

Geog 464 Learning Objective Outline

LOO 11 Green County Multi-Criteria Data Analysis Case Study

11.1 Why are stakeholder perspectives important to consider? What are the similarities and differences among the stakeholder perspectives for siting the Green County wastewater facility?

11.2 How are personal/organizational values reflected in the stakeholder perspectives and used in multiple criteria evaluation to rank-order candidate site locations for siting the wastewater facility?

11.3 How do we move from criteria to site rankings for the Green County wastewater facility siting?

11.4 What is the difference between a multi-criteria ranking for a plan and a multi-criteria ranking for an improvement program, e.g. capital improvement program?

Today we discuss the connection between functional planning and improvement programming data analysis for Green County wastewater treatment comparing two related, but different, approaches to GIS data analysis. The RUGIS books presents a preliminary analysis of parcels and eliminates parcels not meeting the location suitability criteria – call this prescreening. It then moves to perform a final analysis reducing the set of parcels still further call this functional planning. How small is a “small set” of parcels (generically alternatives) is a matter of context for an overall problem. A set of 1000 parcels is smaller than 500,000+ parcels, but not quite as small as 20 parcels. Reduction of the set of parcels has its advantages and disadvantages. Reduce to make the problem more manageable. However, if one of the decision makers wanted to change the assumptions about what makes for a “capable” parcel, let alone a “suitable” parcel, or even just hypothetically explore a different criterion consideration, then we could not easily return to the full dataset to incorporate that additional perspective. In the wastewater case study, a small set of parcel sites is used to consider stakeholder preferences using the decision rules presented in section 4.4.3. So, how small should this data set be to perform a ranking analysis? Stakeholder input can be used to help answer that question.

11.1 Why are stakeholder perspectives important to consider? What are the similarities and differences among the stakeholder perspectives for siting the Green County wastewater facility?

RUGIS Chapter 7 Section 7.5.1

Stakeholder Group Perspectives for Siting a Green County Wastewater Facility

The following stakeholder perspectives were identified as part of the Duwamish Waterway’s salmon habitat redevelopment site selection starting in mid-1990’s, which continues today. The perspectives were modified slightly to embrace the Green County Wastewater problem. A Green County Facility Siting Panel representing diverse stakeholder groups was convened. Members of the Panel hold strong values for environmental protection and stewardship to balance with economic development – a foundational perspective for integrated resource management. Each stakeholder groups promote certain community values. Values and associated criterion are shared by some groups, but other values are in opposition for some groups. Articulating values and associated criteria fosters transparency.

Regulatory/Resource Agency Perspective

Representatives of the regulatory/resource agencies generally show a strong concern for protecting the environment and preventing pollution in the river as per their respective agency mandates and missions. A number of the agencies believe that controlling pollution should be the first priority for the panel. Some believe the best approach is to balance among potentially conflicting needs, striving for the best return on investment and using the panel’s work as a catalyst for more work later. Two evaluation criteria derive directly from this perspective: 1) maximizing the distance of facility from the river, and 2) selecting sites outside the floodplain zone.

Elected Official Perspective

Elected officials show a strong appreciation for the environment and its importance to people and the region's quality of life. Clean water is one of the important values expressed by the elected officials, with one official citing the importance of clean water for children. Correcting environmental problems and the sources of those problems is also an important value as long as doing so doesn't create other problems. In fact, the work of the panel is seen as an opportunity to look for creative solutions, some of which may solve multiple problems. Gaining the most long-term value for the money spent is another strong value of the elected officials. The least expensive parcels are those that are vacant as established by the County assessor. Individual elected officials show interest in developing public safety and odor control, keeping the facility as far from residential housing as possible. Maintaining a safe distance from housing will ensure that homes in the near proximity do not drop in assessed value. Two evaluation criteria, in addition to those already established for the regulatory agency perspective, can be derived from this perspective: 1) sites should be contained in vacant parcels and be within the city limits, and 2) maximizing the distance between candidate sites and residential properties.

Engineering Consulting/Academic Perspective

Consulting/academic individuals focus to a great degree on planning ahead, picking priorities and choosing projects that help us understand the externalities caused within the community so that such problems can be avoided in the future if at all possible. Planning for the long-term is very important to avoid unforeseen problems. As a way to set priorities, the group values the use of risk assessment, with a focus on clear risks to people; maintenance of existing resources while looking for other opportunities, and the ability of projects to sustain themselves beyond the panel's work. Four criteria are emphasized in this perspective; 1) sites should not overlap with historic areas, and 2) be close to largest wastewater junctions, 3) parcel elevation below 365 meters, and 4) maximize the parcel size.

Environmental Group Perspective

Representatives of environmental groups feel strongly about preventing pollution and reducing risks to people and the environment, restoring areas to a greatly improved state, and finding ways to involve the public. An important value is pollution prevention and the protection of living things, including people. Generally, priorities should be based on reducing the greatest risks to human and environmental health. Protection of salmon is important, in part, because of its economic contribution to the region's quality of life. A public process will also help the panel establish values to use in making decisions and make implementation less difficult. The values and concerns voiced by the representatives of environmental group point to some of the same criteria that have been already identified, so for now no new criteria are added to the list

Business/Community Leader Perspective

Business and community leaders express a range of values that the panel should use in guiding its decisions. To varying degrees, many of these leaders acknowledge that the panel will be trying to site a facility with the least overall impact to the community. The panel should balance economic values with social values. Reasonableness and an eye to multiuses may be important to finding a balance between potentially conflicting needs. Yet, efforts to restore the water resources, remediate land use problem areas and eliminate sources of pollution are very important to these leaders. In fact, eliminating sources of pollution is a higher priority for many of the leaders than employment opportunities. Improving public health fosters healthy employees. Public health is also important, particularly as pollution affects the quality of fish, shellfish and other edible fishes. Several leaders use the phrase, "fishable/ swimmable," to summarize their definition of clean water. Thus, keeping the facility away from the river is a major consideration for this group. Spending excessive amounts of money to get infinitesimal results is not valued; yet, doing the job right the first time is valued. The

group wants to see the sites located as close as possible to the existing roads in order to use the existing infrastructure. This is yet another criterion.

The above stakeholder perspectives help identify the connection between values, interests and criteria.

11.2 How are personal/organizational values reflected in the stakeholder perspectives and used in multiple criteria evaluation to rank-order candidate site locations for siting the wastewater facility?
RUGIS Chapter 7 Section 7.5.2

Various stakeholder perspectives contain personal and/or organizational values that sometimes get articulated as specific concerns and recommendations that can be adopted as evaluation criteria. Nine different criteria can be identified as being critically important among the five stakeholder groups. The criteria present specific user information needs in terms arriving at their values for each identified site. In order to find out what these criteria data values are, we need to compute them, but how? Let us use the framework introduced early in chapter 6; noticing that many of the criteria correspond to spatial data transformation and feature relationships presented in Tables 6.2 – 6.5, and describe nine criteria and the corresponding GIS data analysis functions that can be used to compute the criteria data values.

1. **Identify parcels that are below 365 meters;** Table 6.4; Containment/Polygon->Polygon; Clip available parcels from the polygon layer with areas below 365 meters. Also, can use Overlap/Polygon->Polygon; Overlay Intersect polygon elevation layer (lowland) with parcel layer.
2. **Locate parcels that are within the city;** Table 6.4; Overlap/ Polygon->Polygon and Containment/Polygon->Polygon; first Overlay Union available parcels with the city boundary polygon layer, next Select from the result layer the polygons representing parcels within the city boundary.
3. **Find large-size properties;** No specific transformation (actually simplest) is needed to answer this criterion; however, the parcels can be easily found through an attribute query selection.
4. **Identify parcels that are not in the historic district;** Table 6.4; (No) Overlap/ Polygon->Polygon and Containment/Polygon->Polygon; first Overlay Union available parcels with the historic district polygon layer, next Select from the result layer the polygons representing parcels outside the historic district boundary.
5. **Minimize the distance from parcels to the closest wastewater pipe junction;** first we observe that there is GIS data analysis operation corresponding to Proximity/Point->Polygon combination in Table 6.2. In this instance we need to abstract polygon to point, which can be the polygon's centroid. We then look at the combination Proximity/Point->Point, which offers Point Distance operation. Using it we can find distances between each parcel centroid and each point representing the wastewater pipe junction.
6. **Maximize the distance from parcels to the closest river;** similar to the criterion #5 we first need to transform parcel polygons to points (centroids) and then the combination Proximity/Point->Line affords as Near operation, which can compute the shortest Euclidean distance between each point and the corresponding location on the line. We can then sort the distances in the increasing order to find parcels that are the farthest away from the river.

7. **Minimize the distance from parcels to the closest road.** Apply the same combination of transformations as for criterion #6.
8. **Maximize the distance from parcels to residential properties.** Apply the same combination as for criterion #5 except that here we need to transform both layers from polygon to points (centroids): parcels and residential properties.
9. **Find parcels located outside the floodplain.** Apply the same combination as for criterion # 4.

11.3 How do we move from criteria to site rankings for the Green County wastewater facility siting?
RUGIS Chapter 7 Section 7.5.3

The GIS operations applied to input data layers result in computing data values for the criteria. The data values can be organized into a decision table with raw records representing candidate sites and columns representing criteria.

- Before one can apply any of the decision rules, criteria data values must be standardized.
- Preferences in regard to evaluation criteria must be enumerated.
- Assume that the criteria data values have been standardized with the non-linear standardization formulas
- Assume we have used the Rating formula to arrive at criterion weights.
- Weights are given in Table 7.1.

Weights in Table 7.1 represent one specific perspective that seems to be close to the business/community leader perspective protecting residential properties (the highest weight = 15) and promoting cost-related criteria (parcels in the city, distance to wastewater pipe junction, distance to roads).

Table 7.1 Weights for the Green County Criteria

Criterion	Weight
Identify parcels below 365 meters	9
Locate parcels that are within the city	11
Find large-size properties	11
Identify parcels that are not in the historic district	10
Minimize the distance from parcels to the closest wastewater pipe junction	12
Maximize the distance from parcels to the closest river	11
Minimize the distance from parcels to the closest road	13
Maximize the distance from parcels to residential properties	15
Find parcels located outside the floodplain	8

We use the weights and present the ranking for the top-ranked ten sites (out of 283 candidate parcels in Green County) – **see in Figure 7.1.**

The ranking was obtained with the Ideal Point Decision Rule (section 7.3). Site (option) 64 is the top-ranked location with the final appraisal score equal to 68. The next best site 101 has the final appraisal score equal to 62, which almost 10% less than the top score. Looking at the ranking we may be ready to conclude that site 64 should be recommended to the Panel for the wastewater facility location.

Before we can make the recommendation we should check the sensitivity of the ranking. Let us assume that we are confident about criteria and criteria data values – we do not expect changes in the set of criteria as some become irrelevant and similarly we do not expect our criterion values to change.

However, we are not so certain about the priorities, which can shift up or down. It is always difficult to predict how large such shifts can be and 20% shift up or down seems to be a plausible guess. This would mean that the highest priority criterion “Resid_dist” (distance from parcels to residential properties) could change the weight by +/- 3 from its current weight equal to 15.

We can test whether such changes in weights will result in the change of the ranking especially for the top-ranked site 64. **The result of such change is presented in Figure 7.2**

The weight for the criterion “Resid_dist” was increased from 15 to 18 and the other weights were adjusted proportionally. This resulted in site #64 staying still at the top of the ranking, albeit with a smaller final appraisal score equal 65. However, the order of the lower-ranked sites changed (compare Figure 7.1 with Figure 7.2).

This indicates to us that the top ranked-site 64 is stable and that the ranks of other sites may change due to shifting weights. In light of this result of the sensitivity analysis we recommend site 64 to the Panel.

11.4 What is the difference between a multi-criteria ranking for a plan and a multi-criteria ranking for an improvement program, e.g. capital improvement program?

A plan does not commonly have a budgetary consideration, because it is often long-term and large-area. An improvement program uses a budget to as a realistic constraint about what projects can be considered for implementation, since all project implementation requires resources (either financial or volunteer as the case may be) to put projects in place. Both costs and revenues are part of a budget that are used to identify a “package” of projects for funding.

The **costs** would be for both land acquisition and for building the infrastructure. The market rate for land would be paid no matter how the land is acquired, i.e. eminent domain or free market. The infrastructure costs are the costs of building materials, labor, fees etc.

There could be three popular sources of **revenue**, for example, user fees, bond levy, and/or tax levy. There are likely others, but let us look at each of these in brief. (see next page for extensive Example)

User fee – We could imagine a service for “cleaning” wastewater. Every time you use the sink, the water goes down the pipe and it triggers a fee to be paid. Is this practical or not for what other service?

Tax levy - Every month you pay a sewer tax based on estimated use (need) to be able to send your sewage to the facility whether or not you use it. Is this practical or not for what other service?

Bond levy – People pay for investing in infrastructure through buying “bonds”. The person who bought the bond receives an interest on their investment each year. Eventually, the bond is repaid. The investor gets all of their money back, and retains the interest they were paid over the life of the bond.

Thus, the main difference between the plan and program multi-criteria ranking, is that the improvement program would use a budget composed of costs and revenues as part of the decision problem in combination with the other criteria that have been identified as important to the problem.

Example: Funding mechanisms for ecosystem services improvement in Washington State's Water Resource Inventory Area 9 (Green/Duwamish and Central Puget Sound Watershed) have considerable context for development. The following web page lists many documents that describe watershed investment district activity for WRIA 9.

<http://www.govlink.org/watersheds/9/plan-implementation/FundingMechanisms.aspx>

In particular, see Table 4 on page 36 of the following document for a list of funding mechanisms and the funding rates proposed.

<http://www.govlink.org/watersheds/9/pdf/WRIA9-Funding-Mechanisms-April-2009.pdf>