Modeling Vista and Landscape Aesthetics for Natural Resources Decision Making

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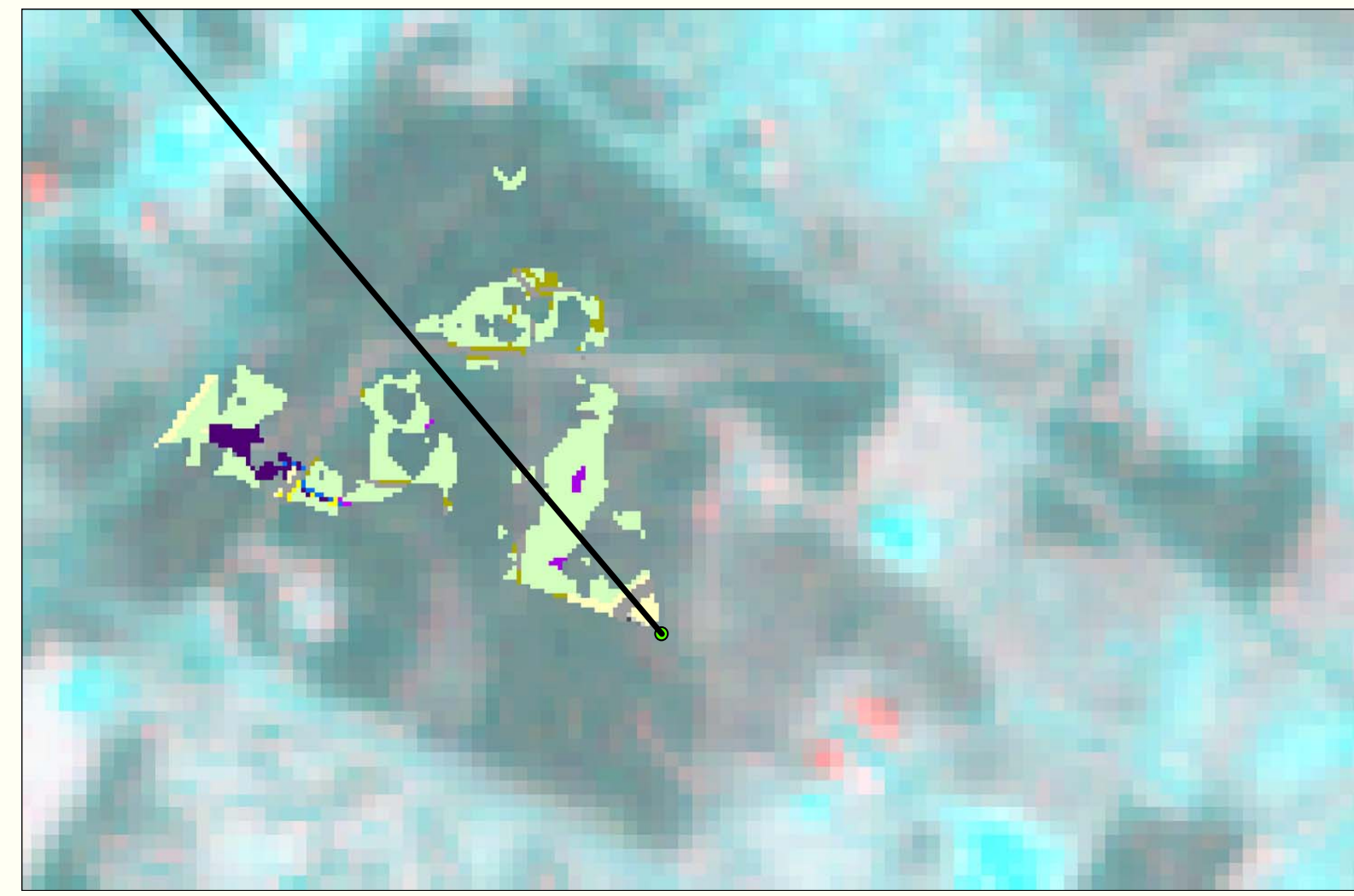[2] Exponent, Bellevue, WA, USA

Abstract

The EcoAIM™ geospatial tool was used to evaluate the aesthetic benefits of natural areas at Aberdeen Proving Ground, a military installation in Maryland. Decision makers indicated that an underlying mission for the installation was to attract and retain talented personnel by offering a world-class work environment where employees would have an aesthetically pleasing natural area for work and would have opportunities for recreational activities. In response, two models were developed to quantify geospatial variables that are important to people's perceptions of visual aesthetics. The vista aesthetics model measures the area of the viewshed, and the diversity and richness of different land-use types in fields of view greater than 100 m. The landscape aesthetics model evaluates wetland, forest, and grassland habitat patches in spaces less than 100 m from the observer, and considers nine variables that have been shown to be important determinants of landscape aesthetic quality.

A scenario was developed in which a natural area was replaced with an office complex and a new road. The vista model results show that, with all else being equal, a greater viewshed area generally produces a greater overall vista aesthetics value. In the modeled scenario, developing the natural area increased the overall landscape aesthetics score by 10%, due to increases in the patch richness and diversity scores. Further scenario building and results from the two models allow decision makers to make explicit tradeoffs among ecosystem services, and thereby support planning for natural resource management. In addition to the aesthetics models described here, EcoAIM™ was used in this demonstration project to model nutrient sequestration potential of wetlands, habitat provisioning potential for biodiversity, and recreation potential.

EcoAIM™ Is...

A DECISION SUPPORT FRAMEWORK AND GEOSPATIAL TOOL FOR MANAGING ECOLOGICAL ASSETS

- Objective is to provide trade-off analysis with scenario-building capabilities
- Several models are incorporated into the tool—habitat provisioning for biodiversity, nutrient sequestration, recreational opportunities, vista aesthetics, and landscape aesthetics

EcoAIM™ was envisioned by the authors as a tool that uses models scaled to the available data and the appropriate degree of sophistication necessary to support user needs. For this demonstration project, the following data were available and used:

- Land use/land cover
- Digital elevation model
- Site-specific field data from forest surveys and wetland delineation studies

Results of Stakeholder Engagement

The stakeholder-derived notional mission for the installation:

- Attract and retain a talented workforce
- Provide a work environment with aesthetically pleasing natural areas

Vista Aesthetics Model

The EcoAIM™ vista aesthetics model helps visualize views that are greater than 100 m from an observer. Conclusions from scientific studies indicate that people prefer views with a greater number and diversity of land-use types and are larger in size. Three variables that reflect these vista aesthetic attributes are:

- Patch richness — weighted sum of the number of different patch types
- Viewshed area — total visible surface area
- Shannon's Diversity Index — the proportion of the landscape occupied by patch type
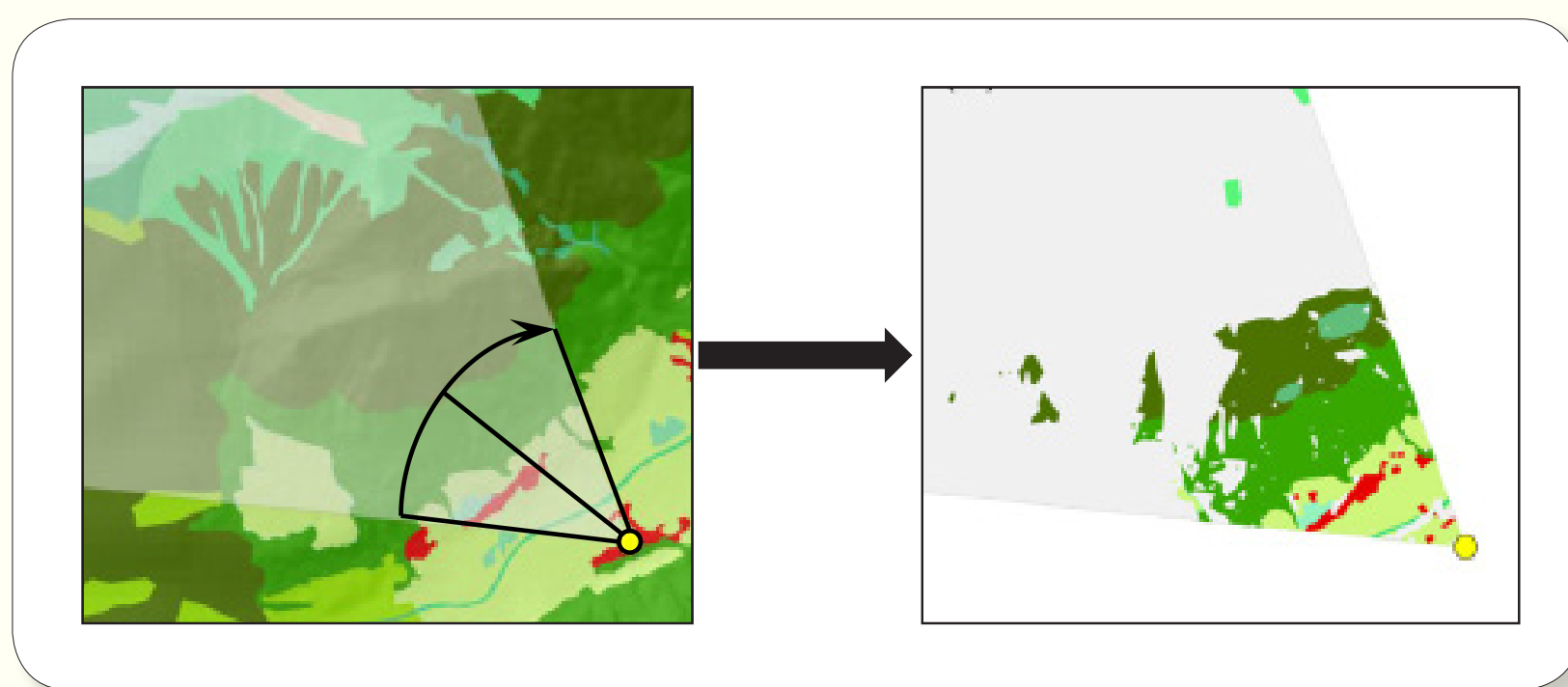
FIGURE 1a. The viewshed is the visible area that can be seen by an observer at a specific location, elevation, and direction.

Horizontal FOV: 90°
Line Azimuth: 315°
Start Angle: 270°
Swept Angle: 0°

FIGURE 1b. Vista model allows an observer to be placed anywhere on a map with parameters defining the observer's field of view. For example, changes in elevation and view angles can simulate a vista view for an observer looking out from a window of a multi-story building.
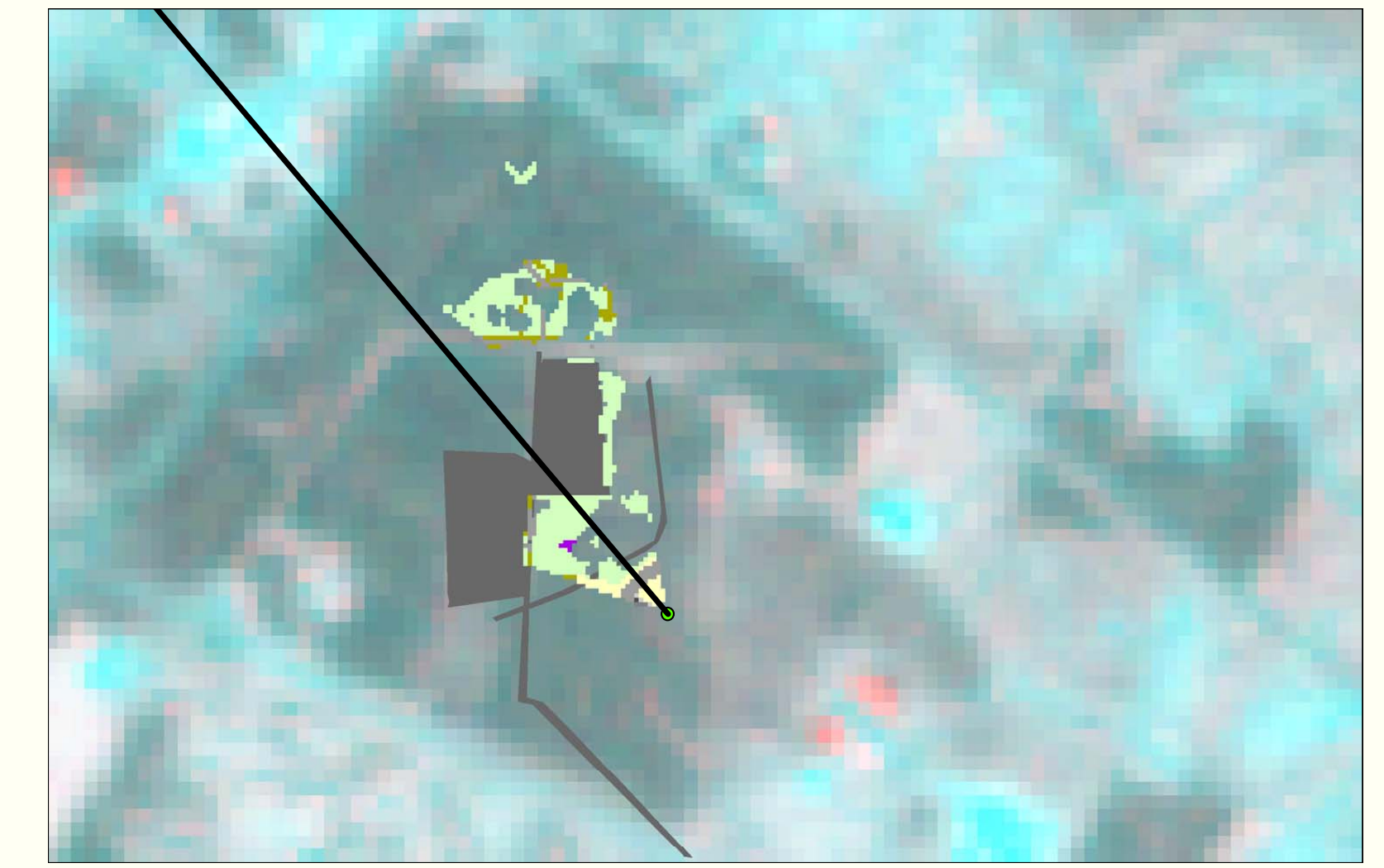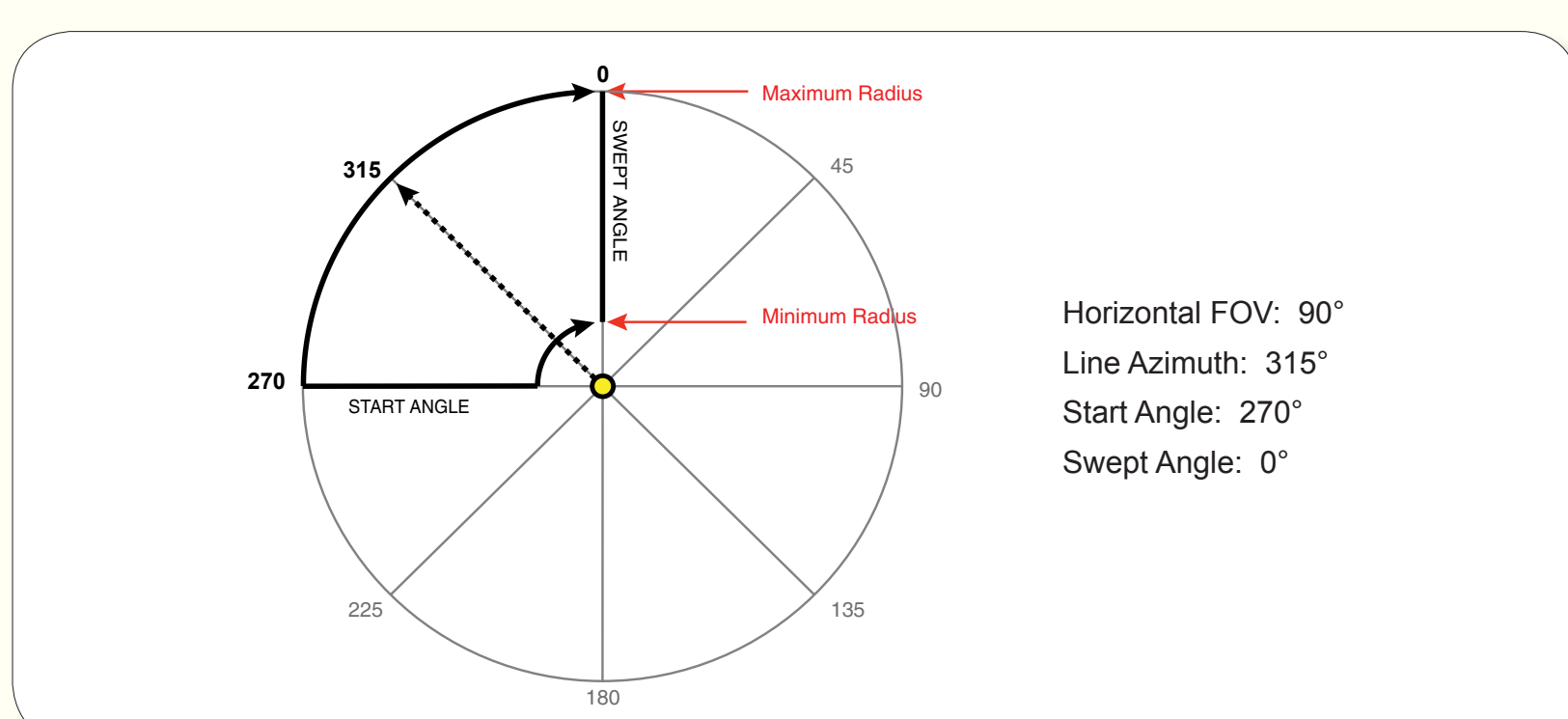
Results

The land-use change reduced the patch richness weighted sum by 11 and the viewshed area by >1 million sq ft. The diversity value did not change significantly, because the patches were reduced relatively proportionately in the hypothetical scenario compared to the baseline case.

Note that results depend on the physical point of view selected for an "observer" and the preference weighting assigned to patch types. Preference weightings are assigned by the user to accurately reflect the physiographic and social preferences in a specific project area.

Note: Map is obscured to keep confidentially.

FIGURE 2a. Screen shot of the baseline case. Preferences for landscape patches were weighted (i.e., higher weights for forests and open waters; low weights for training areas, driveways, and parking lots). Patch richness = 14; Viewshed area = 1,926,732 sq. ft; Shannon Diversity Index = 1.0.

Note: Map is obscured to keep confidentiality.

FIGURE 2b. Screen shot of the hypothetical scenario. Landscape patch preferences remained unchanged from the baseline case. The three measured vista aesthetics variables show changes due to the development. Patch richness = 3; Viewshed area = 881,560 sq. ft; Shannon Diversity Index = 0.959.

Landscape Aesthetics Model

The EcoAIM™ landscape aesthetics model simulates landscapes within 100 m of the observer. Submodels were developed for wetlands, grasslands, and forest landscapes. Conclusions from the scientific literature indicate that people prefer greater richness and diversity of patch types, higher complexity of patch edges/perimeters, greater contrast between adjacent patches, larger viewshed area, uneven dispersion of vegetation, intermediate forest density, and mature forests. A Jenk's natural breaks algorithm was used to rank each land-use patch relative to others in one of ten category values.

The weighted sum of all variables for each land-use patch was determined, and the Jenk's natural breaks algorithm was used to rank each patch relative to every other patch.
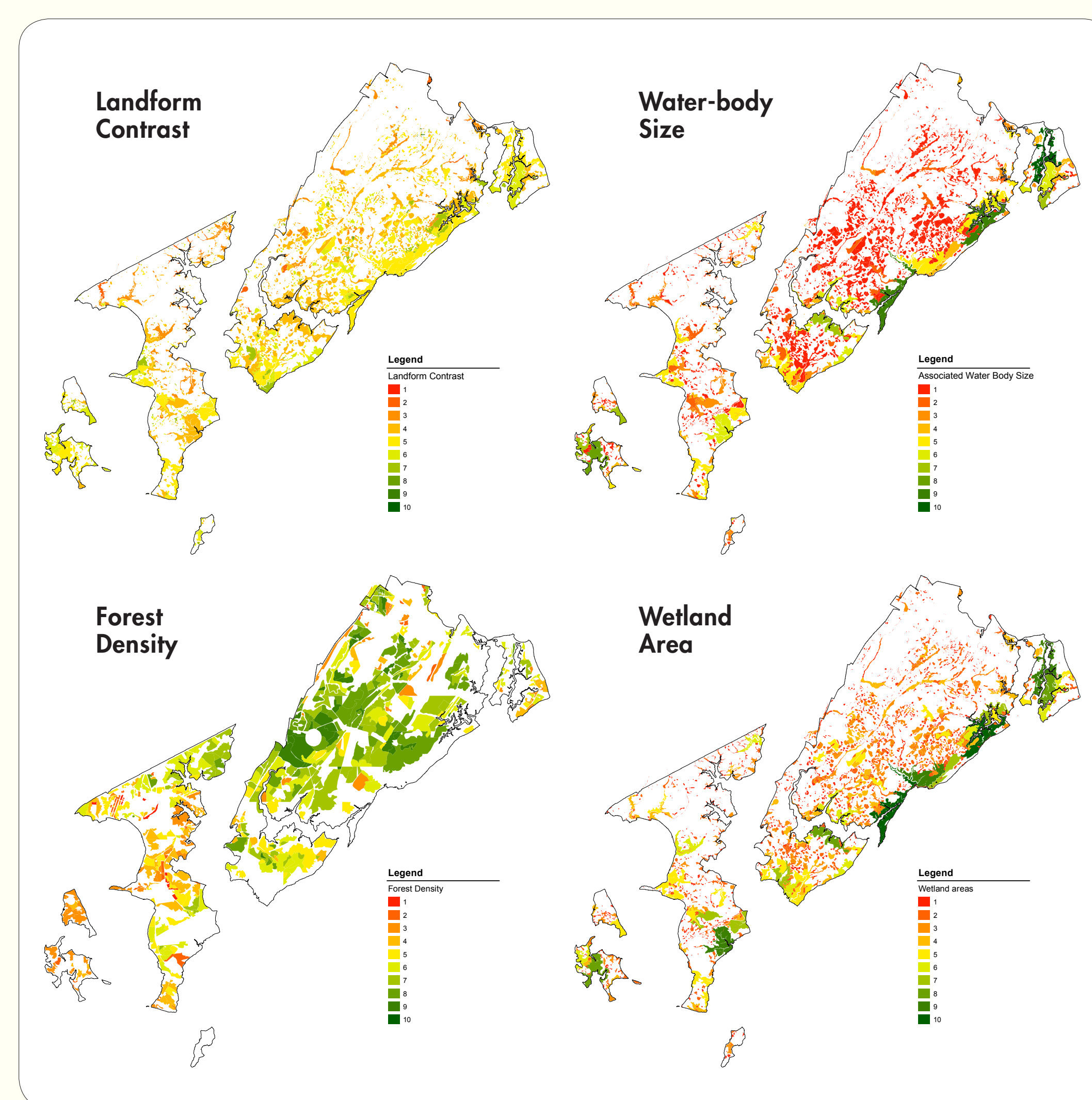

FIGURE 3. Selected example results of measured landscape variables (landform contrast; water-body size, forest density and wetland area). Land-use patches with the lowest values (1) are red, and highest values (10) are green.
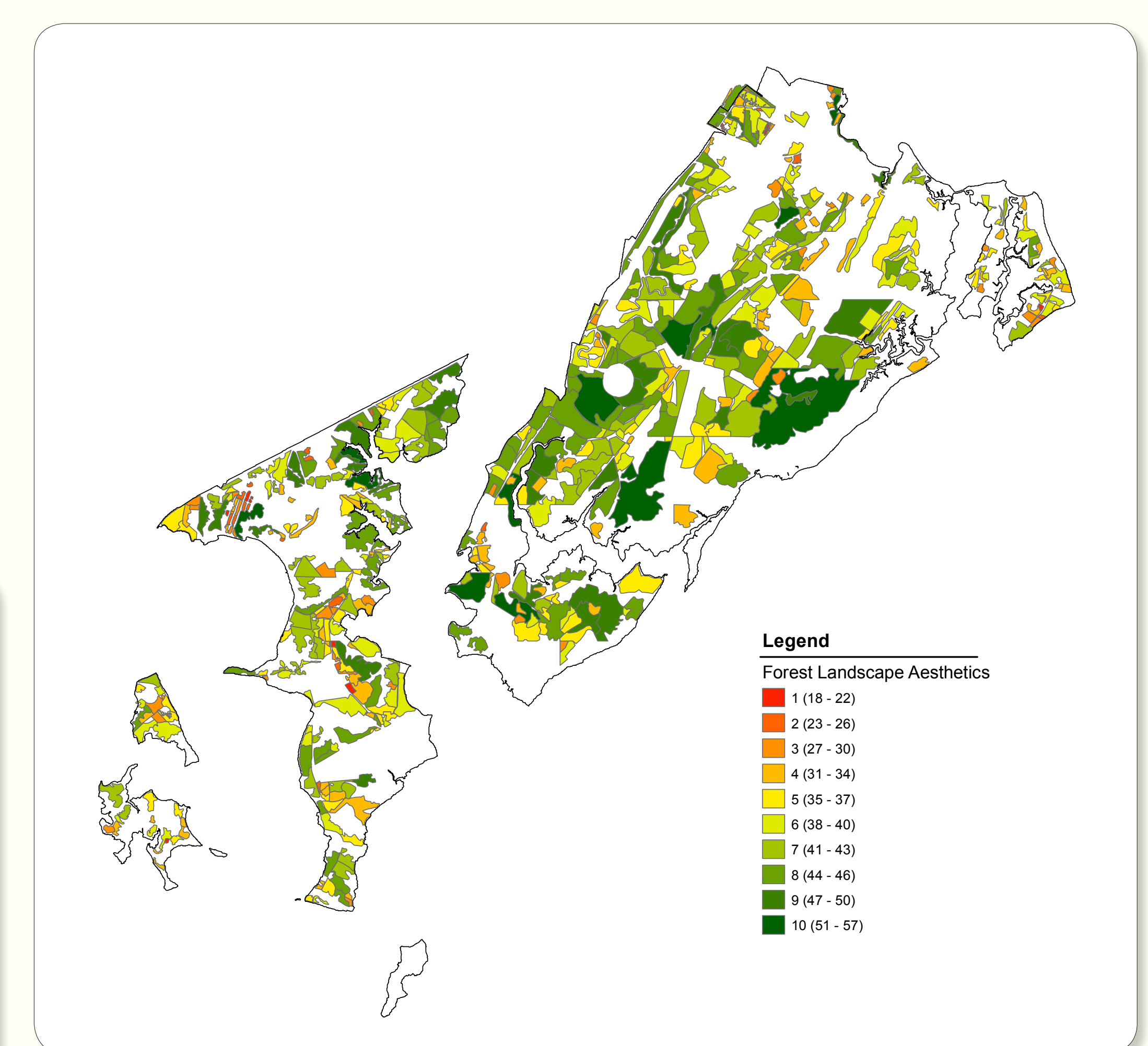

FIGURE 4. Overall results of forest landscape aethetics over the entire study site based on weighted sum of variables (landform contrast, edge complexity, surrounding land-use contrast, surrounding land-use diversity, forest size, vegetation interspersion, forest density, and forest age).
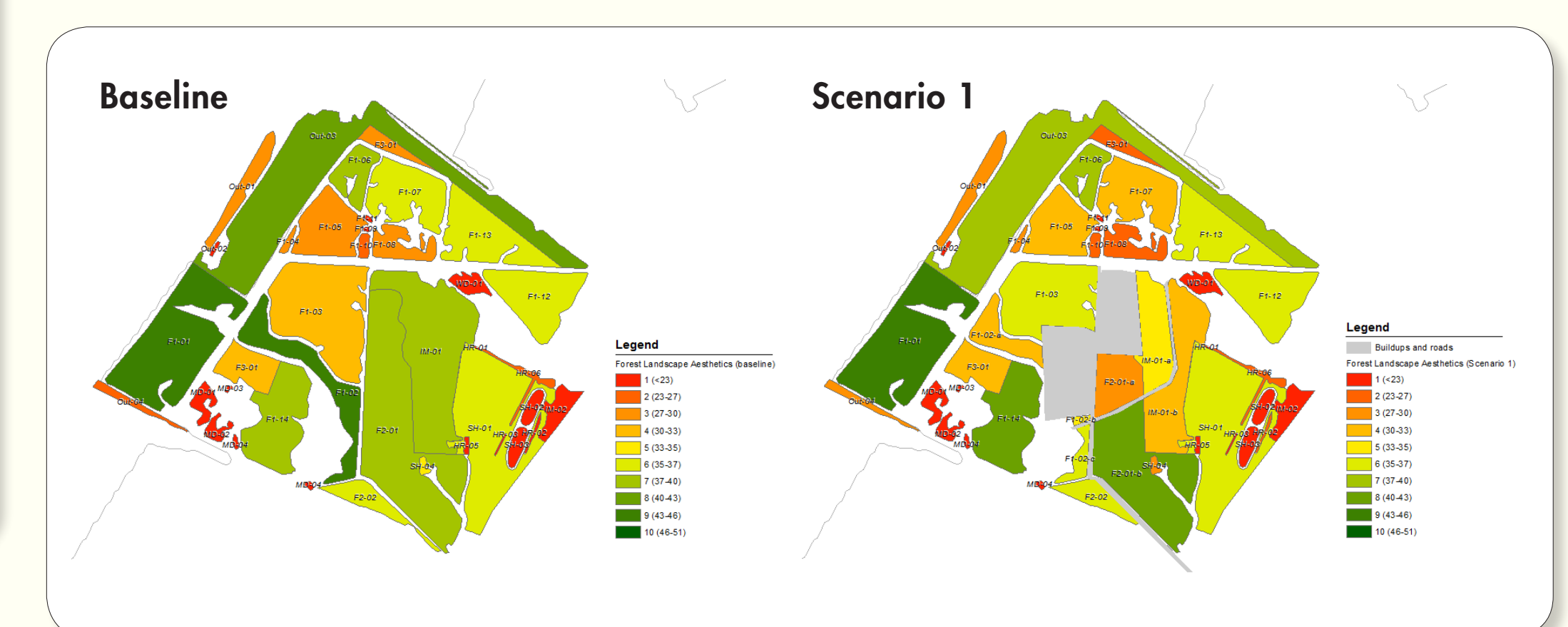

FIGURE 5. Baseline case (left) shows existing value of landscape aesthetics in forested areas. The results of the hypothetical scenario (right) indicate a 10% increase in landscape aesthetic values.

Conclusions

The EcoAIM™ vista and landscape aesthetic models allow users to quickly visualize viewshed qualities and envision alternative scenarios for siting buildings and planning for general land use. The models enable objective quantification of vista and landscape aesthetic qualities while permitting flexibility to include value judgments that reflect local physiography and social preferences. In conjunction with other EcoAIM™ ecosystem services models, users can identify otherwise unrecognized ecosystem service trade-offs. User-defined preference weightings enable sensitivity analyses to be performed and allow users to understand the underlying drivers of the aesthetics scores. Although this demonstration is based on a fairly simple hypothetical scenario, more extensive and complex situations can be modeled as a decision support tool for a wide range of resource management actions such as restoration or conservation, in addition to development.