# Analysis of Scenic Biking Route in San Francisco

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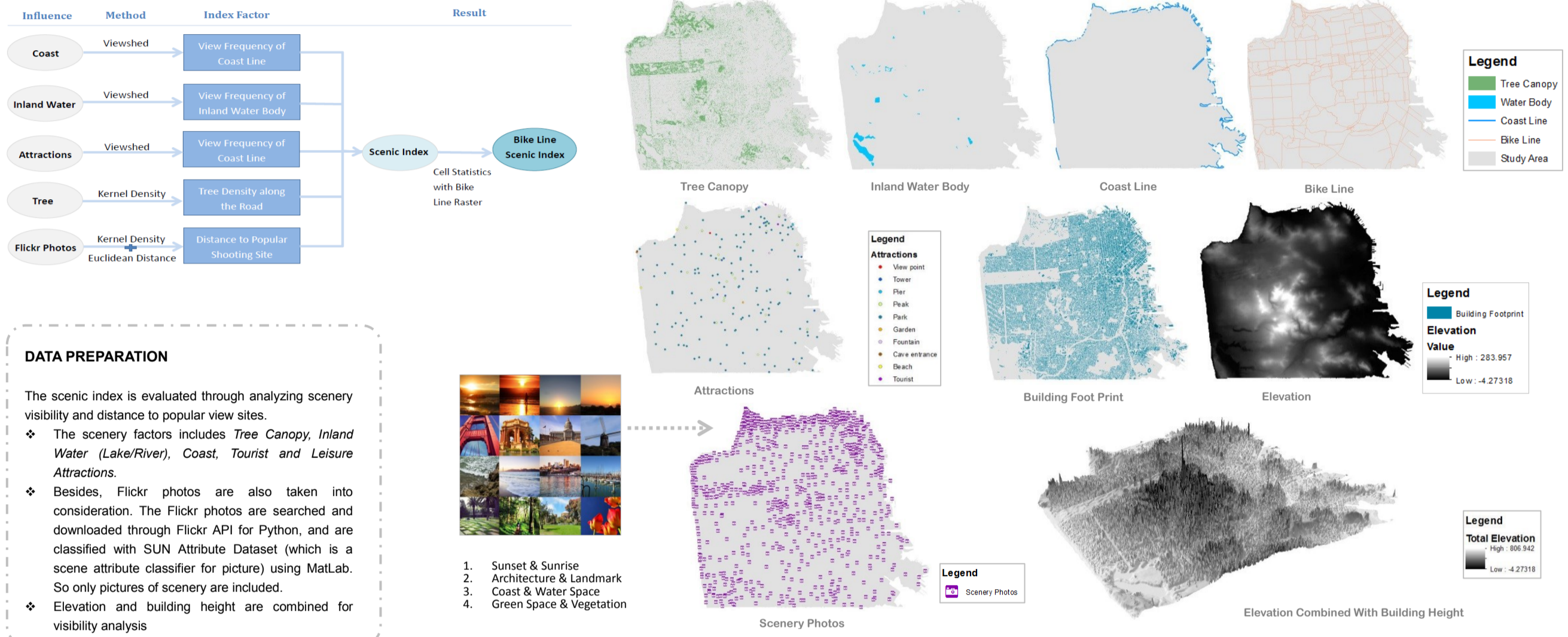WEI YING | APRIL 2015

## ABSTRACT

Nowadays, there are more and more people love traveling or just get out for leisure with bike, a healthy and environmental-friendly travel mode. And route guidance with which they can get beautiful view of nature is quite necessary. Considering these situations, this project takes San Francisco as the study area, and explores ways of assessing road segment scenic degree. The bike line scenic index is analyzed based on raster aspect, taking into considerations of scenery visibility, wood density and also distance to hot scenery shooting site. Finally, a Web Mapping Application is built, where users can calculate scenic index according to their own interest, and generate biking route which is the most scenic.
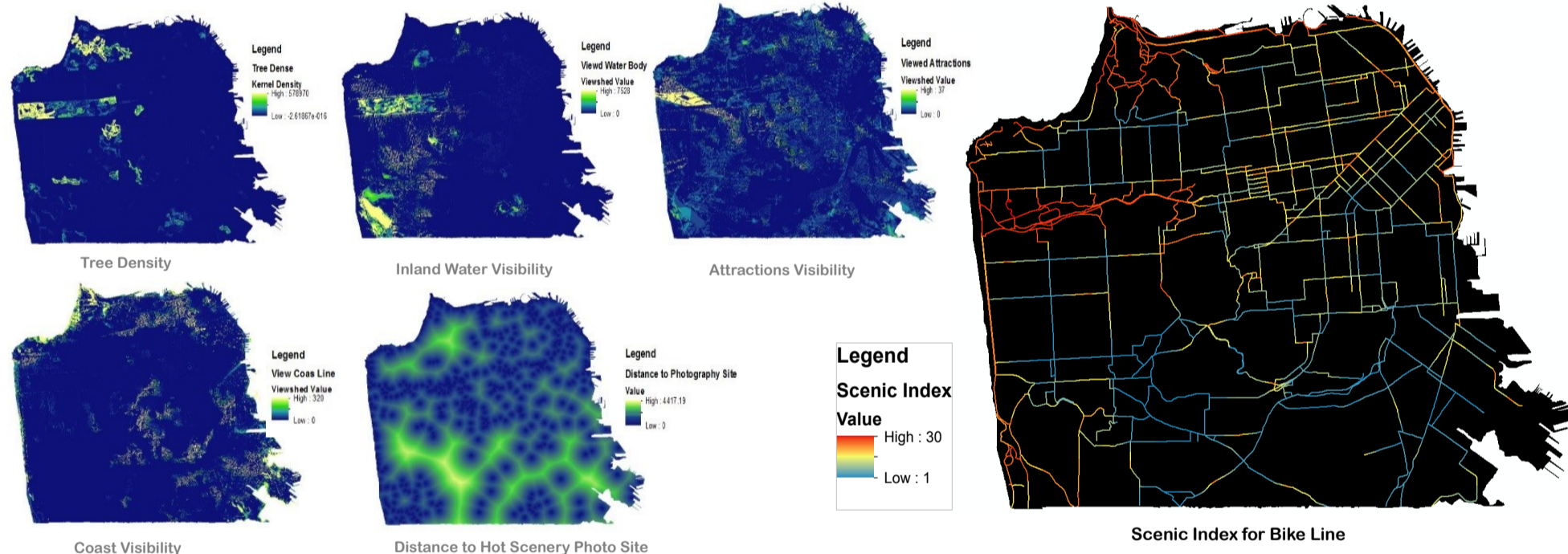
## 1. ① Bike Line Scenic Index Calculation



| Influence | Method | Index Factor | Result |
|---|---|---|---|
| Coast | Viewshed | View Frequency of Coast Line | |
| Inland Water | Viewshed | View Frequency of Inland Water Body | Scenic Index → Bike Line Scenic Index |
| Attractions | Viewshed | View Frequency of Coast Line | Cell Statistics with Bike Line Raster |
| Tree | Kernel Density | Tree Density along the Road | |
| Flickr Photos | Kernel Density + Euclidean Distance | Distance to Popular Shooting Site | |

**Legend**
- Tree Canopy
- Water Body
- Coast Line
- Bike Line
- Study Area

Tree Canopy   Inland Water Body   Coast Line   Bike Line

### DATA PREPARATION

The scenic index is evaluated through analyzing scenery visibility and distance to popular view sites.

- The scenery factors includes *Tree Canopy, Inland Water (Lake/River), Coast, Tourist and Leisure Attractions*.
- Besides, Flickr photos are also taken into consideration. The Flickr photos are searched and downloaded through Flickr API for Python, and are classified with SUN Attribute Dataset (which is a scene attribute classifier for picture) using MatLab. So only pictures of scenery are included.
- Elevation and building height are combined for visibility analysis

**Legend Attractions**
- View point
- Tower
- Pier
- Peak
- Park
- Garden
- Fountain
- Cave entrance
- Beach
- Tourist

Attractions

**Legend**
- Building Footprint
- Elevation Value — High : 283.957 / Low : -4.27318

Building Foot Print   Elevation

1. Sunset & Sunrise
2. Architecture & Landmark
3. Coast & Water Space
4. Green Space & Vegetation

**Legend**
- Scenery Photos

Scenery Photos

**Legend**
- Total Elevation — High : 806.942 / Low : -4.27318

Elevation Combined With Building Height

### SCENIC INDEX

- Viewshed are applied to the scenery factors including coastline, inland water and attraction sites. The viewshed result indicates how many times of the scenery features can be viewed from each cell.
- To evaluate tree density along the roads, Kernel Density is applied to tree canopy.
- For scenery photos Euclidean Distance is applied to the photo locations to indicate how far it is to the photo sites. Besides, kernel density is also created with photo points, to help indicate which sites are more popular.
- The factor results are reclassified with grade from 1-10, and through Cell Statistics the factors grades are combined equally as default Scenic Index and it is assigned to bike line cells. The bike line then can show that where people can see pretty scenery.
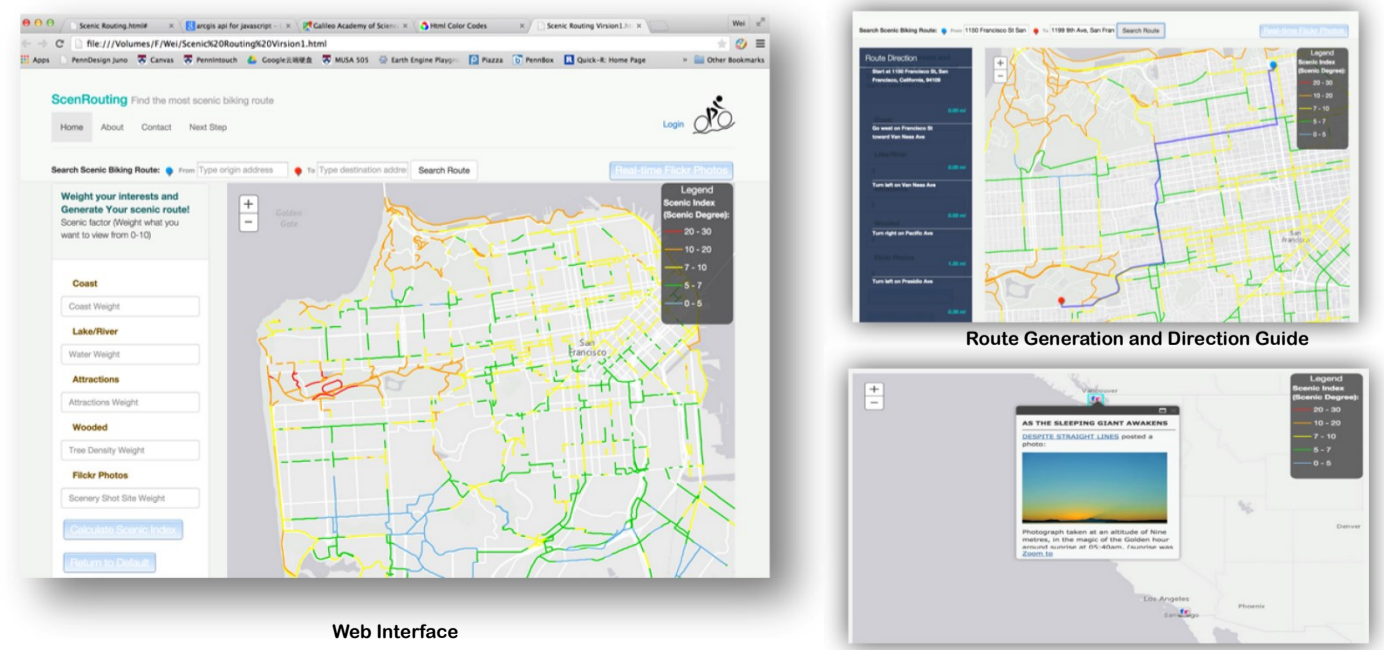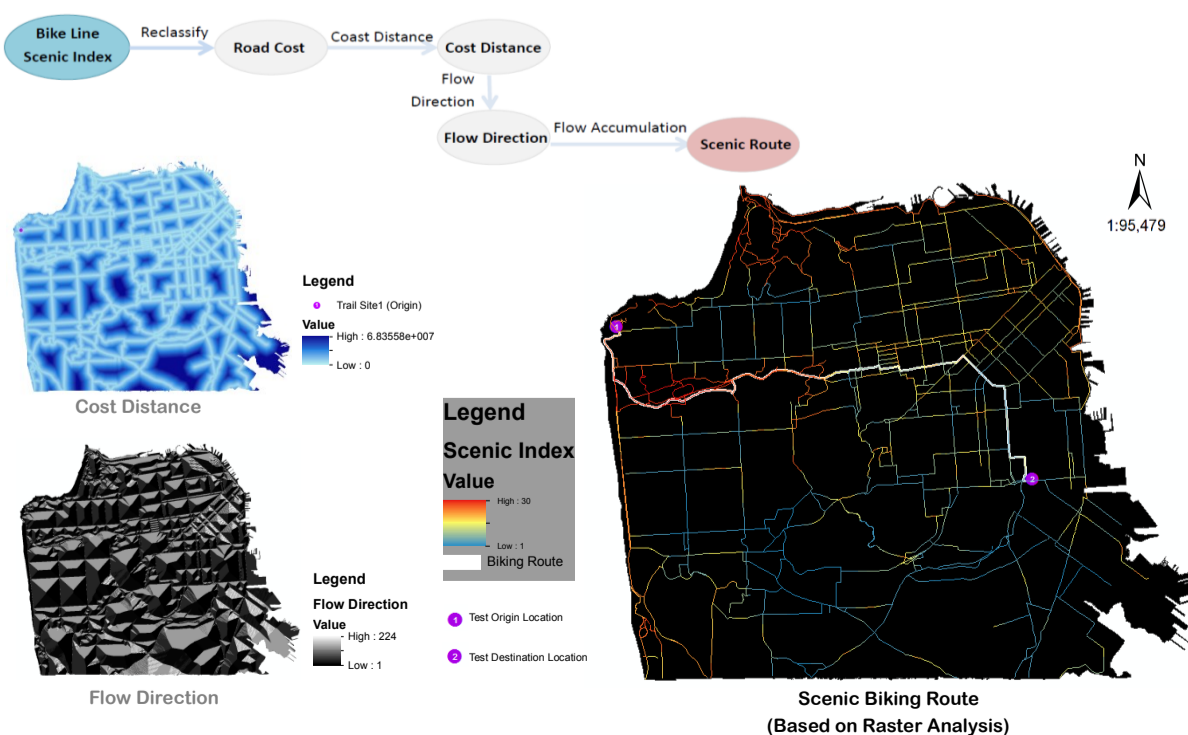
**Legend** Tree Dense Kernel Density High : 578970 / Low : -2.61667e-015

Tree Density

**Legend** Viewed Water Body Viewshed Value High : 7328 / Low : 0

Inland Water Visibility

**Legend** Viewed Attractions Viewshed Value High : 37 / Low : 0

Attractions Visibility

**Legend** View Coas Line Viewshed Value High : 320 / Low : 0

Coast Visibility

**Legend** Distance to Photography Site Value High : 4417.13 / Low : 0

Distance to Hot Scenery Photo Site

**Legend Scenic Index Value** High : 30 / Low : 1

Scenic Index for Bike Line

## ② Scenic Route Analysis

### Route Analysis with Spatial Analyst tool

To analyze route from raster perspective, Flow Direction tool or Cost Path tool can be helpful. Here Flow Direction is used. Bike line Scenic Index layer is first reclassified, where the higher the index the lower cost, and non-bike-line cells are assigned very high cost in order to keep route on the normal line. Then based on the bike-line index cost and trail origin point, Cost Distance and Flow Direction are created. For route generation, Flow Accumulation is applied based on Flow Direction result and trail destination location. The example is given below.

### Route Analysis with Web APP

The route analysis using Spatial Analyst tool in ArcGIS can offer the result precisely, but cannot offer direction guide like Network Analyst. Also different users focus on different scenery factors, So a Web APP where users can check the scenic index based on their own interest, and search route, as well as view scenery photos in the area they want to explore, is very useful. The bike line layer summarized the cells' scenic index as mean value to each segment using Zonal Statistics tool. And the layer is published to the ArcGIS Map Server. Using HTML, CSS, JavaScript, ArcGIS API for JavaScript and Flickr API, the web app demo is built show as the screenshots below.

Bike Line Scenic Index → Reclassify → Road Cost → Coast Distance → Cost Distance → Flow Direction → Flow Direction → Flow Accumulation → Scenic Route

**Legend** Trail Site1 (Origin) Value High : 6.83556e+007 / Low : 0

Cost Distance

**Legend** Flow Direction Value High : 224 / Low : 1

Flow Direction

**Legend Scenic Index Value** High : 30 / Low : 1 — Biking Route

**Legend** Test Origin Location / Test Destination Location

N  1:95,479

Scenic Biking Route (Based on Raster Analysis)

Web Interface

Route Generation and Direction Guide

View Flickr Photos

Three parts:
- Scenic Index Calculation based on users interest (the default is with all factors equally weighted)
- Route analysis by typing in origin, and destination location
- Show real-time Flickr photos that are related to scenery