Lessons and Challenges for Land Change Modelers as Revealed by a Comparison of Thirteen Cases (24)

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This paper presents lessons derived from an exercise that compared maps of predicted changes among land categories over time for thirteen simulation modeling applications, including two in Europe and four in the Untied States. Results showed that there was more prediction error than correctly predicted change for twelve of the thirteen cases at the fine resolution of the raw data, while the accuracy was higher at coarser resolutions (figure 1). The exercise was a collaboration among seven laboratories that culminated in the publication of Pontius et al. (2007), which presents the quantitative methods and results. The value of such an exercise derives from the generalizations that can be learned, which are presented in these conference proceedings.

The exercise revealed ten challenges facing land change modelers. The first challenge is to separate calibration data from validation data. More than half of the modeling applications used information from the subsequent time to simulate the change between the initial and subsequent times; not surprisingly, those applications tended to be the more accurate ones. The second challenge is to interpret the influence of a prediction of too much or too little change on the model assessment, which is important because some popular statistics are designed to measure only the location of change assuming an accurate quantity of change. Third is to characterize the land change between two points in time, since some simple statistical measurements fail to capture important dynamics, while other detailed measurements are difficult to interpret. Fourth is to select relevant resolutions. Nearly all of the cases adopted the resolution of the raw data; however that resolution was usually determined by data storage convenience, not by any characteristic of the landscape. Fifth is to predict small amounts of observed change. There was less than ten percent observed change between the initial and subsequent times for all six applications in the United States and Europe, and all six applications contained more error than a null model that predicts no change (figure 2). Sixth is to prepare the data appropriately. The two different models applied to The Netherlands illustrate that the format of the data can have more influence on the results than the characteristics of the model. Seventh is to include analysis of uncertainty, most of which tends to be ignored in such modeling exercises. Eighth is to use appropriate map comparison measurements to compare the observed change to the predicted change. Many statistics are available to compare maps, while some methods are clearly more useful than others. Ninth is to use the results of modeling exercises to learn about LUCC processes, because a major reason of modeling is to learn about the mechanisms of the landscape dynamics. Tenth is to collaborate among scientists. Presentation of this paper is one of the most important ways in which the wider scientific community can continue to benefit from this multi-year collaboration in ways that have important implications for the education and practice of land change science.

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References

Pontius Jr, Robert Gilmore, Wideke Boersma, Jean-Christophe Castella, Keith Clarke, Ton de Nijs, Charles Dietzel, Duan Zengqiang, Eric Fotsing, Noah Goldstein, Kasper Kok, Eric Koomen, Christopher D. Lippitt, William McConnell, Bryan Pijanowski, Snehal Pithadia, Alias Mohd Sood, Sean Sweeney, Tran Ngoc Trung, A. Tom Veldkamp, and Peter H. Verburg. 2007. Comparing the input, output, and validation maps for several models of land change. Annals of Regional Science, in press.

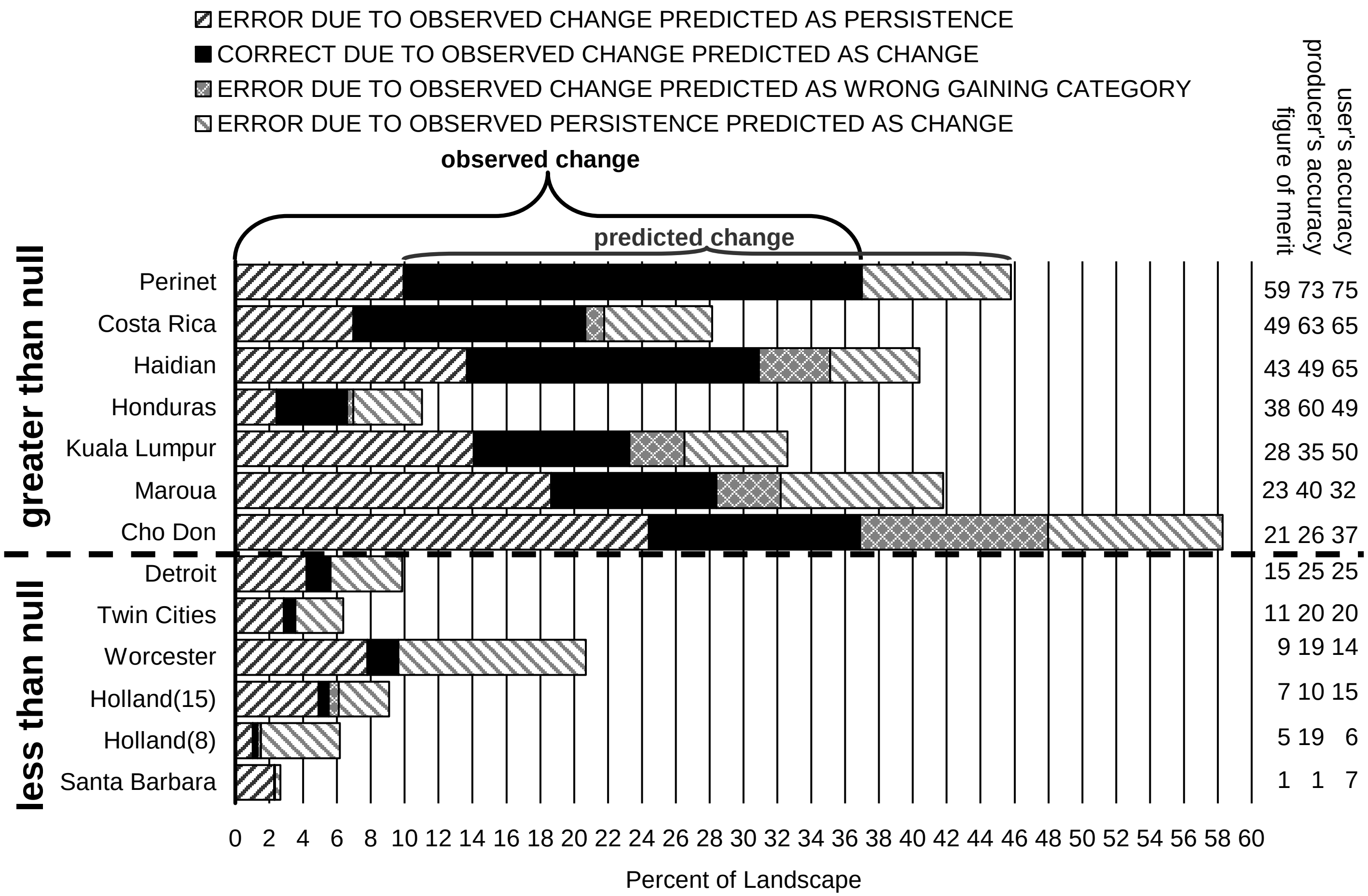

Figure 1. Sources of percent correct and percent error in the validation for thirteen modeling applications. Each bar is a Venn diagram where solid and cross hatched areas show the intersection of observed change and predicted change.

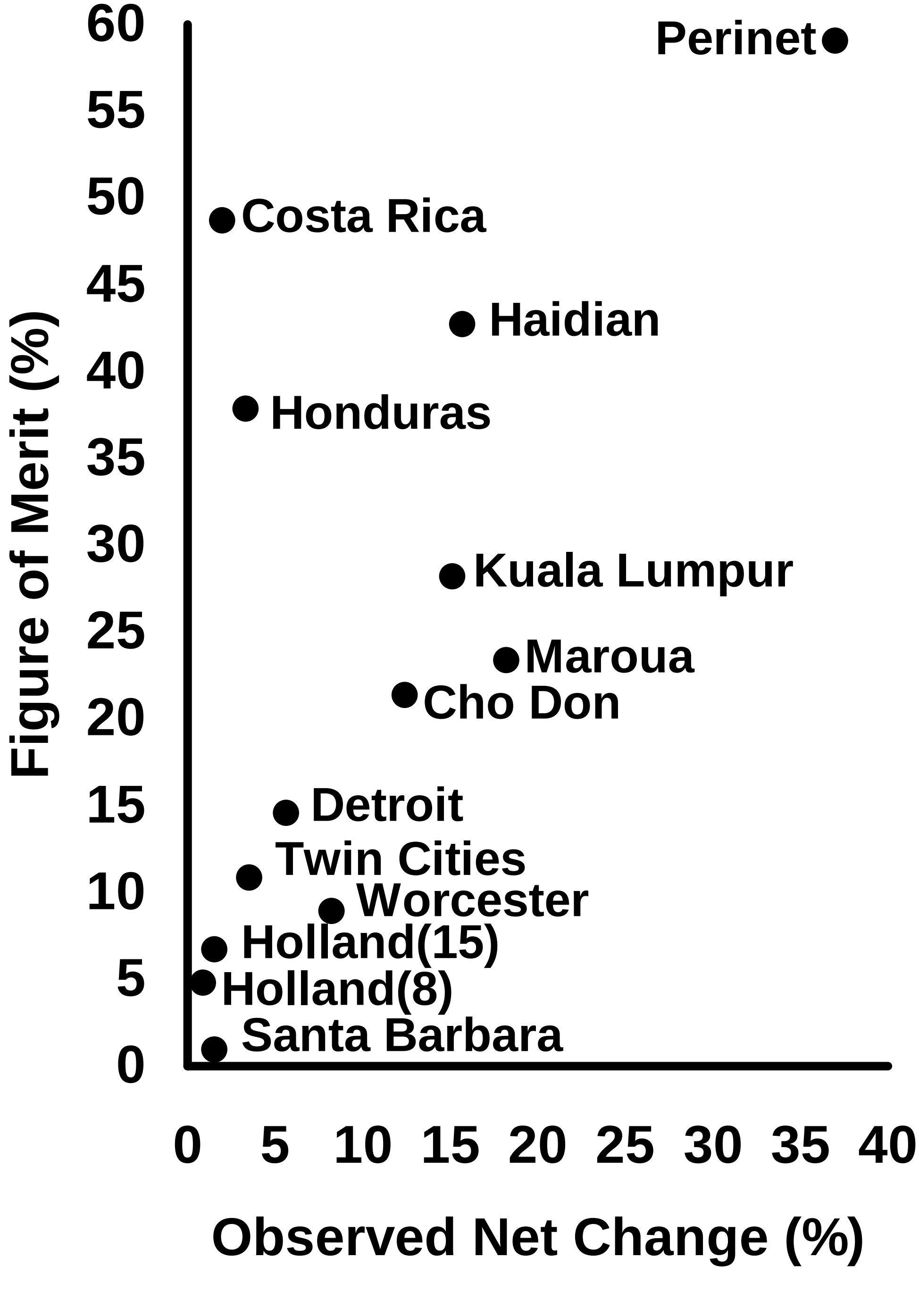

Figure 2. Positive relationship between the figure of merit (i.e. prediction accuracy) versus observed net change (e.g. landscape dynamics).