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The Corbusier Dream and Frank Lloyd Wright Vision: Cliff Detritus Vs. Urban Savanna

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Abstract

Investigators are seeking methods to assess the visual and environmental quality of the landscape across urban areas. In addition investigators are interested in applying these predictors to study landscape transformation and change. In our study we employed an environmental quality prediction equation, which assesses environmental quality to create a visual quality map of southern Michigan and then evaluated the map's ability to determine the map's reliability. Through the Kendall's coefficient of concordance statistical test, we determined that the map is significantly reliable ($p \leq 0.01$) and conclude that constructing such a map of a large area is possible. We then applied this approach to quantify environmental quality change to southeast Michigan (Detroit metropolitan area) from land-use maps in the 1800s, and from a map constructed in 2008. Only areas with cliff detritus had statistically significant changes. Many of these cliff detritus areas are now being transformed back to pastoral urban savanna environments, a vision that had been embraced by Frank Lloyd Wright. Wright's approach compares differently with the grand vision Le Corbusier had for urban areas, a series of multiple-use towers spaced across an urban forest. The sprawling towers of Shanghai, P.R. of China exemplify this model in a modern manner.

Keywords: environmental psychology, landscape architecture, land-use planning
landscape planning, urban sprawl

1. Introduction

For the last 50 years, investigators have been seeking quantitative methods to predict and assess the visual and environmental quality of the landscape. The literature on this subject is vast. Mo *et al.*, reviews much of this pertinent literature and discusses the perceptions

of respondents in North America, France, Portugal, and P.R. of China. One of her and her colleagues' findings suggests that Europeans and North Americans may have broad similar perceptions about landscape [1]. Asians may have a different sensibility concerning environmental preference. Concurrently, Partin *et al.*, studied the response of participants to computer generated images and reported that the perception of computer images was similar to the perception of photographs of landscapes [2]. In other words it was possible for investigators to present computer generated images to respondents and obtain a similar response as if the respondents were examining photographs. He also demonstrated how a small study could be folded into a larger and widely studied set of images to obtain stable and reliable results. In addition, Burley *et al.*, presented a model that predicted a high proportion of explained respondent preference [3]. The model included esthetic, economic, ecological, functional, and cultural requirements. Their work provides the current background and theory concerning the types of variables presently used in developing predictive models. In their study, they specifically addressed the reclamation of Detroit's "gray-fields". The study team employed an investigative approach to evaluate Frank Lloyd Wright's vision for cities, called "Broadacre City" to current visions for Detroit, and with the past environmental conditions of Detroit. They concluded that the new visions for Detroit and Frank Lloyd Wright's vision was indeed significantly preferred over past built environments. Liu and Burley and Yilmaz and Burley provide additional background concerning the variables that Mo *et al.* and Partin *et al.*, have employed [4, 5]. Liu and Burley noted that respondents can have widely dispersed expectations concerning values and criteria to assess landscapes; yet Yilmaz and Burley note that collectively and statistically, strong and reliable predictive equations evaluating landscapes can be generated from respondents, explaining up to 90% of the variance in respondent preferences [5].

During this timeframe, Lu *et al.*, examined the Lower Muskegon watershed, located on the west side of the lower peninsula in Michigan [6]. He and his colleagues studied images of urban areas, farmland, wetlands, and forests and attempted to construct an environmental quality map of his study area. The result he obtained through statistical analysis revealed that the relationship between his predictions in the map and the real photographs are in concordance and at a reasonable (95%) confidence level. He concluded that visual/environmental quality could be mapped and reliably predicted in the Lower Muskegon Watershed. These recent studies provide a setting for our investigation.

As an extension of Lu's *et al.*, research, we were interested in applying this approach to all of the southern part of Michigan. We wanted to make a validated map of southern Michigan. In addition we were interested in examining the transformation of environmental quality in the Detroit metropolitan area, comparing pre-settlement environments from the 1800s to current conditions. In addition, we desired to compare the environments of greater Detroit with the vision held by Le Corbusier [7]. Le Corbusier envisioned a grand sea of urban forest penetrated by multiple-function buildings spreading endlessly across the urban landscape. Two structures were built in France applying his principles, one in Marseilles and the other in Rezé-les-Nantes. The experiment ended there. However, the broad expanse of towers forming the city of Shanghai, with

a population of 25 million people, is a modern version, expressing this vision. We were interested in assessing the perceived environmental quality of Detroit and Shanghai with the evaluation equation.

2. Study area and methodology

Michigan is located in the Great Lakes Region of the United States of America. Michigan is the only state to consist of two peninsulas. These two peninsulas are linked by the Mackinac Bridge. The Upper Peninsula is separated from the Lower Peninsula by the Straits of Mackinac. The Lower Peninsula whose shape looks like a mitten was chosen as the study area. The area of this research is known as Southern Michigan, which is no further north than N. 44.2 in latitude (**Figure 1**). The majority of people live in this southern portion of Michigan containing many more people than the other part of Michigan. Cities in the study area include: Grand

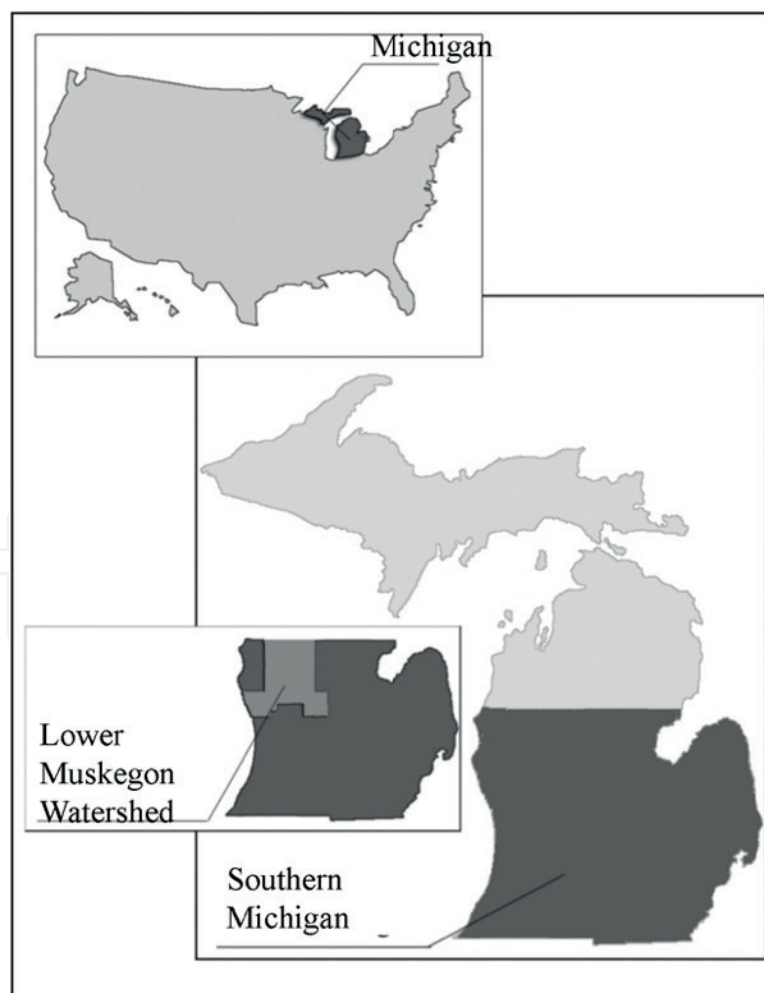


Figure 1. Location of the study area and related study areas (north is at the top of the figure).

Rapids, Battle Creek, Benton Harbor, Jackson, Kalamazoo, Flint, Pontiac, Bay City, Midland, Holland, Saginaw, Muskegon, East Lansing, Ann Arbor, and Metropolitan Detroit.

Le Corbusier's Unité d'Habitation of Nantes-Rezé, France was built in 1955 [7]. Nantes is a French port along the Loire River, in western France. The structure contains a school at the top level. From this basic idea emerged in Shanghai a vast collection of towers, many multi-function. The architectural towers emerged over 100 years after the a French Concession trading



Figure 2. A model of the central urban core of shanghai in 2007 copyright © 2007, Jon Bryan burley, all rights reserved, used by permission.

port south of the Chang Jiang (Yangtze River), along the sea coast was established. Since the 1990s, Shanghai has experienced extensive redevelopment with towers extending sometimes as far as the eyes can see (**Figure 2**).

The methodology to evaluate large areas of urban and rural landscape was similar to Lu *et al.* [6]. Lu *et al.* explains in great detail the methodology. In summary, images of various landscapes across the Michigan study area were collected and randomly sorted into two groups: one group to assist in making a prediction and another group to validate or refute the prediction. From the first group, scores for the images were generated by employing an Eq. (1) developed by Burley [8]. This paper by Burley, published in 1997 is the formative paper in this line of work and investigators interested in understanding the fundamentals of this line of research are urged to examine this paper. Once one has obtained the scores, then the scores are applied to similar land-uses to form a map predicting environmental quality. Next the second group of images are compared to predictions made by the map through the use of Kendall's Concordance, a statistical technique that examines and tests for significant agreement/similarity [9, 10]. If the scores agree, then it is possible to make a reliable visual quality prediction map. Jin also provides more detail, step-by-step concerning this methodology [11]. Investigators seriously interested in applying this methodology should obtain copies of Lu *et al.*, and Jin for a full and complete explanation [6, 11]. Single images can also be scored and compared with other images with this equation. Scores below 50 are very biospheric, meaning the image contains predominantly plants, water, sky, and flowers. Images in the 60s contain some roads or buildings. Images that are 70 and above are rather noospheric with some images scoring in ranges over 110 (highly un-preferred images).

$$\begin{aligned}
 Y = & 68.30 - (1.878 \cdot \text{HEALTH}) - (0.131 \cdot X1) - (0.064 \cdot X6) + (0.020 \cdot X9) + (0.036 \cdot X10) + \\
 & (0.129 \cdot X15) - (0.129 \cdot X19) - (0.006 \cdot X32) + (0.00003 \cdot X34) + (0.032 \cdot X52) + (0.0008 \cdot X \\
 & 1 \cdot X1) + (0.00006 \cdot X6 \cdot X6) - (0.0003 \cdot X15 \cdot X15) + (0.0002 \cdot X19 \cdot X19) - (0.0009 \cdot X \\
 & 2 \cdot X14) - (0.00003 \cdot X52 \cdot X52) - (0.0000001 \cdot X52 \cdot X34)
 \end{aligned} \tag{1}$$

where (See **Table 1**):

The test statistics are provided in Eqs. 2 and 3. The statistics are based upon rankings of treatment scores across rows. In this case the rows are pairs of images between two treatments: the predicted score for a randomly chosen site in the study area and the actual score from a photograph taken at that location. There are 30 rows (pairs of scores) for this study ($n = 30$). The treatments are the columns ($m = 2$). The rankings are summed and squared, to compute Kendall's W value Eq. (2). $(R_j)^2$ is the sum of the squares of the rankings for a column in computing the Kendall's W value [8, 9].

$$W = \frac{12 \sum_{j=1}^m R_j^2 - 3 m^2 n (n+1)^2}{m^2 n (n^2 - 1)} \tag{2}$$

HEALTH	environmental quality index
X1	perimeter of immediate vegetation
X2	perimeter of intermediate non-vegetation
X3	perimeter of distant vegetation
X4	area of intermediate vegetation
X6	area of distant non-vegetation
X7	area of pavement
X8	area of building
X9	area of vehicle
X10	area of humans
X11	area of smoke
X14	area of wildflowers in foreground
X15	area of utilities
X16	area of boats
X17	area of dead foreground vegetation
X19	area of wildlife
X30	open landscapes = $X2 + X4 + (2 \times (X3 + X6))$
X31	closed landscapes = $X2 + X4 + (2 \times (X1 + X17))$
X32	openness = $X30 - X31$
X34	mystery = $X30 \times X1 \times X7/1140$
X52	noosphericness = $X7 + X8 + X9 + X15 + X16$

Table 1. Variables for the environmental quality/Health index in Eq. 1.

Kendall’s W value is a number ranging between 0 and 1. When W is near 0, there is no strong overall trend of agreement among the respondents. If W is near 1, then the responses could be regarded as close to unanimous in their agreement. The W test statistic approximates a Chi-square distribution with n–1 degrees of freedom (Eq. 3). If computed values for Chi-square (Eq. 3) are greater than significant values in a Chi-square table for n–1 degrees of freedom (in this case 29 = 30–1), then there is a high level of agreement/concordance—the predicted scores and the actual scores are in agreement.

$$X^2 = m (n - 1) W \tag{3}$$

3. Results

The sample of images gathered in the investigation include forested lands (**Figure 3**), agricultural lands (**Figure 4**), residential environments (**Figure 5**) (known as urban savanna), down-town-like environments (**Figure 6**) (know as cliff detritus) and industrial sites (**Figure 7**) [12].



Figure 3. Image of sample number 26 of a forested landscape in southern Michigan (visual score of 54.40120) — Copyright © 2011, Yuemin Jin, all rights reserved, used by permission.



Figure 4. Image of sample number 16 of a farmland landscape in southern Michigan (visual score of 59.12320) — Copyright © 2011, Yuemin Jin, all rights reserved, used by permission.



Figure 5. An image of a residential landscape (urban savanna with visual quality score of 61.58117), sample number 10 — Copyright © 2011, Yuemin Jin, all rights reserved, used by permission.

Table 2 presents the rankings of the images from the study. The predicted ranks are scores generated by developing a map of the study area. The actual scores are values taken and measured from a random site in the study area. Kendall’s Concordance analysis revealed a Chi-square score of 51.8 (see Min for details) [8]. This value is larger than 49.58788 (a 99% confidence level ($p \leq 0.01$) for 29 degrees of freedom. Since 51.8 is larger than 49.58788, the predicted scores and the actual scores are in agreement at a 99% confidence level ($p < 0.01$). These results suggest that it is possible to construct an environmental/visual quality map of Southern Michigan that is relatively reliable (**Figure 8**).



Figure 6. An image of sample number 12 of a downtown environment (cliff detritus with a visual score of 69.28333) — Copyright © 2011, Yuemin Jin, all rights reserved, used by permission.



Figure 7. An image of sample number 22 of an industrial environmental (with a visual score of 86.56068) — Copyright © 2011, Yuemin Jin, all rights reserved, used by permission.

Property	Predicted Ranking	Images from Set Number 2	Actual Score	Set 2 Ranking
Industrial	3	55	107.80	1
Downtown	8	42	89.68	2
Industrial	3	52	83.12	3
Industrial	3	51	82.92	4
Commercial	13	31	82.12	5
Downtown	8	45	81.84	6
Downtown	8	41	77.91	7
Industrial	3	54	77.12	8
Commercial	13	33	76.05	9
Downtown	8	43	75.23	10
Commercial	13	32	74.15	11
Downtown	8	44	74.04	12
Residential	23	39	73.41	13
Commercial	13	35	72.92	14
Industrial	3	53	67.91	15
Commercial	13	34	66.76	16
Farmland	18	46	66.15	17
Residential	23	36	65.50	18
Residential	23	38	62.66	19
Farmland	18	47	62.13	20
Residential	23	37	61.68	21
Residential	23	40	61.64	22
Forested	28	58	55.1	23
Forested	28	59	55.09	24
Farmland	18	49	54.74	25
Forested	28	60	54.71	26
Forested	28	56	53.83	27
Forested	28	57	53.74	28
Farmland	18	48	53.27	29
Farmland	18	50	51.94	30

Table 2. The predicted rankings of sites across Michigan and the actual scores and ranking of images on those sites.

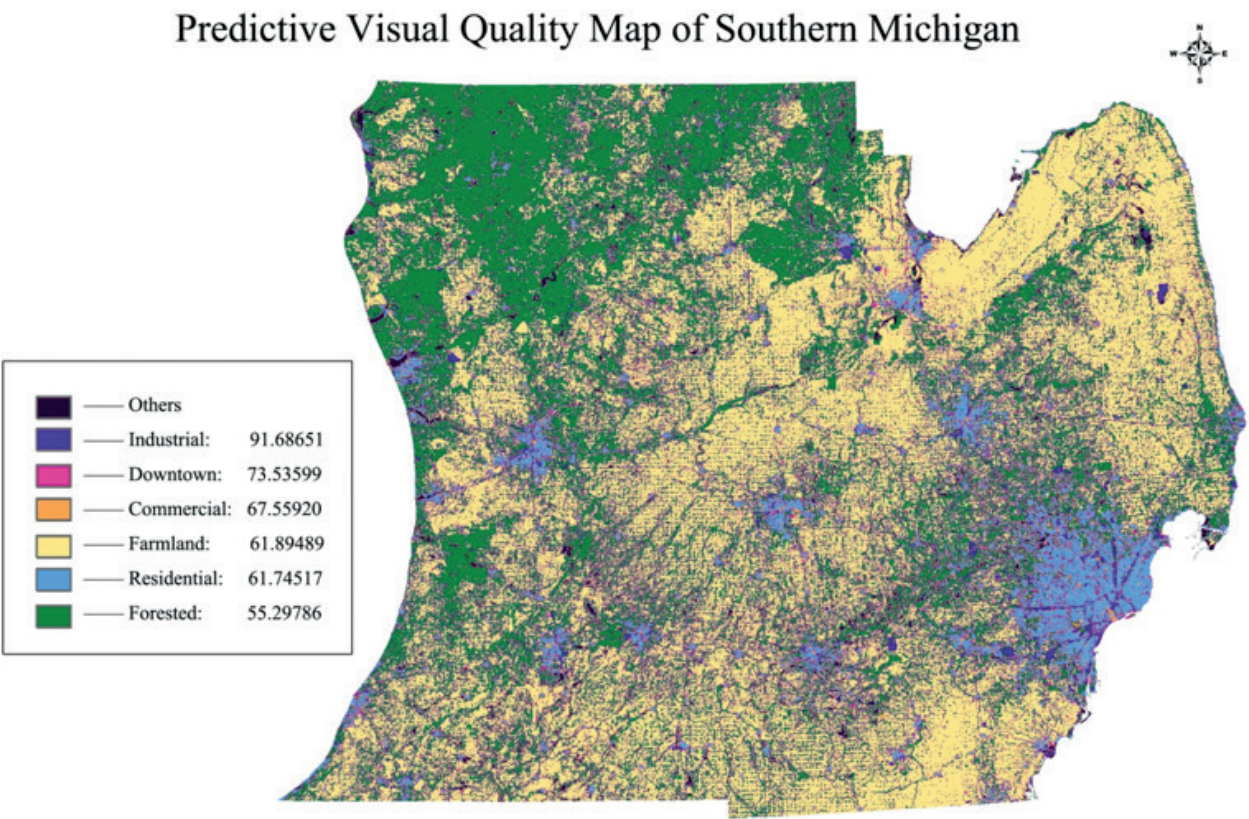


Figure 8. A map of the predicted environmental/visual quality of southern Michigan.

4. Discussion

4.1. Metropolitan Detroit environmental quality transformation

While maps as artifacts are interesting to inspect, we were interested in examining the environmental quality transformation of the environment in our study area, especially the Detroit metropolitan area. The Detroit metropolitan area is in the southeast portion of the study area (**Figure 7**). The area is comprised of numerous communities with the city of Detroit at its core. The area can be characterized as containing competing communities, distributed, and entrepreneurial. Using the middle-ages as a metaphor, the Detroit metropolitan area can be described as having a weak monarchy and ailing centralized authority (Detroit proper), with strong nobility and robust vassal states (the suburbs). Instead of one dominant business district, there are many competing commercial centers, industrial zones, and visions for urban organization [13–16]. The expansive metropolitan area is quite vibrant, enterprising, active, and engaging, at the cost of its core. While Detroit proper is suffering, the suburbs are thriving. Visitors to the Detroit metropolitan area are often surprised how normal, active, and busy the suburban communities are, because in the news, the perception is that the area is ailing. However, it is primarily the core that is failing and the rings around the core are thriving. It is in this setting that we desired to examine urban transformation.

We applied our results in this study to a 2008 land-use map of the Detroit metropolitan area, supplied by SEMCOG (Southeast Michigan Council of Governments) [17]. The result was a map of the generalized environmental/visual quality for the Detroit metropolitan region

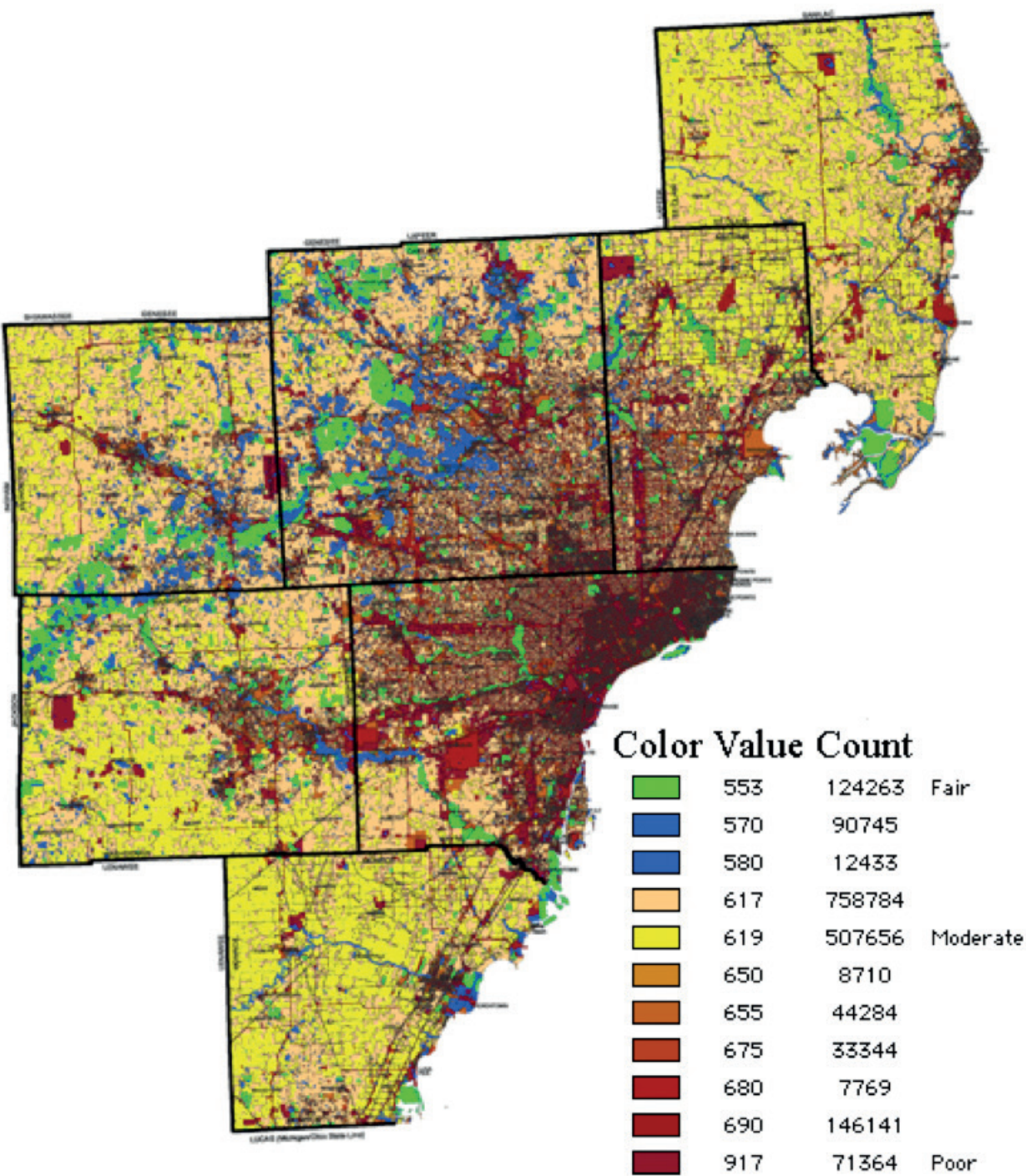


Figure 9. A map of the 2008 predicted environmental/visual quality of the seven county Detroit metropolitan area, divide each value by 10 to obtain the correct decimal reading.

(Figure 9). We then applied our results to a map from the 1800s containing pre-settlement land cover data [18]. This resulted in a map of the generalized and estimated environmental/visual quality from 200 years ago (Figure 10).

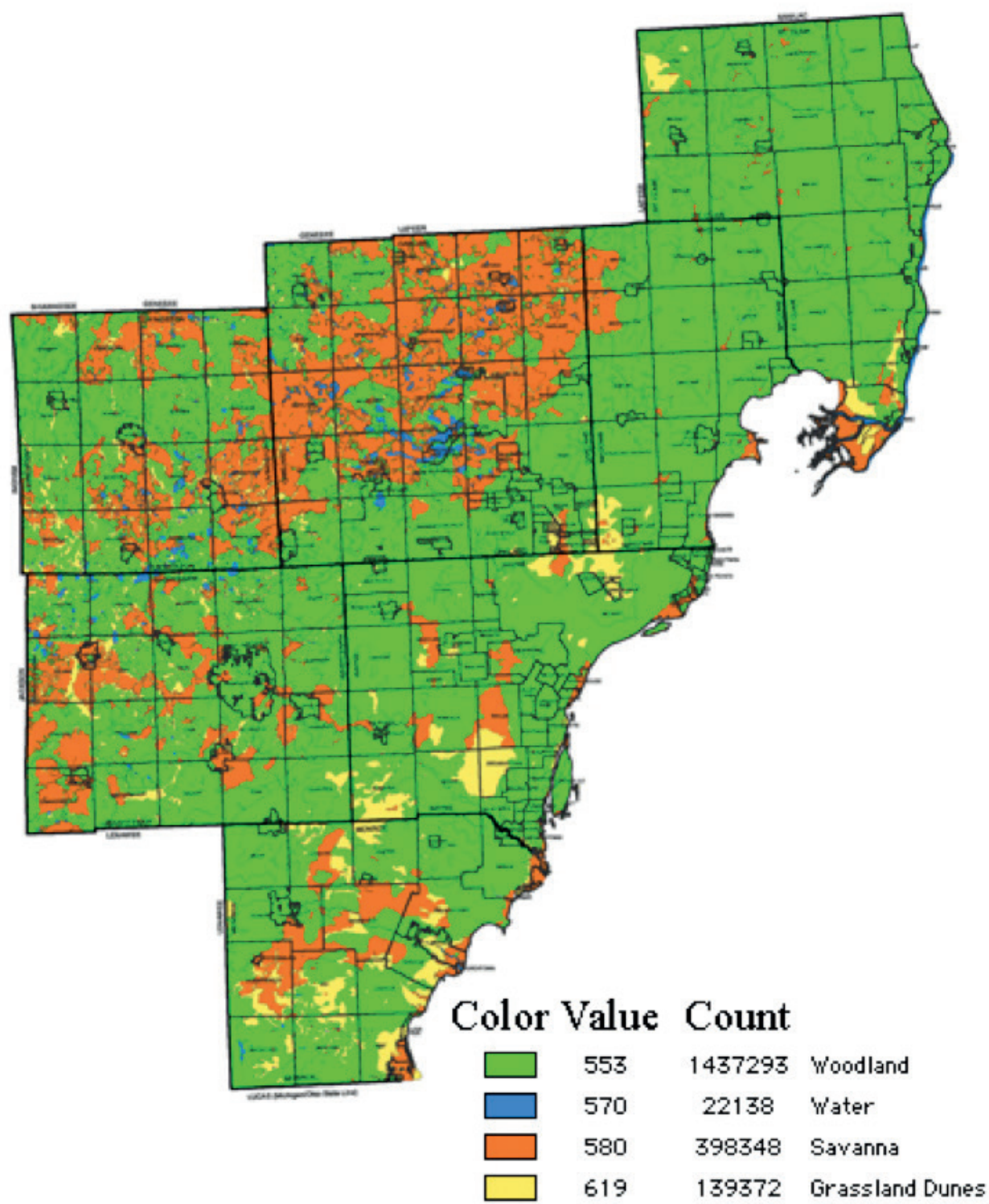


Figure 10. A map of the predicted environmental/visual quality of the seven county Detroit metropolitan area for the 1800s, divide each value by 10 to obtain the correct decimal reading.

The values (integers) in the legend for **Figures 9** and **10**, must be divided by 10 to obtain the environmental quality score (an artifact of the GIS software employed, where no floating point decimal was used). To interpret the scores, Burley notes that scores in the 30s indicate highly preferred environments. Scores in the 50s and 60s are often modestly preferred environments. Scores in the 70 are less preferred and scores near 100 are not preferred [19]. The 95% confidence interval for any scores is +5 points [20]. Thus it takes a separation of 10 points for any pairs of images to be notably different as perceived by respondents.

We subtracted the scores from **Figure 9** with the scores from **Figure 10**, producing **Figure 11**. This map (**Figure 11**) represents the expected change environmental/visual quality for the last 200 years. The light gray areas indicate the landscape where the greatest negative change occurred, meaning where the environmental/visual quality became worse. Some areas actually improved in visual quality (**Figure 12**). The improvement primarily took place on grassland and dunes that become vegetated with woody plants.

The largest transformations (as much as 30 points) came from landscapes that were forested to environments that became industrial areas, downtowns, and large multi-unit housing complexes, often comprising the cliff detritus. Most of the cliff detritus is centered around and in Detroit proper, representing an evolution of transformations as the urban area grew. Cliff detritus allows planners and designers to provide higher densities of human populations and activities. The idea is that creating density is less expensive, offering affordable solutions and preserving more countryside [21]. The problem is that cliff detritus, whether in Paris, France, San Francisco, California, or Detroit, Michigan is considered relatively marginal as a place to live when compared to the Loire River Valley, France, Marin County, California, or Charelvoux, Michigan. The environmental preference models employed in this study only reconfirm the obvious but often unstated. Packing people into less preferred cliff detritus environments may potentially be an inhuman planning and design choice.

Smaller transformations near zero or only modest changes (statistically insignificant transformations), can found in the change from woodland (55) to urban savanna (61) (note the change must be great than 10 points to be statistically notable). Much of the land transformation has been from woodland (55) to agriculture (61) to urban savanna (61). The change actually took place with the felling of trees and installation of agriculture. Transforming the agriculture to urban savanna produced predominantly no change. For us, this is an interesting observation as urban sprawl is often portrayed as an undesirable effect. Yet, urban savanna with its highly diverse and productive gardens are environmentally/visually acceptable, high in wildlife diversity, productive in biomass growth, diverse in vegetation composition, and extensive food production, meaning that the urban savanna has some positive attributes [12, 22]. The urban savanna represents a relatively new and evolving ecology, possibly being equal in value and contribution to greenways and other efforts to preserve natural areas in the urban fabric. We are not proposing the urban savanna replace greenways, rather we are suggesting that the urban savanna has been undervalued. In addition, the pre-settlement landscape of the study area did not consist of landscape with strong visually pleasing environments (scores in the 20s, 30, and 40s) such as those in the American mountain west. Therefore the measured changes from woodland to agriculture to urban savanna were not drastic.

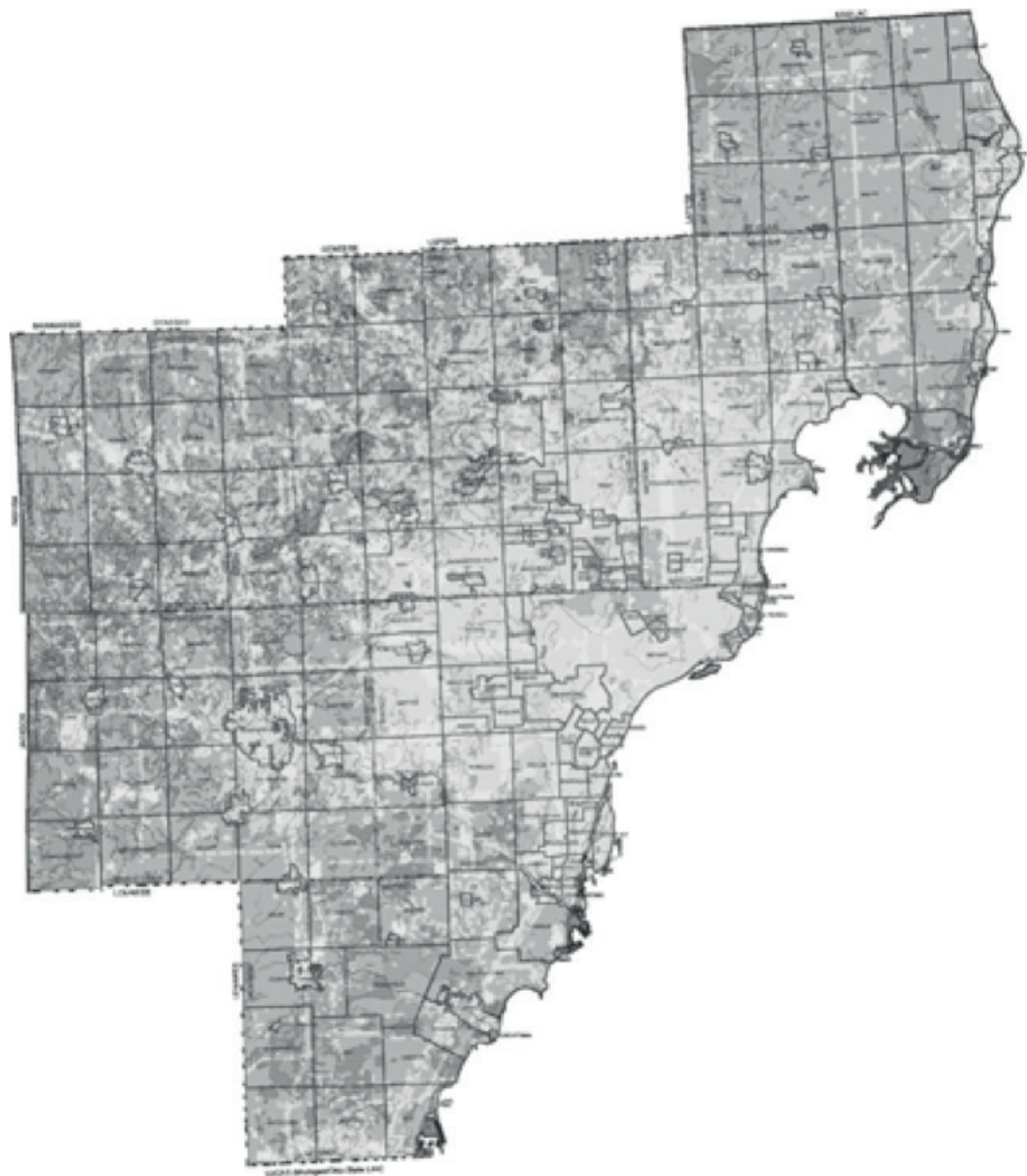


Figure 11. A map of change/transformation in environmental/visual quality over 200 years. The light gray areas indicate where the change tended towards less preferred environments. The mid-gray levels indicate no detectible change and the dark gray areas indicate a slight improvement in environmental/visual quality.

4.2. Comparison of visions

Recently planners, designers, citizens, and public employees have been embracing ideas first presented by Frank Lloyd Wright concerning the distributed and savanna-like character of

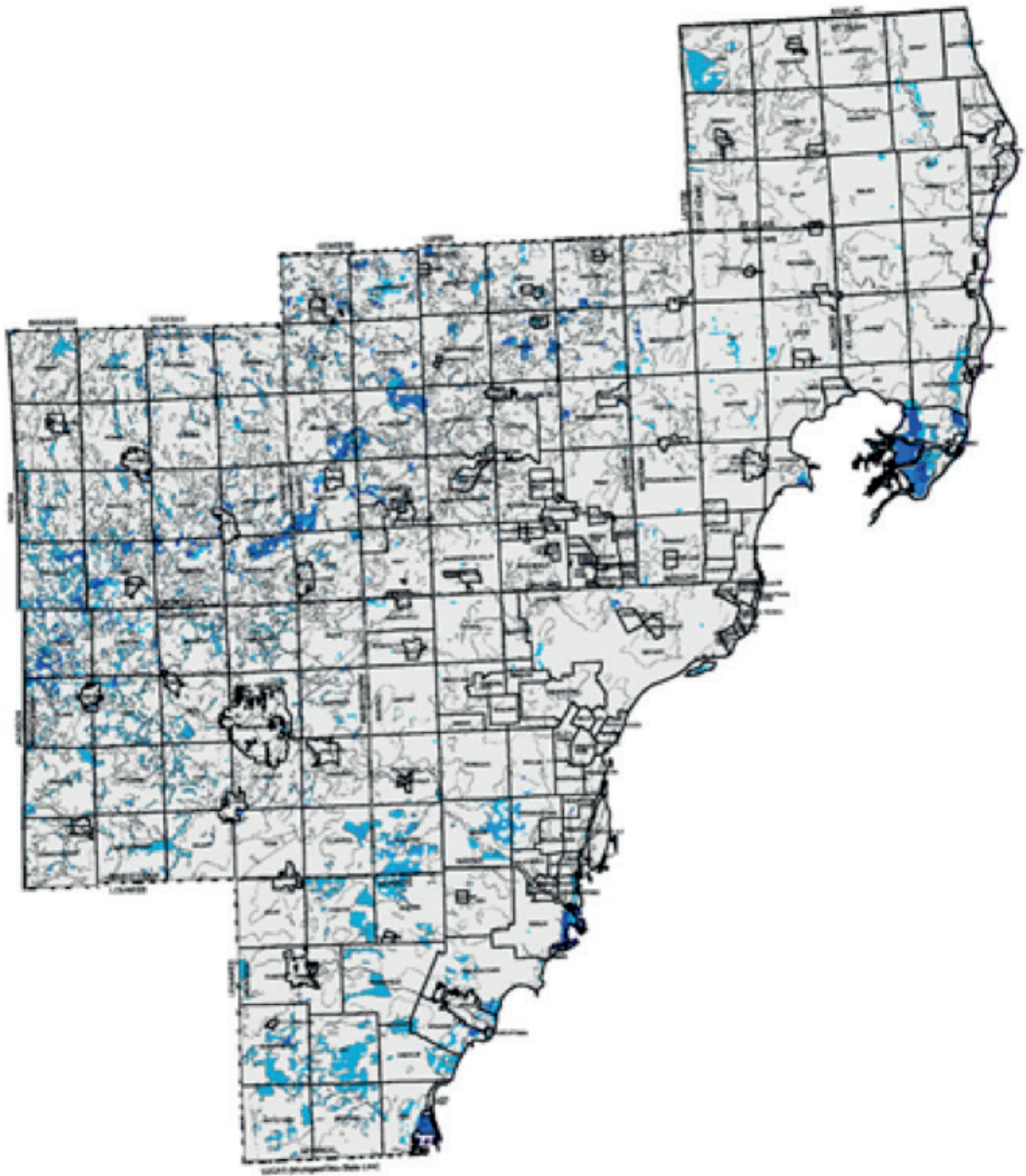


Figure 12. A map of change/transformation in environmental/visual quality over 200 years. The blue areas indicate zones with a slight improvement in environmental/visual quality.

the urban fabric [23, 24]. Long held notions about transforming landscape into extensive cliff detritus are being reconsidered. **Figures 13** and **14** are images from L Corbusier's project in Rezé-Nantes. **Figure 13** scores 73.4 and **Figure 14** scores over 110 (the upper limit for the regression line predicting environmental quality). These scores indicate the environment is much less preferred than much of the environment in Detroit. In addition, **Figures 15** and **16**



Figure 13. This is an image of the le Corbusier structure in Rezé-Nantes. This building is popular for artists and architect to live within — Copyright © 2012, Jon Bryan Burley, all rights reserved, used by permission.



Figure 14. This is an image of the ground floor area le Corbusier structure in Rezé-Nantes and illustrates the realities of urban structures — Copyright © 2012, Jon Bryan Burley, all rights reserved, used by permission.



Figure 15. A view from an urban dwelling across the shanghai towers — Copyright © 2017, Haoxuan Xu, all rights reserved, used by permission.



Figure 16. Another view of the shanghai urban landscape, even with the sea of urban trees, the image does not score well — Copyright © 2017, Haoxuan Xu, all rights reserved, used by permission.

are images from the tower urbanscape of Shanghai. **Figure 15** scores 78.41 and **Figure 16** scores 79.12, similar to a score for **Figure 13**. The expanse of towers is much less preferred than the urban savanna of metropolitan Detroit. The pastoral urban savanna is being given a renewed look. Our study provides some insight into why this fresh approach is being explored in the Detroit Metropolitan area. If these reinventions of the Detroit metropolitan area's cliff detritus are successful, we could imagine the environmental/visual quality scores of these areas to significantly improve (20 to 30 points) over the next generation. We encourage other investigators to employ this approach to study other areas of the world.

5. Conclusion

Predictive, respondent based models have been constructed to measure environmental and visual quality. This work is based upon over 50 years of research by investigators in the social, recreational, and planning and design disciplines/profession. The attributes of the landscape can be measured to form reliable maps of environmental/visual quality, providing a metric to assess landscapes, including urban landscapes. We were able to produce such a metric map for southern Michigan. Then, we applied our approach to study landscape transformation in the Detroit metropolitan area. We discovered that from the 1880s until 2008, much of the area had only modest change from woodland, to agriculture to urban savanna. Some small areas even improved. The predominant areas with degraded environments were in the large cliff detritus complex near and within Detroit. Much of this cliff detritus is being transformed again to resemble a pastoral urban savanna, similar to visions for the urban fabric as originally expressed by Frank Lloyd Wright. Numerous authorities, planners, and designers have developed visions concerning the creation of urban environments, from densely packed skyscrapers to pastoral living spaces. We believe our approach allows investigators to evaluate these visions and assess, measure, and quantify the environmental perceptions of these visions.

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