

PREFEASIBILITY  
DESIGN OF A TIDAL  
BARRAGE POWER  
PLANT IN TUMACO.

- Miler Ivan Maya Maya
- Dr. Eng. Juan Gabriel Rueda Bayona

Faculty of Engineering

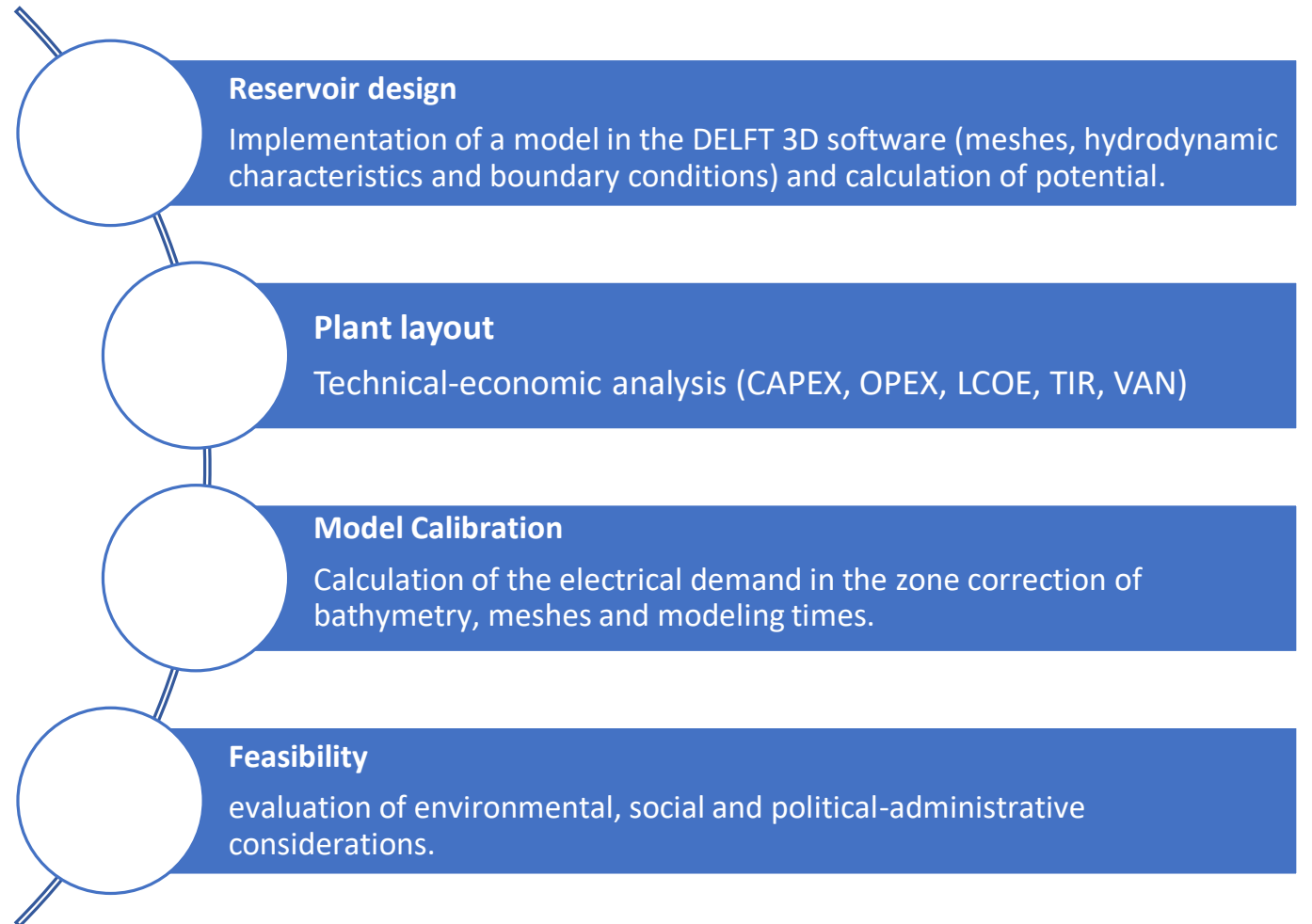


# Introduction:

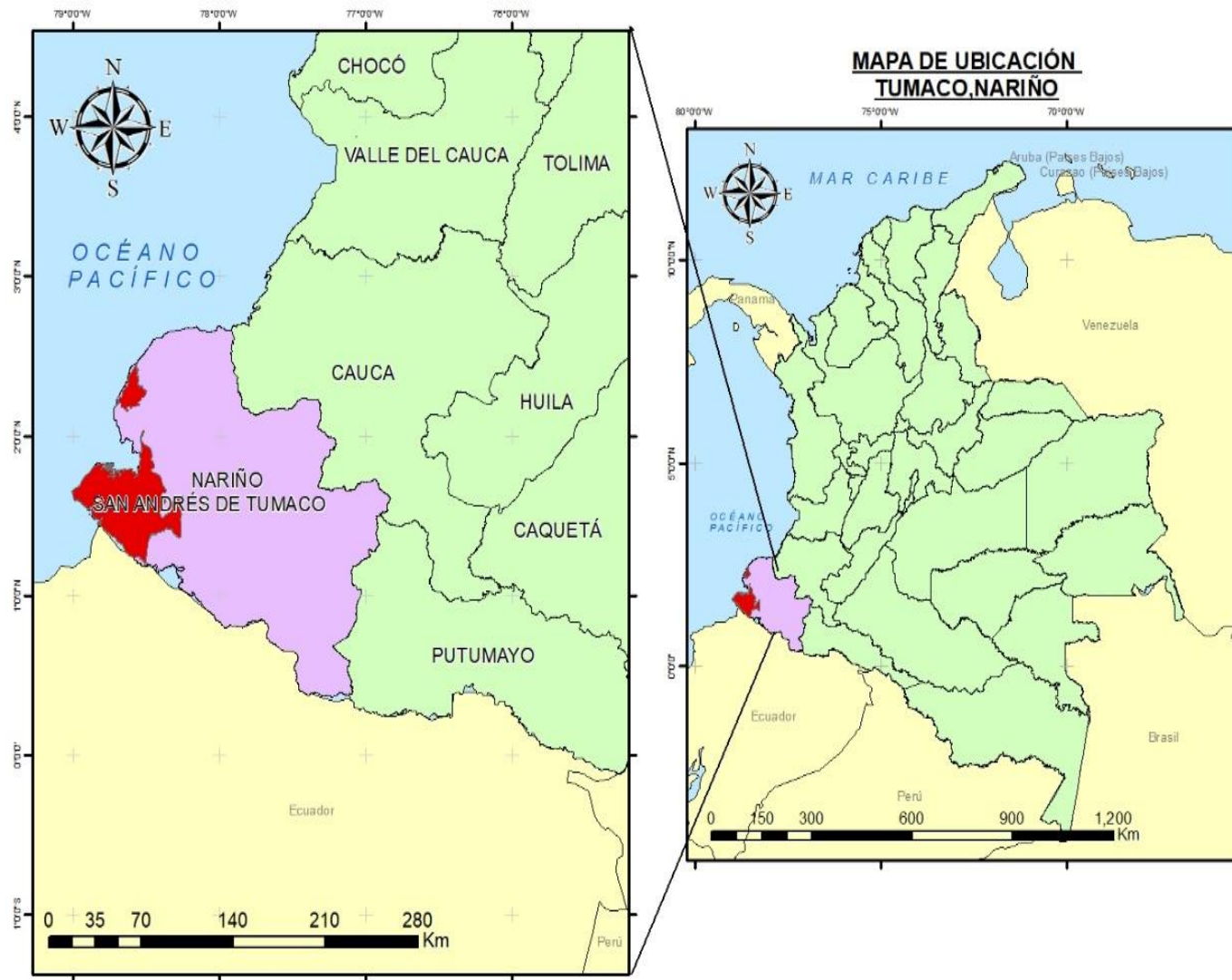
- Tidal energy is a renewable energy source that has the potential to generate large amounts of electricity.
- Colombia has great potential for tidal energy, with a coastline of more than 3,000 kilometers.
- The objective of this study is to evaluate the prefeasibility of the design of a reservoir-type tidal power plant in Tumaco, Colombia.



# Methodology

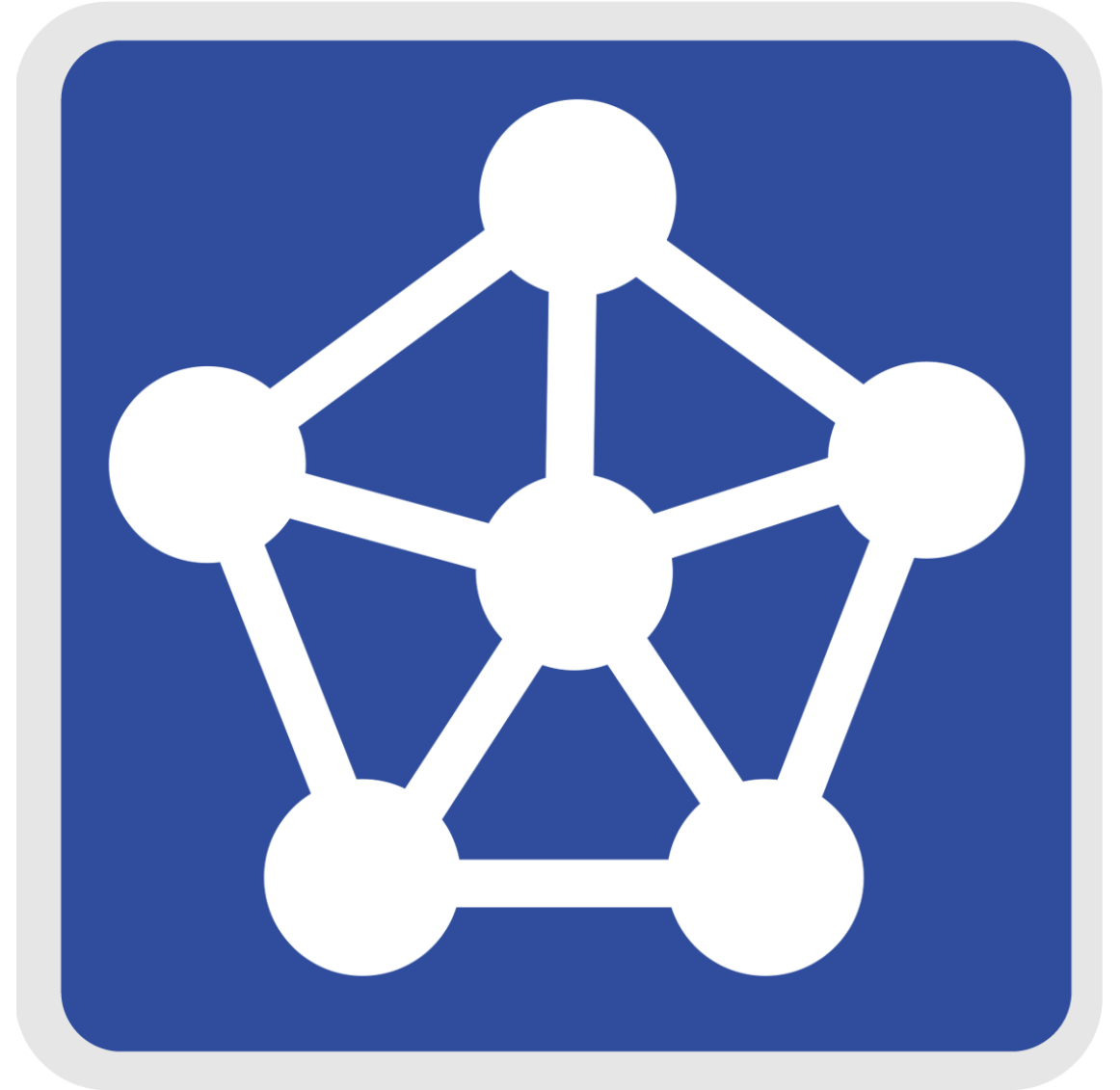


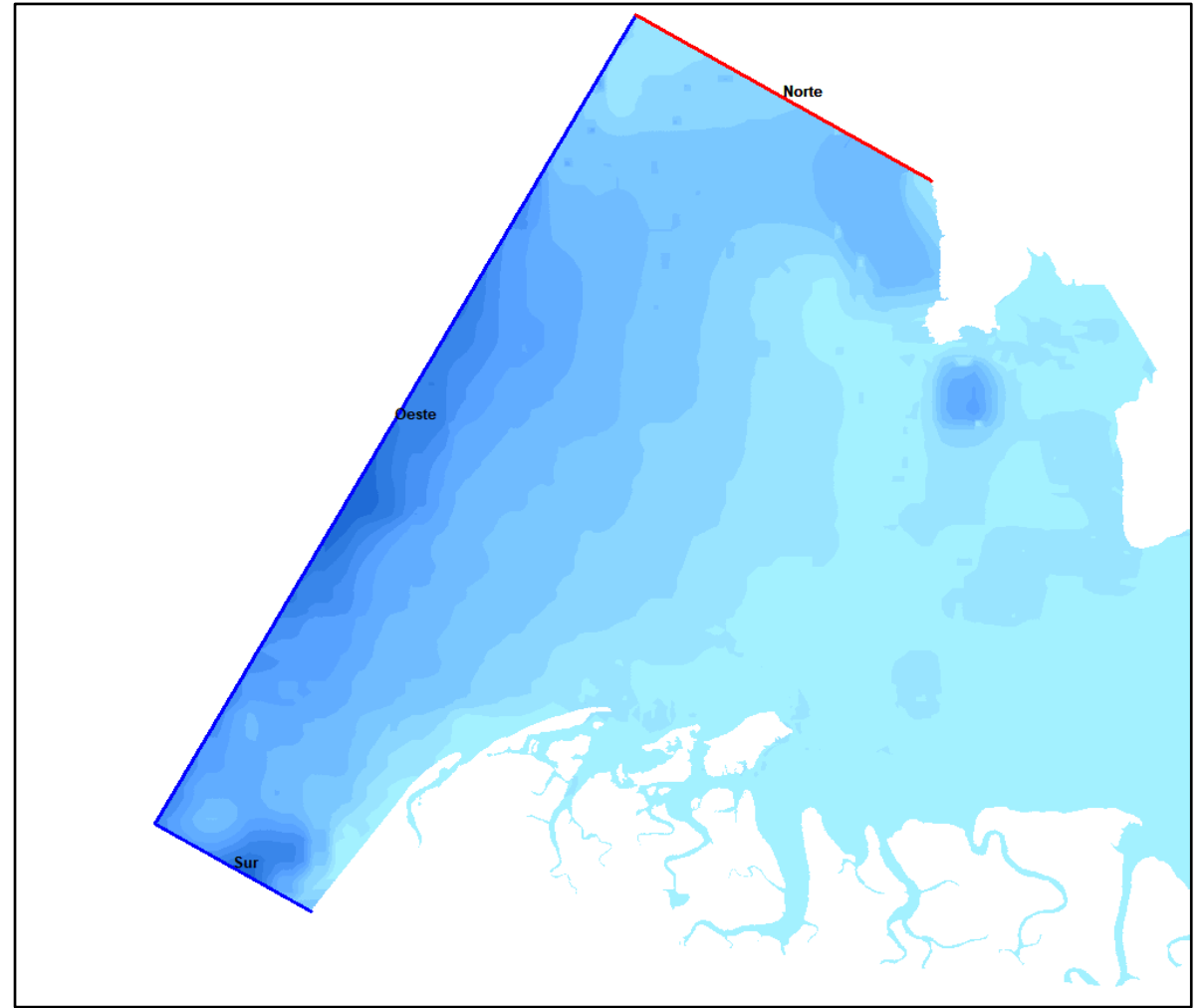
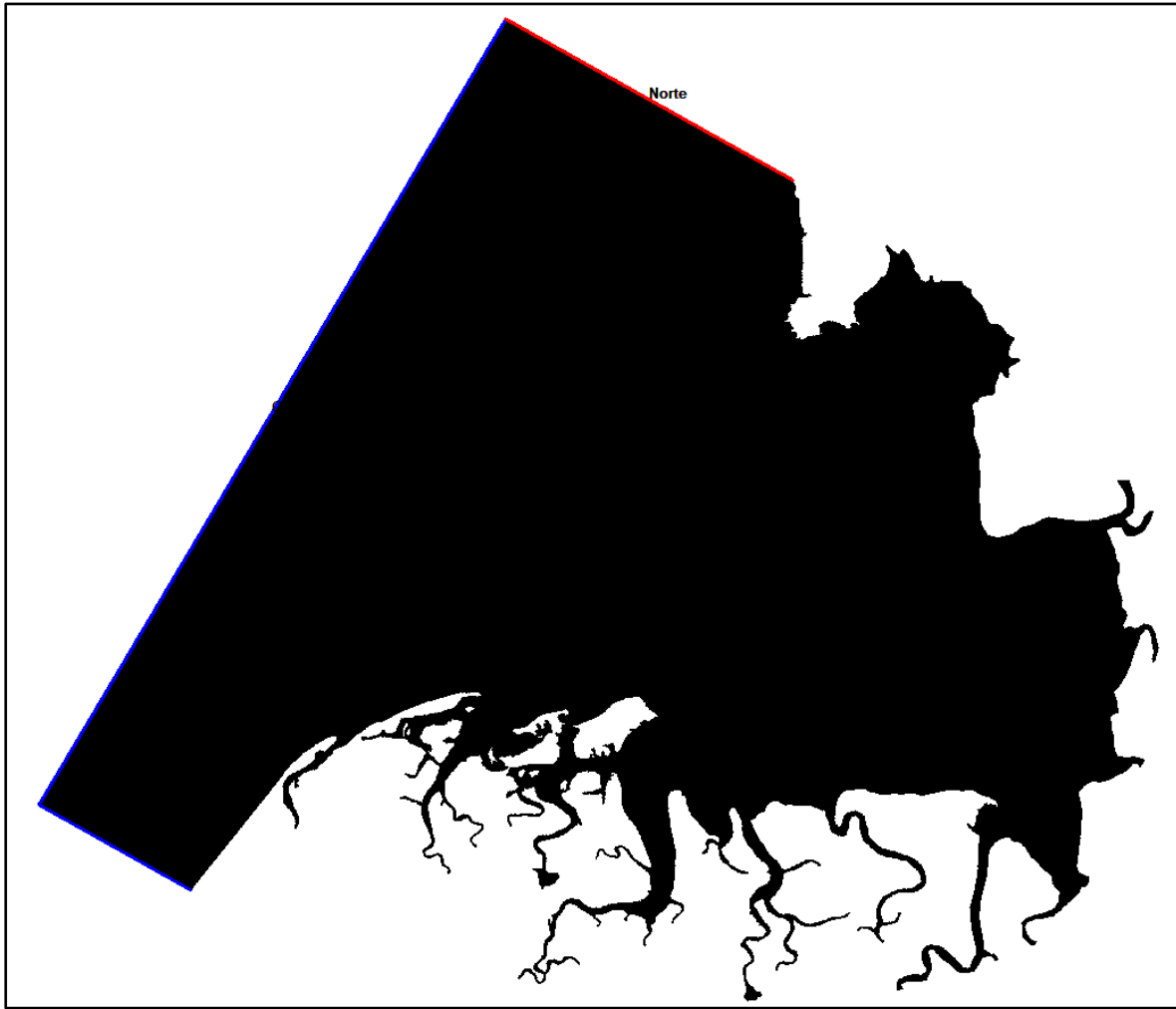
Hydrodynamic modeling in Tumaco, Colombia.



# Hydrodynamic modeling in Tumaco, Colombia. (DELFT-3D)

- Relevant data:
- Tumaco is located on the coast of the Pacific Ocean, a region with strong ocean currents.
- Tumaco Bay has a semidiurnal tidal regime, with an average height of 2.45 meters.
- Tidal currents in the bay can reach speeds of up to 1.5 m/s.



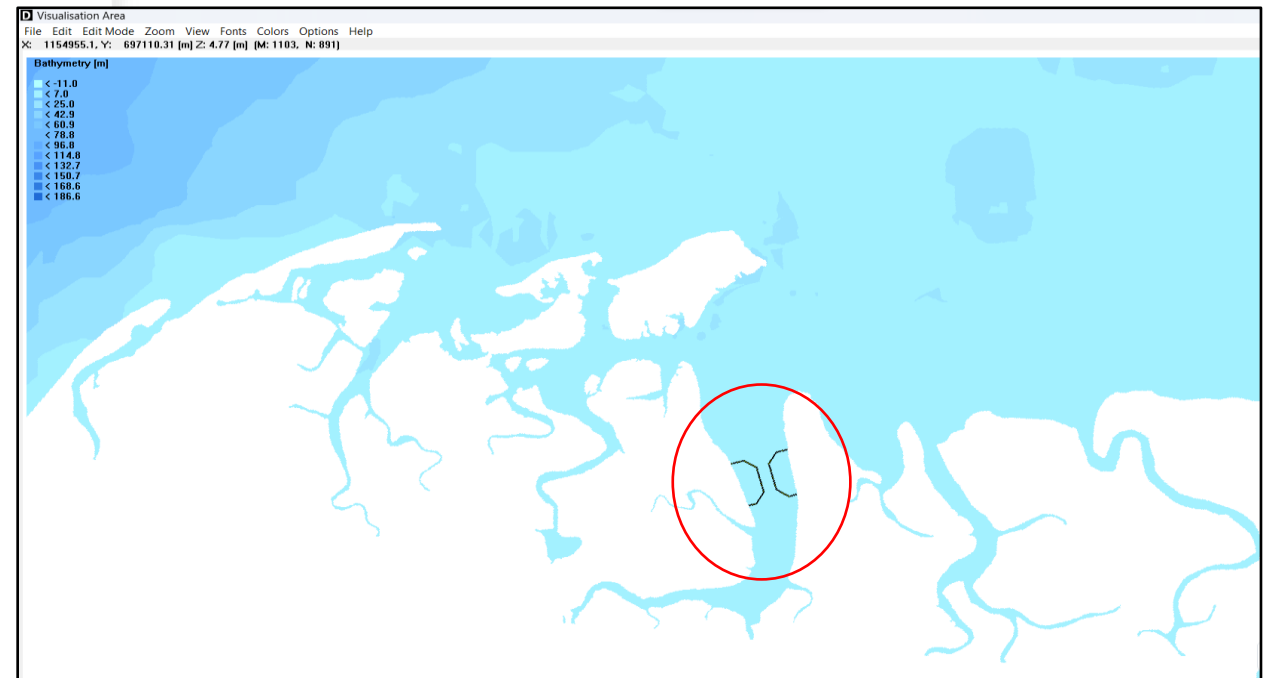
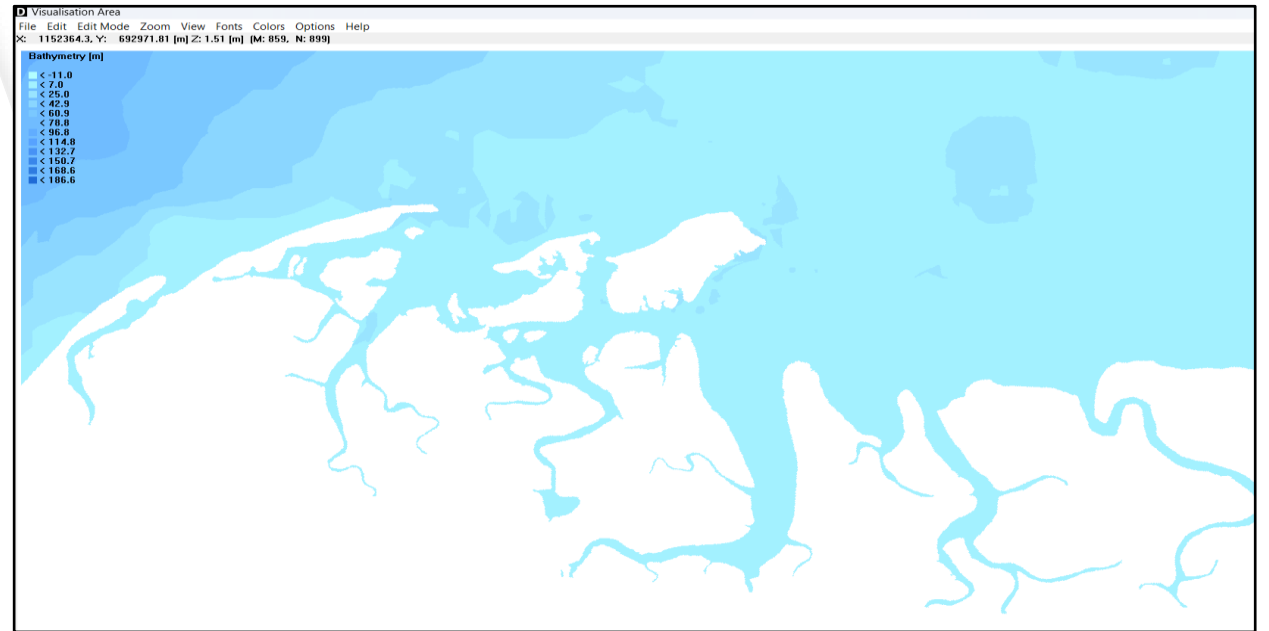


Hydrodynamic modeling in Tumaco, Colombia.  
(Grid & Bathymetry)

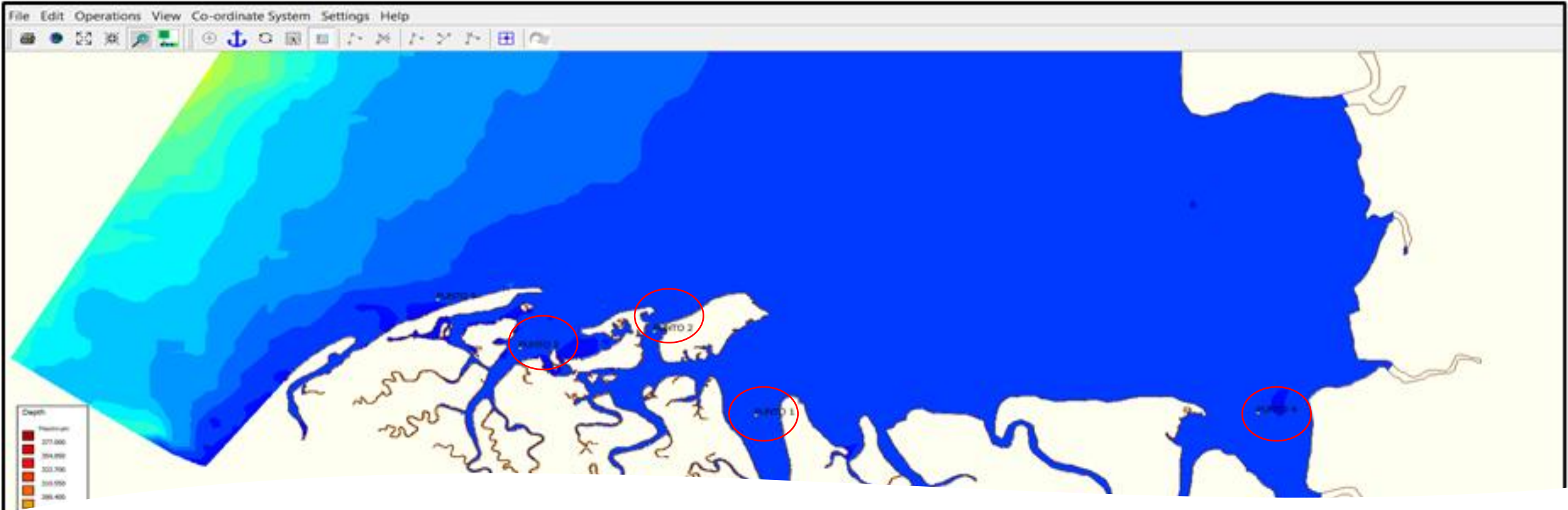
# Hydrodynamic Model Conditions and Physical Properties in Tumaco Bay

Property	Rank
<b>Border Conditions</b>	
Type	Open conditions
Limits	All mesh boundaries (20 meters)
<b>Forcing</b>	
Guy	"Synthetic" tidal conditions
Data Source	Historical tidal data in Tumaco Bay
Strategic Point	A strategic point of the mesh (meshing centroid)
<b>Physical Properties of Water</b>	
Temperature	27 to 32 °C
Salinity	32 to 35 g/L
pH	7,8 a 8,2
Water Density	1024 Kg/m <sup>3</sup>
<b>Sediment Properties</b>	
Composition	Sandy to silty clay
Texture	Fine to coarse
Organic Matter Content	1 a 10%

# Hydrodynamic Simulation: Natural Behavior vs. Parshall Configuration



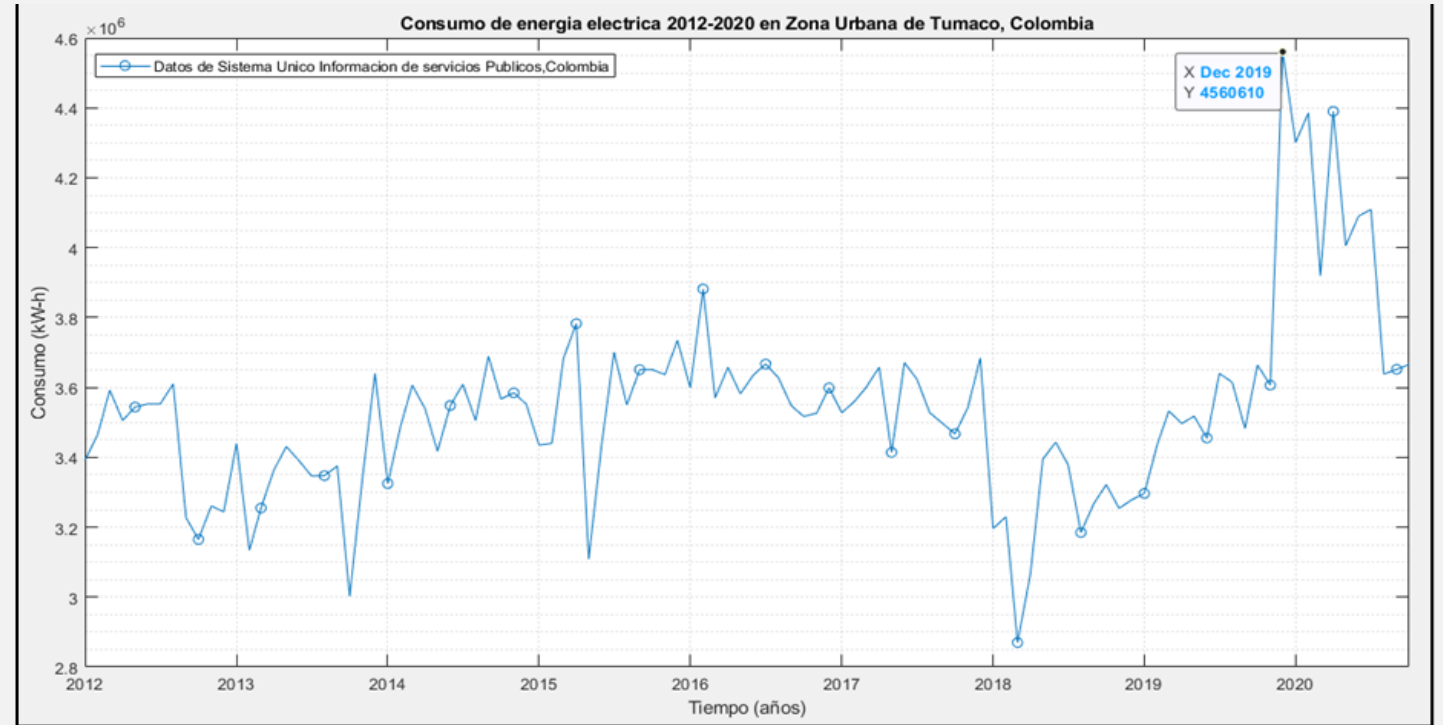




Hydrodynamic  
modeling in  
Tumaco, Colombia.

- Depth: up to 6 meters
- Average speed: 1.5 m/s Accessibility: Good
- Estimated tidal power: 0.5 MW

# TECHNO- ECONOMIC ANALYSIS OF THE IMPLEMENTATION OF A TIDAL PLANT IN THE COASTAL ZONE OF THE DEPARTMENT OF NARIÑO



- The information from the Unified Information System (SUI) was used to estimate the electrical demand at the residential level in the area where the tidal plant will be located.
- The total accumulated electricity demand through 2070 is projected to be 63,070,265 kilowatt-hours (kWh).

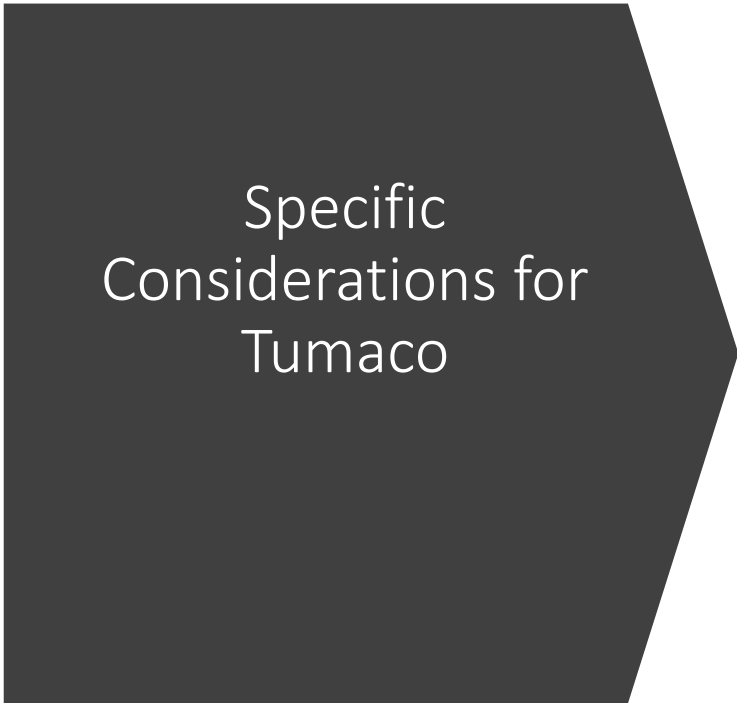
# Technical-economic evaluation

- The study estimates that the tidal power plant in Tumaco Bay would have a useful life of 30 years. The price of the energy produced by the plant would be 2.4 dollars/kWh. Operation and maintenance costs would be estimated at 1% of the annual investment cost.

Technical-economic model of reservoir-type tidal power plant	
	2023
Nominal plant power (KW-hour)	57.0997
Initial Investment	-USD 3,397,685.37
Operation & Maintenance Cost	USD -0
Plant lifespan (years)	30
Hours of the year worked	4000
Factor Planta (%)	40%
Energy required for Aux services (%)	5%
Loss of network interconnection (%)	5%
Fixed unit cost in USD/KW-hour	USD 0.19
Variable Unit Cost USD/KW-hour	USD 0.20
Depreciation or discount rate	10%
Tax rate	15%
expected power generation in the year (KW-h)	82223.52587
Plant Efficiency (%)	70%
Plant Availability (%)	50%
Plant degradation (%)	5%
Expected Minimum Annual Energy Production in Dollars (USD/kWh)	15375.80
LCOE (\$/KWh)	2.4
VAN to 30 years	USD 6,879,195.40
30-year IRR	11%

# Social and environmental recommendations

Impact	Environmental	Social
Protected and Biodiversity-Key Areas	Avoid projects in these areas	Avoid impacts in these areas
Natural and Critical Habitats	Assess impact on mangroves, seagrass beds, coral reefs, and other habitats	Assess impact on artisanal fishing communities
Sensitive Marine Species	Avoid impacts on dolphins, sharks, turtles, and threatened species	Assess impact on artisanal fishing communities
Artisanal Fishermen	Assess impact on fishing grounds	Assess impact on artisanal fishing communities
Commercial and Industrial Fishing Zones	Assess impact on maritime routes and fishing sites	Assess impact on commercial and industrial fishing communities
Coastal Aquaculture and Mariculture	Assess impact on coastal aquaculture and mariculture	Assess impact on aquaculture communities
Landscape and Cultural Heritage	Assess visual impact on nearby heritage and cultural features	Assess visual impact on nearby heritage and cultural features



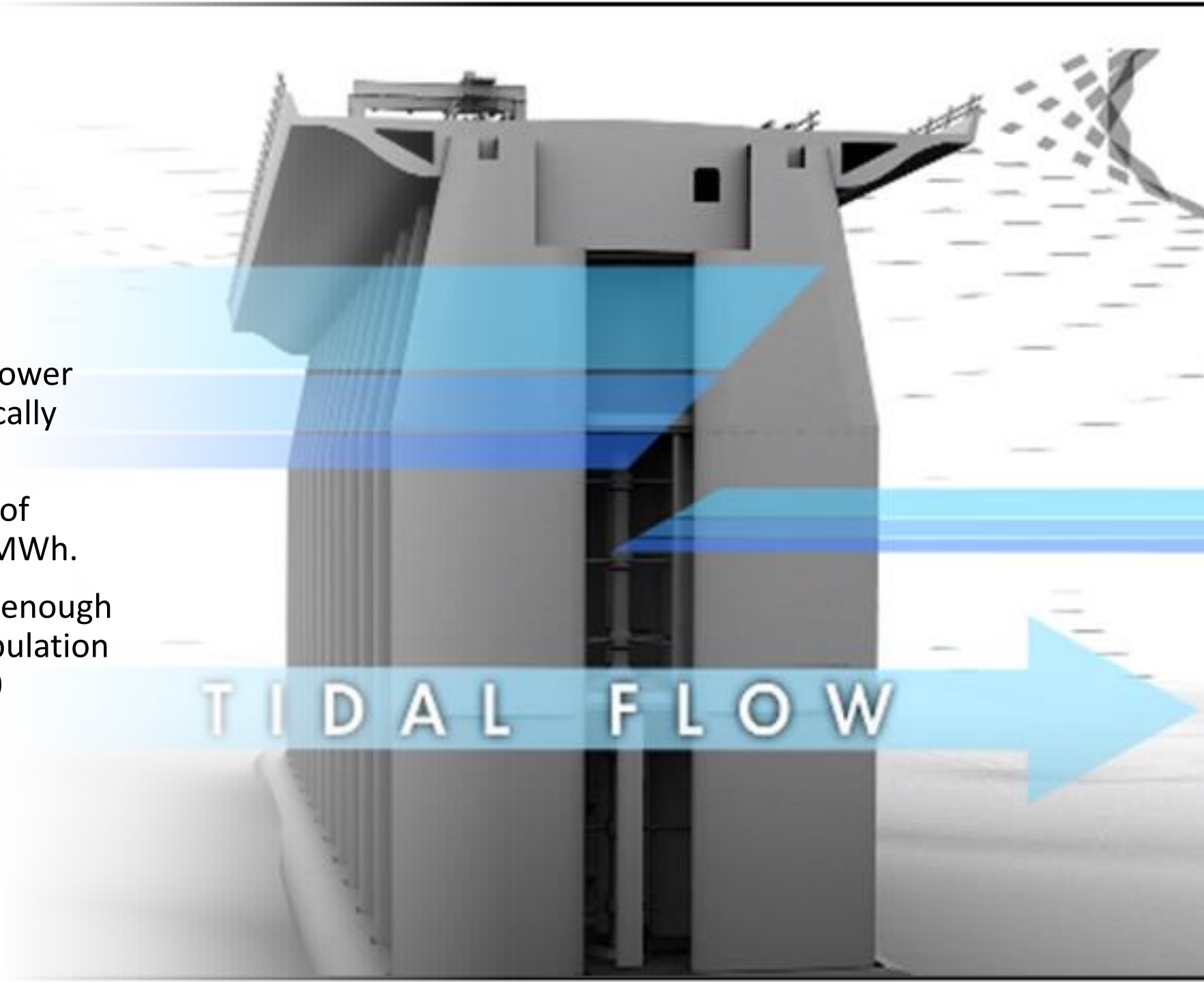
Specific  
Considerations for  
Tumaco

---

Impact	Recommendation
Protected Areas	Avoid projects in Gorgona National Park and Malpelo Flora and Fauna Sanctuary
Biodiversity	Assess impact on mangroves, which harbor significant biodiversity
Fishery	Assess impact on artisanal fishing communities, which depend on fishing for their livelihoods
Cultural Heritage	Assess visual impact on Tumaco's rich cultural heritage

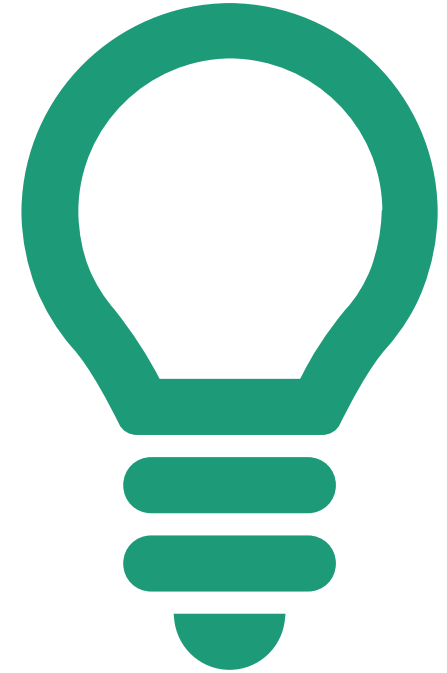
# Results

- The reservoir-type tidal power plant in Tumaco is technically feasible.
- The plant's levelized cost of energy (LCOE) is \$75.71/MWh.
- The plant could generate enough electricity to supply a population of approximately 100,000 inhabitants.



# Conclusions

- The study concludes that tidal energy is a viable option for electricity generation in Tumaco, Colombia.
- The reservoir-type tidal power plant could help reduce dependence on fossil fuels, mitigate climate change and generate employment in the region.



QUESTIONS

