GIS-based scenarios of SOC annual change on croplands at sub-national level: case studies of Burkina Faso and Uzbekistan

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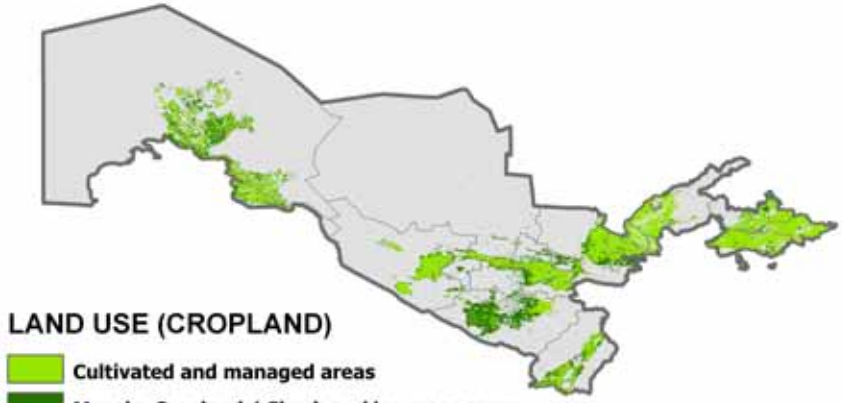
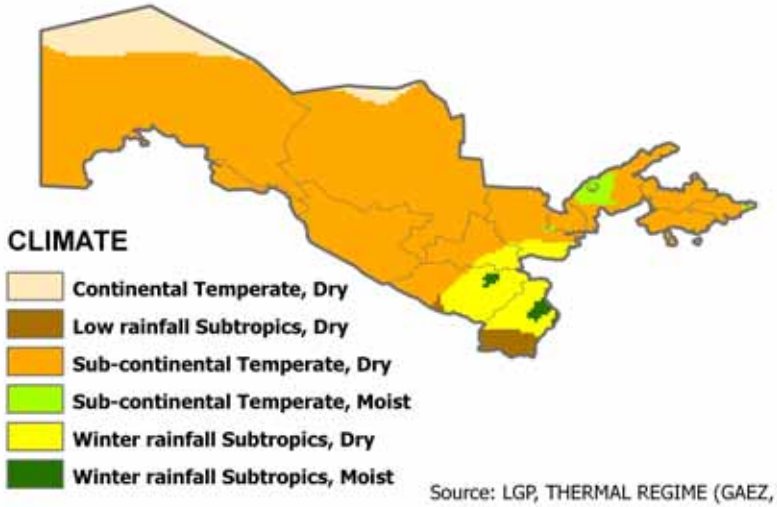
GIS-based scenario of SOC change on croplands at sub-national level

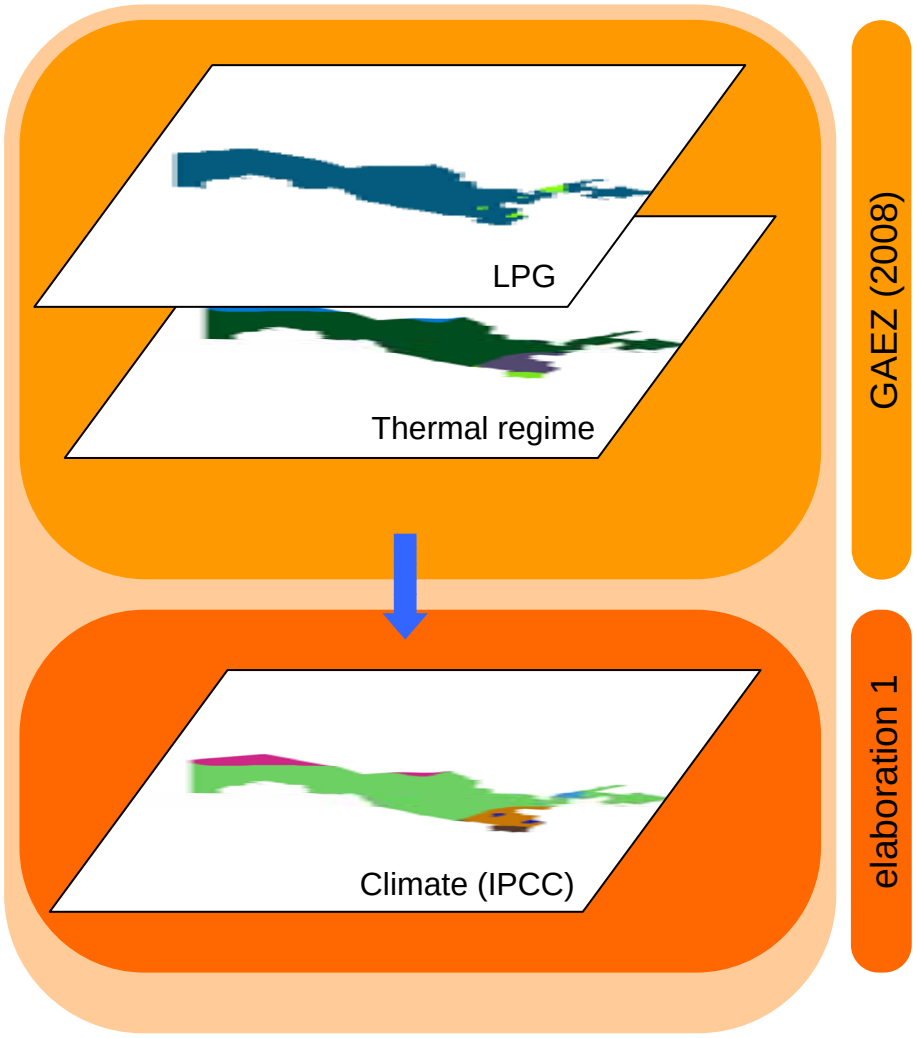
based on **chapter 5** of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, simulated scenarios of carbon stock change in mineral soils under croplands were developed under Tier 1 at sub-national level.

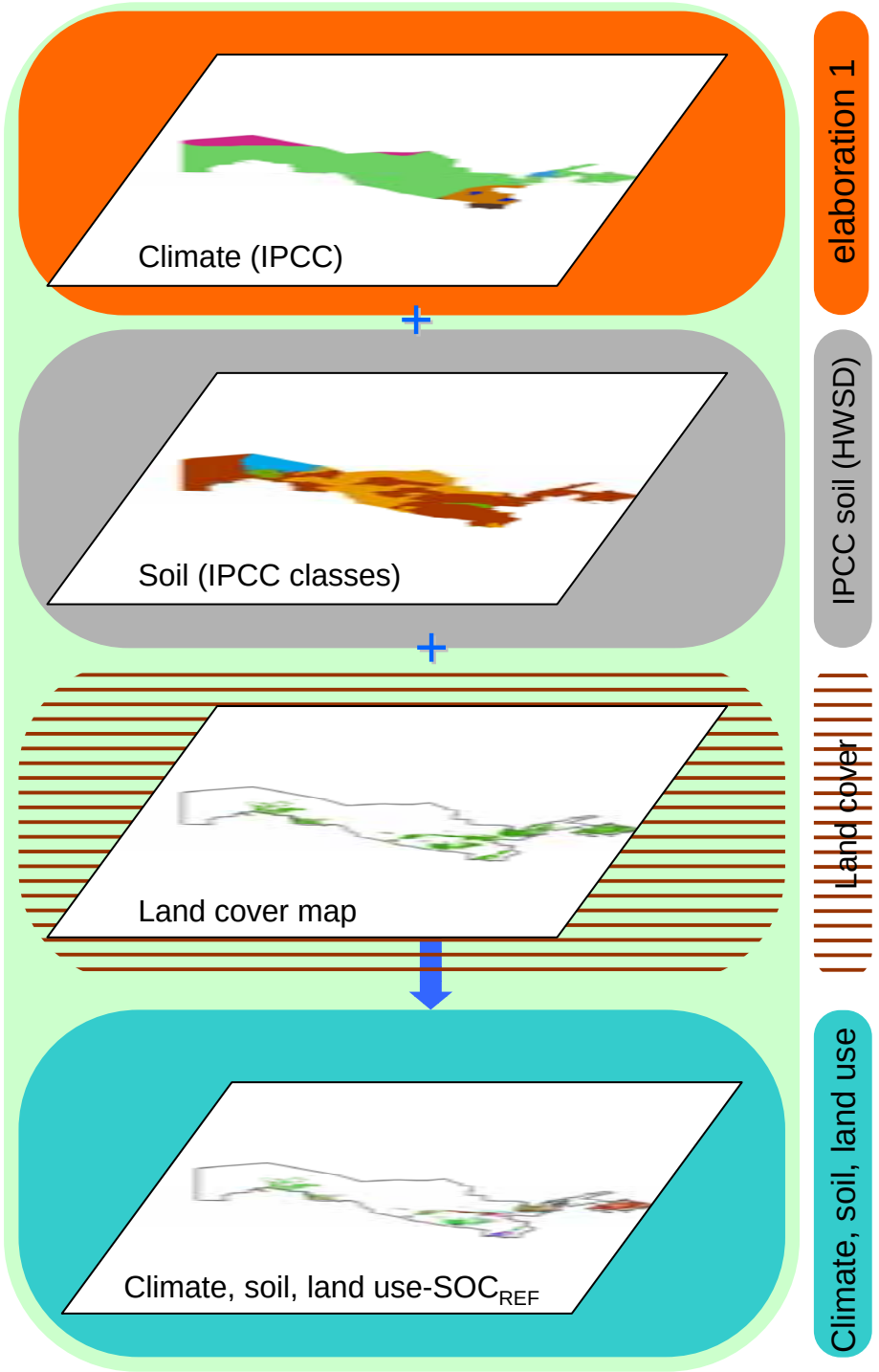
Case study: Uzbekistan. Thematic layers obtained for application of Tier 1, 2006 IPCC guidelines
(soil and climate data, used with Table 2.3 of the guidelines to estimate SOC_{REF})





Elaboration of thematic layers using FAO and global datasets





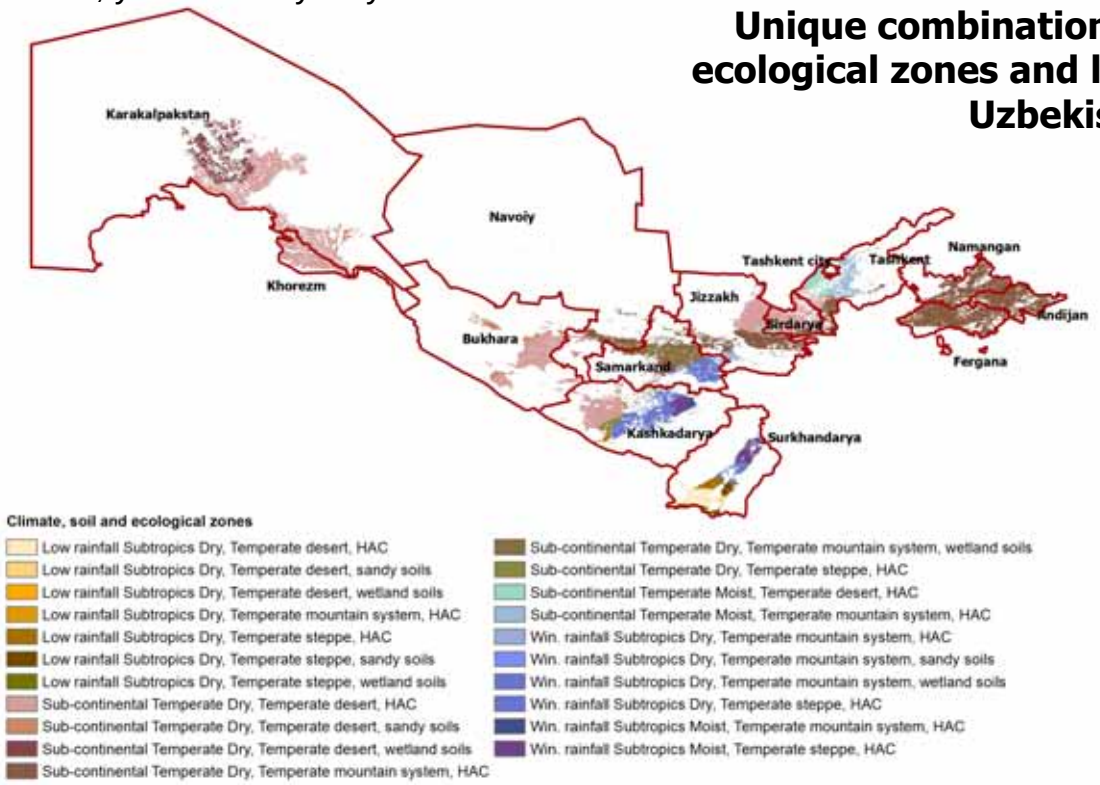
Assumptions made for scenario definition

- The countries studied used only FAO datasets;
- The extent of areas under Croplands in GLC 2000 represents Croplands remaining croplands;
- Differences in management and levels of input of organic matter between the beginning and the end of the hypothetical inventory period are represented by most likely changes and not by actual changes (C storage potential capacity due to hypothetical changes in management is simulated).

$$\Delta C_{\text{Mineral}} = \frac{(SOC_O - SOC_{(0-T)})}{D}$$

$\Delta C_{\text{Mineral}}$ = annual change in carbon stocks in mineral soils, tonnes C yr^{-1}.
SOC_0 = soil organic carbon stock in the last year of an inventory time period, tonnes C.
$SOC_{(0-T)}$ = soil organic carbon stock at the beginning of the inventory time period, tonnes C.
T = number of years over a single inventory time period, yr.
D = time dependence of stock change factors which is the default time period for transition between equilibrium SOC values, yr. Commonly 20 years.

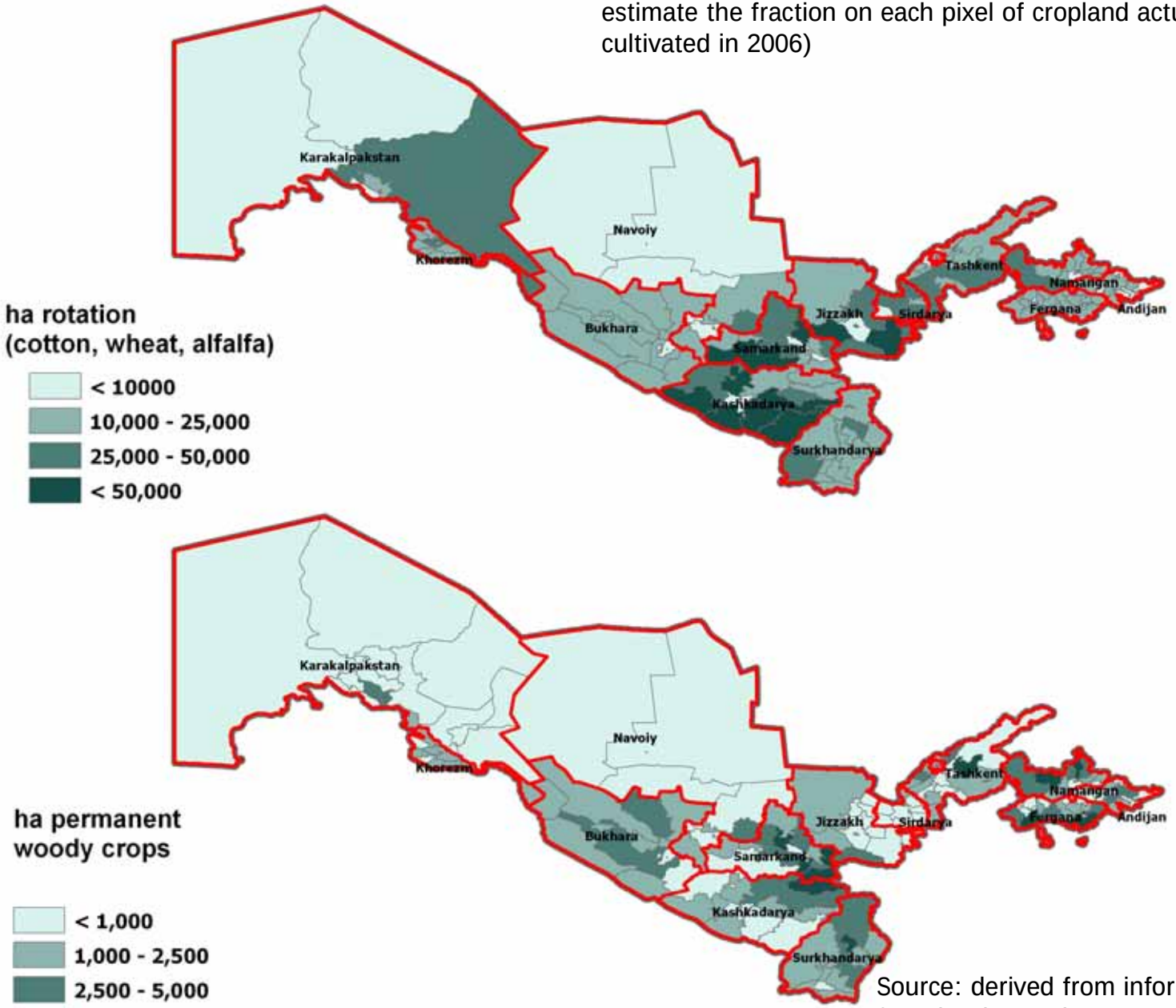
Unique combinations of climate, soil, ecological zones and land use (croplands, Uzbekistan)



Source: GLC 2000, GAEZ 2008,
FAO ECOLOGICAL ZONES 2001, HWSD 2008, GAUL

Rotation and permanent woody crop data, 2006. Second administrative level (district)

(This data was apportioned to the GLC2000 information to estimate the fraction on each pixel of cropland actually cultivated in 2006)



Source: derived from information obtained from local consultant, GAUL ADM_2

Identification of the main constraints encountered

•Croplands remaining croplands are difficult to estimate. Land cover map for T_0 and $T_{(0-T)}$ should be available, but this is not the case when using global datasets. By using aggregated data for administrative units of the country it would be possible to obtain sub-national simulations, again, it is difficult to obtain two data points (in many cases administrative units change over time –polygons change shape or even dissapear–). For similar reasons, land converted to croplands is even more difficult to estimate;

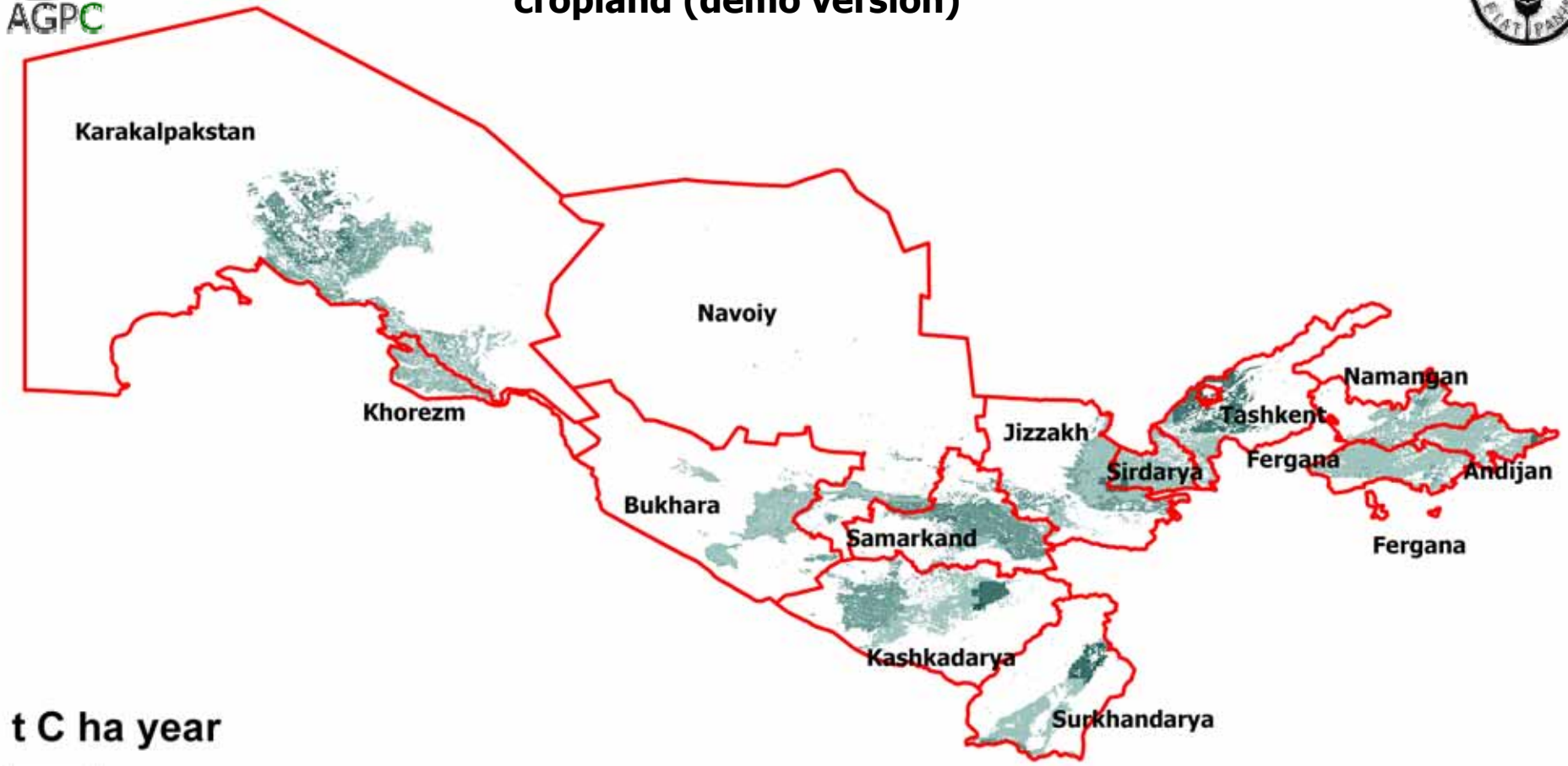
•Changes in management and levels of input of organic matter are difficult to determine, in this study we assumed that changes are likely to take place in the near future, therefore the simulation obtained is not an attempt of inventory, but a scenario analysis);

•Validation of results is difficult because of lack of locally derived experimental;

•Detailed data is difficult to obtain. The local statistical databases may not include most of the information required for inventory purposes, namely:

-two time points, on land area in each spatial or administrative unit (municipality/district level) cultivated with (1) perennial crops; (2) paddy rice; (3) annual crops –except paddy– with details of *(a)* cropping system (low, medium and high input, high input w/organic amendment), *(b)* tillage intensity, *(c)* irrigation regime; (4) set-aside <20 yrs;
-detailed data on (1) areas per each typical rotation; (2) areas under each perennial crops / use of biomass obtained from prunning; (3) areas under paddy, with details water regime specifying application rate of organic amendment; (4) areas of cultivated (drained) organic soils; (5) areas of croplands with details of crops which residues are burnt in the field as post-harvest practice; (6) amount of calcic limestone and dolomite applied for soil Liming, urea fertilization and N fertilization for each of the rotation or crop listed in (1); (7) amount of N input in flooded rice.

Results of the GIS-based scenario of Δ SOC in cropland (demo version)



t C ha year

- land uses other than cropland
- < 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 0.76

Tillage: full → reduced

Full: soil disturbance with frequent inversion and/or tillage operations. At planting <30% of the surface is covered by residues.

Reduced: tillage with reduced soil disturbance, without full soil inversion.

Input: low → medium

Low: removal of residues, bare fallowing, no mineral fertilization or N fixing crops.

Medium: all crop residues are returned to the field or organic matter or N fertilization/fixation applied

Δ SOC (t C ha year)
D = 20 years (IPCC default)
Scenario*:
Tillage: full → reduced
Input: low → medium
Total annual potential C storage (below-ground): 1.17 Mt

*as advised by local consultant

Results of the GIS-based scenario of Δ SOC + Δ C biomass in cropland (demo version)

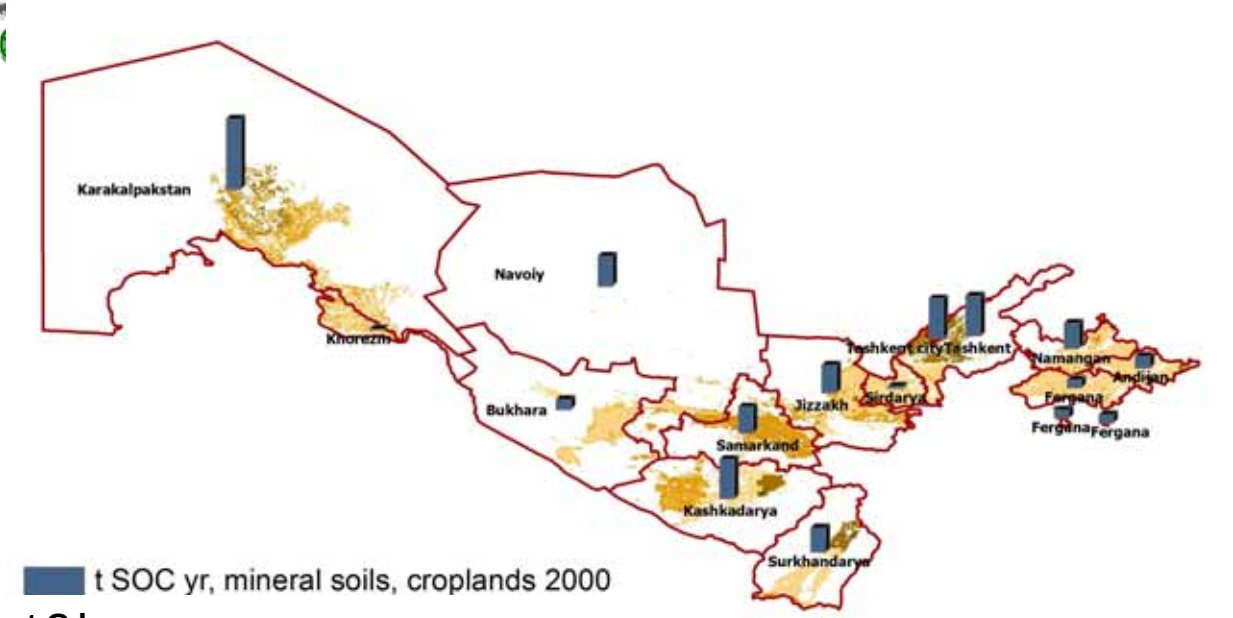
t C ha year

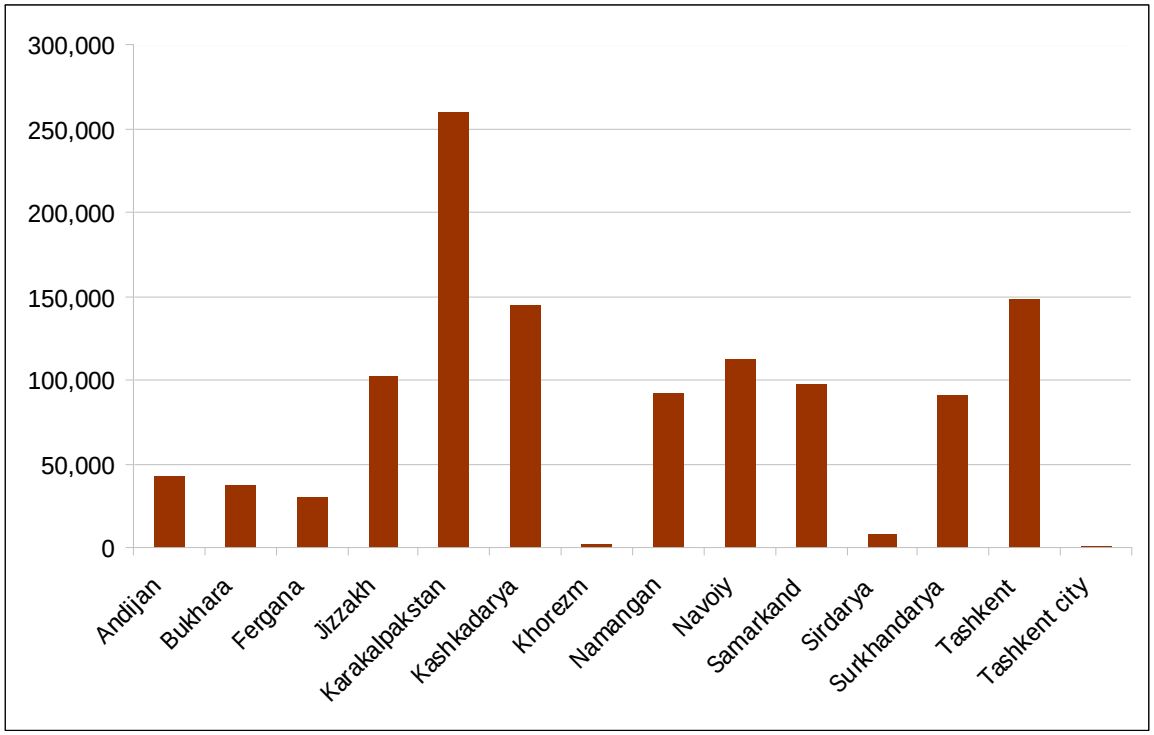
- land uses other than cropland
- < 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.05

Δ SOC (t C ha year) +
Δ C biomass (t C ha year)
D = 20 years (IPCC default)
Scenario*:
Tillage: full → reduced
Input: low → medium
Total annual potential C storage (above and below-ground): 1.84 Mt

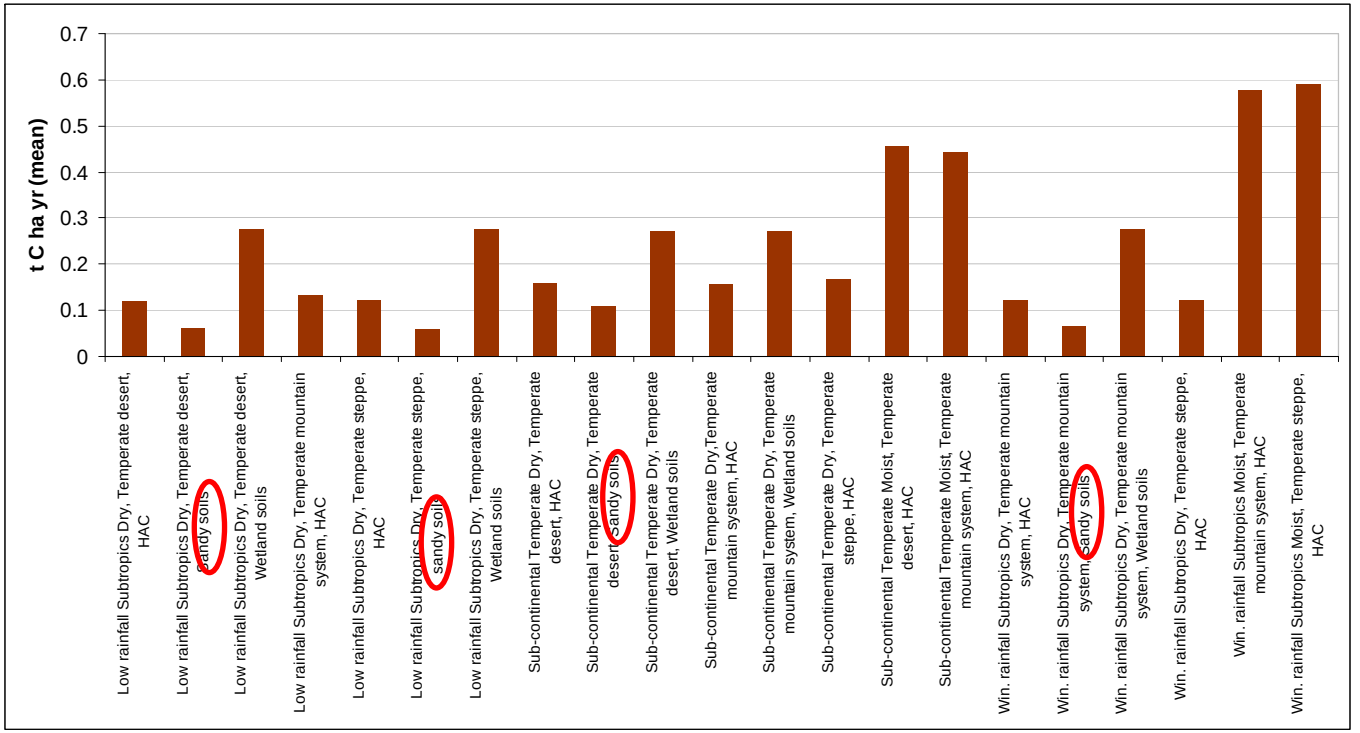
***as advised by local consultant**

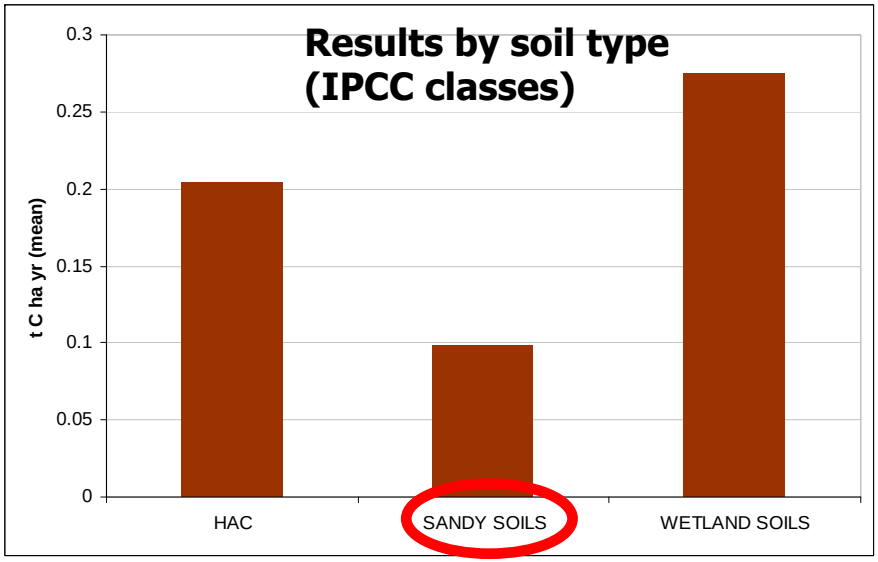
Aggregated results by administrative unit

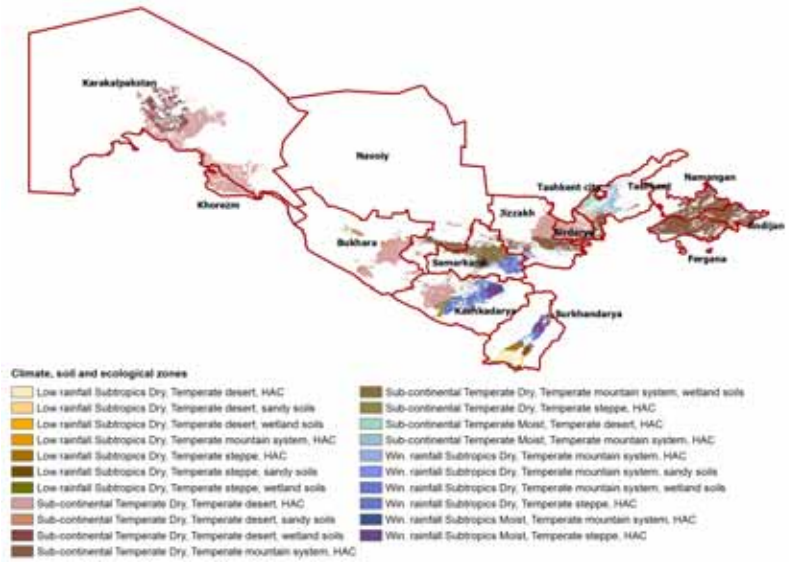




Aggregated results by each combination of climate, soil and ecological zones







Case study: Burkina Faso

Thematic layers obtained for application of Tier 1, 2006 IPCC guidelines

LAND USE

- Cultivated and managed areas
- Mosaic: Cropland / Shrub and/or grass cover

Source: GLC 2000

ECOLOGICAL ZONES

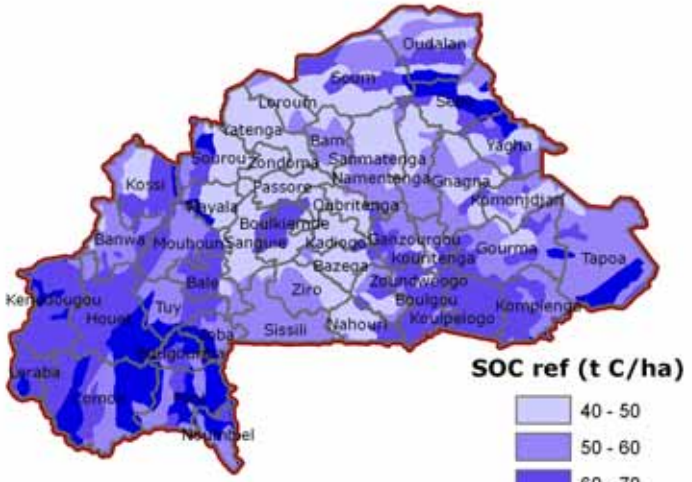
- Tropical dry forest
- Tropical moist deciduous forest
- Tropical shrubland

Source: FAO ecological zones (2001)

CLIMATE

- Warm Tropics, Dry
- Warm Tropics, Moist
- Warm Tropics, Wet

Source: GAEZ (2008)



SOC ref (t C/ha)

- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 88

Source: HWSD (2009)

(SOC 30 cm)

Case study: Burkina Faso

Results of the GIS-based scenario of Δ SOC for cropland (demo version)