

Tuning a land use change model with socio-economic data

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Introduction

Land change dynamics are created by a coupled human-environment system (Turner et al. 2007). The interactions of humans and the natural resources produce land use/cover change (Rindfuss et al. 2004). Modeling of these interactions faces methodological problems, e.g. linking human activities (land use) to pixels. This linkage can be installed either by focusing on people or on pixels (ibid.). Only few studies combine people-centered approaches (empirical socio-economic data) and grid-based approaches (physical GIS data, satellite imagery). We incorporate empirical socio-economic data into the CLUE-S land use change model (Verburg et al. 2002). Study area is a nature reserve (270 km²) in South-West China. Our aim is to test if modeled land use change improves when we integrate empirical socio-economic data.

NabanFrame modeling framework

CLUE-S is run within the NabanFrame modeling framework (and therefore called CLUENaban). NabanFrame provides decision support for land use planning. Within NabanFrame, several disciplinary models are linked to CLUENaban. They deliver input for CLUENaban and assess the impacts resulting from the modeled land use changes (Figure 1).

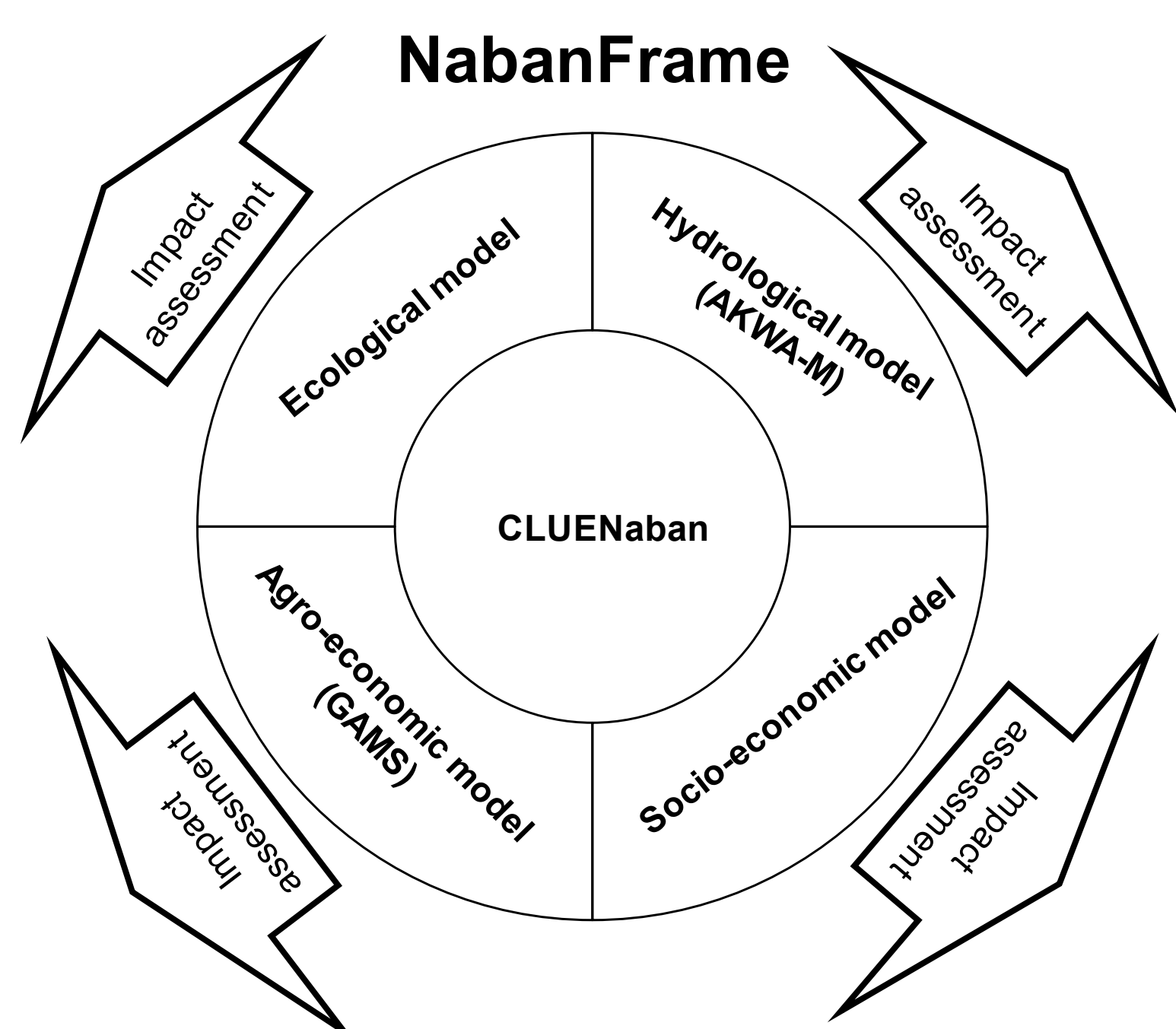
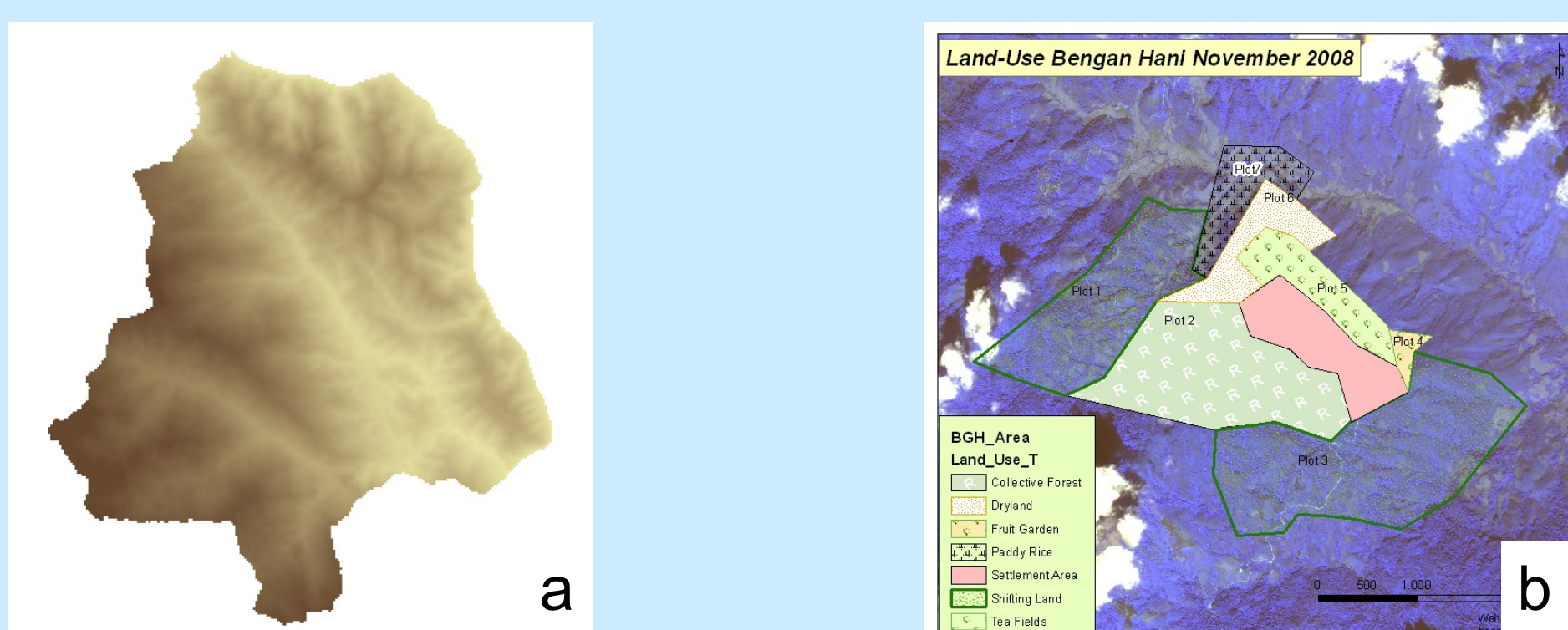


Figure 1: The NabanFrame modeling framework

Figure 2 contains the data sources we use for CLUENaban. In the following, we concentrate on the socio-economic data (local statistics, interviews). The focus is more on the data collected for the socio-economic model rather than on the model itself because it is still in development.



VILLAGE_ID	ID	POPUL	VILLAGE	TOTAL Land	Lab Perc	Lab
V_01	0	283.00	Mandian	2457	74.9	212.0
V_02	1	91.00	Chahe	921	68.1	62.0
V_03	2	110.00	Huilaoxiaozhai	476	55.5	61.0
V_04	3	154.00	Huilaoxingzhai	1532	63.6	98.0
V_05	4	204.00	Nabanhexiazhai	1499	71.6	146.0
V_07	5	80.00	State Farm	900	63.8	51.0
V_08	6	80.00	Zhouzhongzhidui	400	63.8	51.0
V_09	7	836.00	Bengangha	5839	52.9	441.0
V_10	8	261.00	Bengangla	1725	47.9	7
V_11	9	251.00	Bengangxinzi	1913	40.6	7
V_12	10	95.00	Geiyanggongdi	922	55.8	51.0

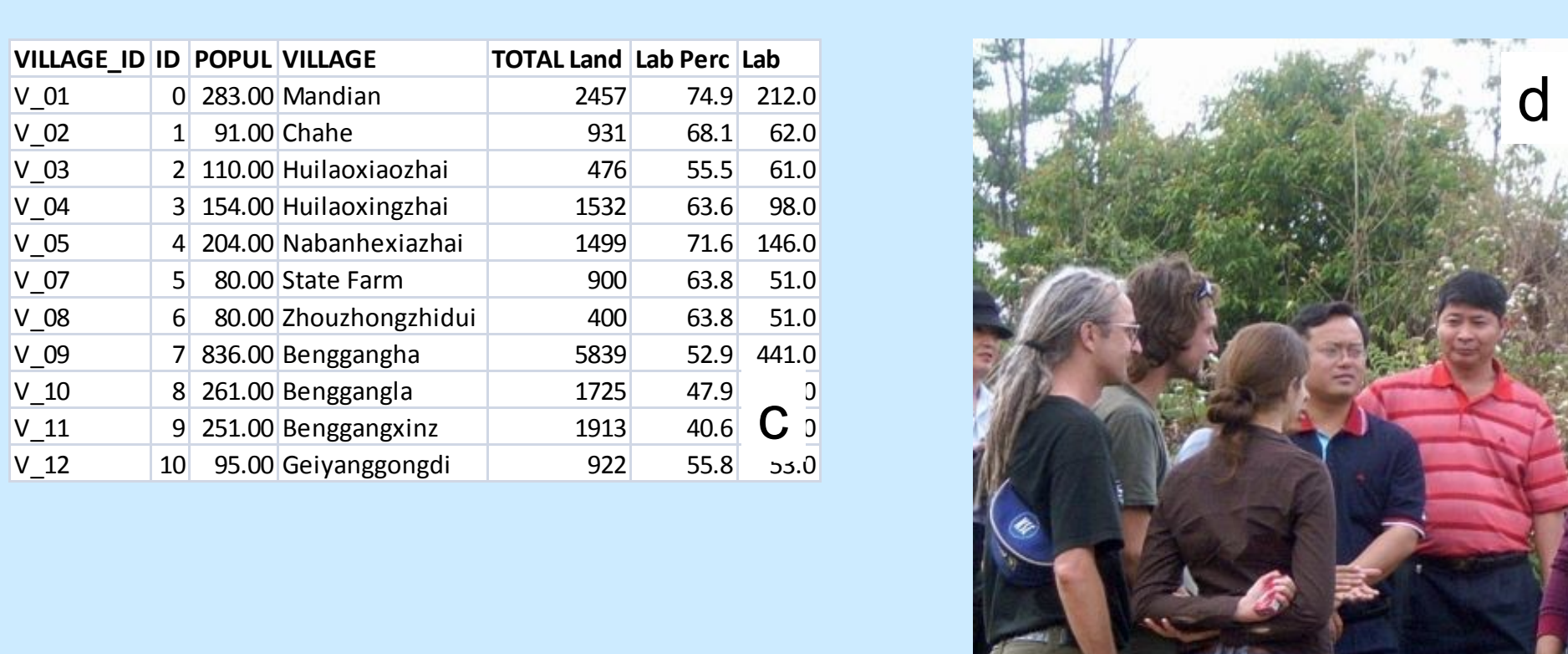


Figure 2: Data sources in CLUENaban (a: GIS elevation map, b: field mapping of land use, c: statistical data, d: interviews)

Linking socio-economic data to pixels

Socio-economic data from statistics and interviews needed to be referenced to pixels for the CLUENaban model.

Statistical data referred to the village level, the empirical data were collected in household interviews. The interview results were aggregated to the village level because it was not possible to define for all households the land they cultivate. Thus, we defined the village level as spatial reference for all socio-economic data. Since no information whatsoever has been available about village boundaries they were mapped using the knowledge of farmers and village heads in the study area.

Figure 3 shows the procedure we used to link socio-economic data to pixels using the example of "Available labor". The labor data were collected in household interviews.

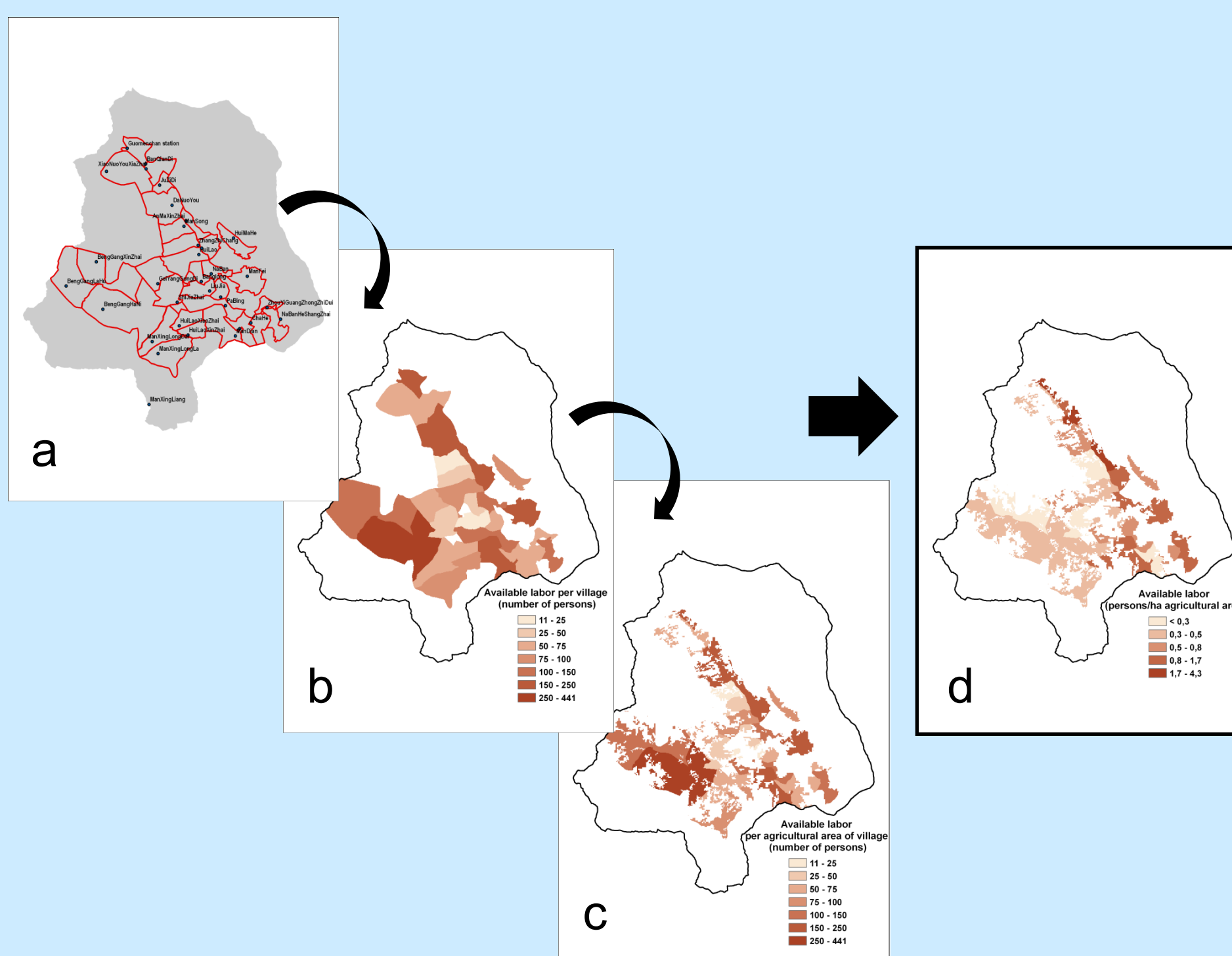


Figure 3: Data processing of labor data collected in household interviews
a Mapping of village boundaries
b Joining of data to village boundaries
c Cutting out forest area (labor is only applied to agricultural land)
d Normalizing data by the area of agricultural land = final location factor for CLUENaban

Modeling procedure

We modeled the time period 1996-2006 because at that time rubber production increased rapidly. A reliable land use map (supervised classification based on IKONOS/SPOT satellite imagery) was available for the year 2006. Thus, a validation of the modeled land use map was possible using the observed land use map 2006.

We started with a basic model run that comprised only three physical location factors: elevation, distance to river, exposition. But physical factors alone could not explain the highly differentiated land use pattern (dryland, irrigated land, shifting land, rubber, tea, settlement, forest) in the study area. Thus, we integrated additional socio-economic data.

Results

In China, collective land and state land are distinguished. Farming usually is restricted to collective land. This land designation turned out to be the most important factor for the land use types dryland, irrigated land, and rubber (distribution of collective land and state land can be taken from Figure 4). The striking misallocation of rubber along the eastern border of the study area could thereby be prevented. All land use types were influenced by the ethnicity of village inhabitants because they had different land use traditions. Ethnic traditions were the most important location factor for tea production. The mean ROC value over all land use classes increased from 0.73 to 0.90 when we added socio-economic factors.

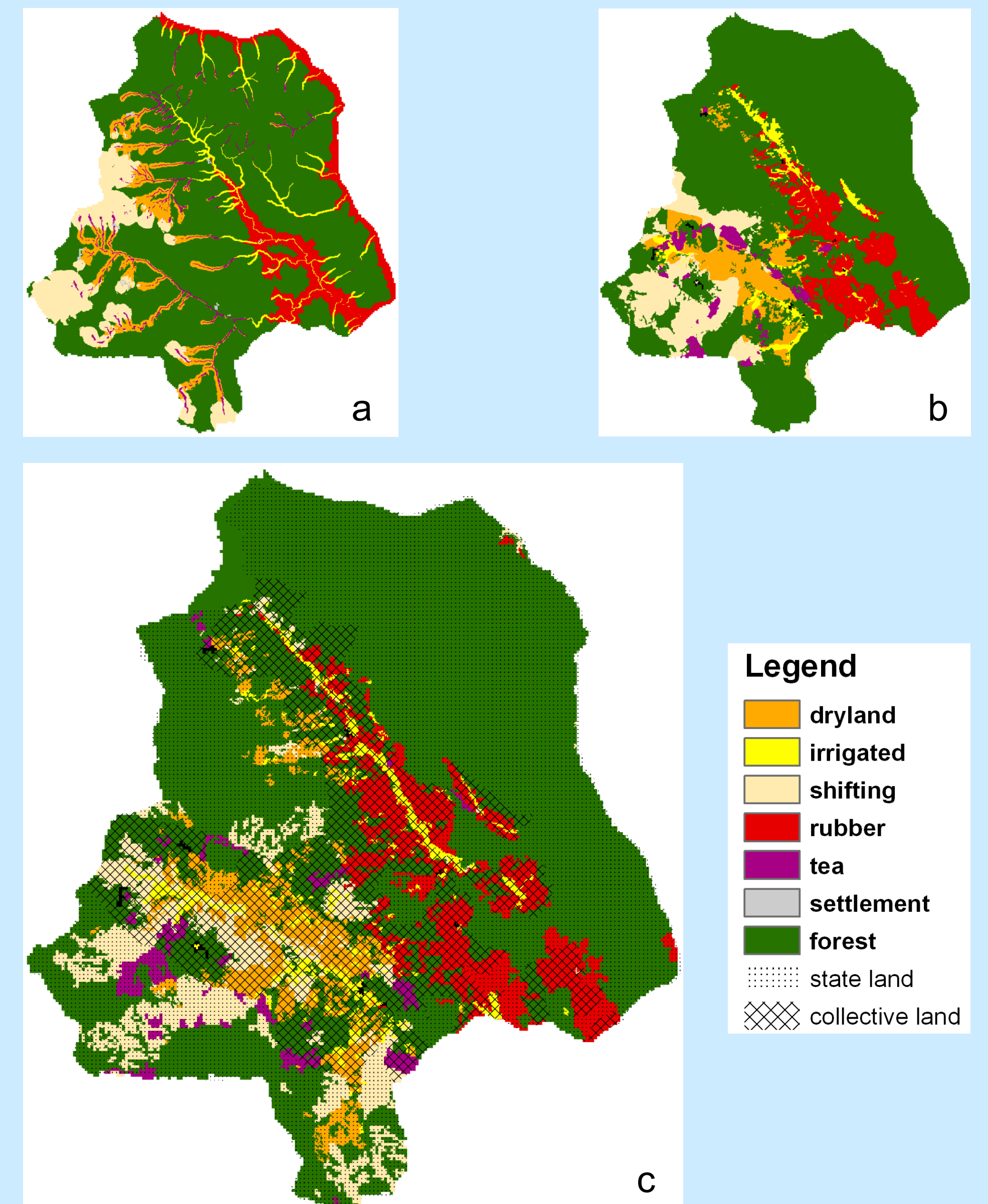


Figure 4: CLUENaban simulation results and observed land use (year 2006)
a Model run with only physical location factors (elevation, distance to river, exposition)
b Model run with physical and socio-economic factors (elevation, distance to river, exposition, distance to road/village/collective land, designation as state/collective land, available labor, and ethnicity)
c Land use map 2006, classified from satellite imagery, and boundaries of state/collective land

Discussion

With the model run described in this poster we demonstrated that model results for the study area improved when we integrated socio-economic data.

We developed a procedure to link household data to pixels. Village boundaries were mapped and served as link between socio-economic and grid-based data.

The linkage between socio-economic data and CLUENaban is only one part of the NabanFrame modeling framework. In an integrated modeling framework it is absolutely necessary to define spatial entities as interfaces. In the NabanFrame modeling framework we use villages as interface between CLUENaban and the socio-economic and the agro-economic model. Hydrological response units are used as link to the hydrological model. The ecological model in NabanFrame is already based on raster data; thus, no additional interface is necessary.

The linking procedure is also applicable to other study areas. It is particular suitable for areas with only few available data because it is based on own empirical data.

A limitation of the study is that we could only integrate a small number of physical location factors (due to data inaccessibility). Integration of other physical factors may improve model results. But the regression analysis with the land use types as dependent variables and the location factors as independent variables proves very clearly that the socio-economic location factors dominate land use patterns in our study area.

Acknowledgements

This work is funded by the German Federal Ministry of Education and Research under promotional reference 0330797 (LILAC - "Living Landscapes China").