

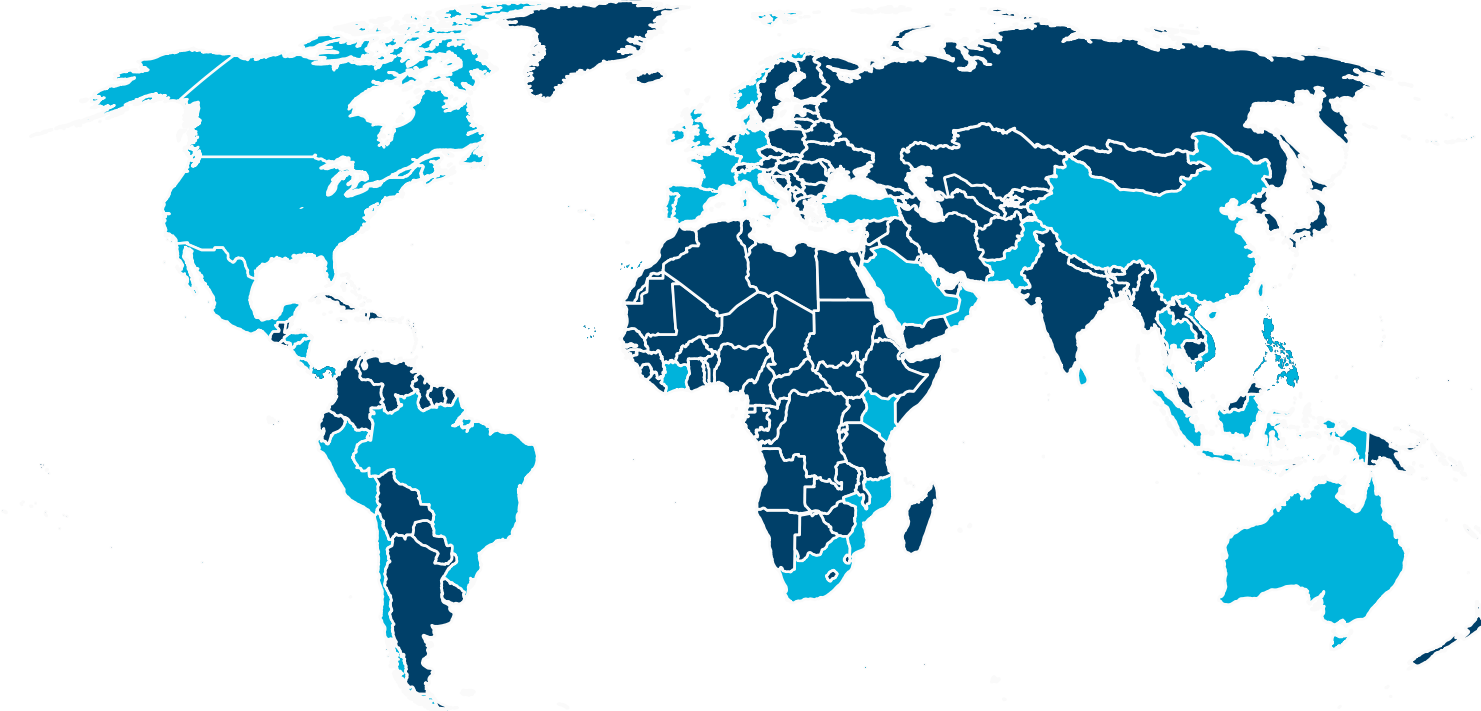


Aquaculture Geospatial intelligence





LONGLINE
ENVIRONMENT



GOVERNANCE | RISK | ENVIRONMENTAL INTELLIGENCE

History – Founded in 2005 and headquarters in London, UK.

Mission – Building applied technology solutions for sustainable aquaculture.

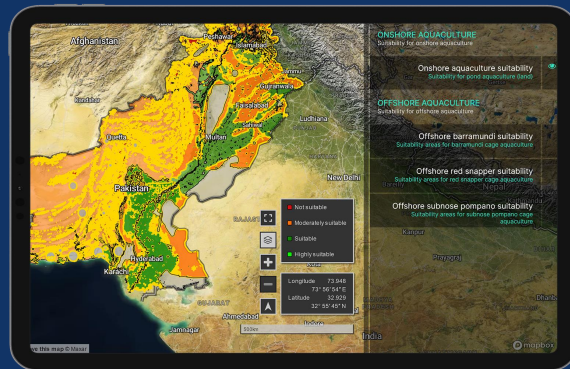
Track record - Clients in over 42 countries across Africa, Asia, Europe, North America, South America and Australia.

LONGLINE ENVIRONMENT | CLIENTS



Mission

Automate aquaculture geospatial intelligence that simplify decisions for farmers, government and investors



- 1. Farmers.** Help farmers locate the best areas to farm aquatic protein.
- 2. Government.** Help governments make the best regulatory decisions at the cheapest cost.
- 3. Investors.** Build the tools that provide investors' confidence and understanding of the sector.





5 Aquaculture Atlases



Cabo Verde



Pakistan



Ivory Coast

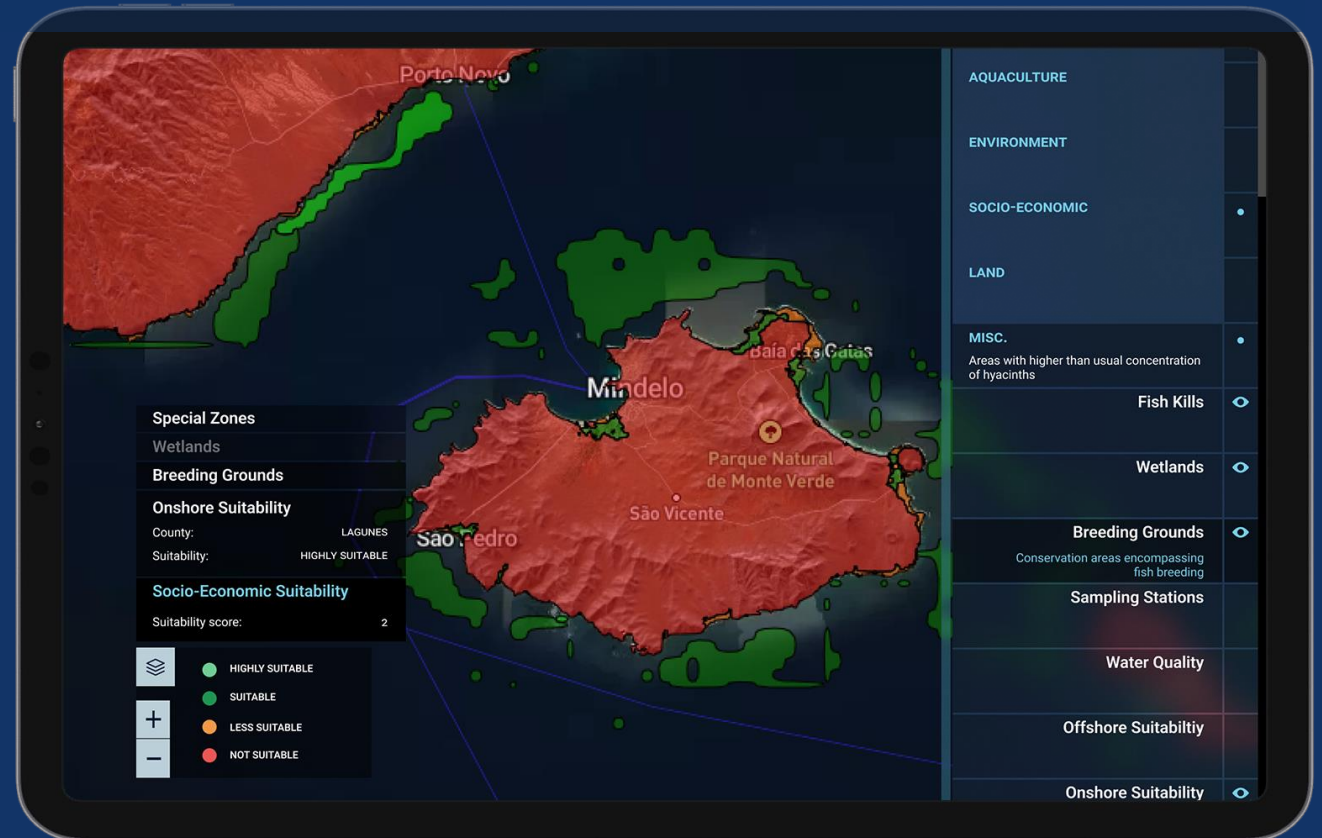


Oman

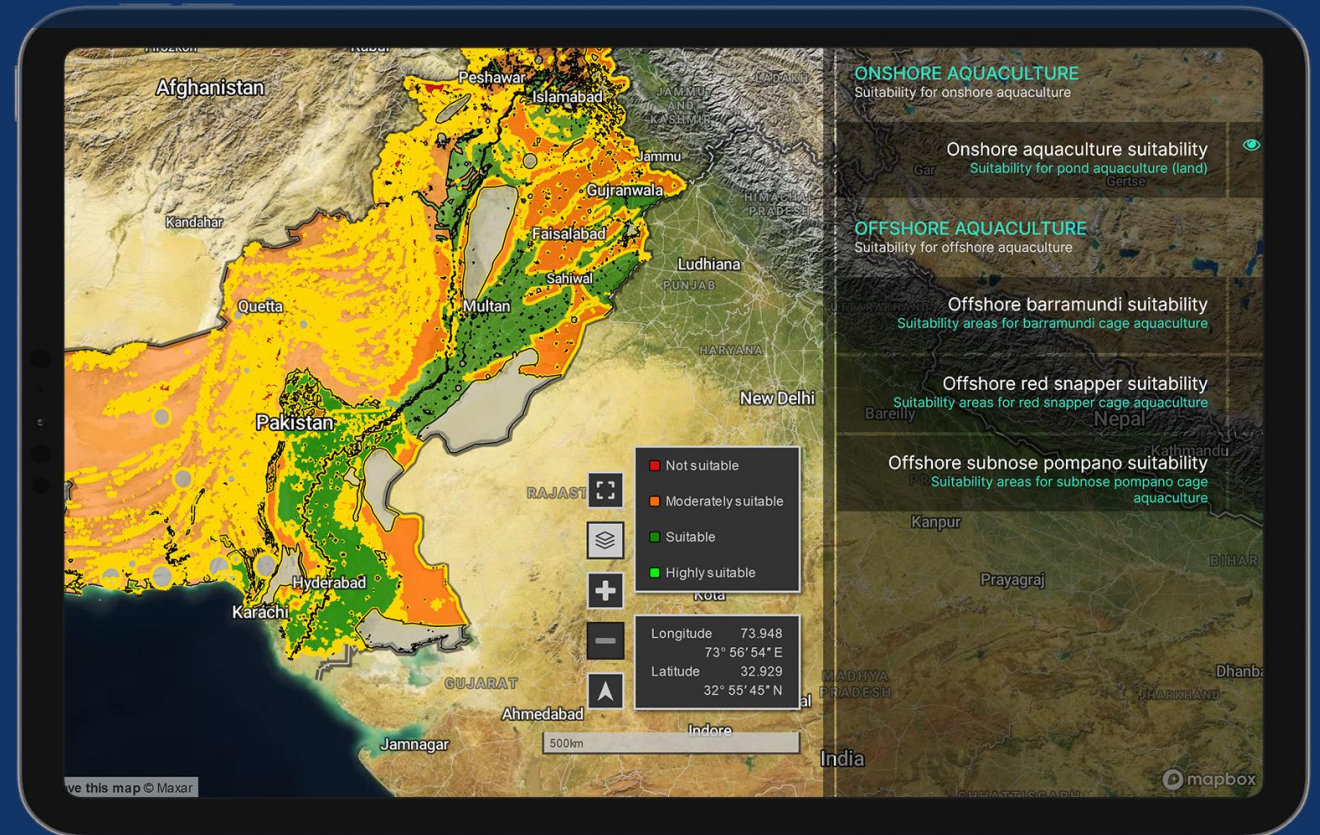


Honduras

Cabo Verde (cva.blue)



Pakistan (pak.blue)



Ivory Coast



An interactive map interface for the Ivory Coast. The map shows a color-coded suitability score for different areas. A legend in the bottom left corner defines the colors: green for 'HIGHLY SUITABLE', light green for 'SUITABLE', orange for 'LESS SUITABLE', and red for 'NOT SUITABLE'. A data panel on the left lists 'Special Zones' including 'Wetlands', 'Breeding Grounds', 'Onshore Suitability' (County: LAGUNES, Suitability: HIGHLY SUITABLE), and 'Socio-Economic Suitability' (Suitability score: 2). A right-hand sidebar contains a list of categories: AQUACULTURE, ENVIRONMENT, SOCIO-ECONOMIC, LAND, MISC. (Areas with higher than usual concentration of hyacinths), Fish Kills, Wetlands, Breeding Grounds (Conservation areas encompassing fish breeding), Sampling Stations, Water Quality, Offshore Suitability, and Onshore Suitability.



EEZ
EXCLUSIVE
ECONOMIC ZONE
700,000 km²



33-46 g
DAILY FISH
CONSUMPTION
PER CAPITA



10%
OF PEOPLE WORK
IN FISHERIES



1/5
OF FAMILIES
DEPEND ON THE
OCEAN



FROM 2004
PRODUCTIVITY
DECLINE DUE TO
OVERFISHING

1

Identification of suitable areas for aquaculture, based on sound science, open access data, and local knowledge

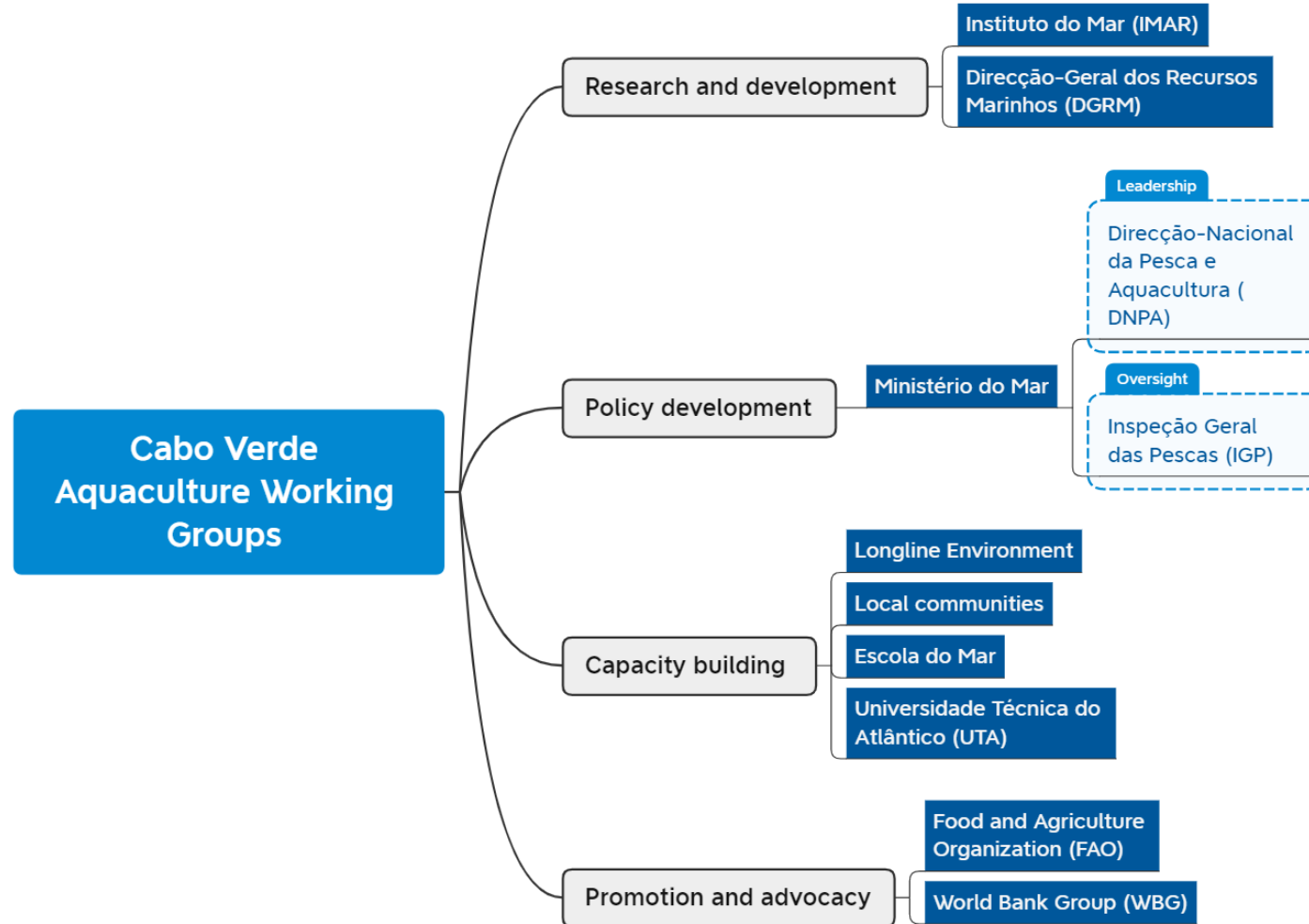
2

Integration with Cabo Verde's strategic vision, legal framework and implementation agencies

3

Guidance towards implementation, spatial planning management, and recommendation of good practices





OFFSHORE

Gilthead seabream
(*Sparus aurata*)



Tuna (*Thunnus thynnus*)



Amberjack (*Seriola dumerili*)

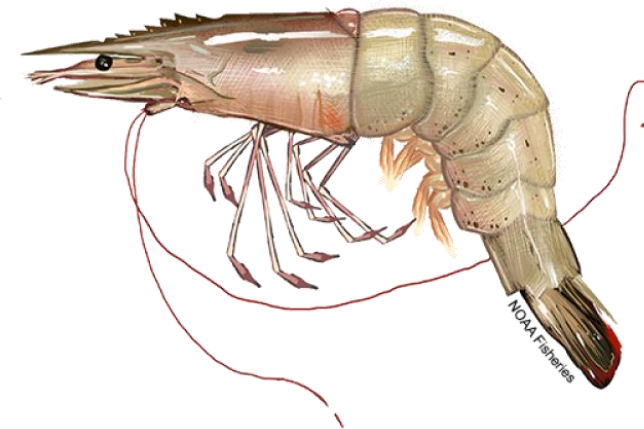


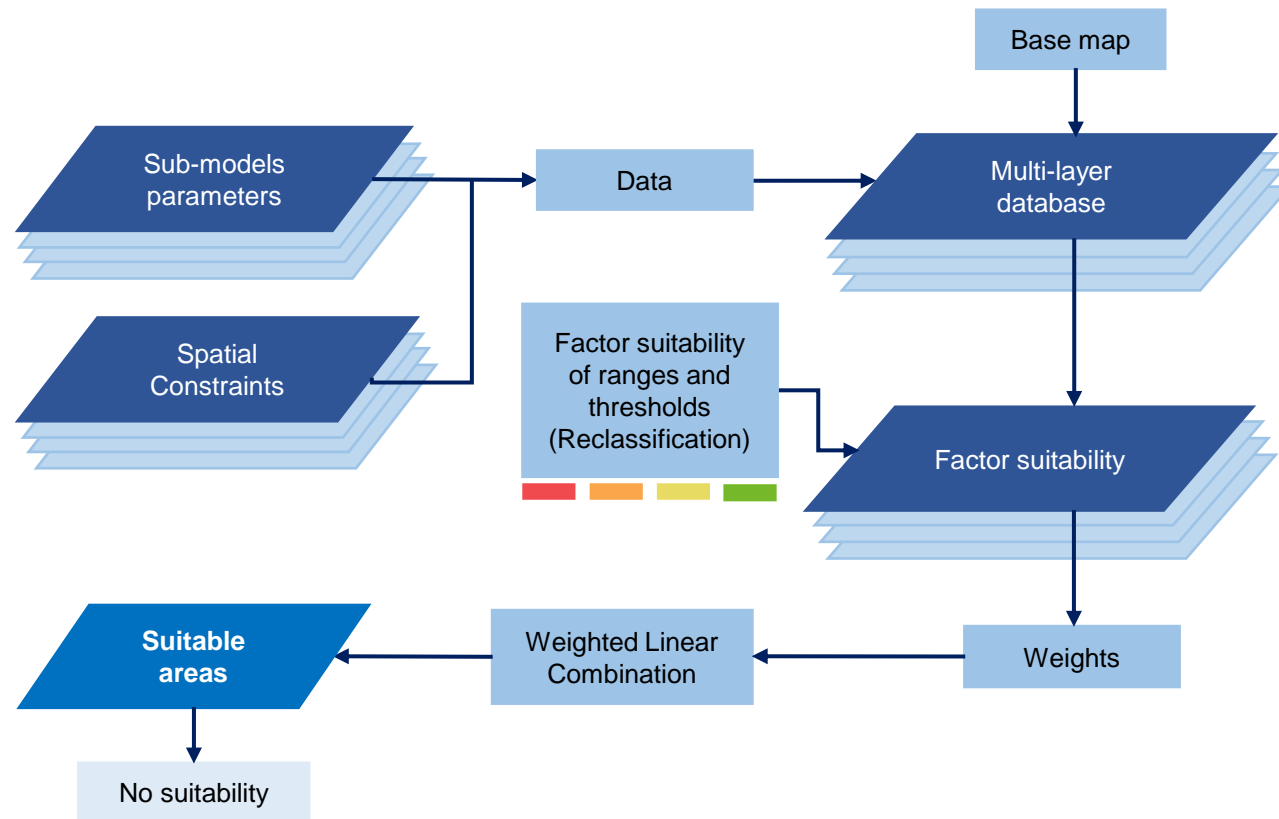
ONSHORE

Nile Tilapia (*Oreochromis niloticus*)



White-leg shrimp
(*Penaeus vannamei*)





- The classification of suitable areas for onshore and offshore aquaculture is based on seven sub-models:

- Water Quality
- Spatial Constraints
- Socioeconomic
- Soil Quality
- Infrastructures
- Hydrography
- Topography

- Datasets are reclassified on a scale of 1 to 4:

- 1 = Not suitable
- 2 = Moderately suitable
- 3 = Suitable
- 4 = Highly suitable

- The sub-models multi-layers are combined using a **Weighted Linear Ponderation**, using a **Multi-Criteria Analysis (AMC)**

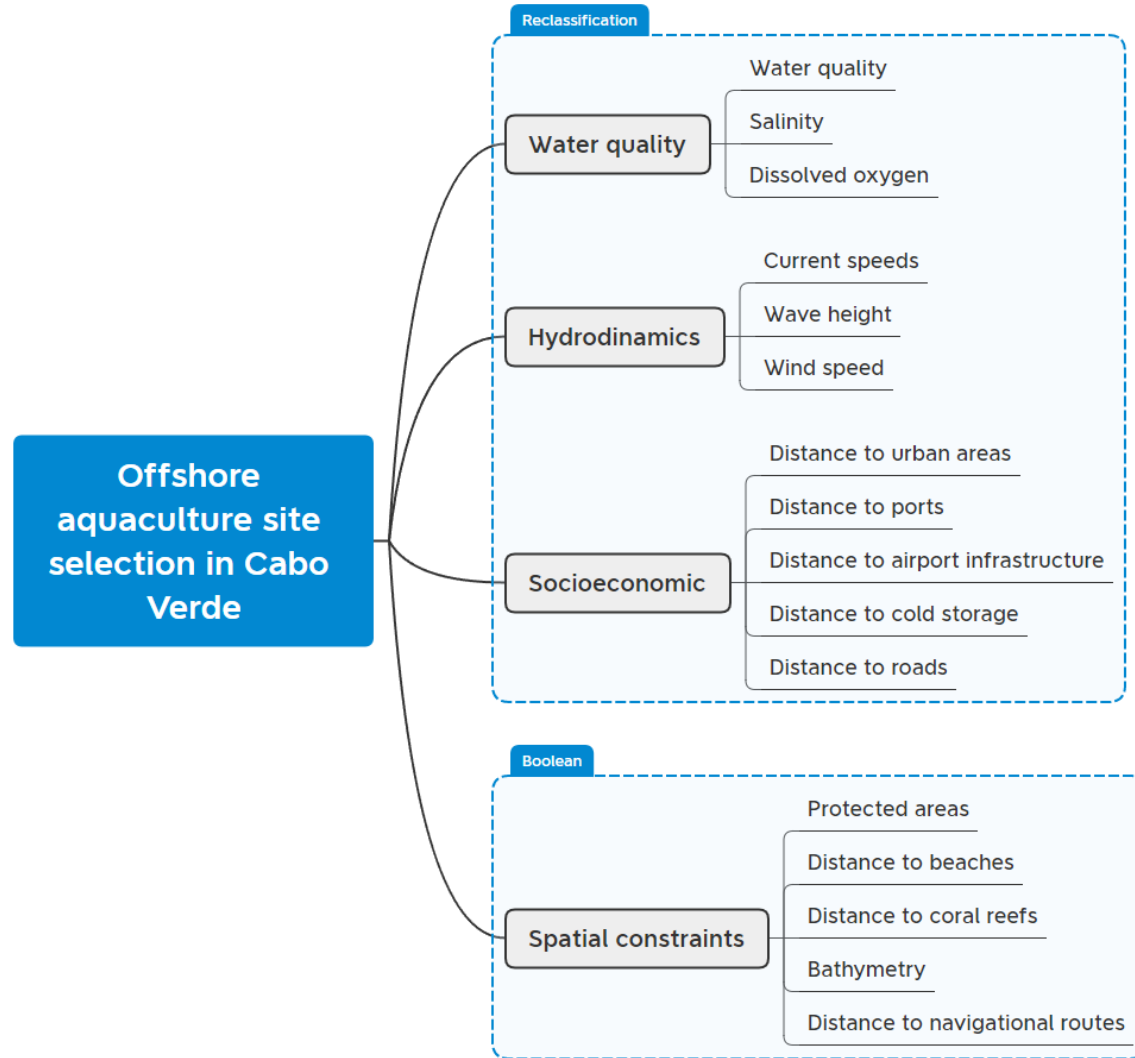
- The final suitability map corresponds to the sum of the sub-models, multiplied by spatial restrictions



- The success of the spatial plan implementation depends on the validation of stakeholders from several sectors, including:
 - Fisheries
 - Tourism
 - Infrastructures
 - Environment
 - Local communities

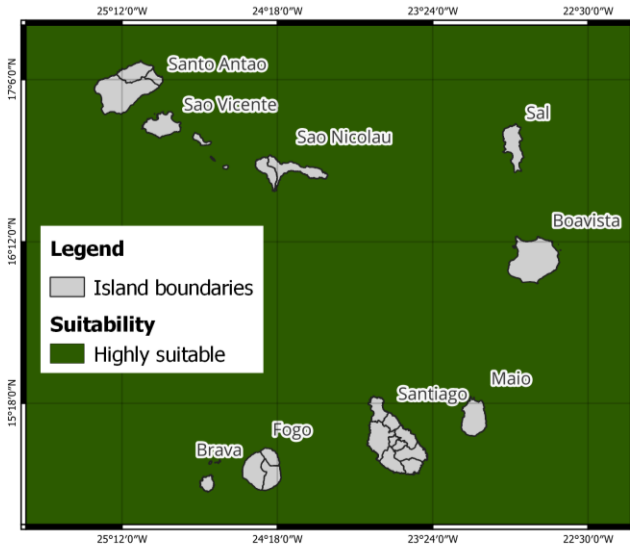


OFFSHORE AQUACULTURE

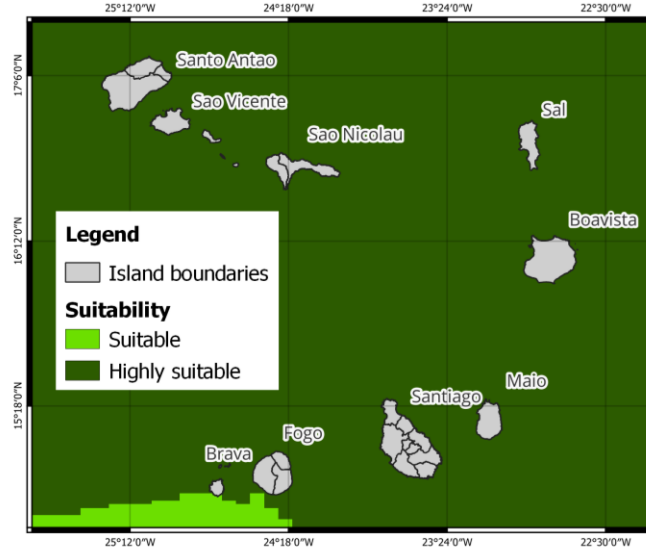




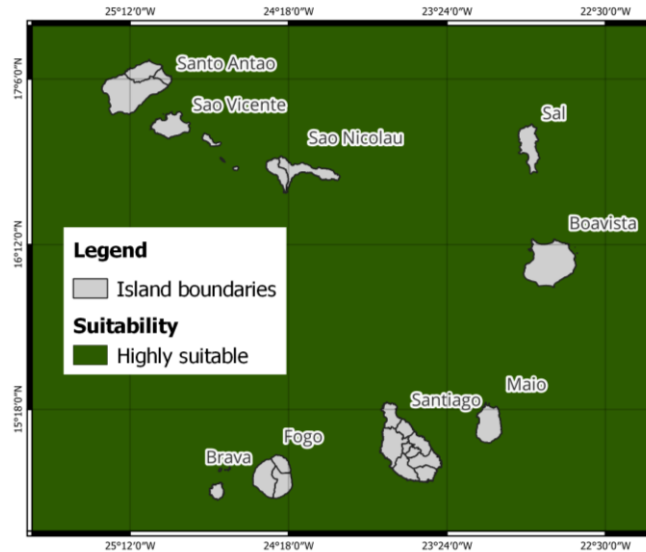
Atlantic Bluefin Tuna



Gilthead Seabream

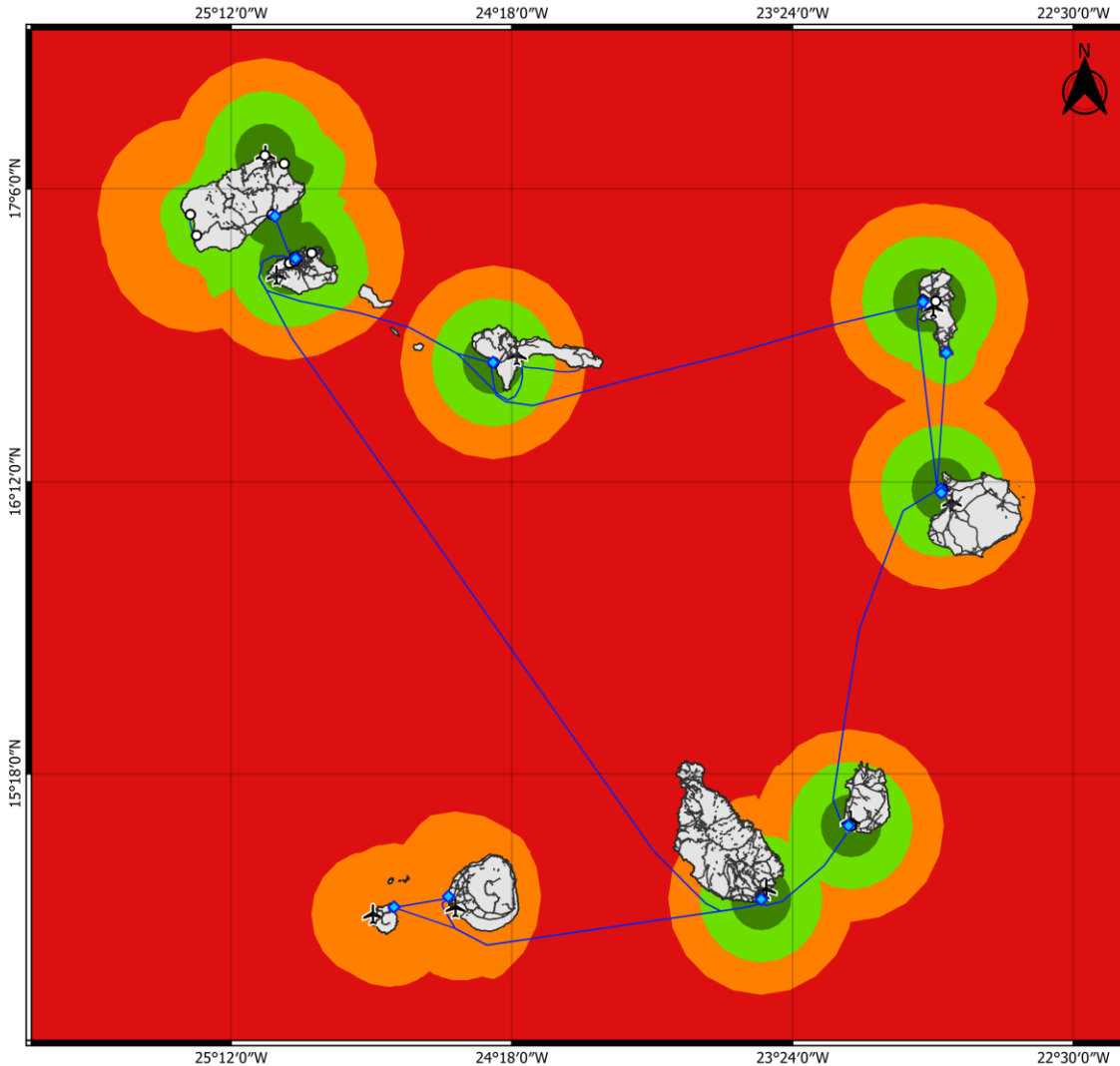


Greater Amberjack



Water temperature, salinity and dissolved oxygen are within the suitable and optimal ranges for the production of **Atlantic Bluefin Tuna, Gilthead Seabream, and Greater Amberjack.**

	Unit	Score			
		Not suitable	Moderately suitable	Suitable	Highly Suitable
Water Quality					
Atlantic Bluefin Tuna					
Temperature	°C	<3 & >30	3-15	20.5-30	15-20.5
Dissolved Oxygen	mg/L	<3 & >13	3-6	9-13	6-9
Salinity	psu	<18 & >40	18-30	38-40	30-38
Gilthead Seabream					
Temperature	°C	<6 & >33	6-17	25-33	17-25
Dissolved Oxygen	mg/L	<2.7 & >10	2.7-7	6-7	7-9
Salinity	psu	<5 & >44	5-15	38-44	15-38
Greater Amberjack					
Temperature	°C	10 & >36	10-18 & 30-36	18-26	26-30
Dissolved Oxygen	mg/L	<2	2-5	5-6 & 7-12	6-7
Salinity	psu	<20 & >40	20-28 & 36-40	28-30	30-36



Offshore aquaculture socioeconomic suitability

- Island boundaries
 - Airports
 - Road network
 - Ports
 - Cold storage
- Suitability**
- Not suitable
 - Moderately suitable
 - Suitable
 - Highly suitable

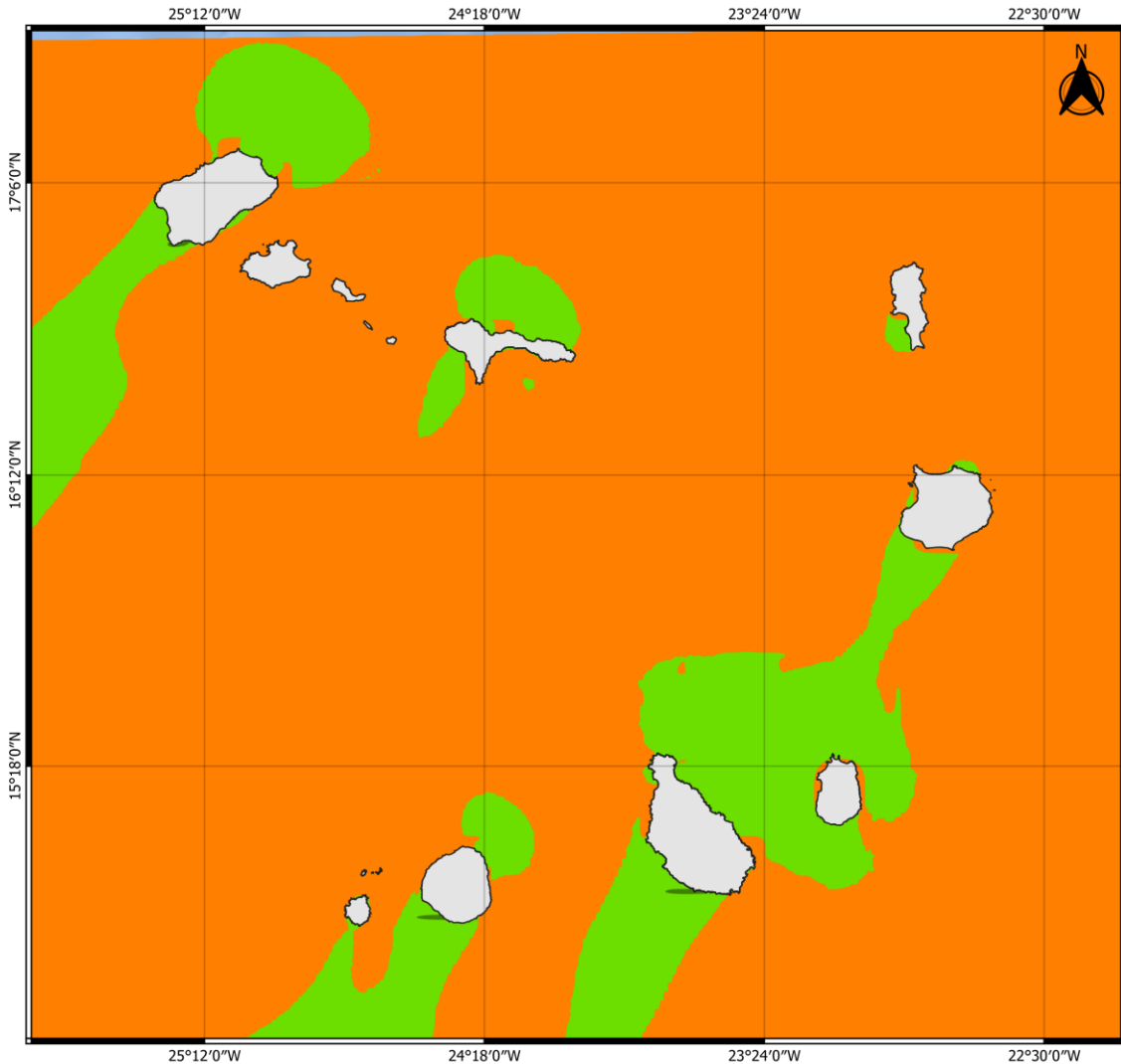
Projection

Coordinate Reference System: WGS84
 Code: EPSG 4326
 Area of use: World - N hemisphere - 22°W to 25°W Open
 CRS Type: Geographic 2D
 Coordinate System: Elipsoidal 2D CS




0 25 50 75 km

	Scoring			
	Not suitable	Moderately Suitable	Suitable	Highly suitable
Socioeconomic				
Distance to roads (km)	>30	20-30	10-20	<10
Distance to urban areas (km)	>30	20-30	10-20	<10
Distance to ports (km)	<1 & >30	20-30	10-20	1-10
Distance to airports (km)	>30	20-30	10-20	<10
Distance to cold storage (km)	>30	20-30	10-20	<10

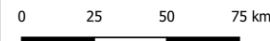
- The results of this sub-model are mainly influenced by the **distance to cold storage**.
- **Highly suitable** areas are located in the vicinity of ports, cold storage, urban areas and airports (< 10km)
- Suitability was considered for a perimeter of 25 km from these socioeconomic parameters, without prejudice for farms operations



Offshore aquaculture hydrodynamic suitability

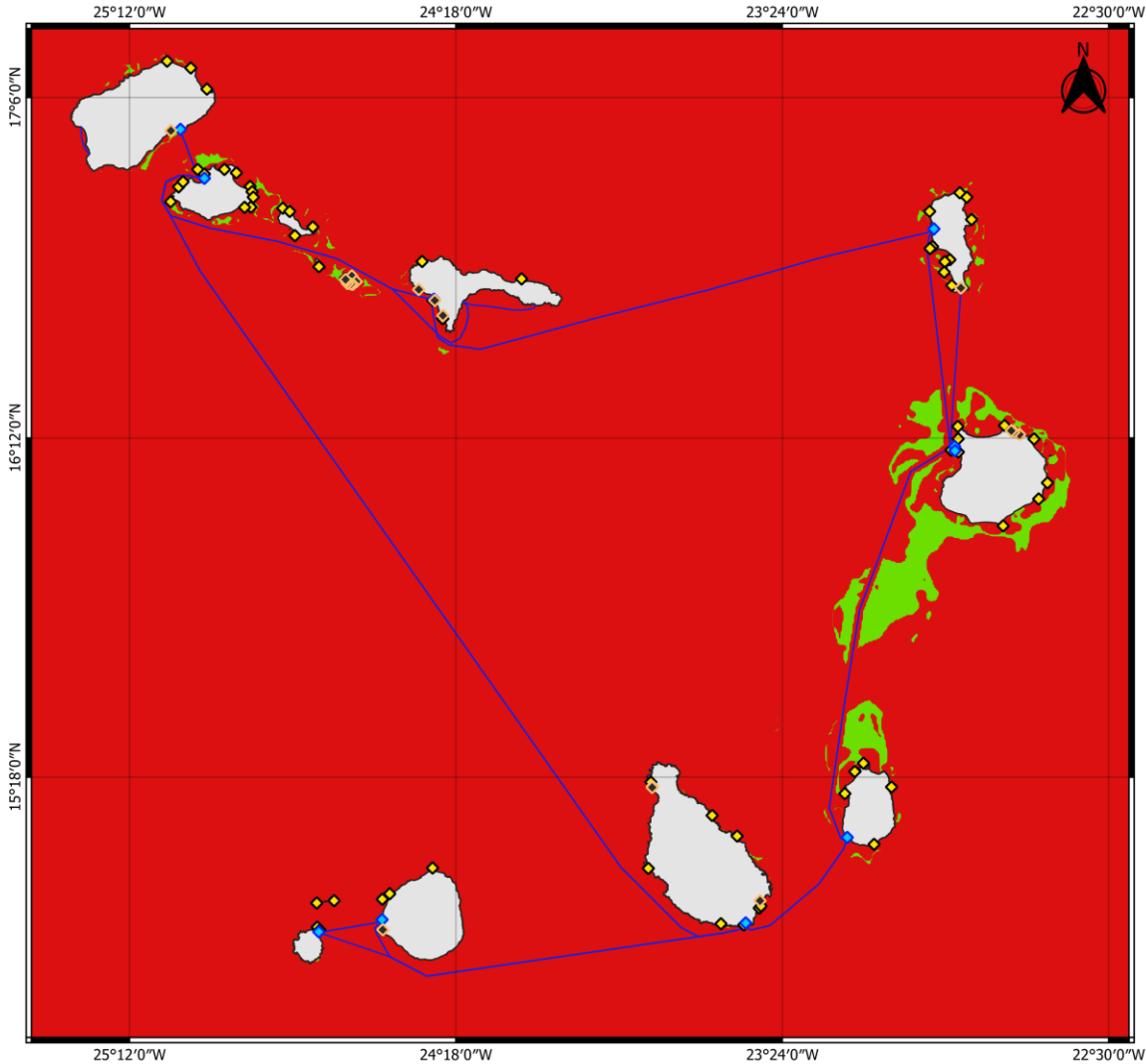
-  Island boundaries
-  Moderately suitable
-  Suitable

Projection
 Coordinate Reference System: WGS84
 Code: EPSG 4326
 Area of use: World - N hemisphere - 22°W to 25°W Open
 CRS Type: Geographic 2D
 Coordinate System: Elipsoidal 2D CS



	Unit	Scoring			
		Not suitable	Moderately suitable	Suitable	Highly suitable
Hydrodynamics					
Current speed	m/s	<0.05 & >0.2	0.05-0.1	0.15-0.2	0.1-0.15
Wave height	mg/L	>8	5-8	1-5	0-1
Wind speed	m/s	>10	5.5-10	4-5.5	0-4

- Hydrodynamic-related suitability varies from **moderately suitable** to **suitable** for the EEZ of Cabo Verde
- Wind speed is the most influencing factor, with a weighting of 67%, followed by current speed (23%) and wave height (10%)
- There was no record of waves higher than 8 m, nor currents under 0.05 m/s



Offshore aquaculture spatial constraints

- Island boundaries
- ◆ Coral reefs
- ◆ Beaches
- Navigation routes

Availability

- Not available
- Available

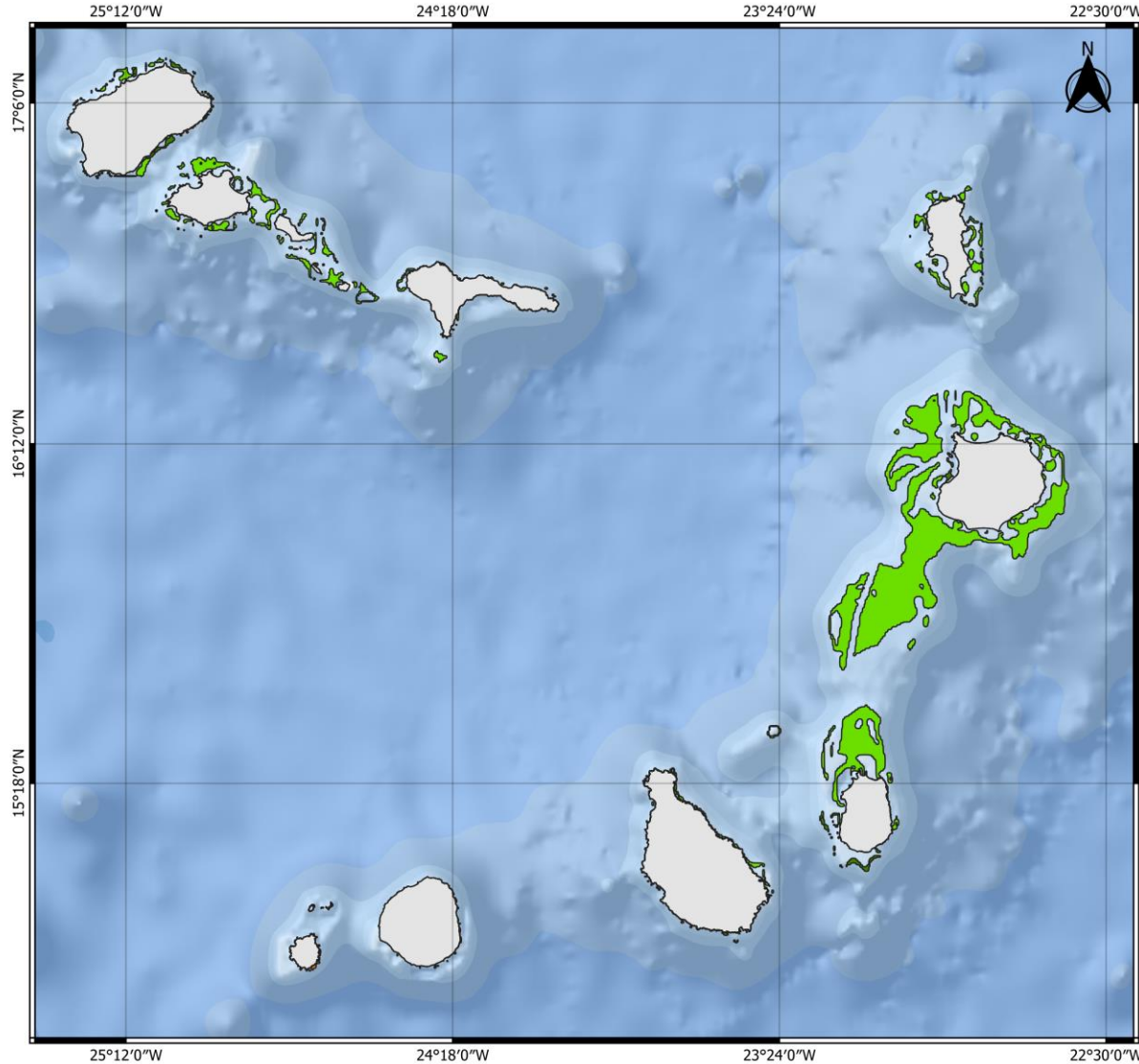
Projection

Coordinate Reference System: WGS84
 Code: EPSG 4326
 Area of use: World - N hemisphere - 22°W to 25°W Open
 CRS Type: Geographic 2D
 Coordinate System: Elipsoidal 2D CS


0 25 50 75 km

	Unit	Scoring	
		Not available	Available
Spatial Constraints			
Protected areas	-	<i>excluded</i>	
Distance to navigation routes	km	<1	>1
Distance to reefs	km	<500	>500
Distance to beaches	km	<500	>500
Bathymetry	m	>20 & >85	20-85

- **1,689 km²** of the Cabo Verde EEZ are **available** for offshore aquaculture
- Most part of the available area is located around the islands of Boavista and Maio.
- Aquaculture is not possible below 85 m, in less than 1 km from navigation routes and less than 500 m from beaches and reefs



Offshore aquaculture suitability

-  Island boundaries
- Suitability**
-  Moderately suitable
-  Suitable
-  Highly suitable

Projection

Coordinate Reference System: WGS84
 Code: EPSG 4326
 Area of use: World - N hemisphere - 22°W to 25°W Open
 CRS Type: Geographic 2D
 Coordinate System: Elipsoidal 2D CS



2.6%

HIGHLY SUITABLE
45.1 km²



97%

SUITABLE
1,637.4 km²



1,689
km²
OFFSHORE
AQUACULTURE

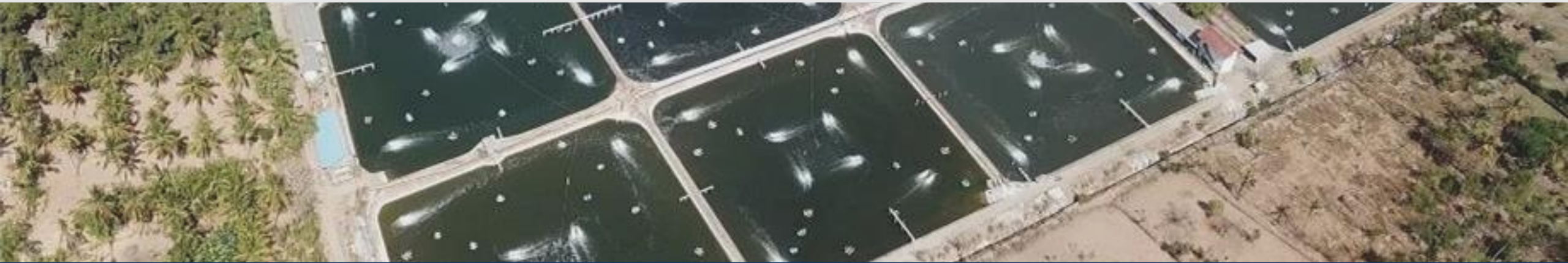


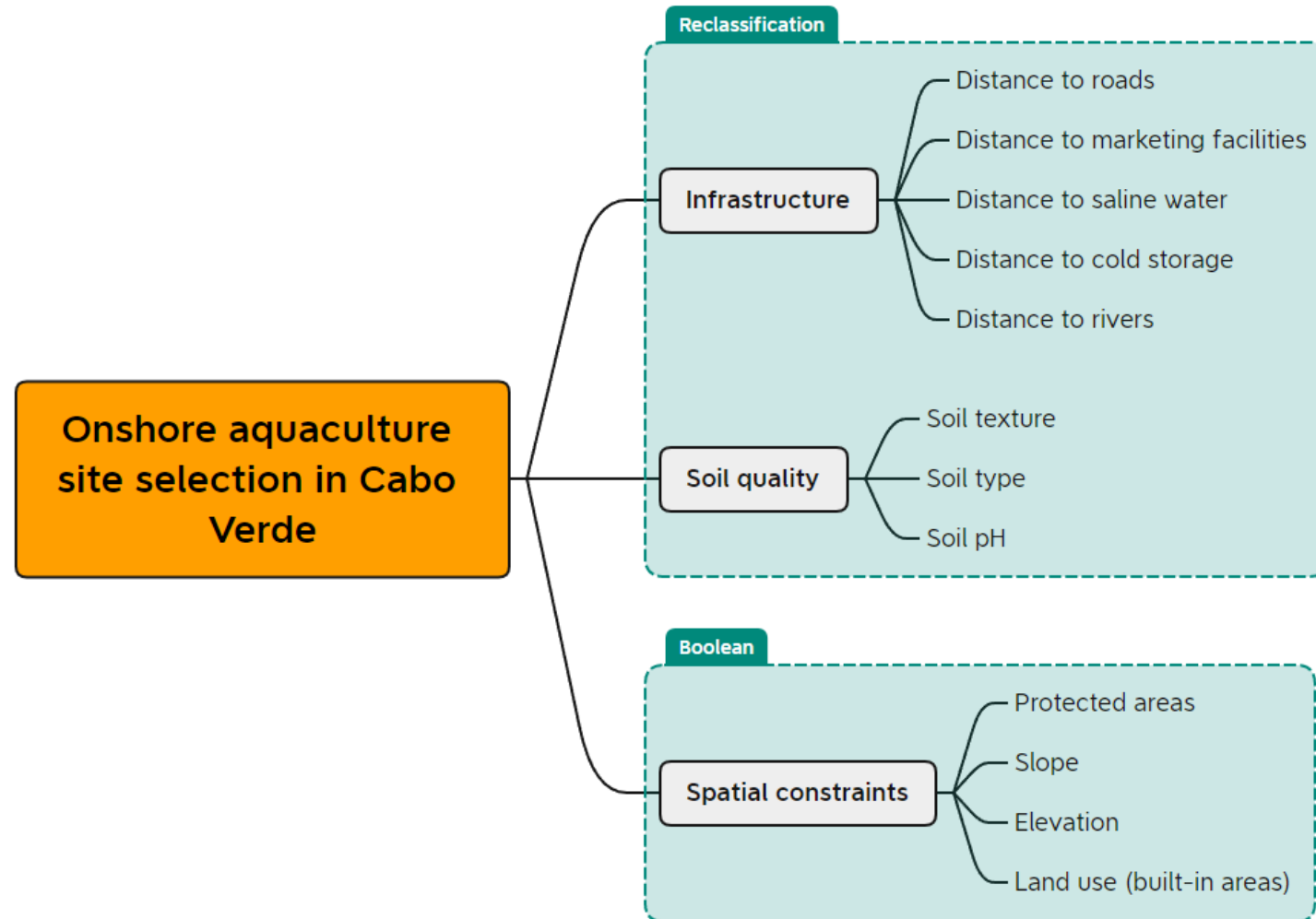
0.4%

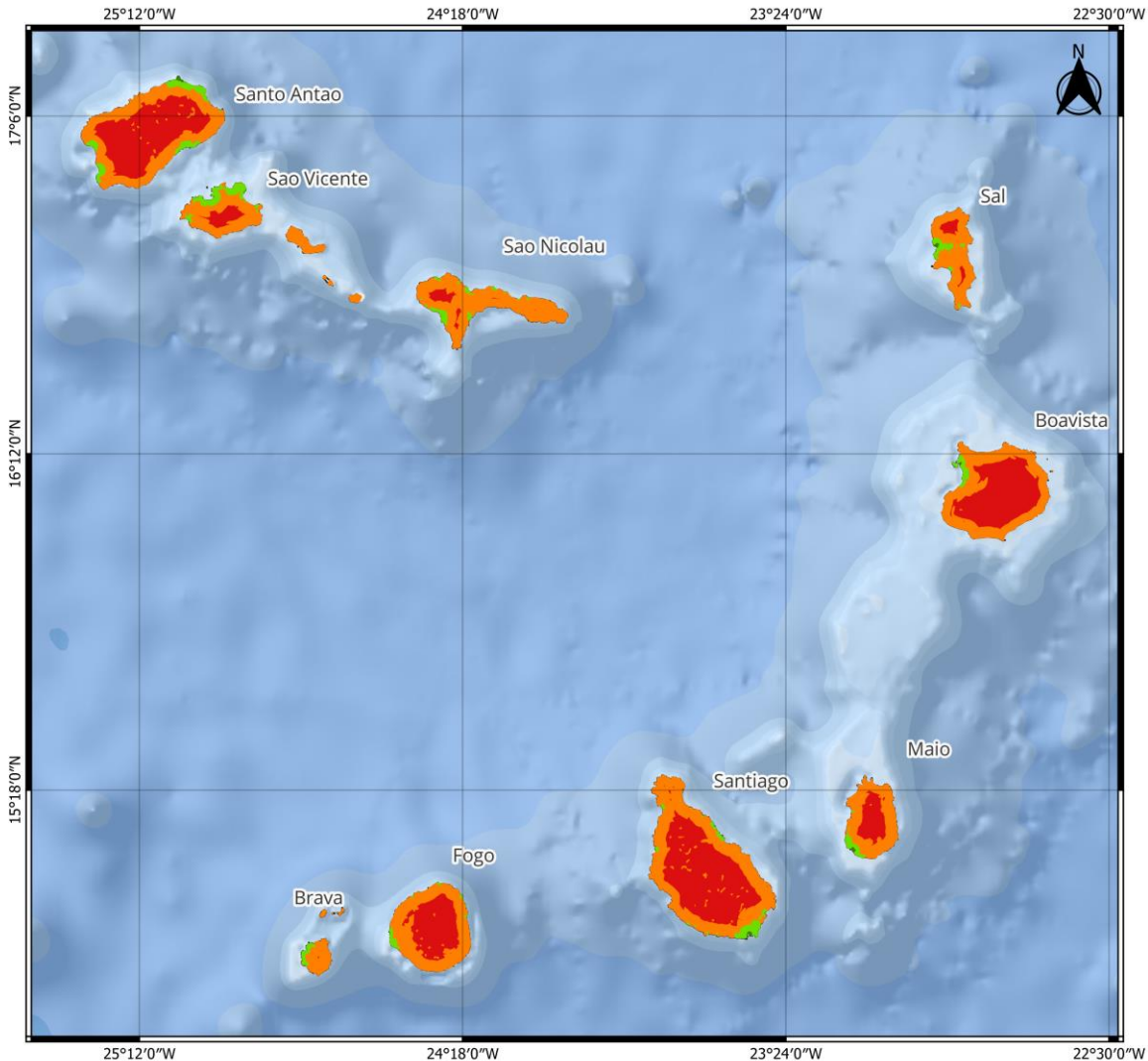
MODERATELY
SUITABLE
6.2 km²



ONSHORE AQUACULTURE







Onshore aquaculture infrastructure suitability

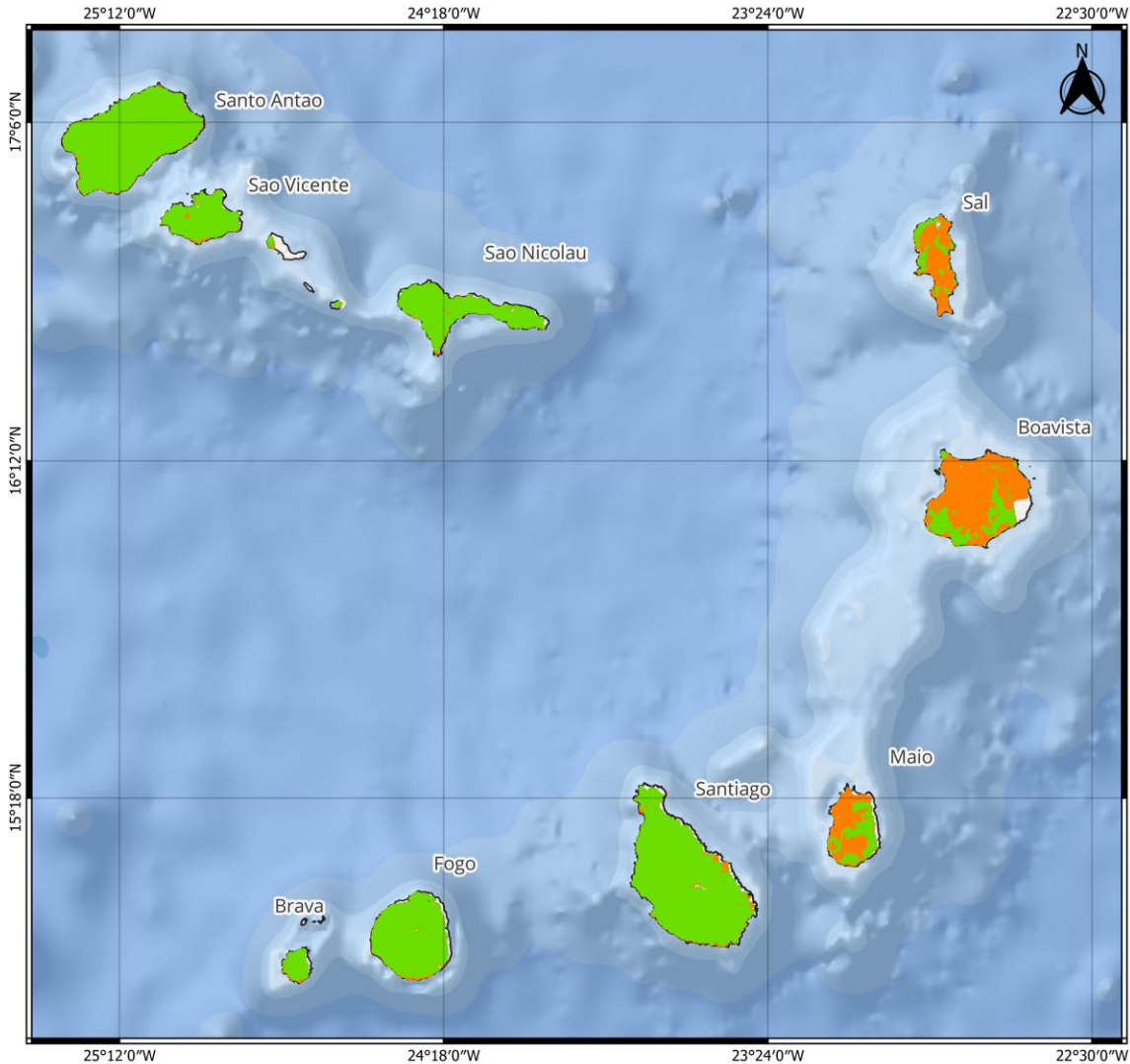
- Island boundaries
- ✈ Aeroports
- Rivers
- Road network
- Markets
- Cold storage

- Suitability**
- Not suitable
 - Moderately suitable
 - Suitable
 - Highly suitable



	Scoring			
	Not suitable	Moderately suitable	Suitable	Highly suitable
Socioeconomic				
Distance to roads (km)	>2	1-2	0.5-1	<0.5
Distance to markets (km)	-	>4	<1 & 2-4	1-2
Distance to salt water (km)	>3	2-3	1-2	<1
Distance to airports (km)	>20	10-20	5-10	<5
Distance to rivers (km)	>3.5	2.5-3.5	1-2.5	<1
Distance to cold storage (km)	>10	4-10	<1 & 2-4	1-2

- The most significant **highly suitable** areas are located in **Ribeira Grande (Santo Antão)** and in the **city of Praia (Santiago)**.
- The remaining locations are classified as **suitable**.
- When the distance to roads, markets, rivers/freshwater and airports, was greater than 8 km, suitability went from **moderately suitable** to **not suitable**.



Onshore aquaculture soil quality suitability

□ Island boundaries

Suitability

- Moderately suitable
- Suitable

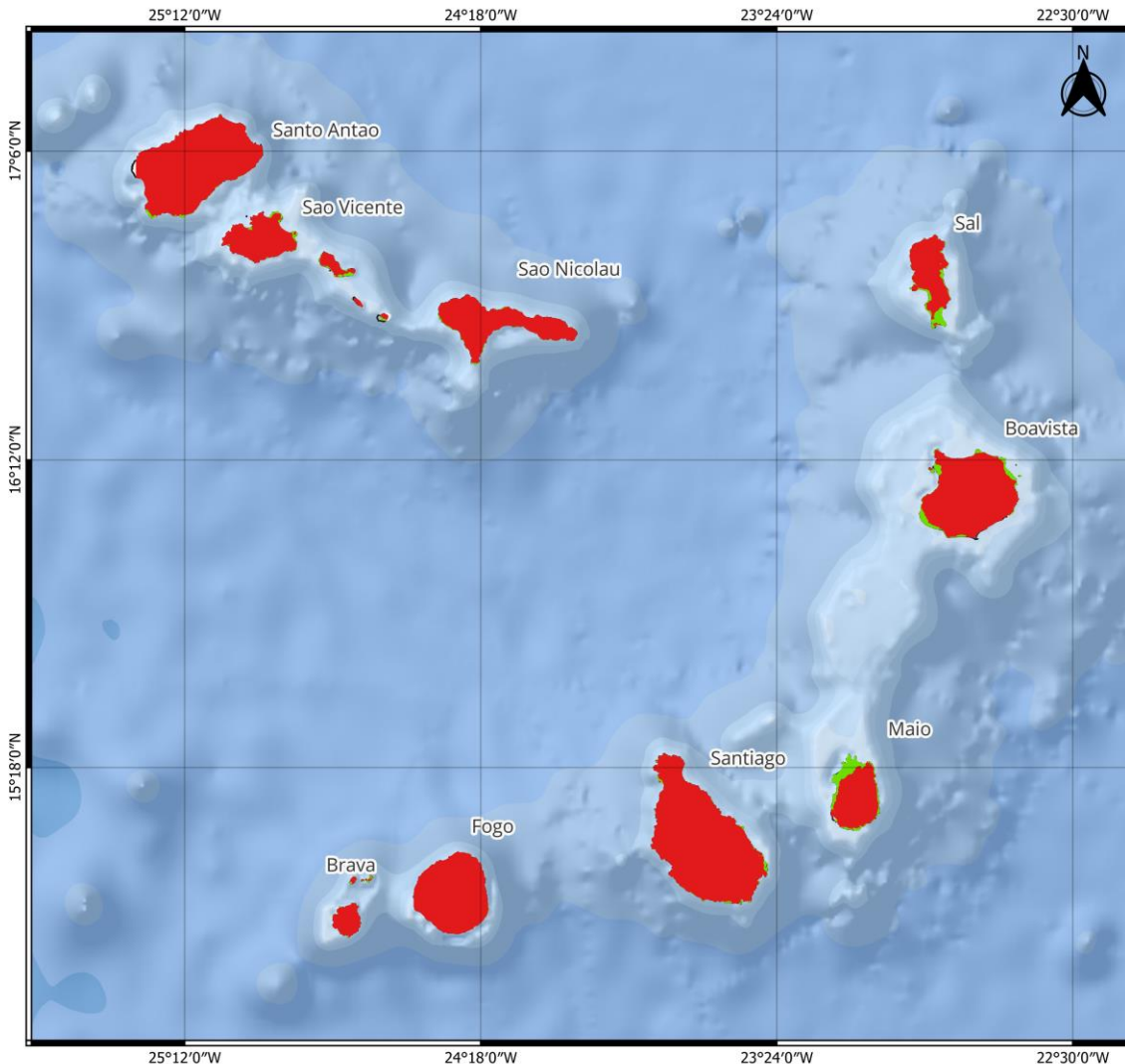
Projection

Coordinate Reference System: WGS84
Code: EPSG 4326
Area of use: World - N hemisphere - 22°W to 25°W Open
CRS Type: Geographic 2D
Coordinate System: Elipsoidal 2D CS



	Unit	Scoring			
		Not suitable	Moderately suitable	Suitable	Highly suitable
Soil quality					
Type	-	Calcisols, Gleysols	Solonchaks, Arenosols, Vertisols	Leptsols, Luvisols, Regosols	Fluvisols, Cambisols
pH	-	<4	4-5 & 7-9.5	5-6	6-7
Texture	% clay	-	<18	18-35	>35

- The islands of **Brava, Fogo, Santiago, São Vicente and São Nicolau** have **suitable** soil quality for onshore aquaculture
- The predominant soil types in Santo Antão, São Vicente, Fogo and São Nicolau are **Leptsols**
- The predominant soil types in Sal, Boavista, Maio and Brava are **Arenosols e Vertisols**



Onshore aquaculture spatial constraints

□ Island boundaries

Availability

■ Not available
■ Available

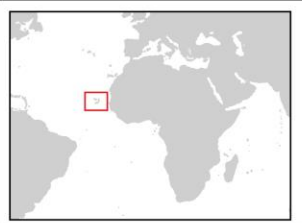
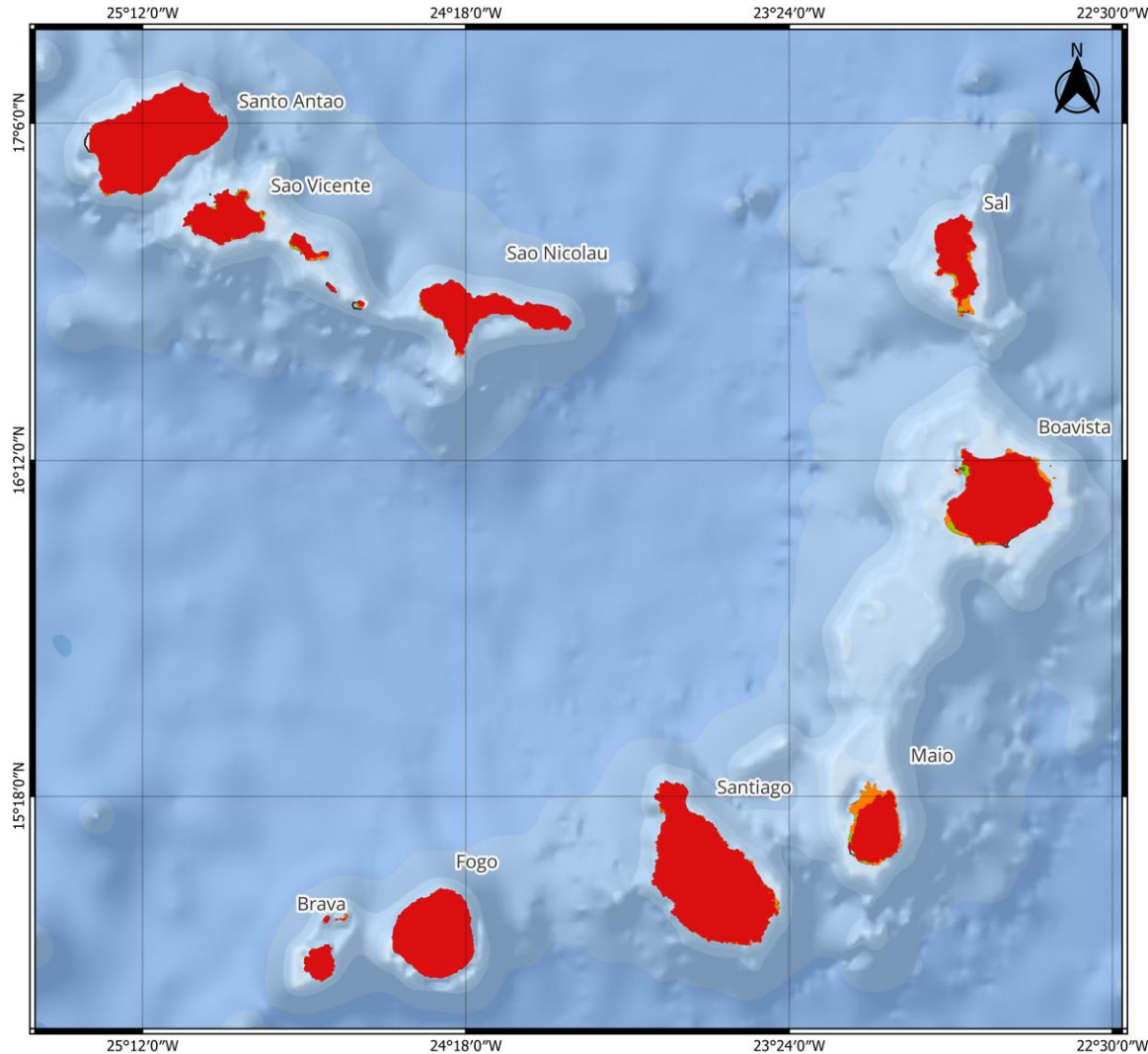
Projection

Coordinate Reference System: WGS84
Code: EPSG 4326
Area of use: World - N hemisphere - 22°W to 25°W Open
CRS Type: Geographic 2D
Coordinate System: Elipsoidal 2D CS



	Unit	Scoring	
		Not available	Available
Spatial Constraints			
Protected areas	-	<i>Excluded</i>	
Built areas	-	<i>Excluded</i>	
Elevation	m	>10 & <1	1-10
Slope	%	>10	<10

- The areas with an altitude lower than 10 m de altitude and <10% slope are found in:
 - Mindelo (São Vicente)**
 - Santa Maria, Feijoal e Murdeira (Sal)**
 - Morrinho (Maio)**
 - Fundo de Figueiras e Povoação Velha (Boavista)**
- The mountainous nature of the islands difficult the development of onshore aquaculture – **94% of the territory was excluded due to topography constraints (elevation and slope)**



Onshore aquaculture suitability

□ Island boundaries

Suitability

- Not suitable
- Moderately suitable
- Suitable
- Highly suitable

Projection

Coordinate Reference System: WGS84
 Code: EPSG 4326
 Area of use: World - N hemisphere - 22°W to 25°W Open
 CRS Type: Geographic 2D
 Coordinate System: Ellipsoidal 2D CS

0 25 50 75 km

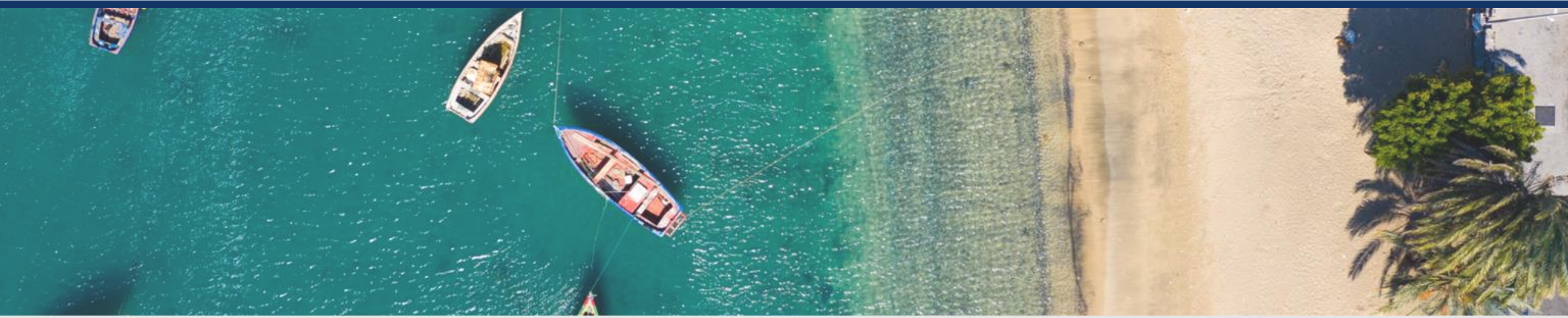
156 km²
ONSHORE
AQUACULTURE

0.2%
SUITABLE
31 km²

98%
NOT SUITABLE
153 km²

0.79%
MODERATELY
SUITABLE
124 km²

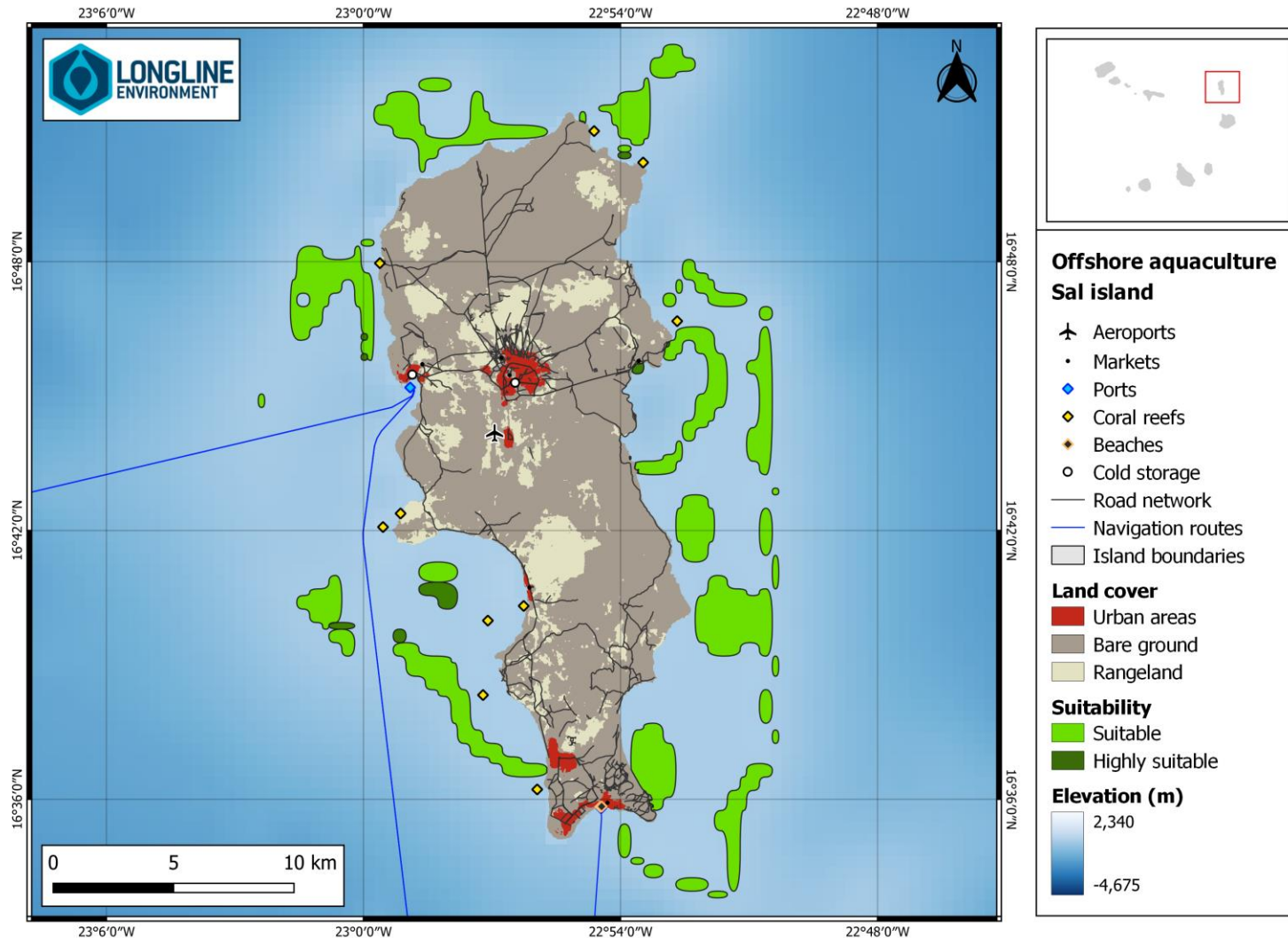
0.01%
HIGHLY SUITABLE
1 km²



SUITABILITY PER ISLAND

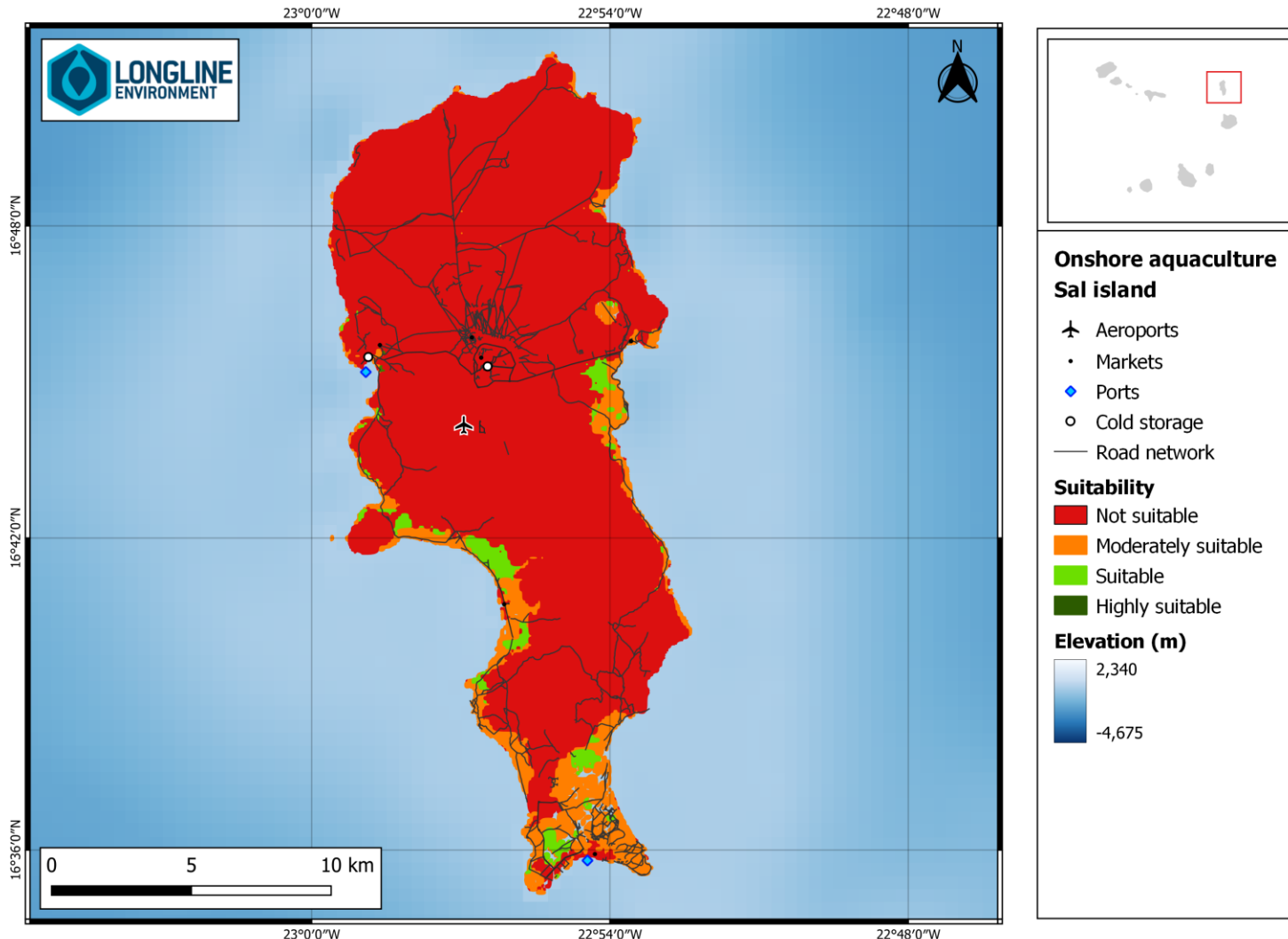


OFFSHORE



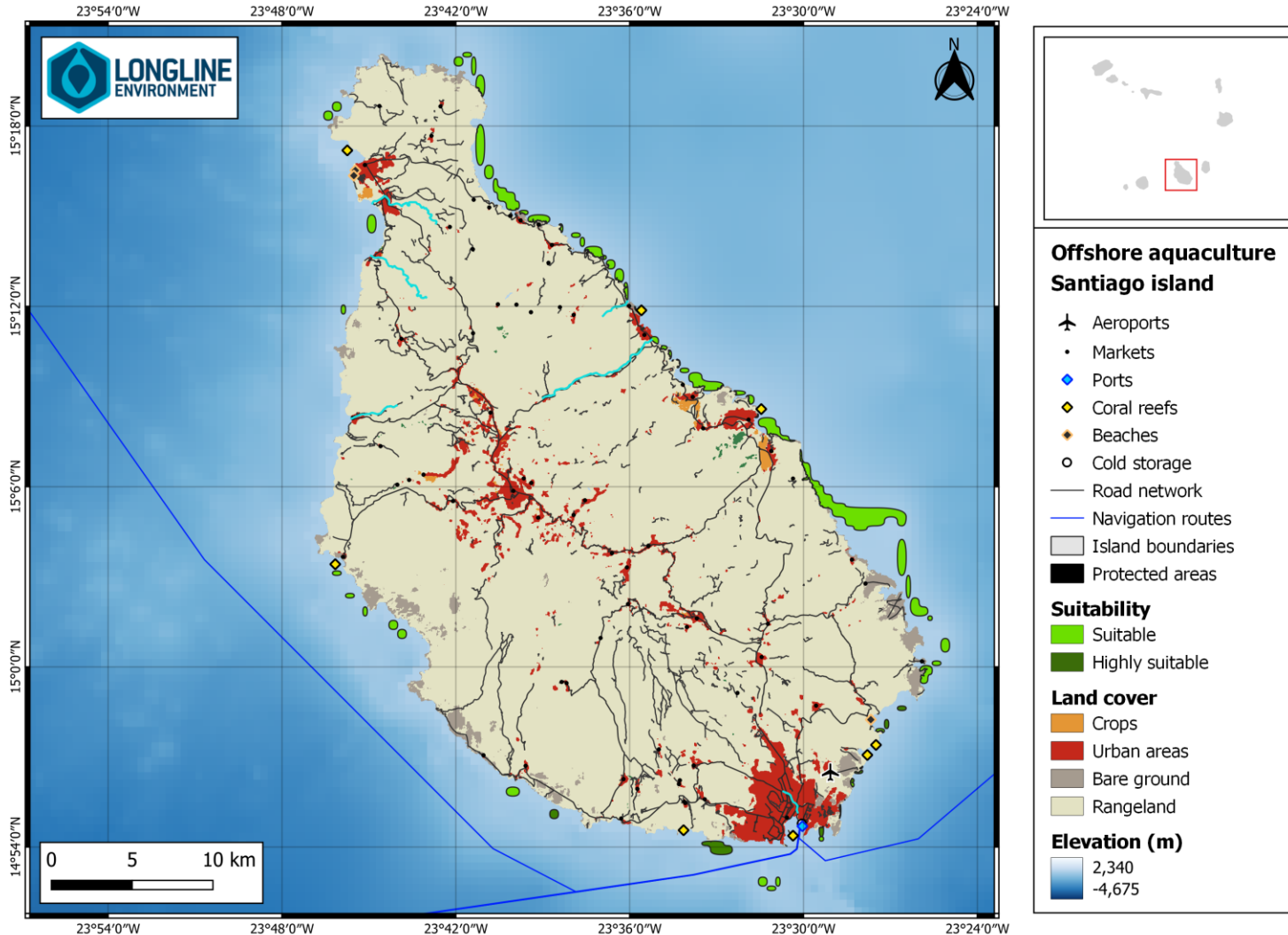
- Offshore aquaculture is available in 71.2 km² of the marine territory around Sal.
- Highly suitable areas represent 3% of the available space (2.1 km²)
- Suitable areas represent 97% of the available space (69.1 km²)
- The vicinities of the Palmeira and Santa Maria ports are excluded from cage siting.
- There are 0.16 km² in front of Pedra Lume, benefiting from optimal water quality for the species in the study, human capital, and infrastructure.
- Murdeira bay's hearth is classified as suitable to highly suitable for cage placement.

ONSHORE



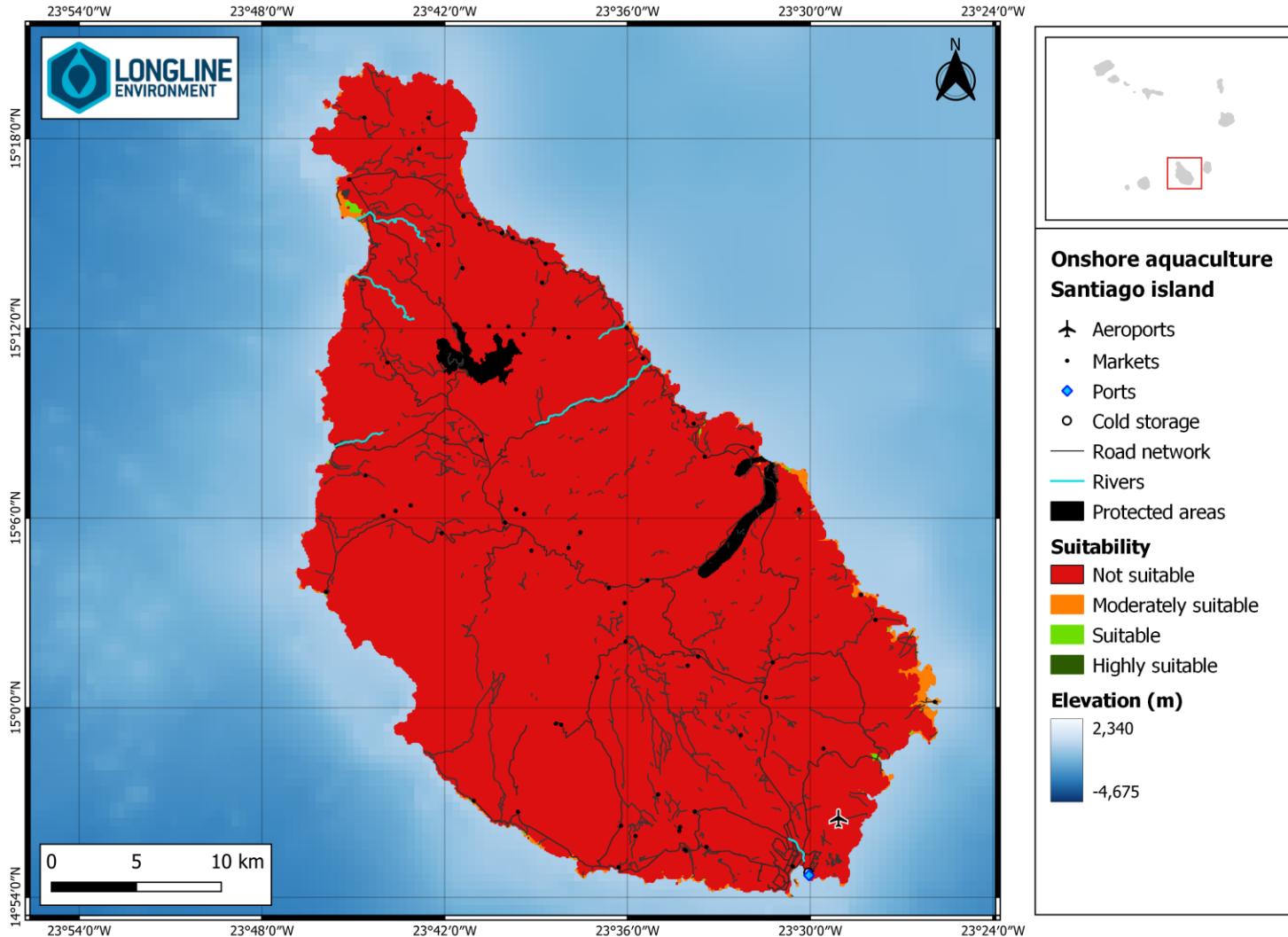
- 87% of Sal territory is excluded for onshore aquaculture (18,913 ha), which means that only 13% is available for placement of ponds (2,753 ha).
- 10% of Sal territory is moderately suitable for aquaculture placement (2,183 ha).
- 2% of Sal territory is suitable for aquaculture (565 ha).
- 4.1 ha in south Palmeira are highly suitable for aquaculture placement (0.02% of Sal territory).
- Suitability in the neighbourhoods of Santa Maria wavers from moderate to good for onshore aquaculture. Suitable areas are bare grounds between Santa Maria and the resorts and north of Santa Maria's salt pans (66 ha and 14 ha, respectively).

OFFSHORE



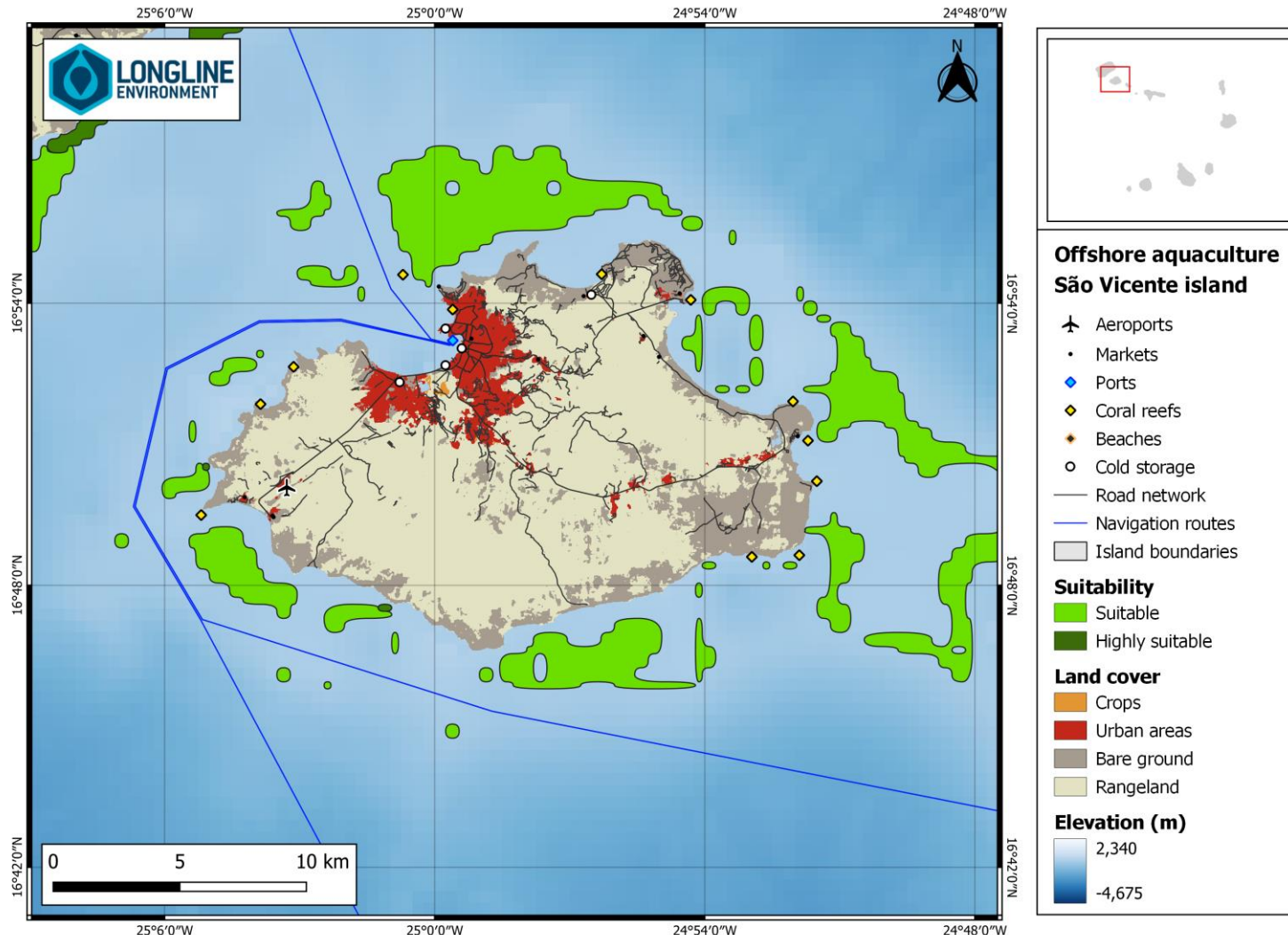
- Offshore aquaculture is available in 23.1 km² of marine space around Santiago.
- Most suitable areas are close to the shore in northeast Santiago.
- Suitable areas represent 92% of the available space (21.4 km²).
- Highly suitable areas are in the south of the island, close to shore, in areas distant 1 to 15 km from Praia town.
- Highly suitable areas represent 8% of the available water space (1.7 km²).
- There is 1.1 km² in front of the Central Eléctrica do Palmarejo, classified as highly suitable, benefiting from infrastructure, human resources, and sound ocean currents for the farmed fish.

ONSHORE



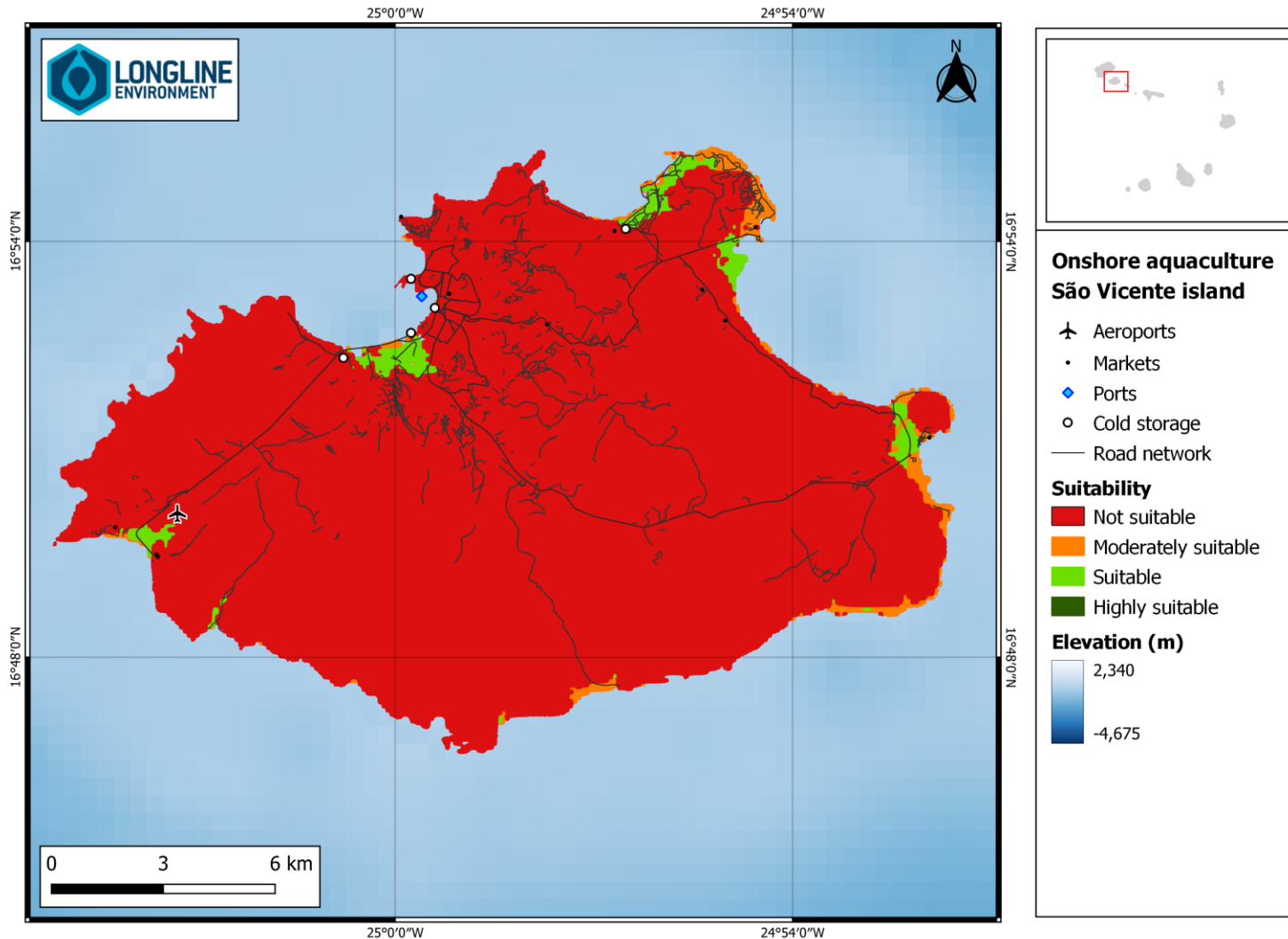
- Over 99% of Santiago territory is excluded for onshore aquaculture (889,841 ha), primarily due to the steep slopes and high altitudes, which means that only 1% of the region is available for the placement of ponds.
- 0.1% of Santiago territory is moderately suitable for aquaculture placement (909 ha).
- 0.02% of Santiago territory is suitable for aquaculture (148 ha). Suitable areas are in south Tarrafal town, near Praia de São Francisco and Cancelo settlement.
- 1 ha of Santiago territory is highly suitable for aquaculture placement in north of Praia city.
- The Natural Park of Serra da Malagueta and the Lagoa of Pedra Badejo, are protected areas excluded for pond construction.

OFFSHORE



- Areas with depths between 20 to 85m are scattered around São Vicente.
- Offshore aquaculture is available in 91.7 km² of the marine territory around São Vicente.
- Suitable areas represent over 99% of the open space (91.5 km²).
- Due to optimal hydrodynamic conditions, highly suitable areas are located south of the island and close to the shore
- The bay of Mindelo is excluded for siting due to shallow depths and proximity to the port and navigational lanes.

ONSHORE



- 99% of São Vicente territory is excluded for onshore aquaculture (889,841 ha), primarily due to the steep slopes and high altitudes for pond construction.
- 2% of São Vicente territory is moderately suitable for aquaculture placement (423 ha).
- 2% of São Vicente territory is suitable for aquaculture (440 ha).
- No highly suitable areas are identified in São Vicente, as suitability wavers between not suitable to suitable (scores 1 to 3).
- 119 ha of bare ground between Mindelo and Lazareto towns is suitable for aquaculture, benefiting from proximity to several cold storage facilities, markets, human capital and good road connection to airports.



www.cva.blue





- Maps the recommended areas for aquaculture, using a suitability scale, supporting science-based governance decisions for aquaculture licencing, private investment and security
- The intuitive interface allows to distinguish between onshore and offshore aquaculture suitability, providing a broader vision of the potential areas for aquaculture development

Offshore aquaculture	
Highly suitable	4.08 km ²
Suitable	1,143.61 km ²
Moderately suitable	0.00 km ²
Onshore aquaculture	
Highly suitable	0.84 km ²
Suitable	11.59 km ²
Moderately suitable	27.57 km ²
Not suitable	583.94 km ²

Boa Vista



Brava



Fogo



Maio



Sal



Santiago



Santo Antão



São Vicente



São Nicolau

The user can consult island-specific results of the Cabo Verde Aquaculture Atlas, disaggregated by onshore and offshore aquaculture, saving on field trips and other management operations



LONGLINE
ENVIRONMENT

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