Methodological Issues in Spatial Land Fragmentation Gradient Analysis

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INTRODUCTION

Landscape fragmentation can strongly influence ecosystems, environment, and society. In the study of land fragmentation, gradient analysis is an important method for effectively capturing the spatial patterns and dynamics of fragmentation for the landscape. Fragmentation gradients can be generated through a moving window (MW) approach using FRAGSTATS. In this study, firstly, through applying various MW sizes (from 90m by 90m to 2370m by 2370m), we propose a methodology to identify the optimal window size which can extract the strongest spatial fragmentation pattern. Secondly, because urban sprawl usually takes place in a radial direction around the city center, this study also compared two popular methods of measuring fragmentation gradients at different distances from the urban center: (1) using concentric rings from the city center, and (2) using a transect across the city center.

OPTIMAL MOVING WINDOW SIZE IDENTIFICATION FOR SPATIAL FRAGMENTATION ANALYSIS

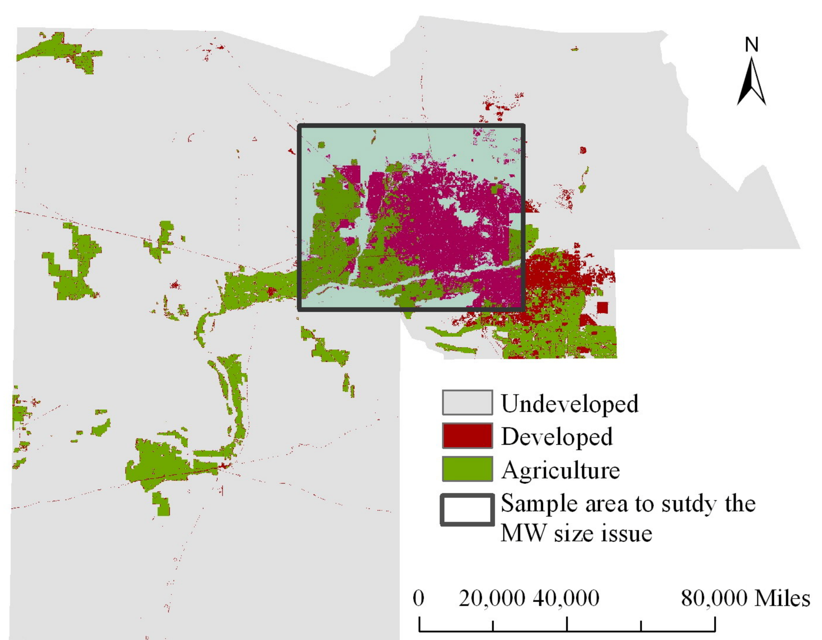

Figure 1. Study Area

Study area

The 30-m resolution USGS National land cover Dataset (NLCD) image in 1992 and 2001 were used for deriving land cover change information and fragmentation analysis for Maricopa County, Arizona. To examine the optimal MW size, we picked a 60km by 50km extent, which characterizes a typical urban to edge area (Fig. 1). The NLCD maps were then reclassified into 3 classes: developed, undeveloped and agriculture.

Research Method

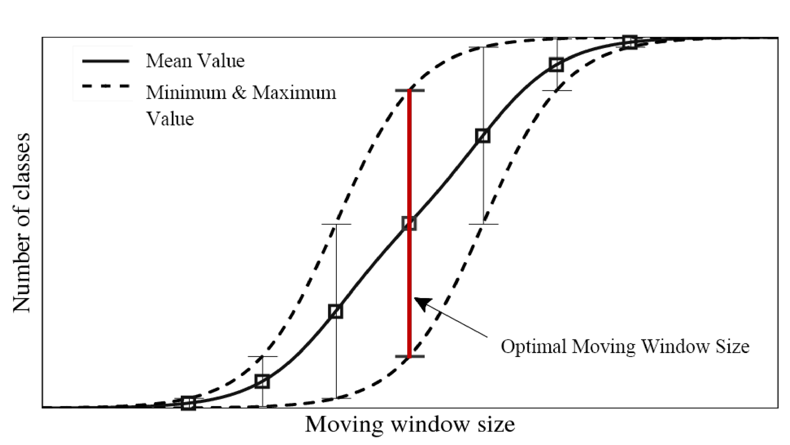

Figure 2. Illustration of the concept of optimal moving window size

Step 1: **Quantify the Patch Richness (PR):**

PR= the number of patch types present

Step 2: **Calculate the Simpson's Diversity index of PR:**

$$D = \sum_{i=1}^{n} p_i^2$$

Here D is the diversity value of PR; pi equals the percentage of the PR value on the total observations, n equals to the number of pi values.

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Research Results

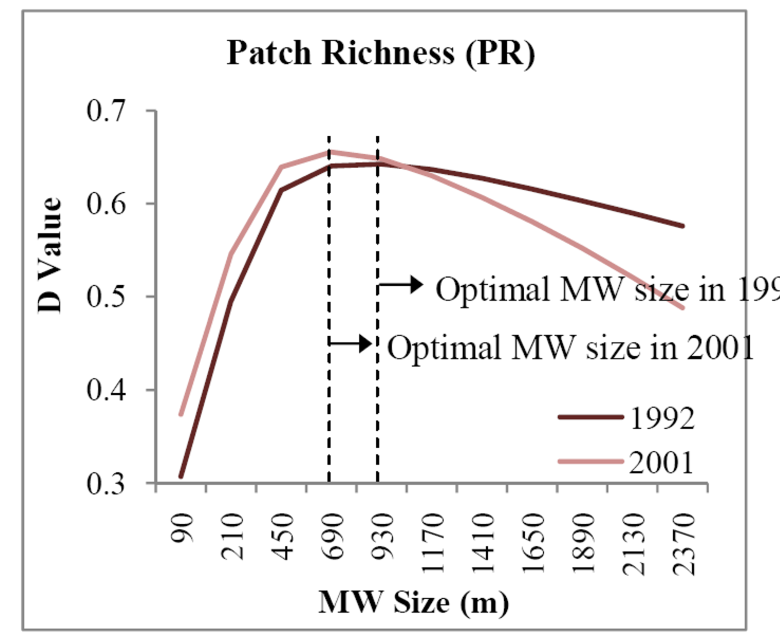

Figure 3. The relation of D value of Patch Richness (PR) versus MW sizes in year of1992 and 2001

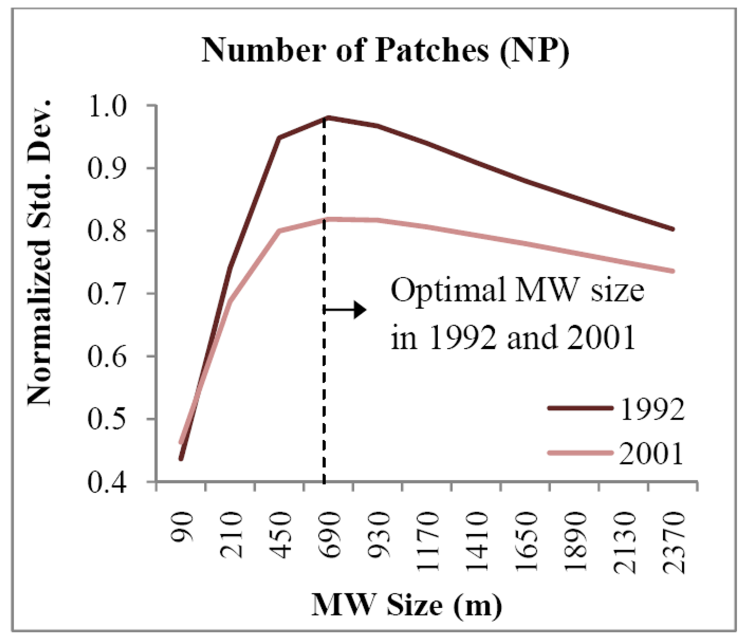

Figure 4. The relation of Normalized Standard Deviation of Number of Patches (NP) versus MW sizes in year of 1992 and 2001

The D index versus MW size for the year 1992 and 2001 are shown in Fig. 3. For the 1992 land cover map, the optimal side length of the MW is around 930m, and for the 2001 map, it is around 690m. Similarly, for the fragmentation metrics Number of Patches (NP), we used Normalized Standard Deviation versus MW size, and the results indicated the optimal window size of 690m side length for both years 1992 and 2001.

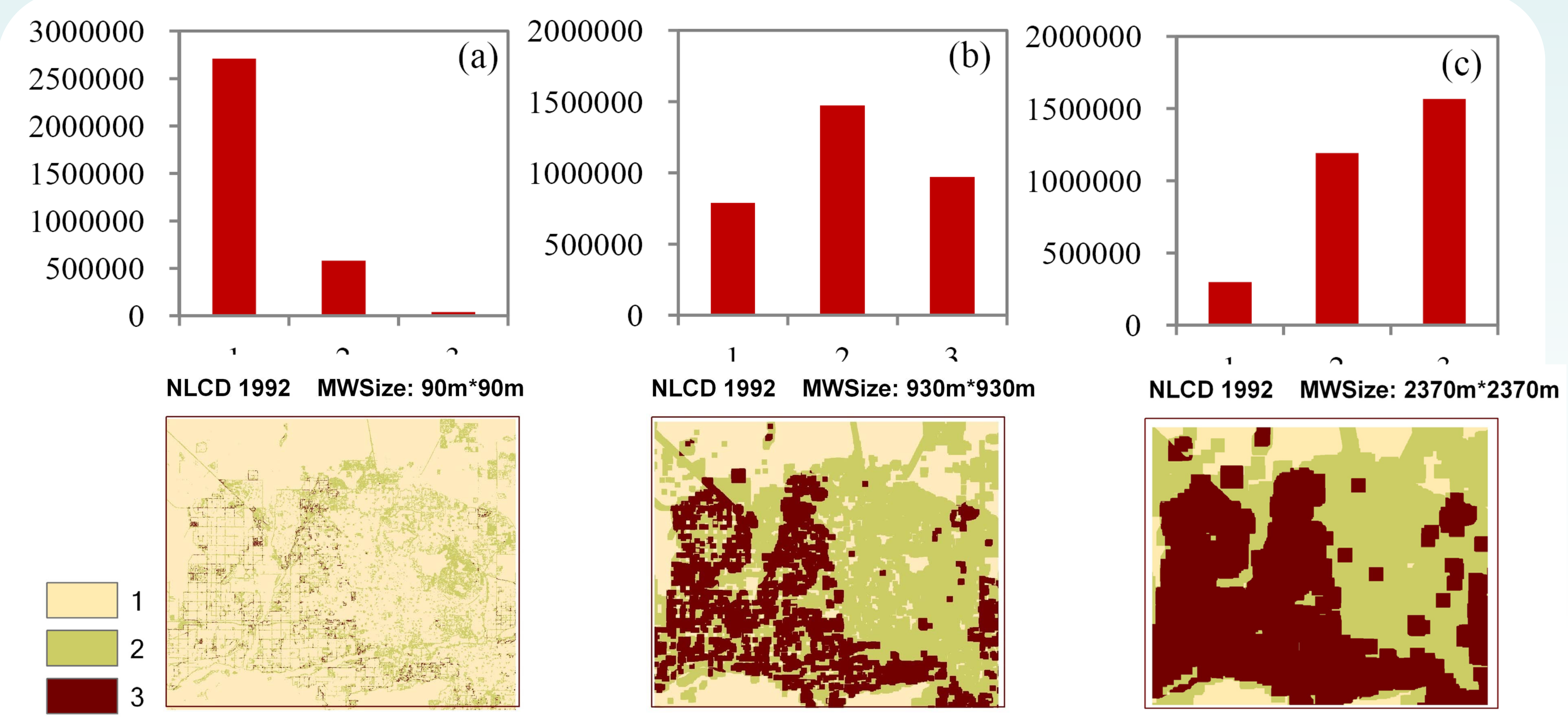

Figure 4. The capability of capturing number of land types at different MW sizes and the PR metrics results using data in year 1992 (a) 90m by 90m; (b) MV size 930m by 930m; (c) MV size 2370m by 2370m

When the size of the MW is set small, it mostly capture only one of the three land classes when moving over the landscape, as shown in Fig. 4 (a). As the MW size increases, the number of observations covering one, two, and three classes becomes more evenly distributed (Fig. 4 (b)), and as the MW size increases further, observations that catch three classes are dominant, and the pattern become to be clustered (Fig. 4 (c)) .

FRAGMENTATION GRADIENT ANALYSIS COMPARISON STUDY OF METHODS IN DIRECTIONAL

Research Method

In fragmentation gradient analysis, two methods -- using concentric rings from the urban core and using a transect across the urban core -- are compared. Both are based on the spatial fragmentation distribution map generated by 450m side length of MW size. Landscape metrics Contagion (CONTAG), the most widely-used index that subsumes both dispersion and interspersion, is selected in the analysis.

Research Results

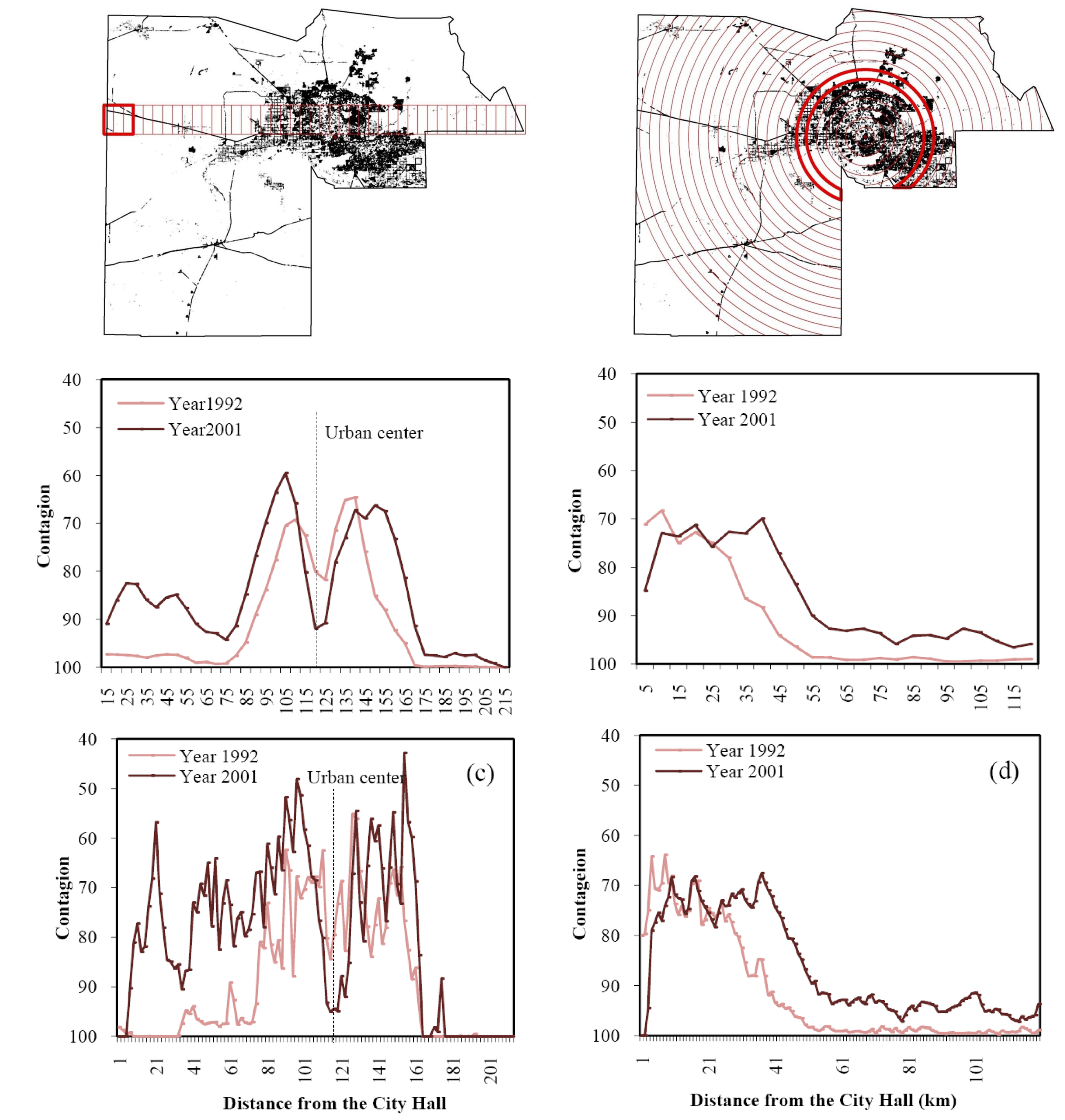

*Figure 5. Comparison of the effect of ring and transect using different observation scales (a) 15km*15km window along transect; (b) 5km centric rings; (c) 2km*10km window along transect; (d) 1km centric rings*

Results of Fig. 5 indicates that the ring method has a better representation on how much fragmentation moves outwards, while the transect method can provide better direction information since fragmentation does not expand evenly outwards.

Comparison of the two different observation scale s(i.e. the width of rings and the size of transect window) shown in Fig. 5 suggested that a carefully designed observation scale can remove the noise in the results.