

Case Study: Informing the Coastal Development of Akua Island

Pack your bags for Akua Island, and prepare to hit the tropics! Nadia Toloa, Executive Director of the Akua Coastal Commission, has just hired you and your team of actuarial consultants to help implement their new 2017 Coastal Act.

After reviewing your client’s background documents, you learn that the Akua Coastal Commission is a government agency with judicial oversight over economic development across Akua’s coastal zones. The commission’s mission is “to protect, conserve, restore and enhance the environment of the Akua Island coastline.”

Nadia explains that the most difficult part of her job is balancing the competing interests of industry stakeholders and environmentalists, since both have representatives within the commission. This was particularly challenging over the period of her more recent efforts to protect Akua’s coastal marshes and endangered species, during which Nadia partnered with a wetland conservationist group to pass a stricter economic development bill. Her decision was met with a diversity of opposition. For example, some commission members wanted the bill to include more tourism-related objectives to promote development of public land, while others wished to see expanded industrial development promoting middle class employment. In order to achieve a compromise mutually acceptable to all parties involved, Nadia lead several sessions during which the initial bill proposal was significantly revised.

This ultimately led to the passage of the 2017 Coastal Act, a set of rules and objectives for future development of Akua’s coastline. Due to the island’s small population size, only five of Akua’s zones have previously been developed, leaving 20 undeveloped coastal zones in which the commission will regulate future expansion. Figure 1 below shows a map of Akua Island that has been provided by the client. Previously developed zones are shown in grey, while undeveloped coastal zones are shown in yellow and numbered 1 through 20.

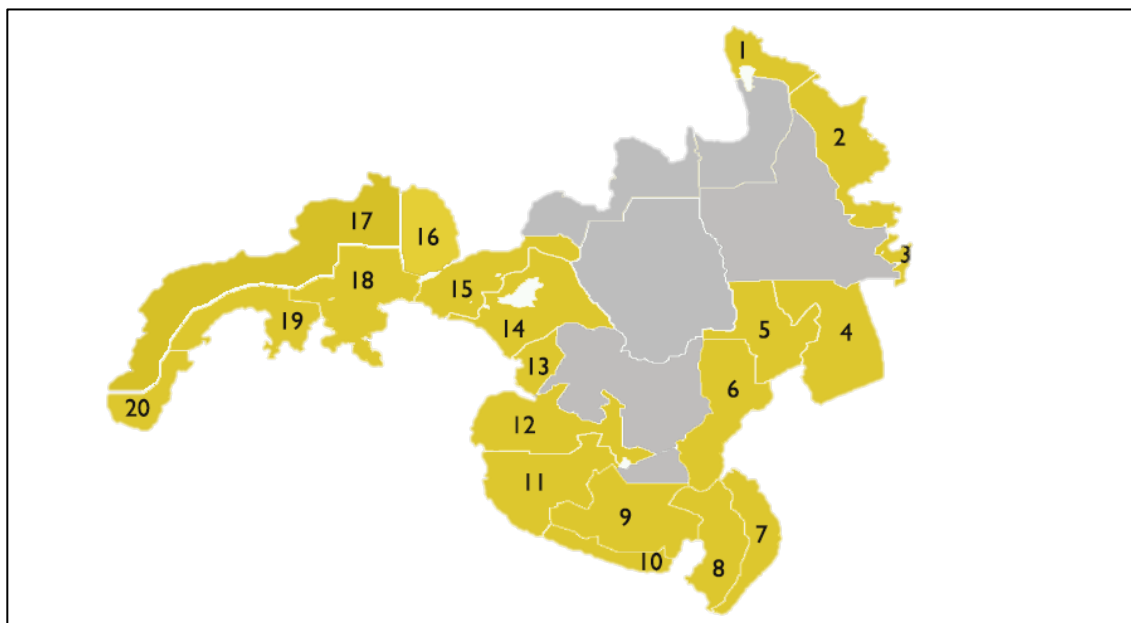


Figure 1: Map Highlighting Akua Island’s 20 Undeveloped Coastal Zones

In order to best regulate future coastline development, the Coastal Commission must identify a land-use plan for each of the 20 remaining coastal zones, specifying the type of public or private development for which each zone is best suited. This is where your team's expertise comes in. Your assignment is to recommend the best land-use plan for each of the 20 zones by analyzing local environmental data collected from these zones (provided by the client in the corresponding Excel file) and applying the following Coastal Act policies.

To determine which zones are best suited for **public development**, consider these Coastal Act rules and objectives:

1) Rules

- a) **At least 30% of the 20 coastal zones** must be designated for **public land use**, which may contain any combination of zones for conservation and/or recreation.
- b) **All public land designations must contain at least two connecting zones.** The connection between the zones must be sufficient to support linkages between passive, recreational and conservationist areas, meaning a narrow connection between two zones at just one or two points is not sufficient. To clarify this requirement, the client has provided a **Zone Adjacency Matrix** in the Excel document specifying zones identified as adequately connected.

2) Objectives

- a) **Conservation:** Preserve zones containing environmentally sensitive habitat lands. Consider a zone ideal for conservation in the case that it contains a:
 - i) large Akua duck population, since the Akua duck is a critically endangered species dependent on wetland ecosystems for survival.
 - ii) significant portion of total surface area comprised of wetlands, especially wetlands that are expected to migrate farthest based on sea level projections looking at least 5 years forward, since wetlands naturally migrate upland to keep pace with rising sea levels (unless obstructed by private development).
- b) **Recreation:** Preserve zones that best support public access to passive and active recreational activities. Consider a zone ideal for recreation-related development in the case that it contains a:
 - i) large aggregate surface area comprised of both grasslands *and* forests that can be converted into neighborhood parks, landscaped areas, hiking/biking trails and camping sites.
 - ii) lengthy coastline for the development of boating areas, marinas, fishing areas and public beaches.
 - iii) low risk of 5-year sea level projections measured 100 meters in from the coastline, since this is the closest to the shore that development is permitted.

To determine which zones are best suited for **private development**, consider these Coastal Act rules and objectives:

1) Rules

- a) **At least 10% of the 20 coastal zones** must be designated for **agriculture**
- b) **At least 10% of the 20 coastal zones** must be designated for **fisheries**
- c) **At least 10% of the 20 coastal zones** must be designated for **private housing**
- d) **At least 10% of the 20 coastal zones** should be reserved for **other forms of economic development**

2) Objectives

- a) **Business Development:** Identify zones best suited for development of Akua's most critical coastal industries.
 - i) **Agriculture:** Consider a zone ideal for agricultural development in the case that it contains a:
 - (1) large aggregate surface area of grasslands that can be converted into farmlands.

- (2) large amount of organic matter found, on average, within grassland soil, ensuring healthy and productive soil that is suitable for growing crops.
- ii) **Fishing:** Consider a zone ideal for fishing-sector development in the case that it contains a:
 - (1) low exploitation rate of Snapper, Akua's most in-demand species of fish, to prevent overfishing.
 - (2) lengthy coastline for the development of fisheries.
- c) **Private Housing:** Consider a zone ideal for private housing development in the case that it contains a:
 - iii) large aggregate surface area of grasslands that can be converted into housing developments.
 - iv) lengthy coastline for beachfront development.
 - v) low risk of 5-year sea level projections measured 100 meters in from the coastline, since this is the point closest to the shore at which development is permitted.

As mentioned, the client has also provided an Excel file containing environmental data collected from each undeveloped zone. This Excel file contains the following four sheets:

- **Current Environmental Data:** The first sheet contains present-day data from each zone, including total surface area, the portion of the surface containing wetlands, grasslands, forests and other topographies, the last known Akua duck population (an endangered wetland-dependent species), the most recent annual Snapper exploitation rate within 150 meters of the shoreline, the amount of soil organic matter most recently averaged per hectare of grassland, current coastline length, and average altitude measured 100 meters inland from the most recent mean sea level recording.
- **Historical Sea Level Data:** The second sheet contains all available monthly sea level recordings captured by tide gauges from 1992 through 2016. Please note that not all zones are within proximity to a tide gauge and that readings from available tide gauges are not always available.
- **Zone Adjacency Matrix:** The third sheet can be used to identify which of the 20 coastal zones are considered connected at more than a point.
- **Allocation of Zones:** The fourth sheet contains a table in which your team is expected to document a final land use designation for each zone.

After analyzing this environmental data in consideration of the Coastal Act's rules and objectives, Nadia would like your team to craft a recommendation around the following:

In your team's expert opinion, which of the 20 zones should be designated toward each of the following six land use categories?

1. Conservation
2. Recreation
3. Agriculture
4. Fishing
5. Private housing
6. Other

Within the table provided on the fourth sheet of the Excel file, labeled "Allocation of Zones", the client has requested that you please choose a land use category for each of the 20 undeveloped zones. All 20 zones require a final designation.

Next, within a written narrative explaining your final allocation decisions, Nadia requests that you clearly discuss each of the following consideration factors:

- **Strategic Approach:** What overall strategy did your team use in determining how to allocate the 20 coastal zones?
- **Data Modeling:** How does your team’s approach to modeling the data support the strategy you’ve outlined above? Is your approach grounded in past literature and secondary research, or is it one that your team has chosen to invent?
- **Data Limitations:** How complete or continuous is the data and information that was provided by the client? Are there any limitations with the potential to impact your conclusions or that may have resulted in the need to make certain assumptions?
- **Decision Rationale:** What led to your team’s decisions regarding the zones you chose to assign to each of the six land use categories? Which objectives did your team prioritize and why? How does your data analysis support these decisions?
- **Trade Offs:** What tradeoffs or opportunity costs were involved in your zone designation decisions across the six land-use categories? Were there situations in which you had to prioritize certain objectives at the expense of others? How did you make these prioritization decisions?
- **Challenges:** Are there any Coastal Act objectives that your team found challenging to address? What ideas do you have regarding how the Coastal Commission or city governments might respond to these challenges?

The Coastal Commission acknowledges that there is no one right answer to this type of optimization challenge. They are counting on your team’s creative problem solving and strategic thinking to consider a diversity of potential alternatives. Nadia has also made clear that your team is not the only consultancy hired for a recommendation and that the Akua government has no obligation to comply with your final recommendation.

Should your team decide to use secondary research in support of your chosen methodology, Nadia requests that you please include citations wherever this research is discussed. She has also requested that any cited sources also be listed within a bibliography, to be submitted within an appendix alongside your calculations. Please be sure to carefully review all client submission requirements listed at the end of this document.

Nadia is grateful for your team’s help designing an optimal land use strategy for Akua’s coast. She is confident it will help to ensure the sustainability of the coastline for generations to come.

Submission Requirements:

Your team's submission will contain a written narrative with all qualitative arguments, an Excel File with all final zone designations, and an appendix with all relevant calculations (as well as a bibliography should you choose to cite secondary sources within your written narrative).

1. Written Narrative

- a. Clear discussion of each consideration factor requested by the client (*including: strategic approach, data modeling, data limitations, decision rationale, tradeoffs and opportunities*)
 - i. Open with an executive summary of your team's **strategic approach** and **data modeling** methodology
 - ii. Discuss **data limitations** and potential consequences
 - iii. For each of the six land use categories, discuss the **decision rationale** behind your team's zone allocations, as well as any **trade-offs** or **opportunities** identified.
- b. 2,000 word limit (*on written submission portion only*)
- c. Graphs/charts summarizing key findings are highly encouraged and will **not** count against the 2,000 word limit, including captions.
- d. Double-space
- e. Use 12 point font
- f. Include citations where secondary research is discussed (*if applicable*).

*** The Coastal Commission will read your written narrative in detail**

2. Zone Designations

- a. Edit the table on the "**Allocation of Zones**" sheet within the provided Excel file, and provide a list of all final zone designations per land use category.

3. Appendix Submission

- a. Show all relevant calculations and analysis in tabular form.
- b. Include a bibliography for any secondary research sources discussed within the written narrative (*if applicable*).

*** The Coastal Commission has no obligation to read your appendix, though its inclusion is highly encouraged in case they wish to verify the claims made in your written narrative**