Lesson 8: Urban Applications of Raster-based GIS Analysis

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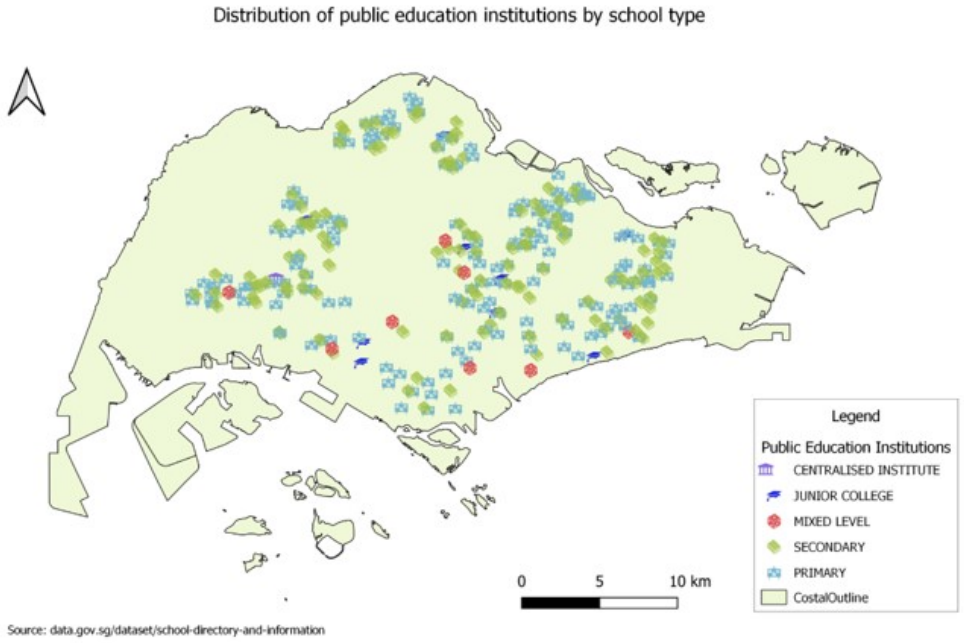
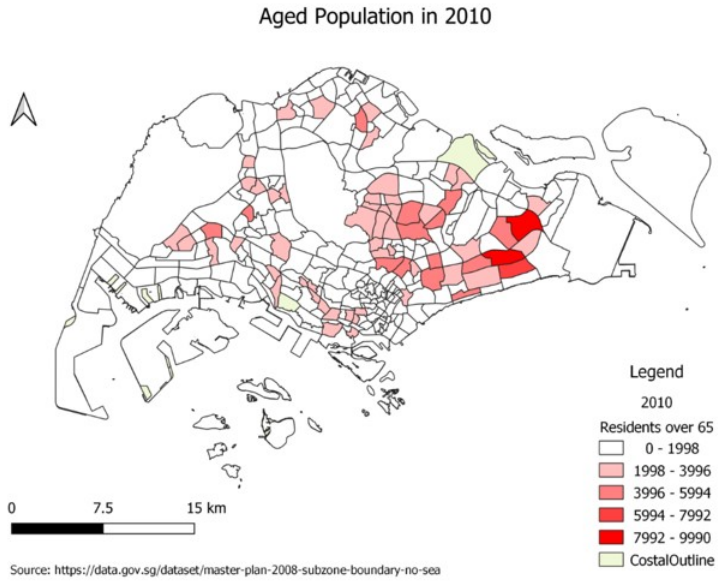
- Descriptive model
- Prescriptive models
  - Binary method
  - Ranking method
  - Rating method
- GIS-Based Multiple-Criteria Decision Analysis
- Analytical Hierarchical Process (AHP)
- Predictive model

GIS-based Descriptive Model

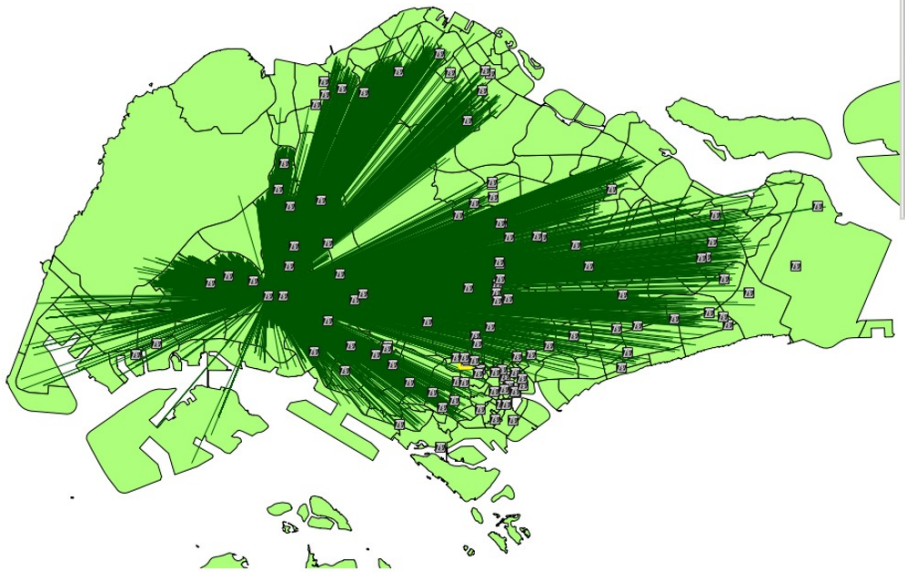
- Using GIS maps to describe the spatial distribution of real world phenomena.

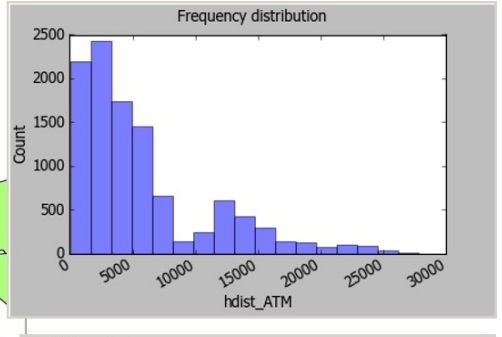




GIS-based Descriptive Model

- Using GIS map, statistical graphic and table to describe footprint of a business.



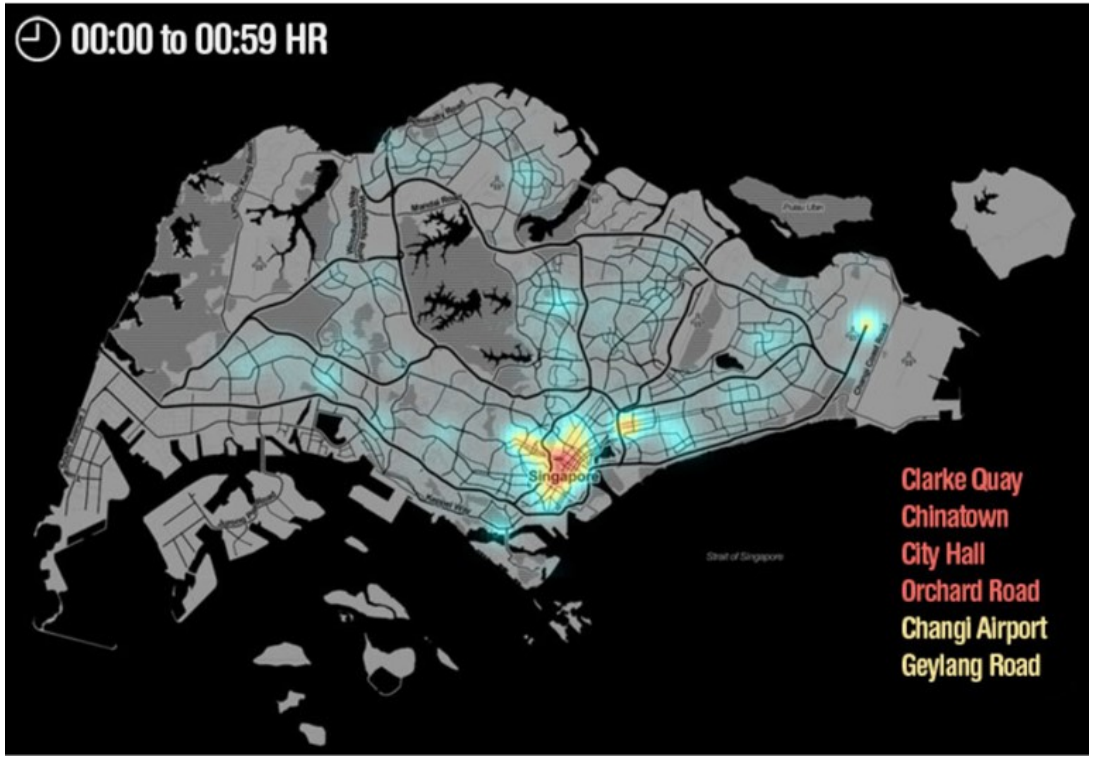


Statistics output:

Parameter	Value
Count	10798
Unique values	4364
Minimum value	43.4
Maximum value	29450.4
Range	29407
Sum	6.26074e+07
Mean value	5798.05
Median value	4052.43
Standard deviation	5377.04
Coefficient of Var...	0.927387

GIS-based Descriptive Model

- Using GIS to analyse and to describe taxi hotspots.



Source: Click on the wiki link.

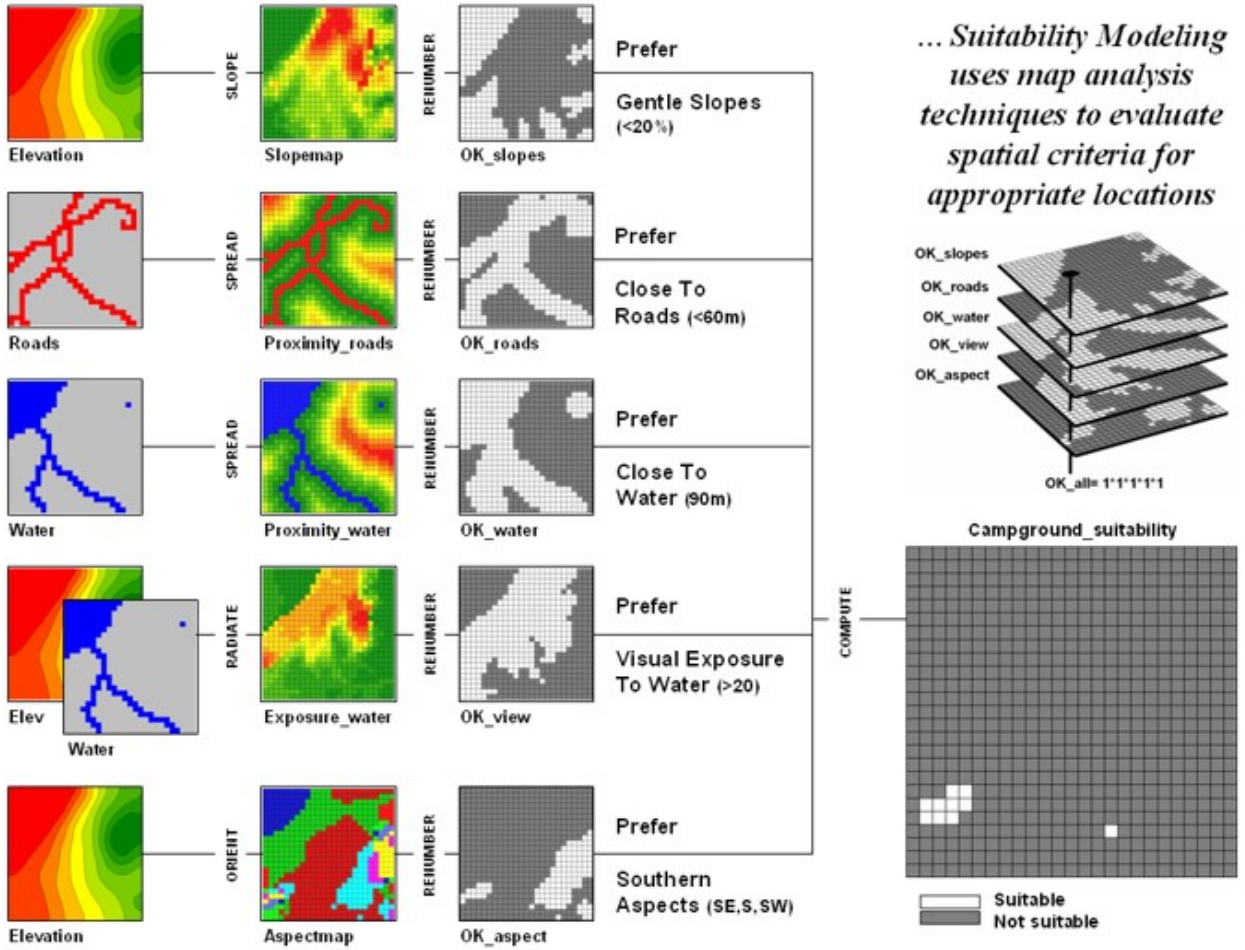
GIS-based Prescriptive Model

- Suitability analysis in a GIS context is a geographic, or GIS-based process used to determine the appropriateness of a given area for a particular use.

- The basic premise of GIS suitability analysis is that each aspect of the landscape has intrinsic characteristics that are to some degree either suitable or unsuitable for the activities being planned.

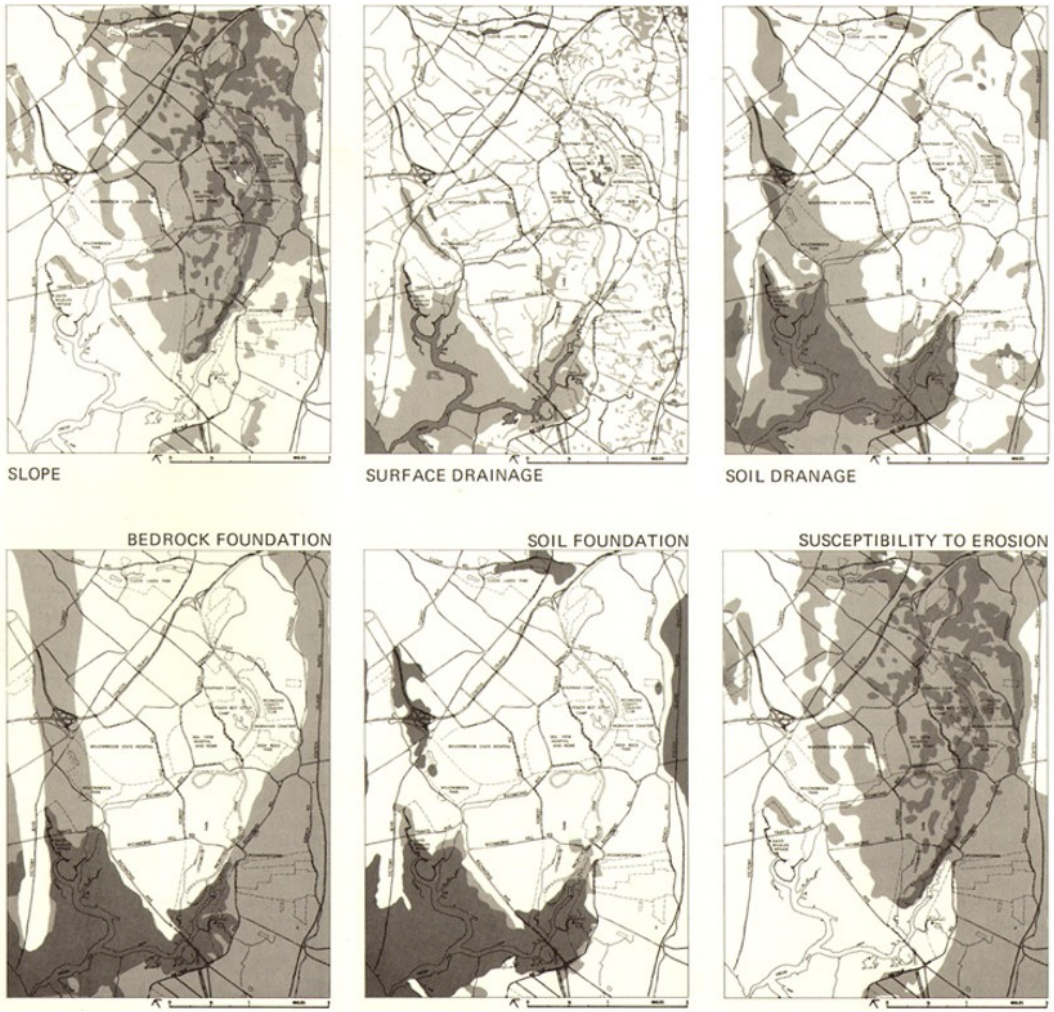
- The results are often displayed on a map that is used to highlight areas from high to low suitability.

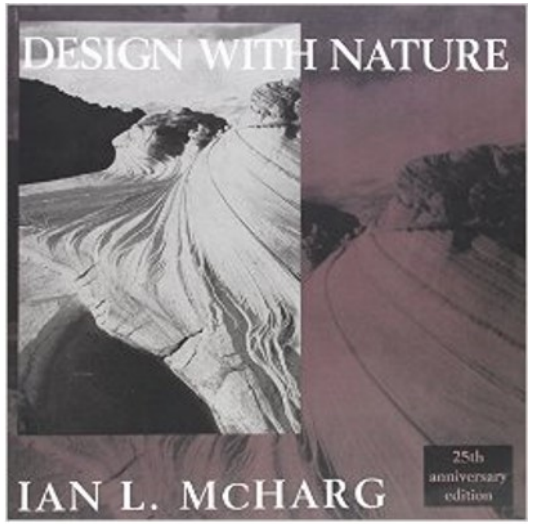
GIS-based Prescriptive Model: Suitability Analysis

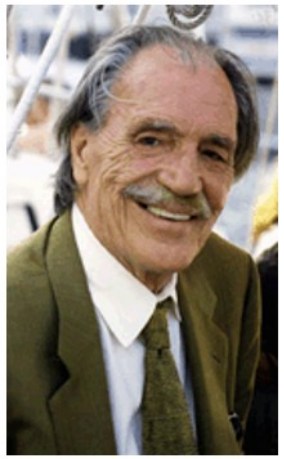


Source: Click on the wiki link.

GIS-based Prescriptive Model: Land Suitability Analysis in History







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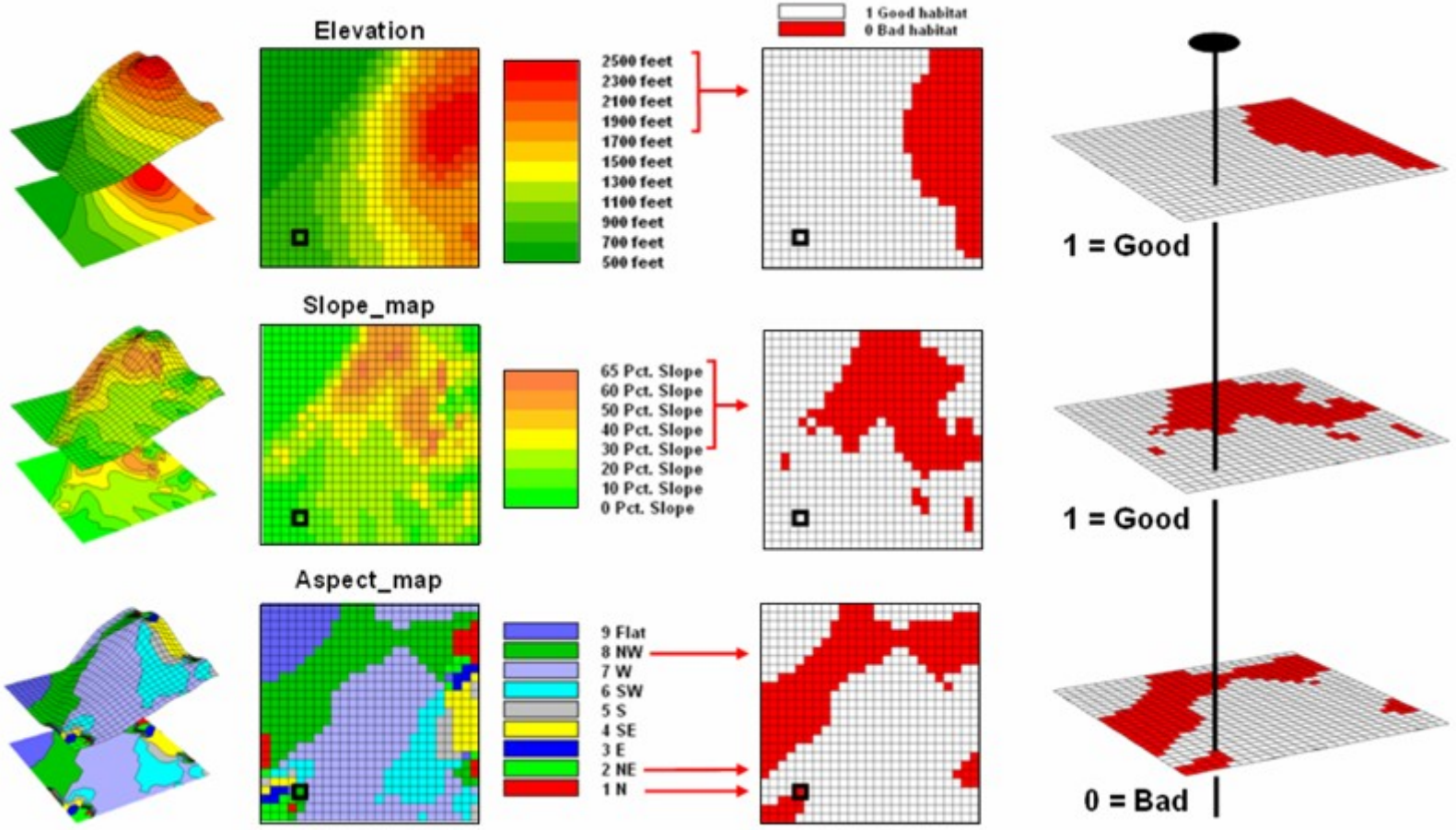
GIS-based Prescriptive Model: Binary Model



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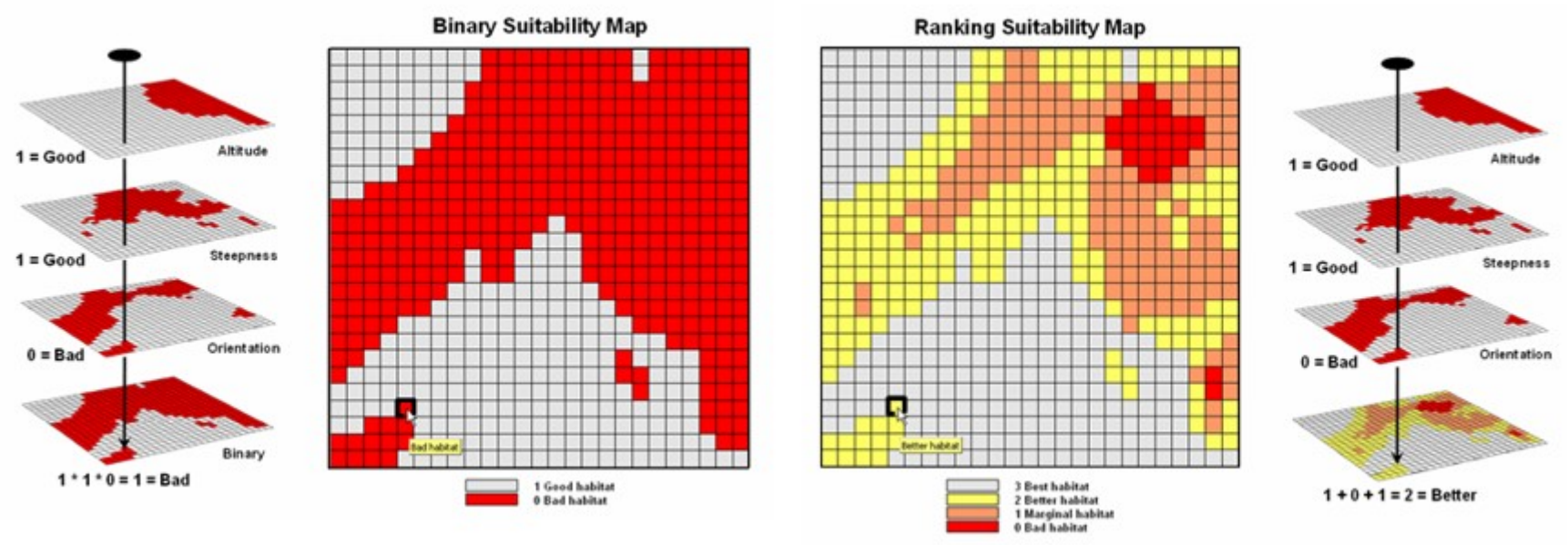
GIS-based Prescriptive Model: Rank model



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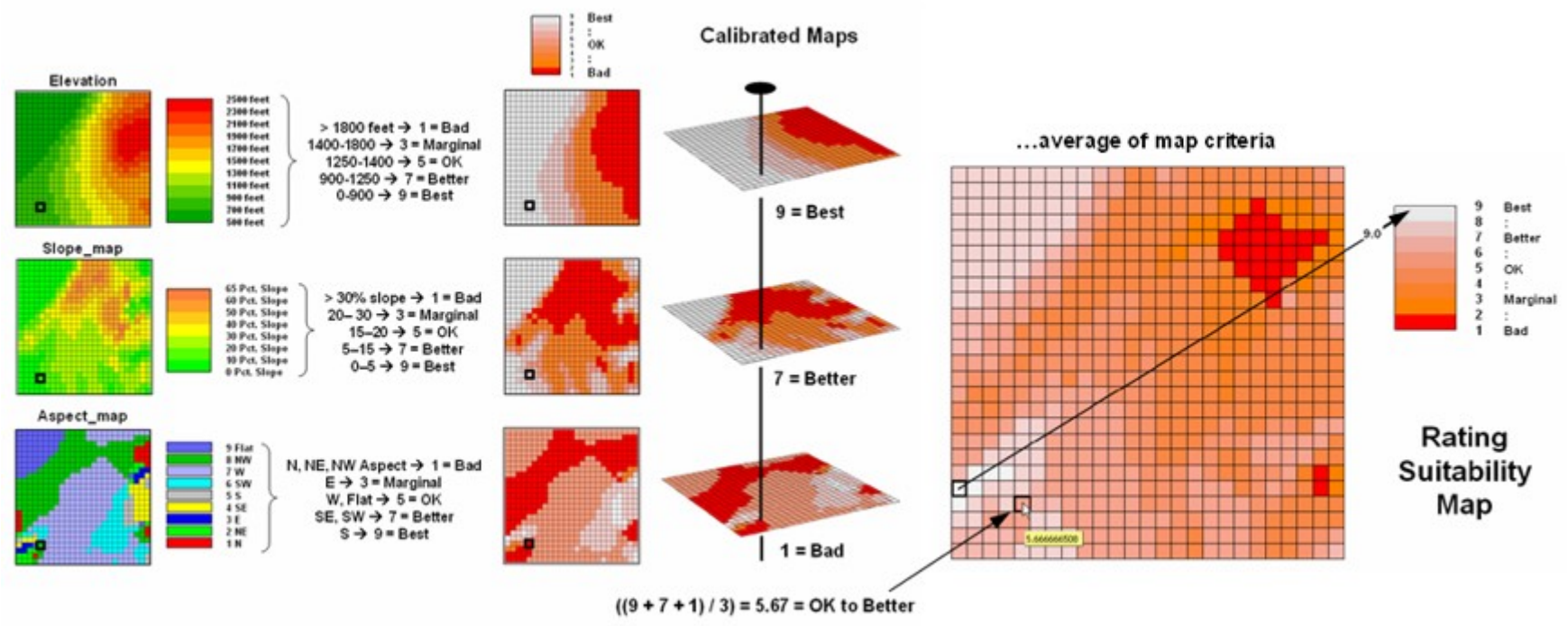
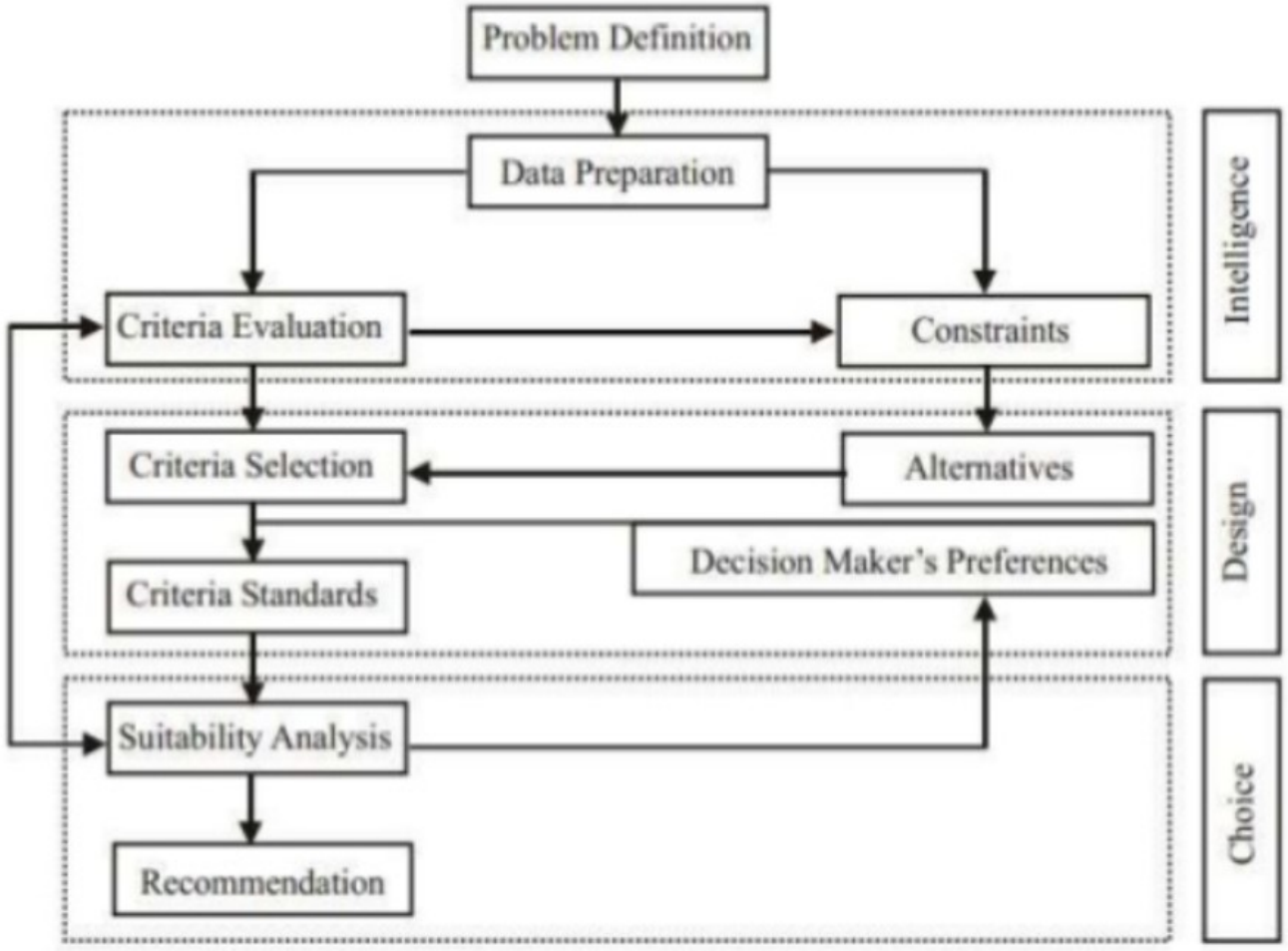
GIS-based Prescriptive Model: Rating model



Source: Click on the wiki link.

Multiple-Criteria Decision Analysis Process



GIS-Based Multiple-Criteria Decision Analysis

Analytical Hierarchical Process (AHP)

- A method for decision making in situations where multiple objectives are present.
- It uses a pair-wise comparison matrix to calculate the relative value and costs of security requirements.
- By using AHP, the requirements engineer can also confirm the consistency of the result.
- AHP can prevent subjective judgment errors and increase the likelihood that the results are reliable.
- To learn more, click on this link.

Thomas L. Saaty

AHP Steps

- Review candidate requirements for completeness.
- Apply the pair-wise comparison method to assess the relative value of the candidate requirements.
- Apply the pair-wise comparison method to assess the relative cost of implementing each candidate requirement.
- Calculate each candidate requirement's relative value and implementation cost, and plot each on a cost-value diagram.
- Use the cost-value diagram as a map for analyzing the candidate requirements.

AHP Pair-Wise Comparison Method

	A	B	C	D	E	F	G	H	I	J
1		SR-1	SR-2	SR-3	SR-4	SR-5	SR-6	SR-7	SR-8	SR-9
2	SR-1	1	8	1/5	3	1	2	2	3	1
3	SR-2	1/8	1	1/5	1/7	1/7	1/7	1/7	1/9	1/9
4	SR-3	5	5	1	1	2	1	3	1	1
5	SR-4	1/3	7	1	1	1/2	1/2	3	1/2	1
6	SR-5	1	7	1/2	2	1	3	3	1	1/3
7	SR-6	1/2	7	1	2	1/3	1	1/3	1	1
8	SR-7	1/2	7	1/3	1/3	1/3	3	1	3	2
9	SR-8	1/3	9	1	2	1	1	1/3	1	1/6
10	SR-9	1	9	1	1	3	1	1/2	6	1

Reference: Click on this link

AHP Scoring

Intensity of Value	Interpretation
1	Requirements i and j are of equal value.
3	Requirement i has a slightly higher value than j.
5	Requirement i has a strongly higher value than j.
7	Requirement i has a very strongly higher value than j.
9	Requirement i has an absolutely higher value than j.
2, 4, 6, 8	These are intermediate scales between two adjacent judgments.
Reciprocals	If Requirement i has a lower value than j

AHP: Consistency Index and Consistency Ratio

Table 5. Random index values

Number of Requirements	2	3	4	5	6	7	8	9	10
RI	***0***	***0.58***	***0.90***	***1.12***	***1.24***	***1.32***	***1.41***	***1.45***	***1.51***

Figure 3. Data and results for CI/RI score

	A	B	C	D	E	F	G	H	I	J	V	X	Y
1		SR-1	SR-2	SR-3	SR-4	SR-5	SR-6	SR-7	SR-8	SR-9	Scores	Product	Ratio
2	SR-1	1	8	1/5	3	1	2	2	3	1	0.1373	1.5427	11.2344
3	SR-2	1/8	1	1/5	1/7	1/7	1/7	1/7	1/9	1/9	0.0146	0.1549	10.5917
4	SR-3	5	5	1	1	2	1	3	1	1	0.1717	1.9647	11.4415
5	SR-4	1/3	7	1	1	1/2	1/2	3	1/2	1	0.0968	1.0743	11.0955
6	SR-5	1	7	1/2	2	1	3	3	1	1/3	0.1259	1.4065	11.1681
7	SR-6	1/2	7	1	2	1/3	1	1/3	1	1	0.0911	0.9550	10.4813
8	SR-7	1/2	7	1/3	1/3	1/3	3	1	3	2	0.1155	1.2740	11.0301
9	SR-8	1/3	9	1	2	1	1	1/3	1	1/6	0.0887	0.9134	10.2961
10	SR-9	1	9	1	1	3	1	1/2	6	1	0.0887	1.7547	11.0884
11												CI	0.2420
12												CI/RI	0.1669

Bank Branch Site Selection Study

Geospatial Data Preparation

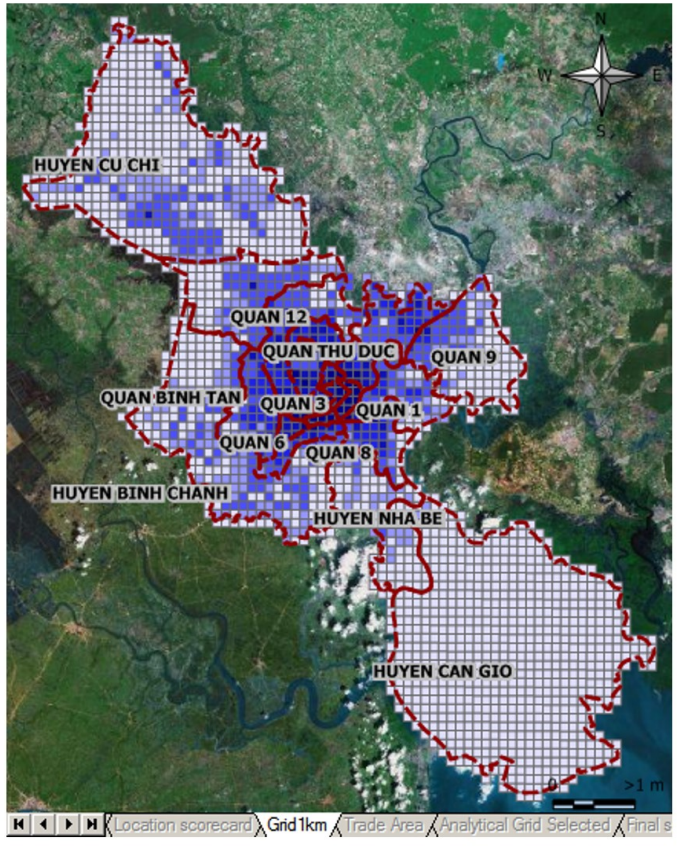
- Database compilation
  - Landcover
  - Urban functions and social services
  - Road network
  - Property market
  - Banking facilities
  - Population census
- Geospatial database design and development

Geographic Market Segmentation

- Construct 1km x 1km analytical grid
- Topological overlay
- Aggregate dataset according to analytical grid
- Prepare factor layers

Multicriteria Evaluation

- Assign attribute scores and data standardisation.
- Assign factor scores
- Perform multicriteria evaluation analysis (MCE)



GIS-based Predictive Model

- Geospatial hedonic pricing modelling