the extent of the previous decade (i.e. the one derived from the historical databases for 1990 if year 2000 is under consideration). If *either* crop *or* pasture increases, then its spatial extent is either increased to the amount needed for the sum (crop+pasture) to be equal to 1, or unchanged. Conversely, if a decrease *in either crop or pasture* extent is found, then *its spatial extent is set to zero*, and natural vegetation can occupy the part of the cell that just became vacant. If they *both increase*, then their extent is increased by 50% of the part of the grid-cell that was natural the previous decade.

An illustration of these different choices and of the way we have chosen to process them can be found figure 1 for the historical changes and figure 2 for the future changes.

3. SUGGESTIONS TO COMBINE ONE'S SPECIFIC LAND-COVER MAP WITH THE DISTRIBUTIONS OF CROP AND PASTURE PROVIDED

The methodology chosen to combine our 'home' land-cover map with this crop and pasture dataset is quite simple and does not request the use of a dynamic global vegetation model as it was suggested for example by RF98 or as it is done at the Hadley Centre. The sum of crop and pasture define, per year and per grid-cell, the amount of natural vegetation cover that can exist. Since our land-surface model deals with mosaic vegetation, that is several vegetation types can coexist within one grid-cell, we derive from our 'home' land-cover map the types that are found in each grid-cell at present-time, together with their relative extent. The natural part of each grid-cell that is derived from the crop&pasture maps is filled up with the natural combination we have identified, the relative proportion of each natural type with respect to the others is maintained. Problems arise when a grid-cell in our 'home' land-cover map has no natural vegetation. In this case we look for the nearest grid-point that has natural vegetation and we project onto our grid-cell the same combination of natural vegetation types.

A final point is the fractionation of crop and pasture extent into C3 and C4 types. This is done using the criteria that is built in our DGVM, and that examines the climatic envelop that is more appropriate to C3 or C4 plants. This of course inhibits us from planting C4 crops in the past, in temperate regions. A file locating the potential distribution of C3 & C4 can be made available to the group of users.

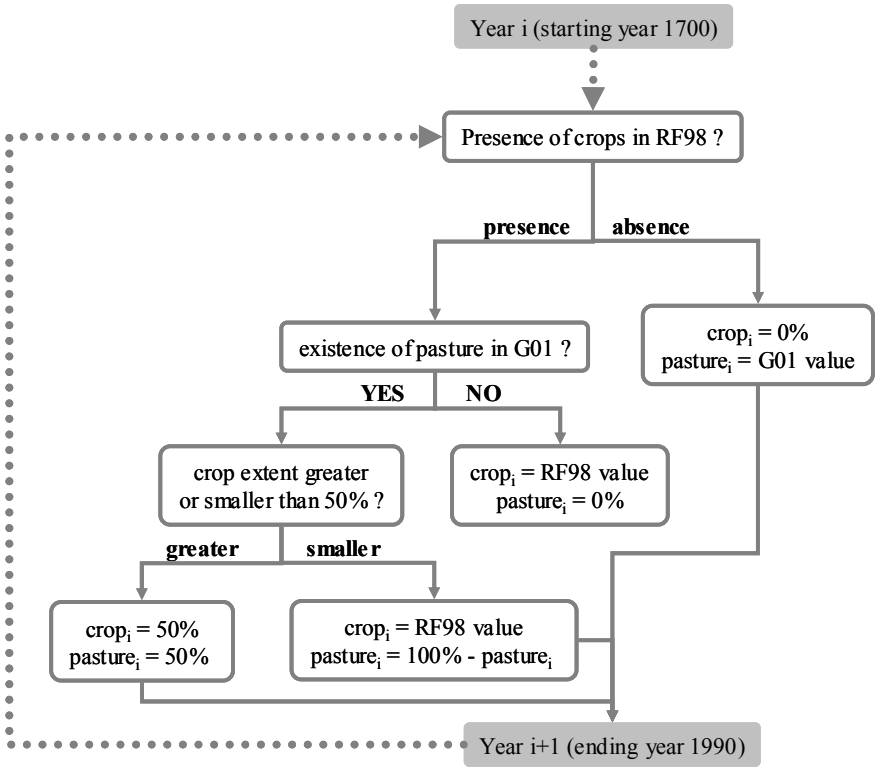

Figure 1: methodology to construct the historical crop and pasture extent per grid-cell. Pasture extent in G01 is either 100% or 0%. Crop extent in RF98 can take any value between 0 and 100%. Reconstructed years from 1700 till 1990.

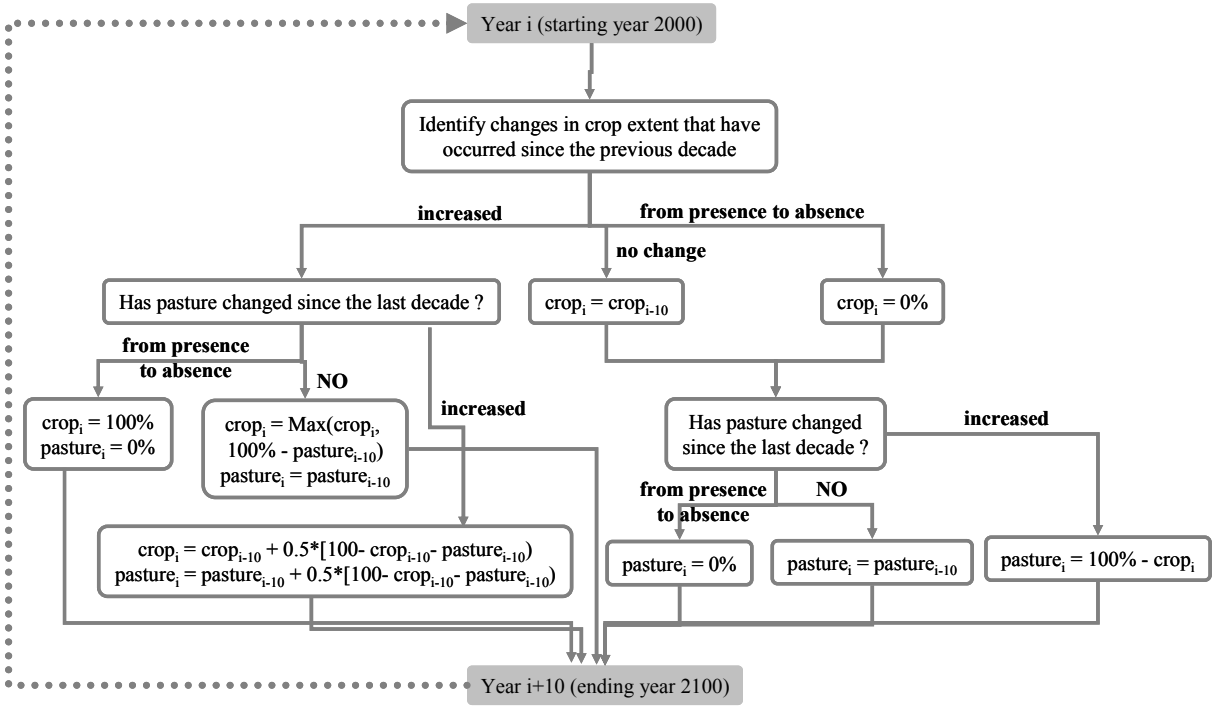

Figure 2: methodology to construct the future crop and pasture extent per grid-cell. Extents in FUTU are either 100% or 0%. Reconstructed years 2000 till 2100. When first year = 2000, i-10 corresponds to year 1990 in the historical dataset (see figure 1).