Relationship between non-stationarity of land-cover change and error due to allocation

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(1) Purpose: The main purpose of this study is to examine the relationship between non-stationarity of land-cover change and error due to allocation in land-cover change modeling in the city of Baguio, the Philippines.

(2) Data and methods: The GEOMOD model was used to simulate the 2009 land-cover map of Baguio city. Remote sensing-derived land-cover maps for 1988 and 1998 were used to calibrate the model, while the 2009 map was used to validate the simulated 2009 map. Figs. 1a-b and 1c show the location of Baguio city and the land-cover changes across 1988, 1998 and 2009.

The four components of correctness and error, namely null successes, hits, misses and false alarms were determined (Fig. 1d). To determine the relationship between the non-stationarity of land-cover change and the error due to allocation, the following were calculated: (i) difference in the gains of built between the calibration and simulation periods (DGB_{dk}) (Eq. 1); and (ii) quantity of error due to allocation (misses and false alarms) of the simulated 2009 land-cover map in each of the bins of the categorized drivers. Subsequently, the DGB_{dk} was categorized into non-stationarity+ and non-stationarity–, where the former is characterized by an increase in the gains of built across the calibration and simulation intervals in each of the bins of the drivers, while the latter is characterized by a decrease. Finally, scatter plots were produced and statistical relationships between the quantity of non-stationarity+ and non-stationarity– on the one hand, and the quantity of misses and false alarms on the other, were examined.

$$DGB_{dk} = GB_{dk(sim)} - GB_{dk(cal)} \qquad \text{(Eq. 1)}$$

where d is a particular categorized driver; $GB_{dk(cal)}$ is the gain of built during the calibration period in category k of driver d; $GB_{dk(sim)}$ is the gain of built during the simulation period in category k of driver d.

(3) Results and Discussion: Fig. 1d shows the cross-tabulation of the simulated 2009 land-cover map and the 1998 and 2009 reference maps. The simulated 2009 land-cover map had an error due to quantity and error due to allocation of 0.76% and 13.54%, respectively, with an overall accuracy of 85.70% (null successes + hits) relative to the whole landscape. It also had a 'hits to observed change ratio' of 0.585, 'misses to observed change ratio' of 0.415) and a 'false alarms to observed change ratio' of 0.381.

Results revealed that there was a much stronger linear relationship of non-stationarity+ with misses than with false alarms, while non-stationarity– had a much stronger linear relationship with false alarms than with misses. This indicates that the variability of misses can be better explained by non-stationarity+, while the variability of false alarms can be better explained by non-stationarity–.

(4) Conclusion: There was evidence of a possible causal relationship between non-stationarity of land-cover change and error due to allocation. A detailed analysis of the relationship between these two variables can provide information useful for the refinement of the calibration done on the model.

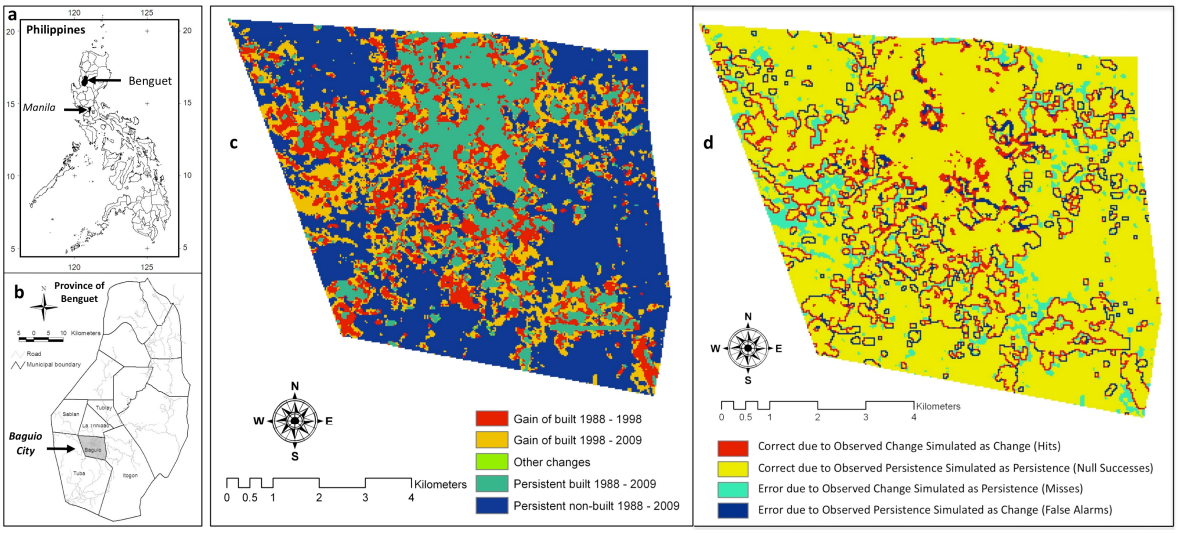

Fig. 1: (a-b) Location of Baguio city; (c) the land-cover changes across 1988, 1998 and 2009; and (d) cross-tabulation image of the simulated 2009 land-cover map and the 1998 and 2009 reference maps.