Storm Surge Bathymetric Modeling and Risk Assessment in the United States Caribbean Territories - Appendix

Appendix A - Elevation Imagery

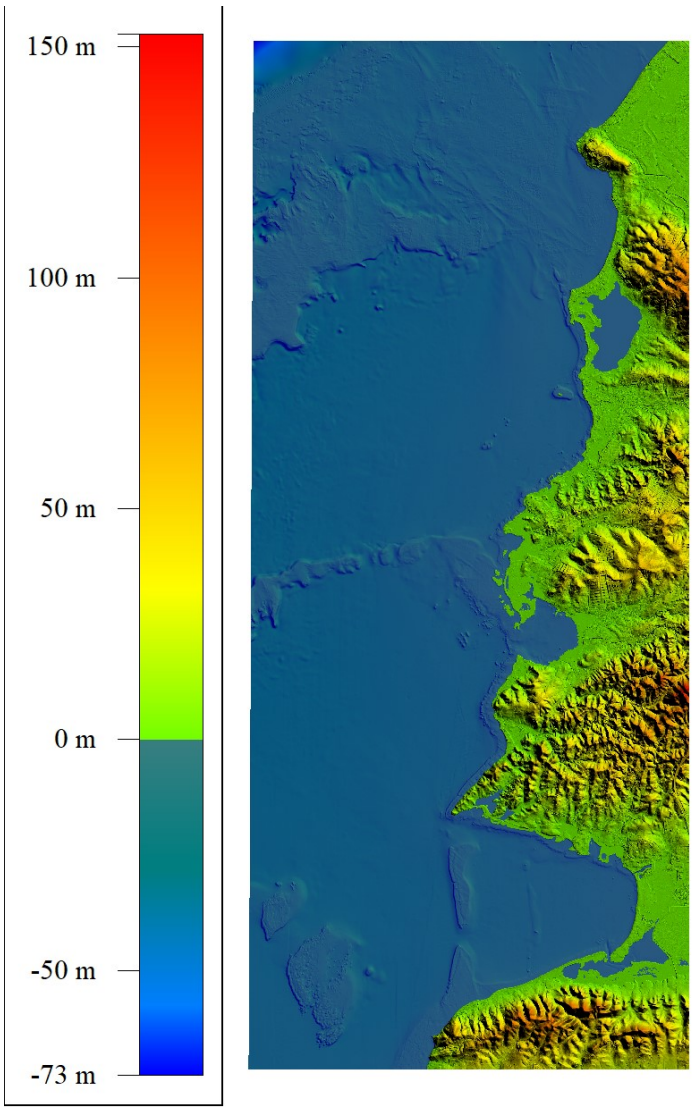


Figure 1: Site 1 Elevation Imagery

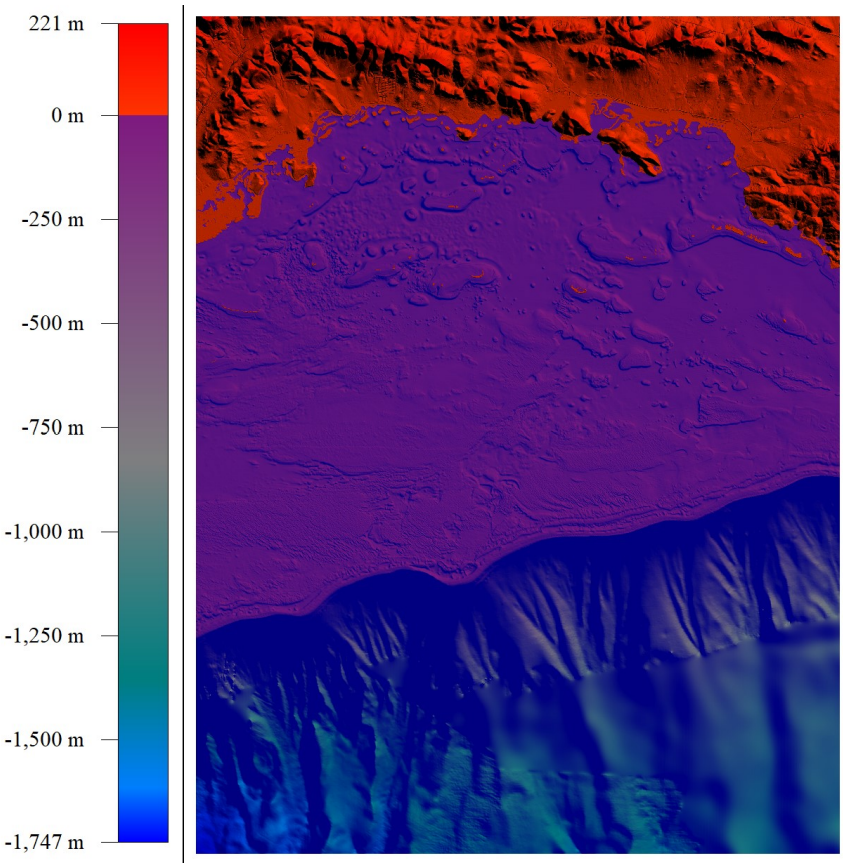


Figure 2: Site 2 Elevation Imagery

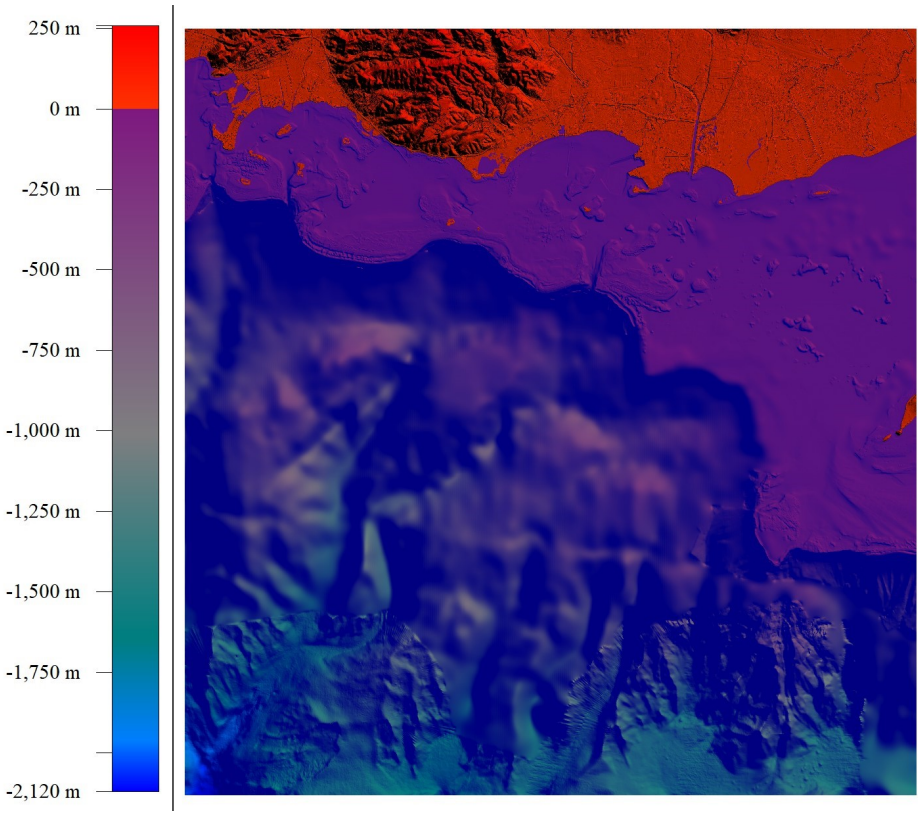


Figure 3: Site 3 Elevation Imagery

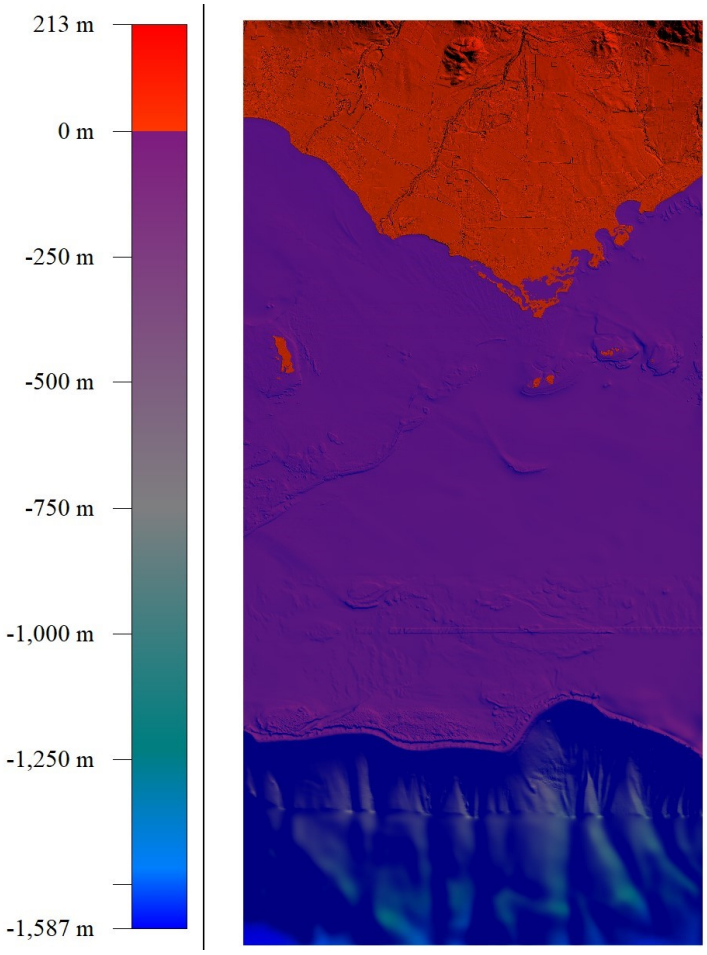


Figure 4: Site 4 Elevation Imagery

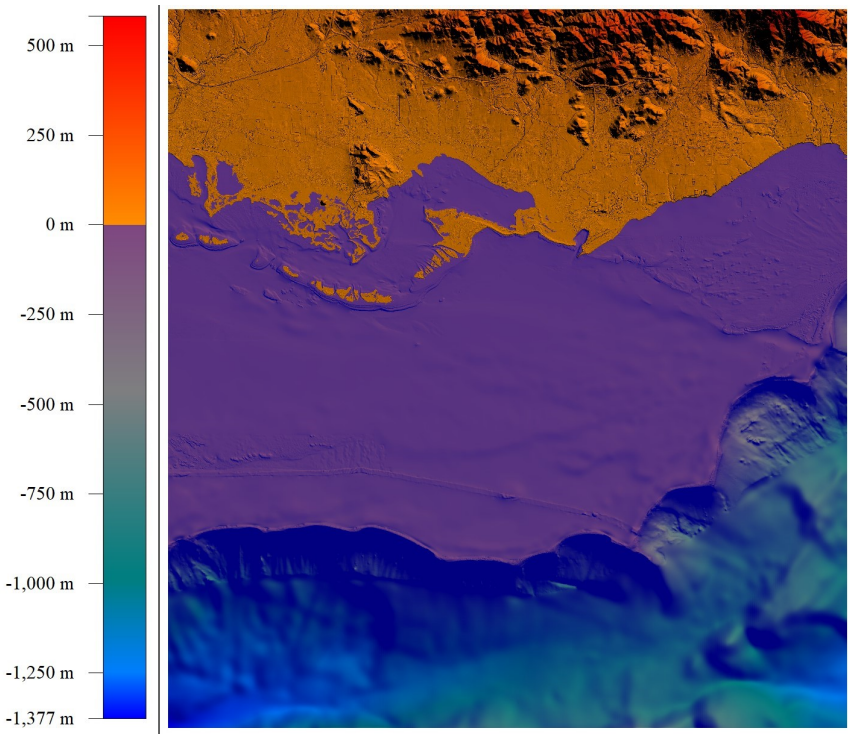


Figure 5: Site 5 Elevation Imagery

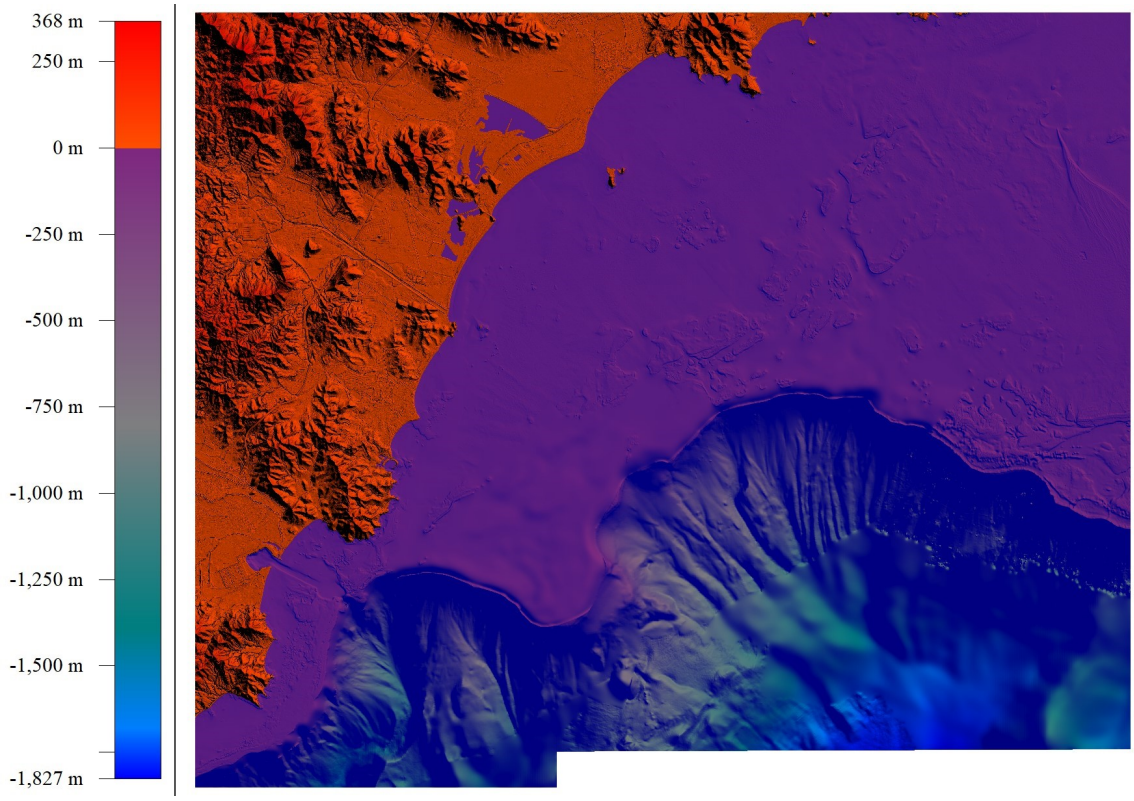


Figure 6: Site 6 Elevation Imagery

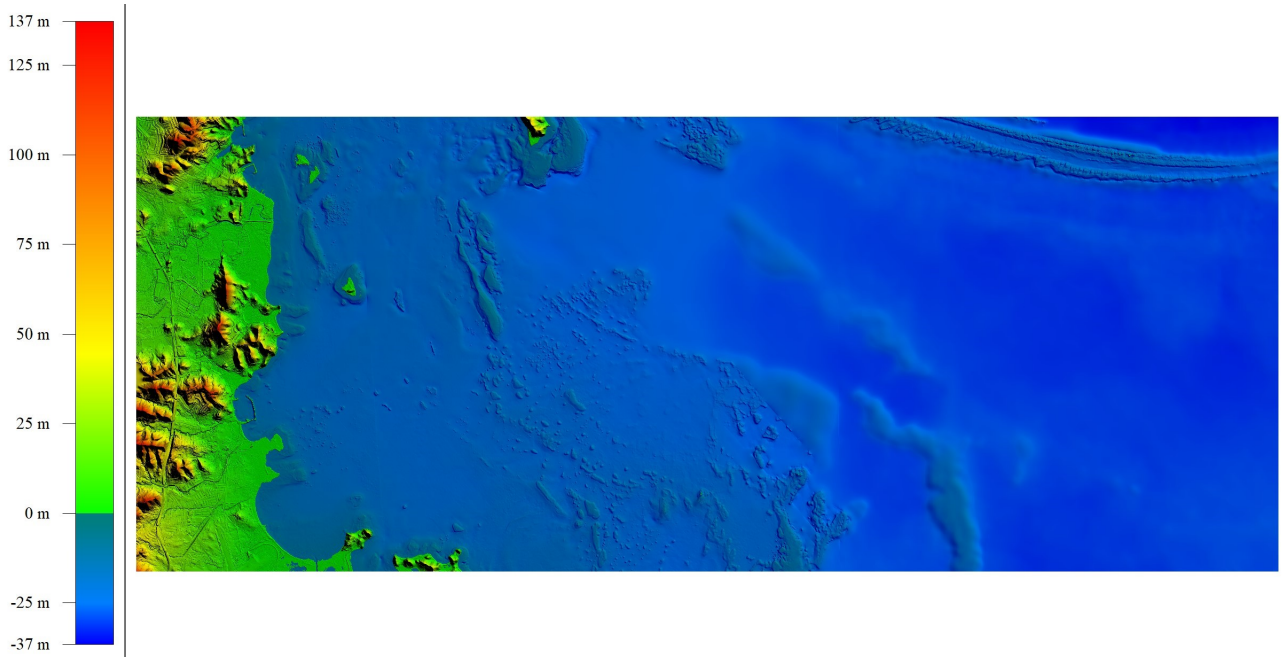


Figure 7: Site 7 Elevation Imagery

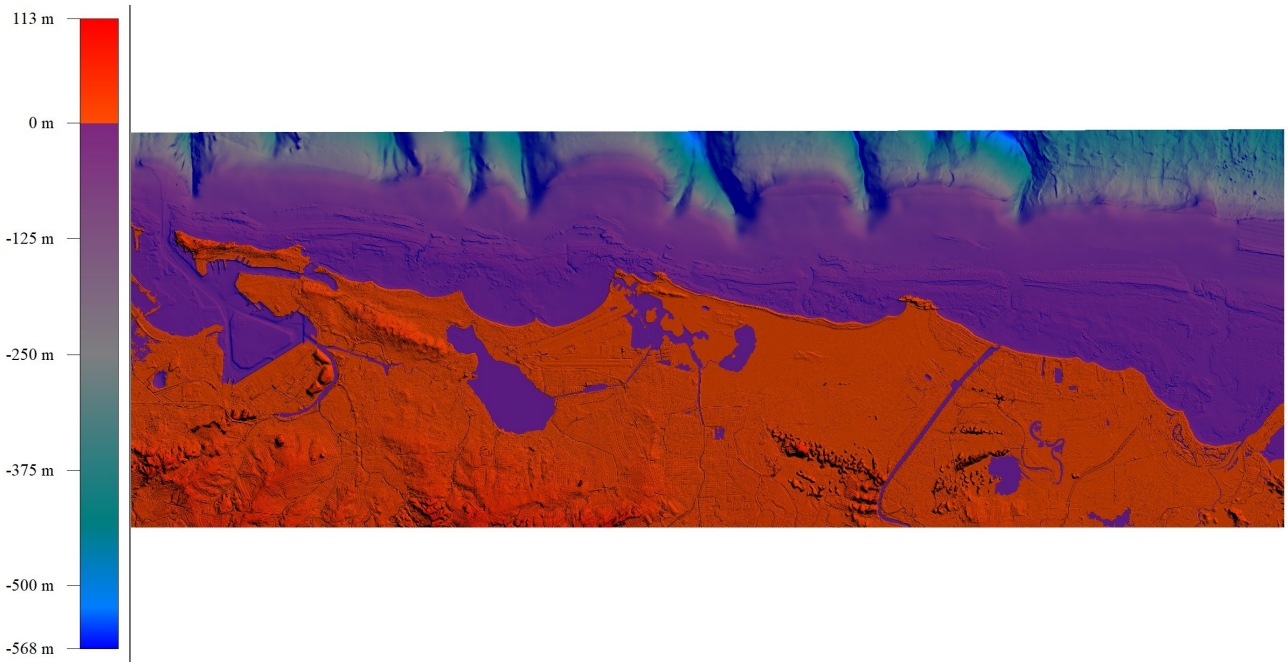


Figure 8: Site 8 Elevation Imagery

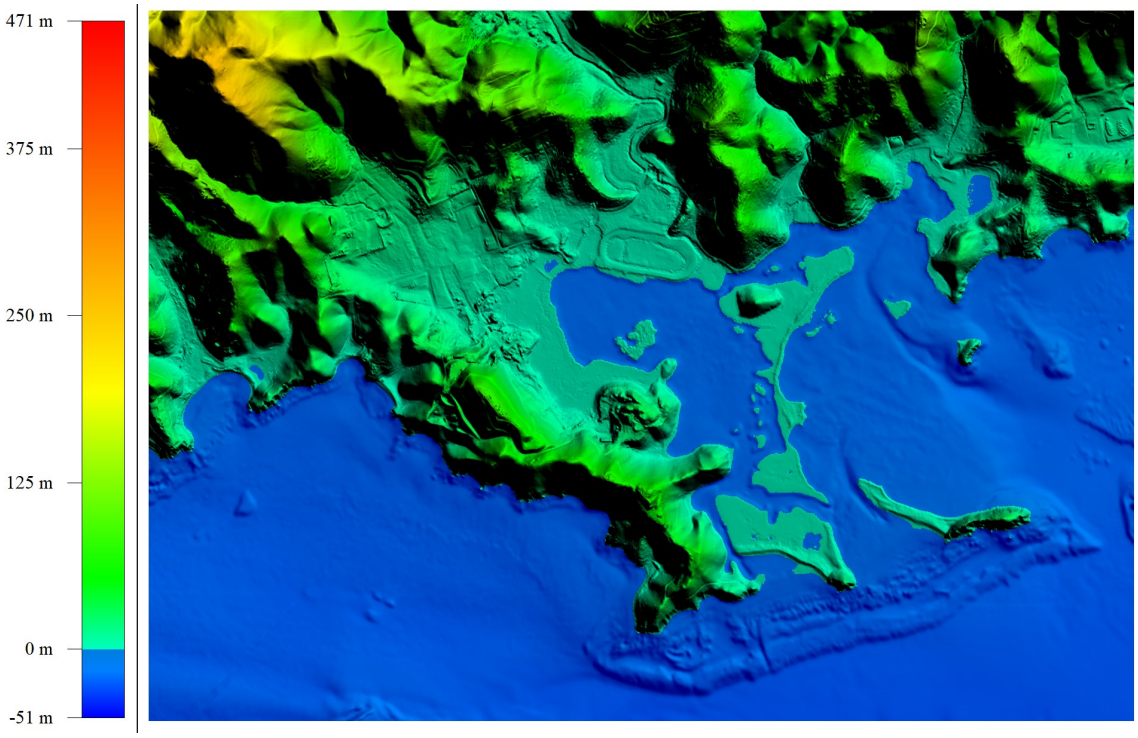


Figure 9: Site 9 Elevation Imagery

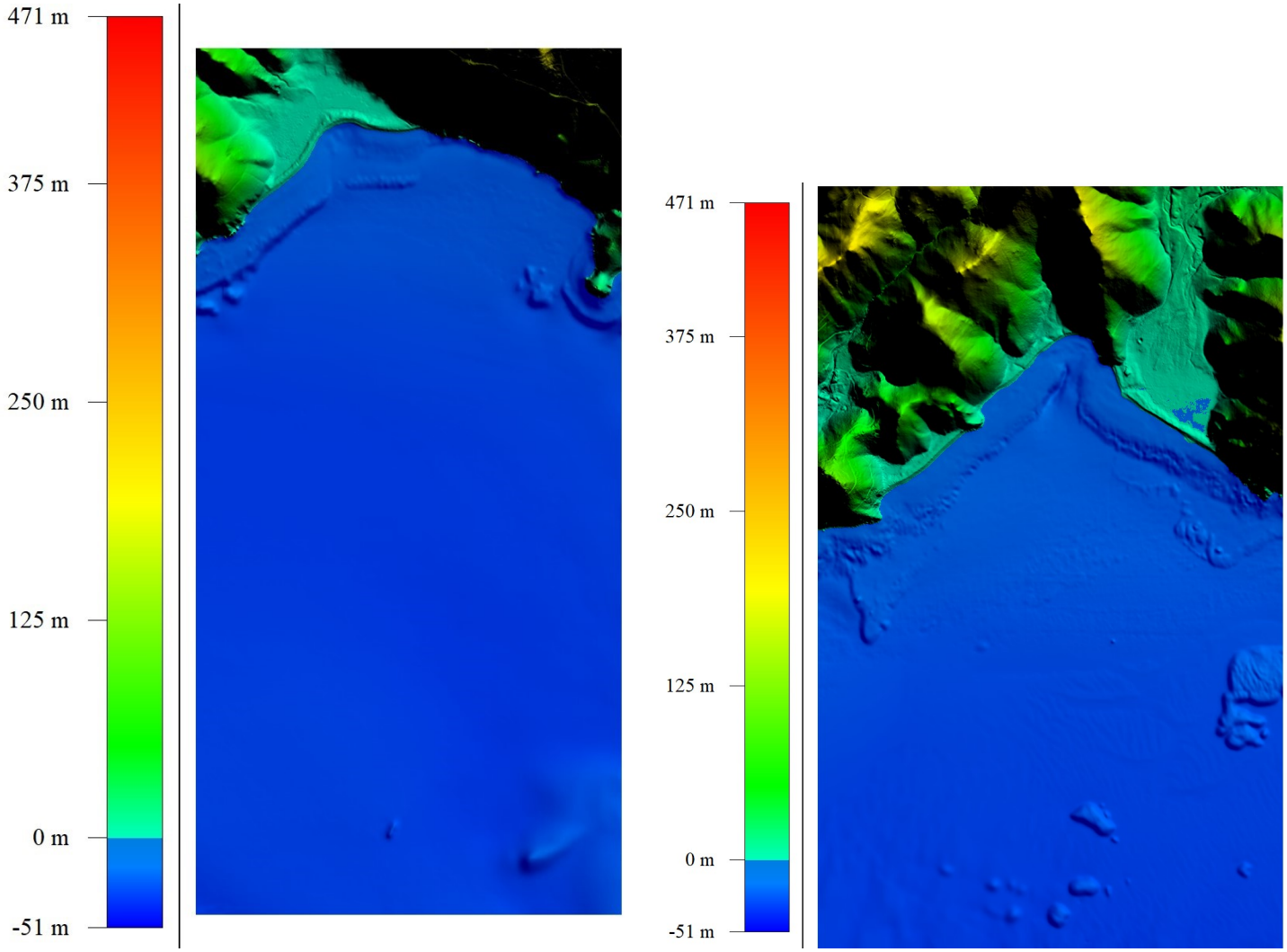


Figure 10: Sites 10 and 11 Elevation Imagery

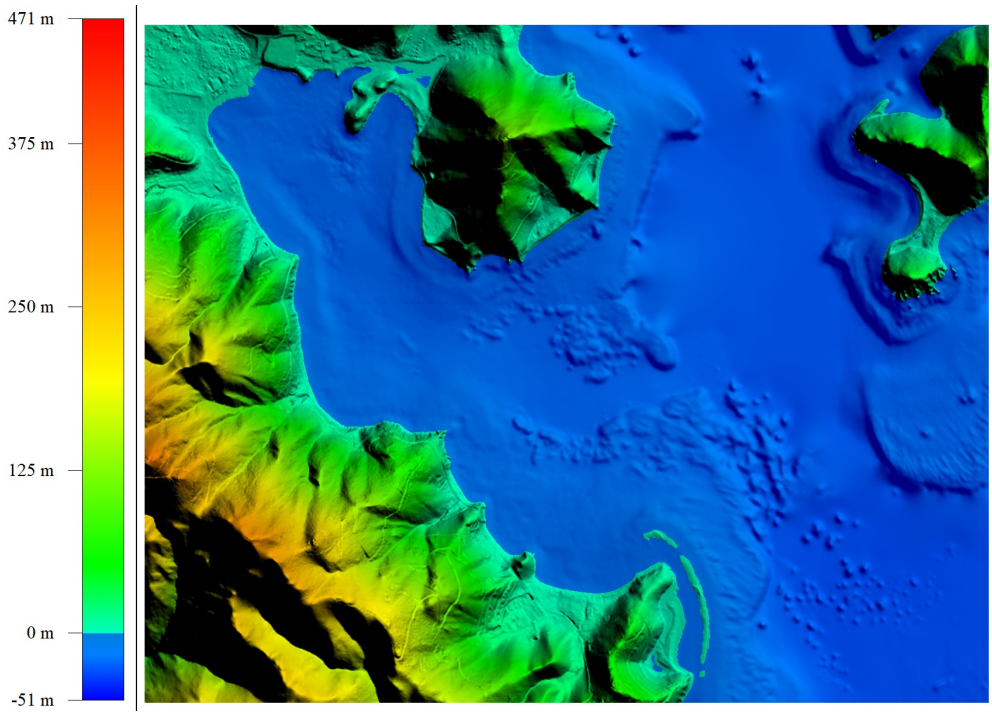


Figure 11: Site 12 Elevation Imagery

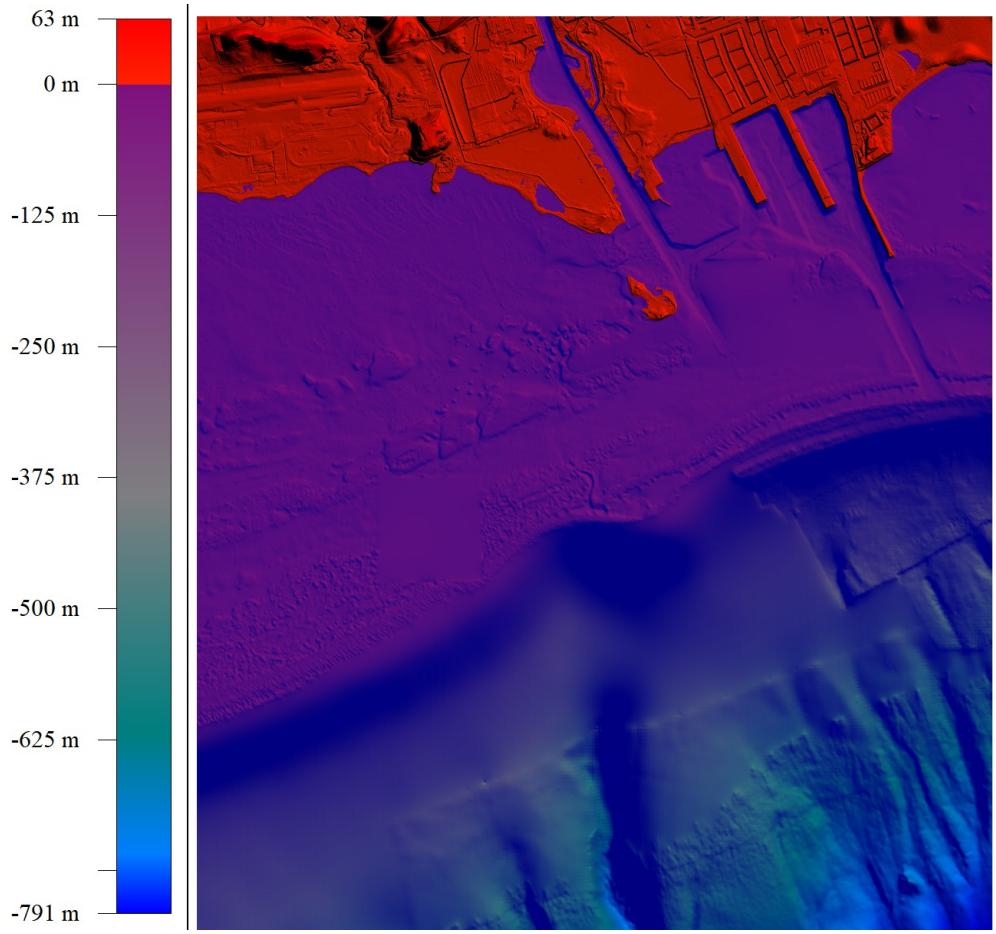


Figure 12: Site 13 Elevation Imagery

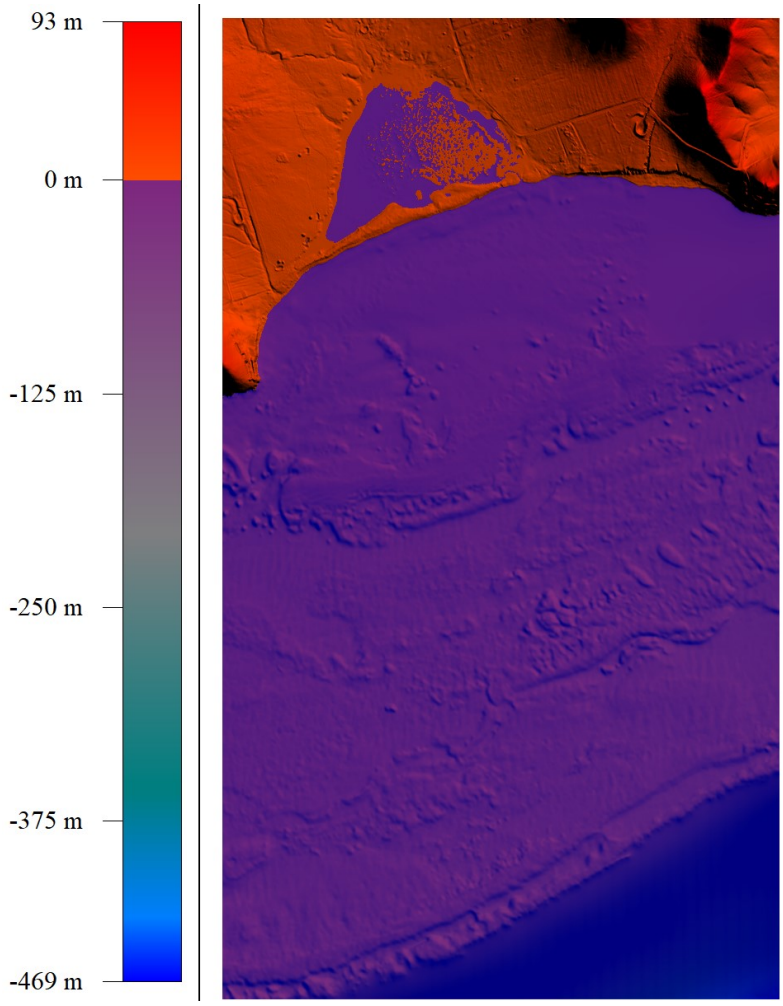


Figure 13: Site 14 Elevation Imagery

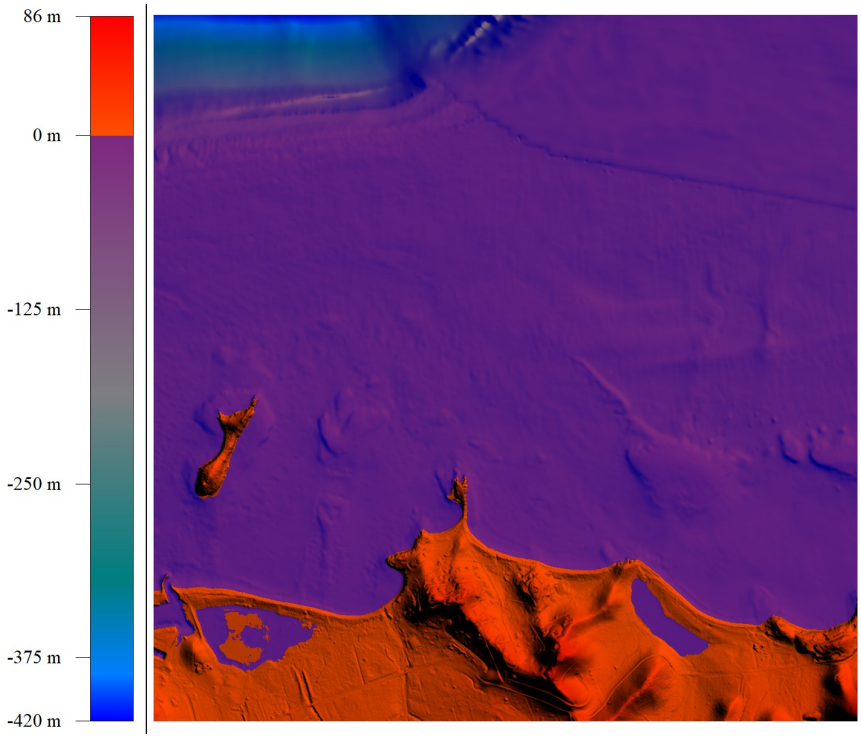


Figure 14: Site 15 Elevation Imagery

Appendix B - Slope Imagery

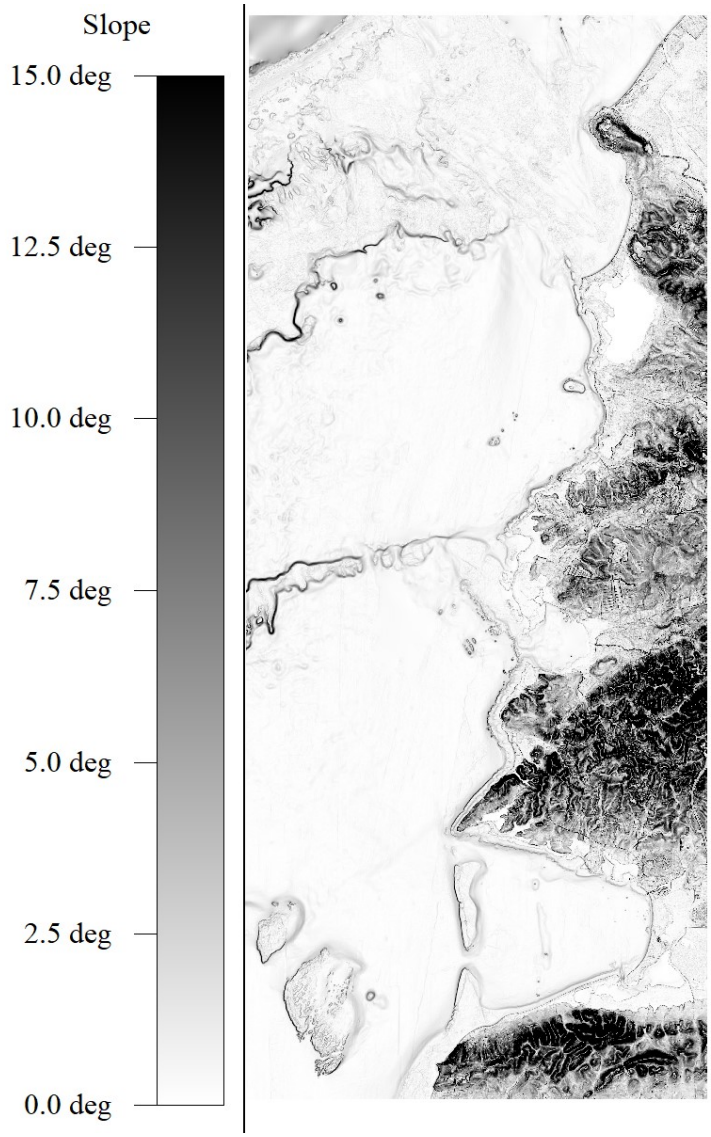


Figure 15: Site 1 Slope Imagery

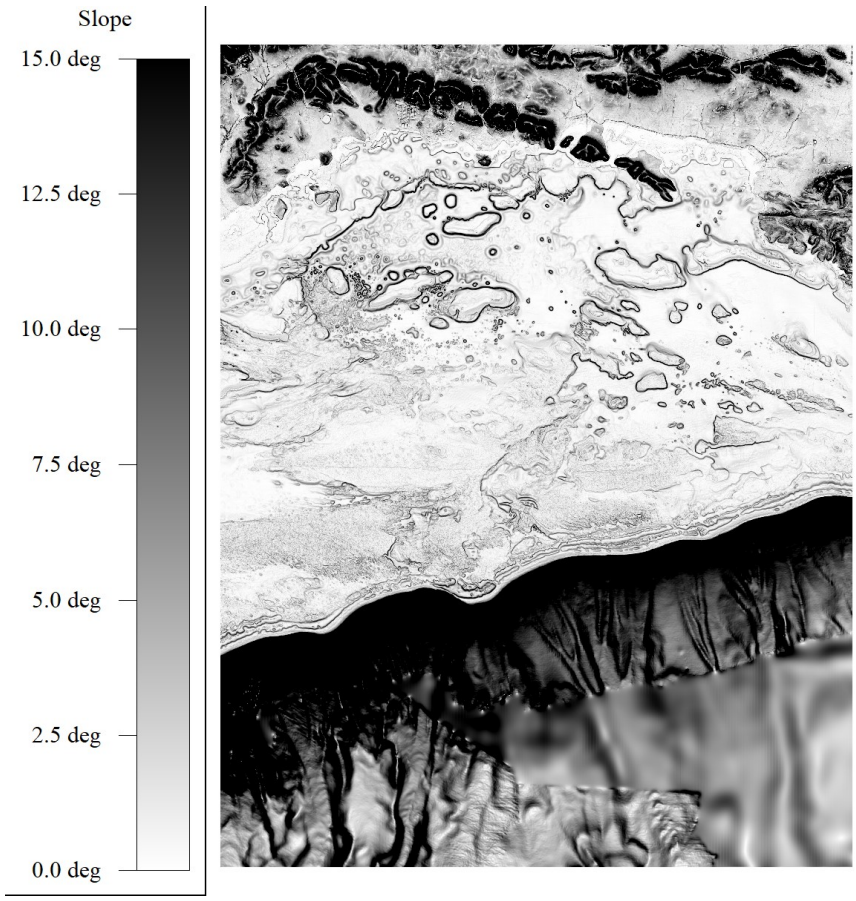


Figure 16: Site 2 Slope Imagery

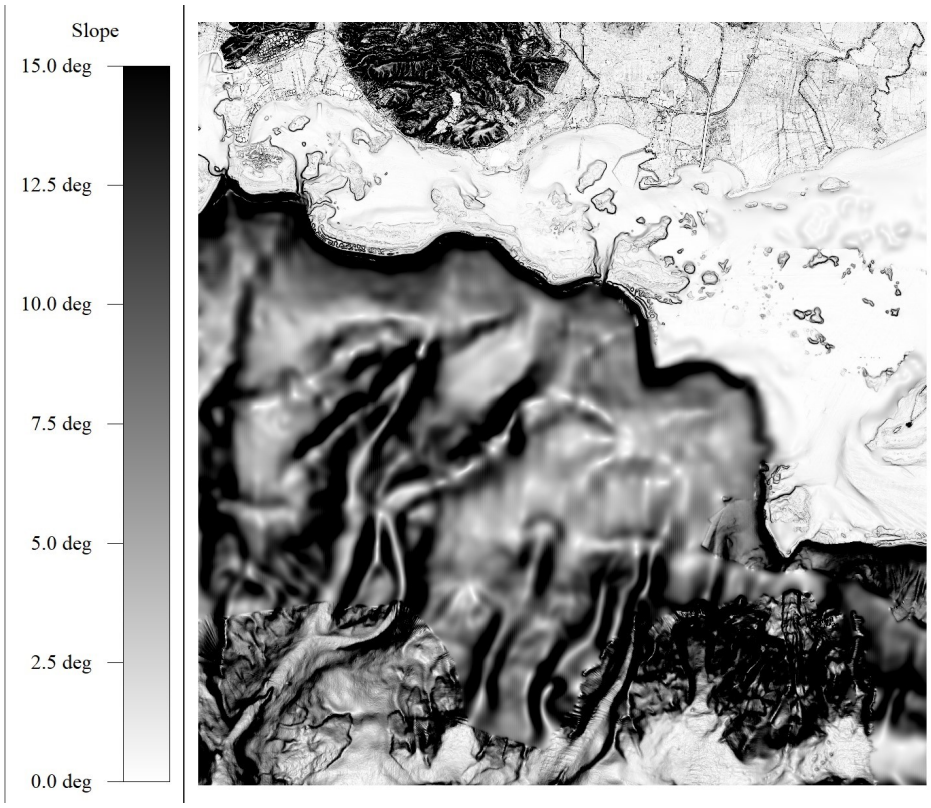


Figure 17: Site 3 Slope Imagery

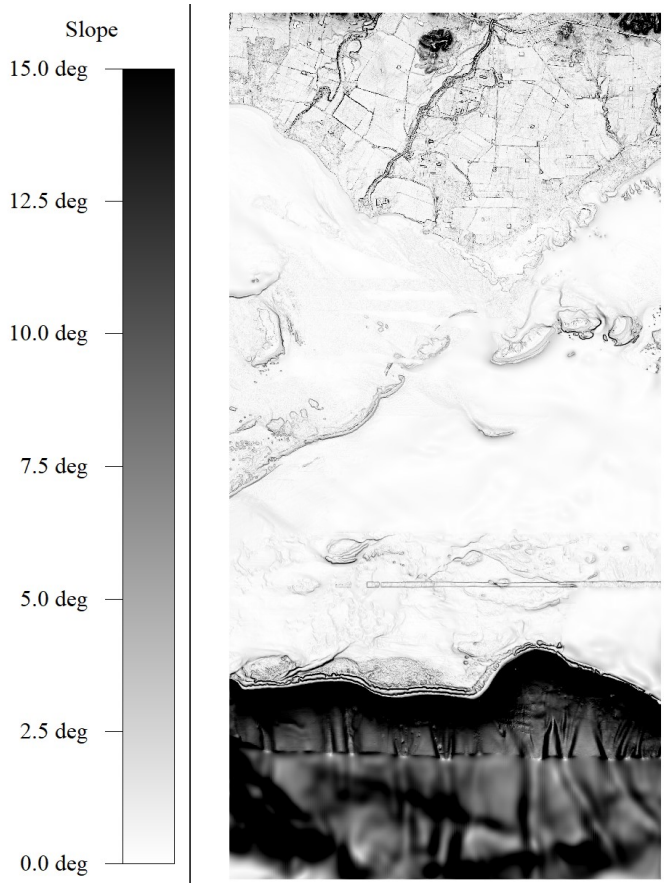


Figure 18: Site 4 Slope Imagery

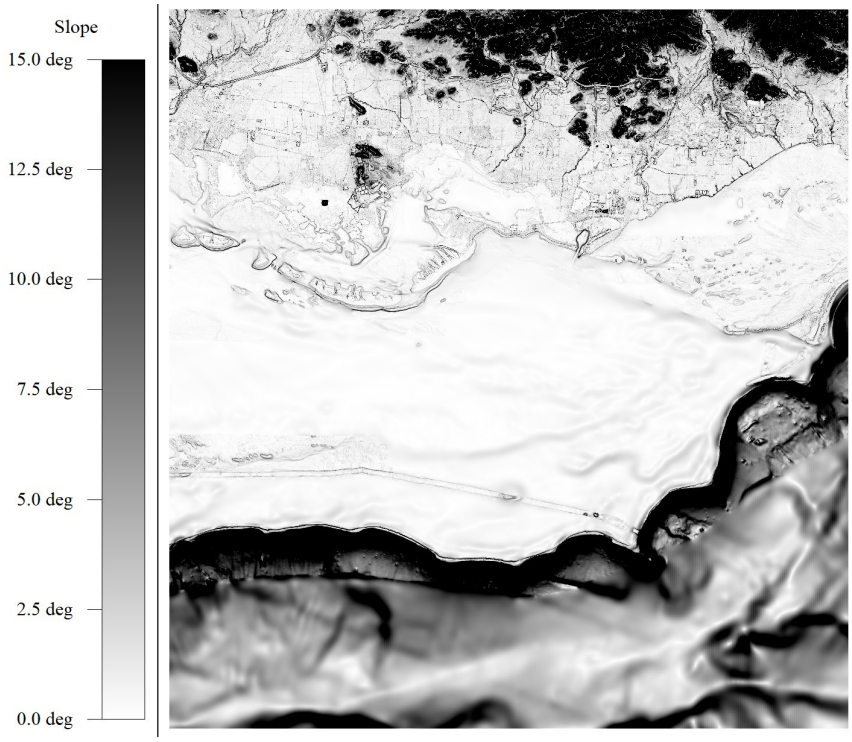


Figure 19: Site 5 Slope Imagery

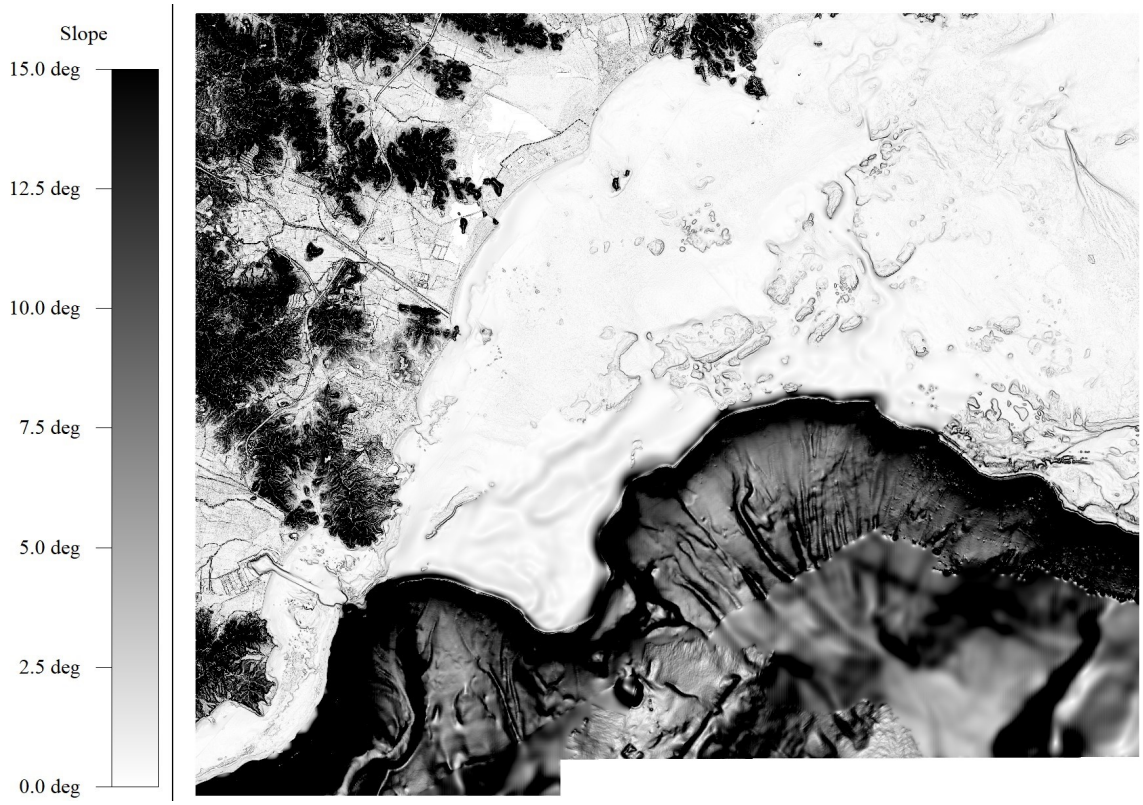


Figure 20: Site 6 Slope Imagery

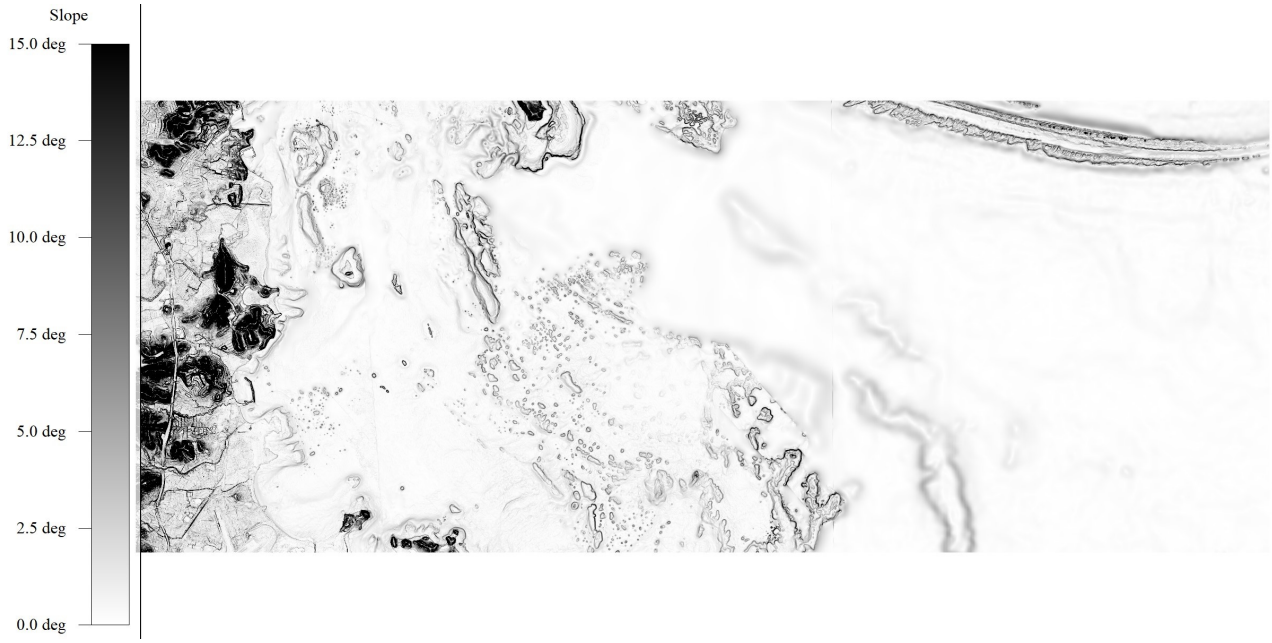


Figure 21: Site 7 Slope Imagery

Figure 22: Site 8 Slope Imagery

Figure 23: Site 9 Slope Imagery

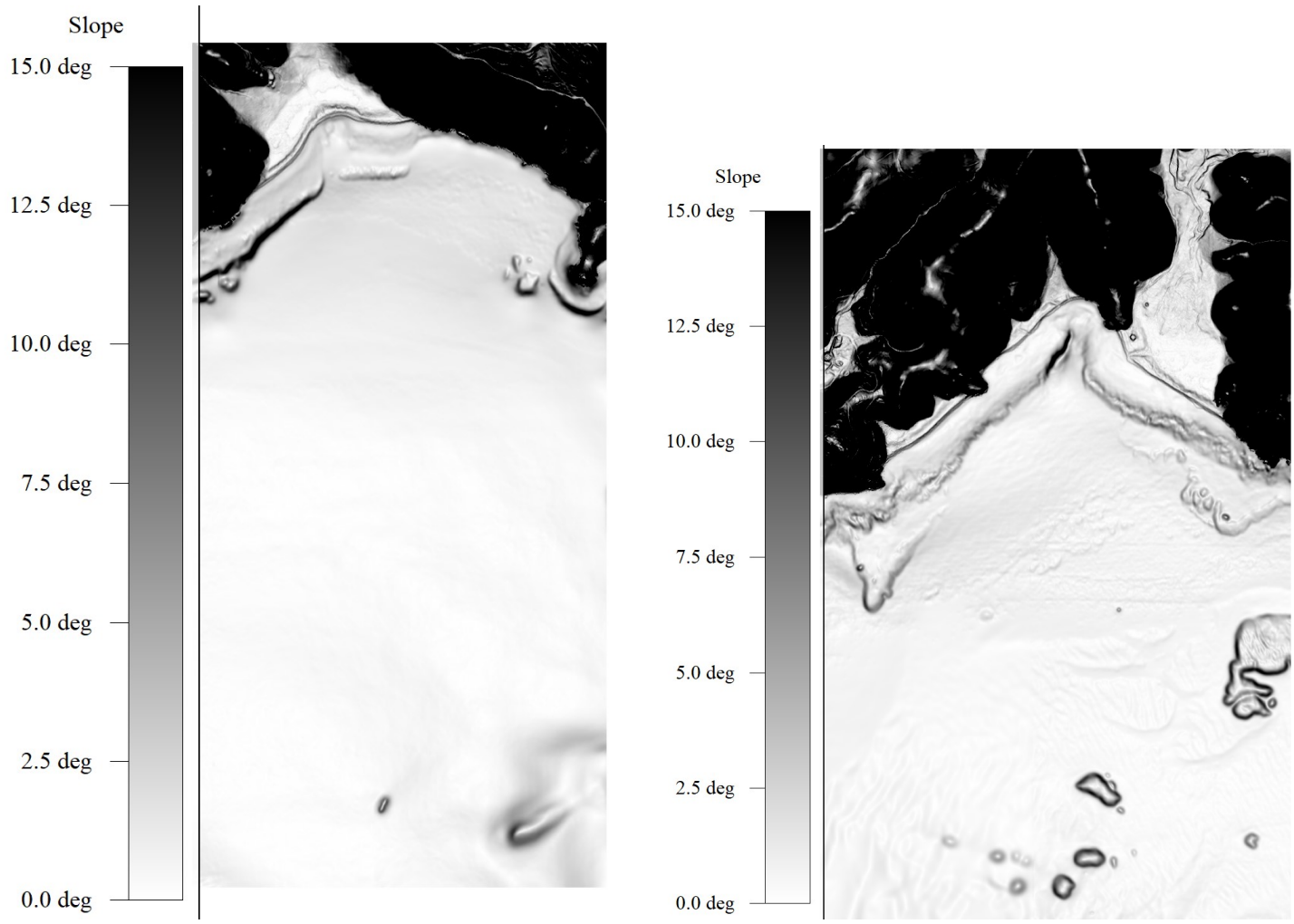


Figure 24: Sites 10 and 11 Slope Imagery

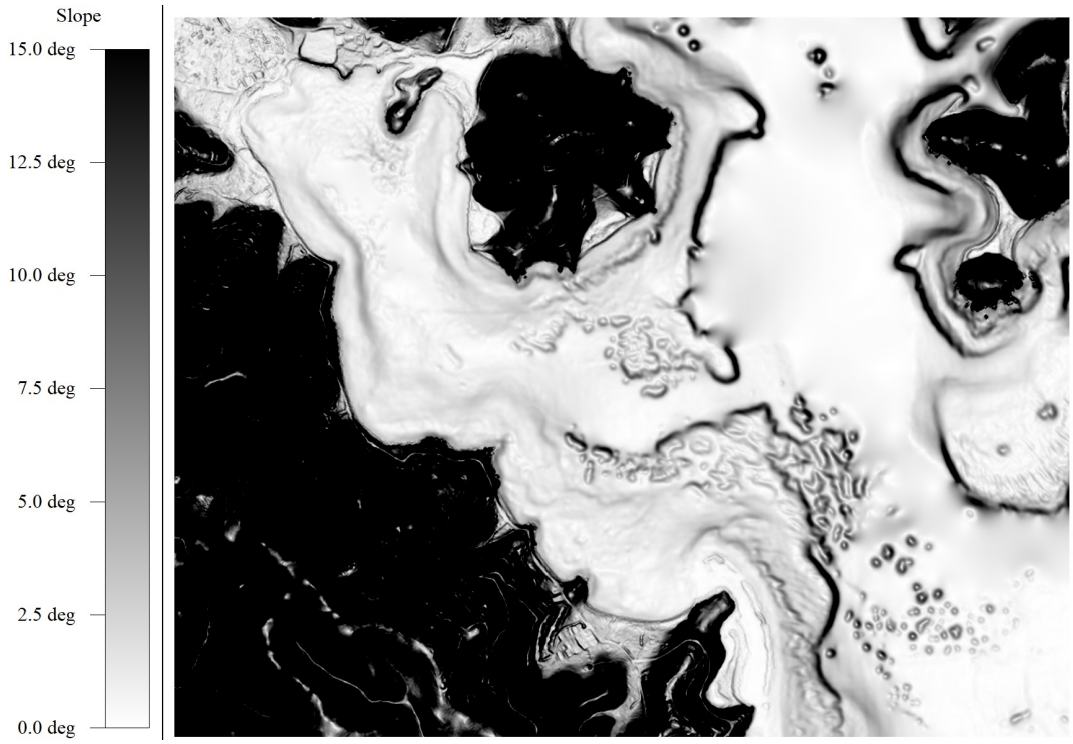


Figure 25: Site 12 Slope Imagery

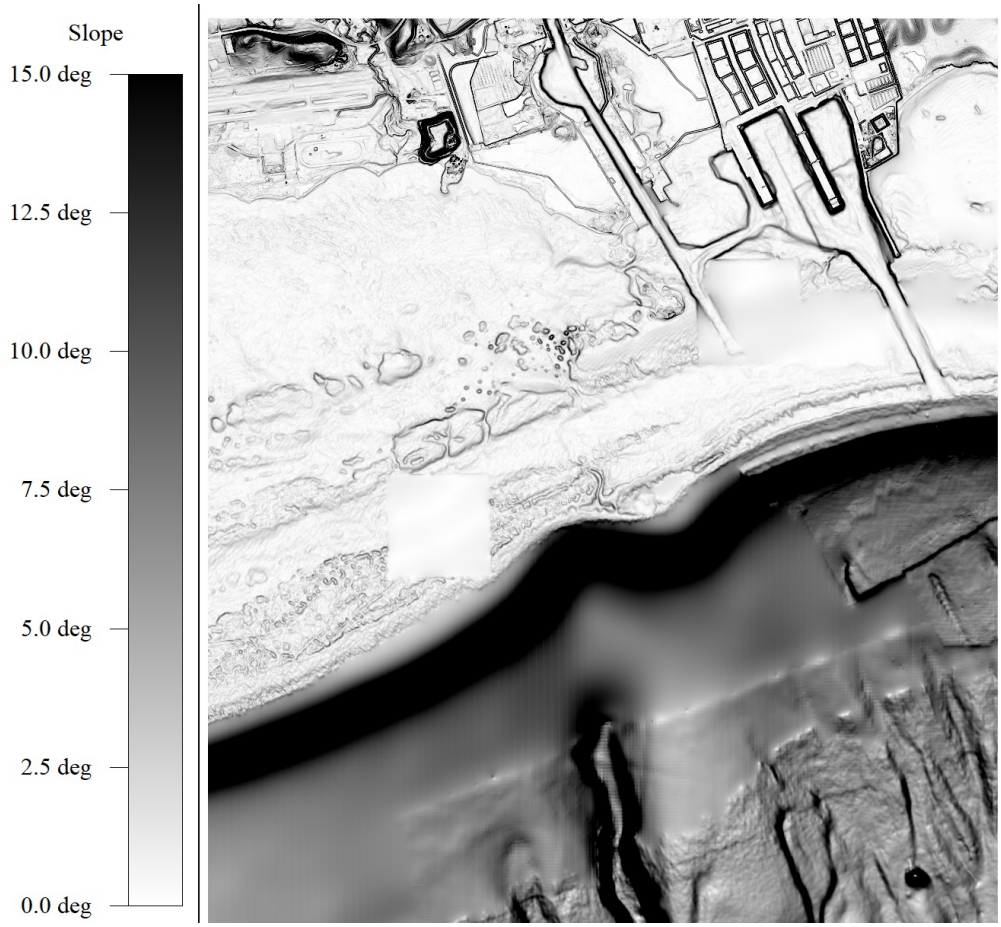


Figure 26: Site 13 Slope Imagery

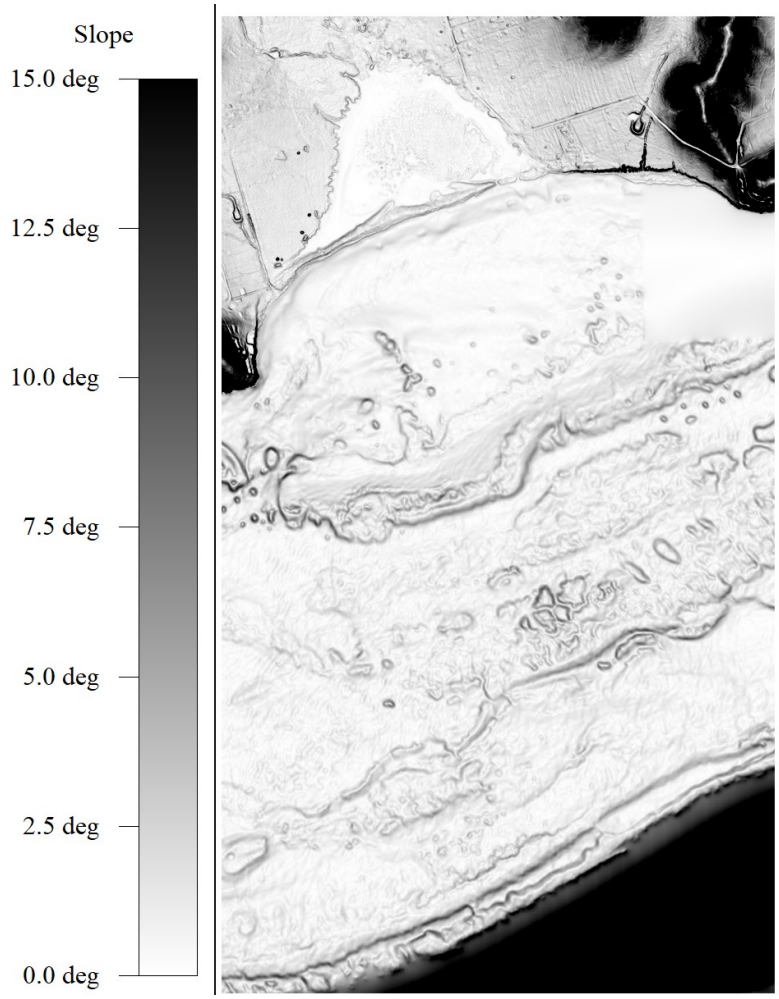


Figure 27: Site 14 Slope Imagery

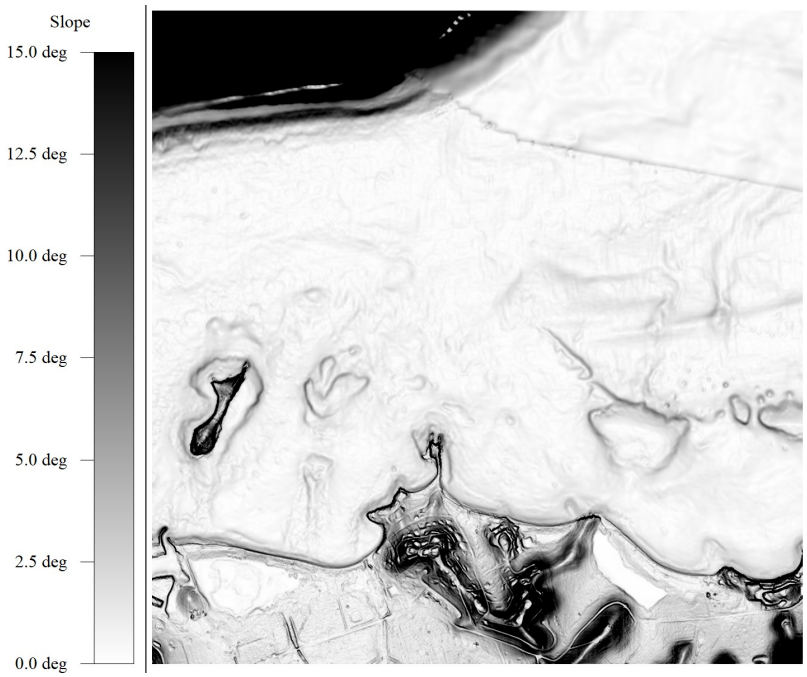


Figure 28: Site 15 Slope Imagery

Appendix C - Contour Imagery

Figure 29: Site 1 Contour Imagery

Figure 30: Site 2 Contour Imagery

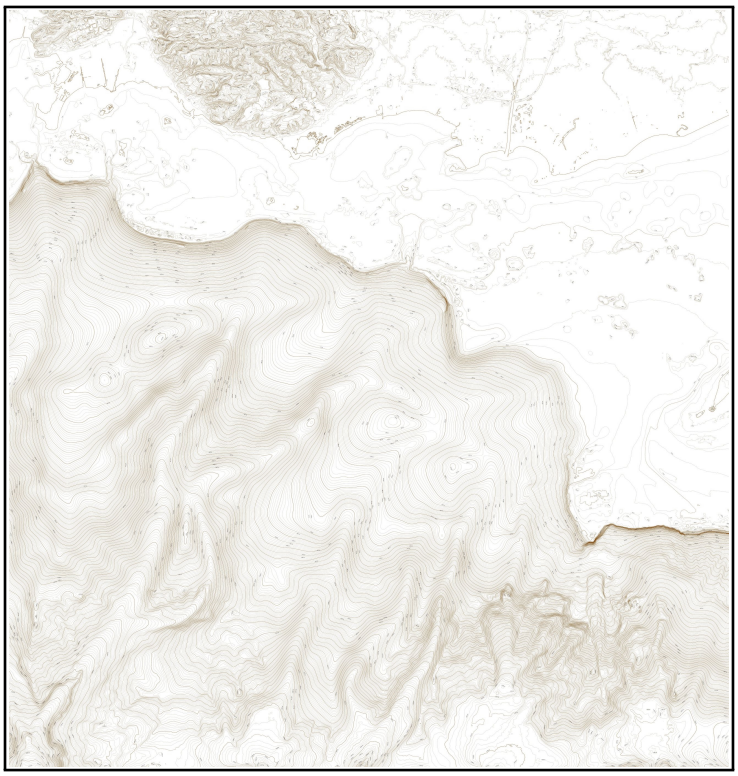


Figure 31: Site 3 Contour Imagery

Figure 32: Site 4 Contour Imagery

Figure 33: Site 5 Contour Imagery

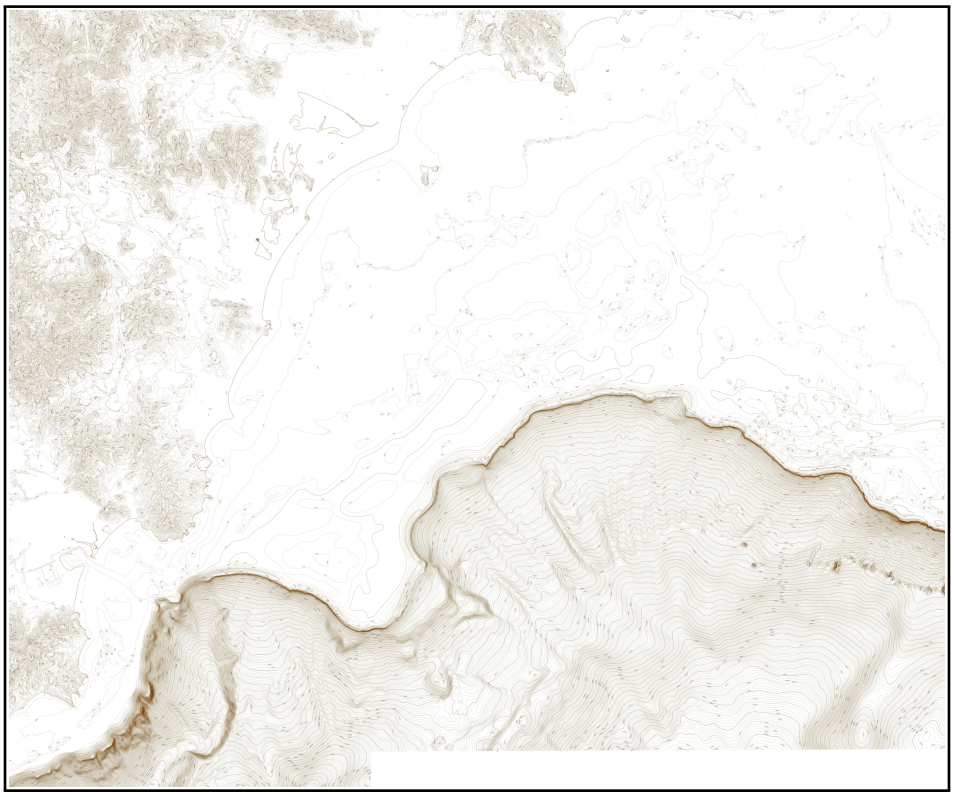


Figure 34: Site 6 Contour Imagery

Figure 35: Site 7 Contour Imagery

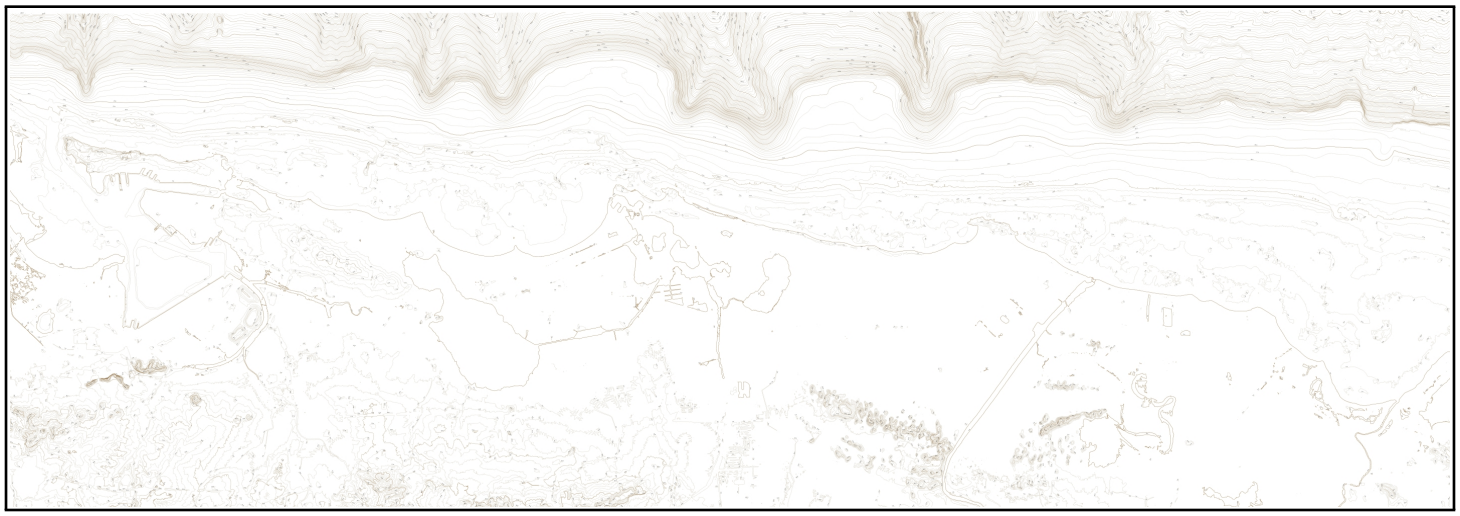


Figure 36: Site 8 Contour Imagery

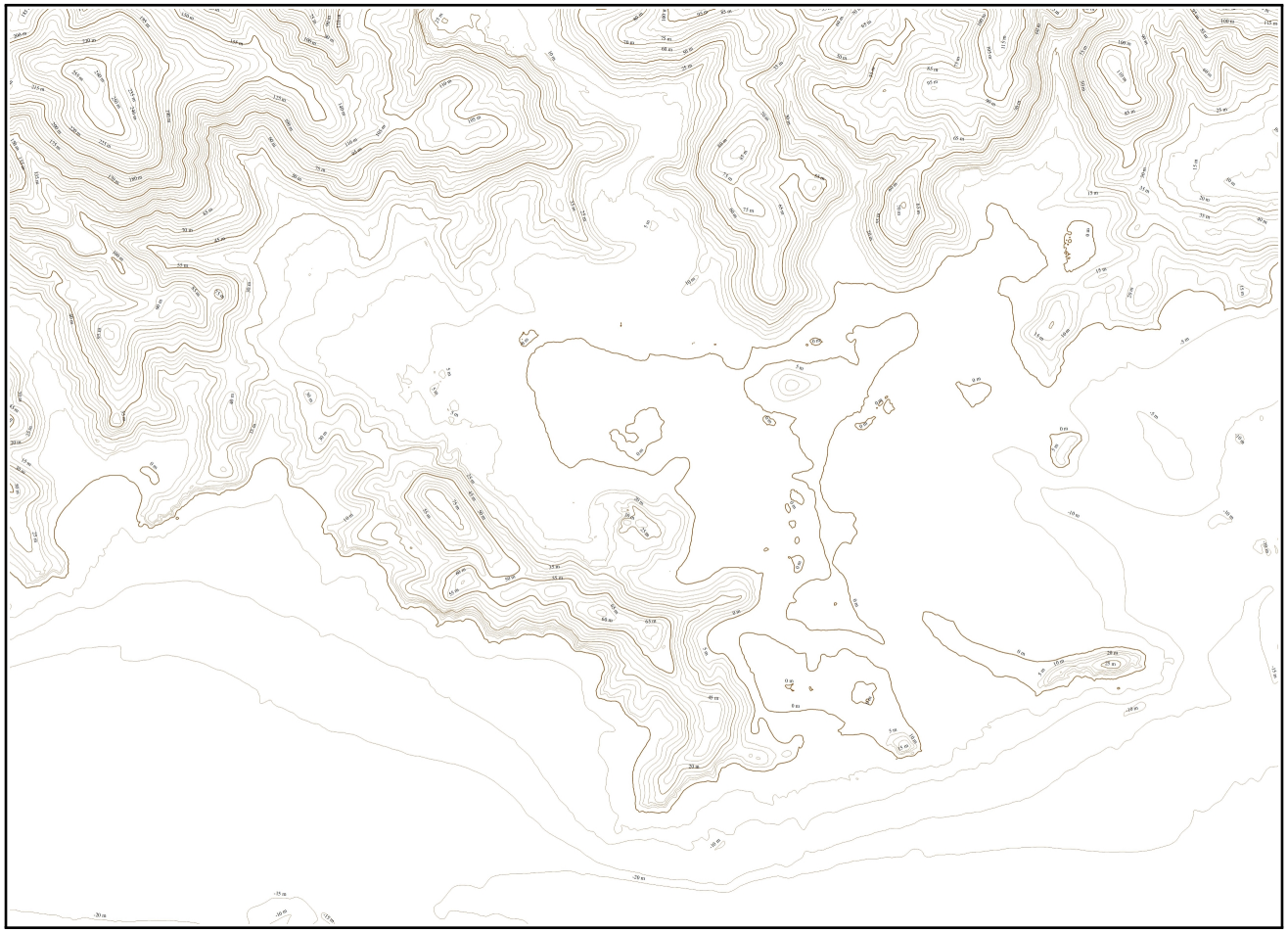


Figure 37: Site 9 Contour Imagery

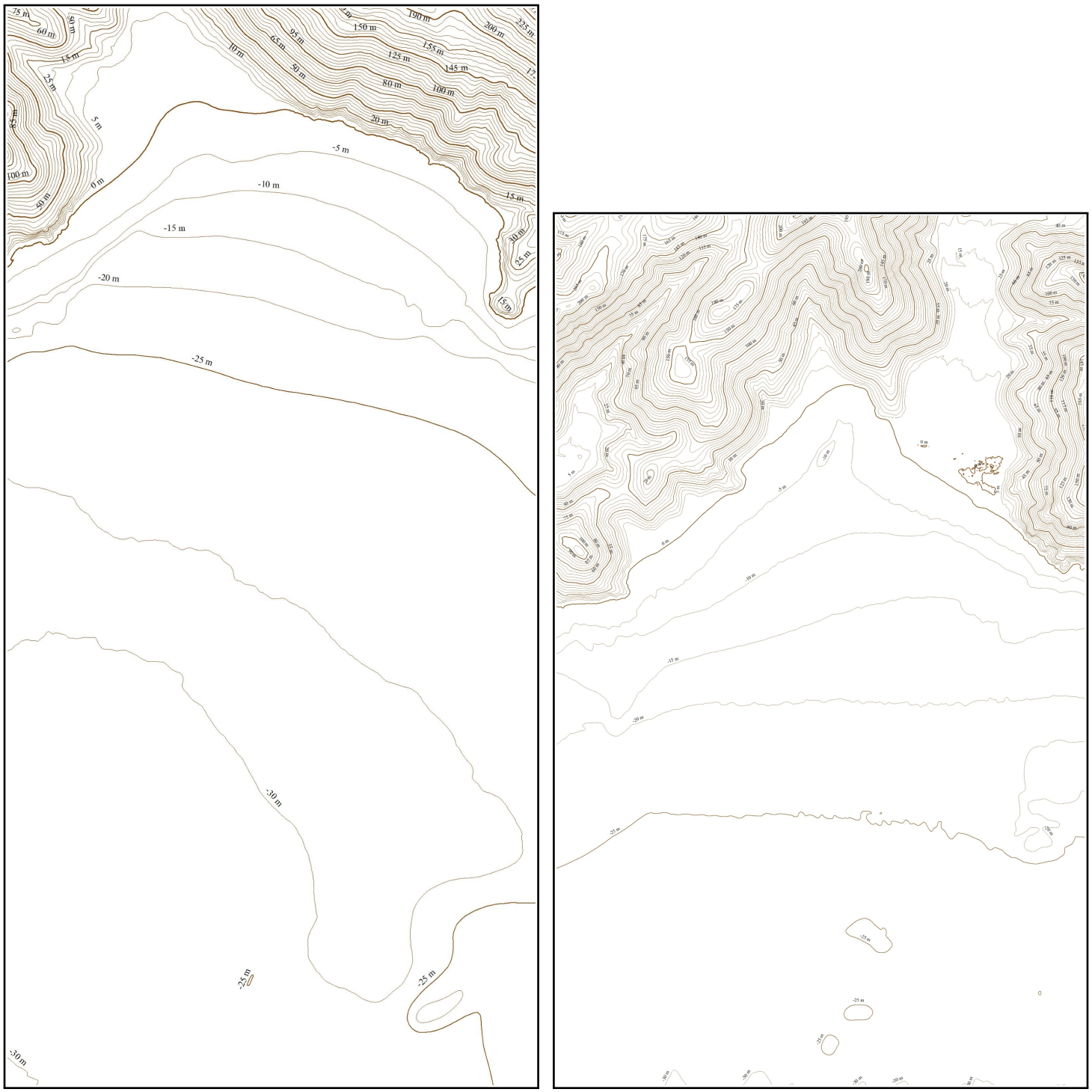


Figure 38: Sites 10 and 11 Contour Imagery

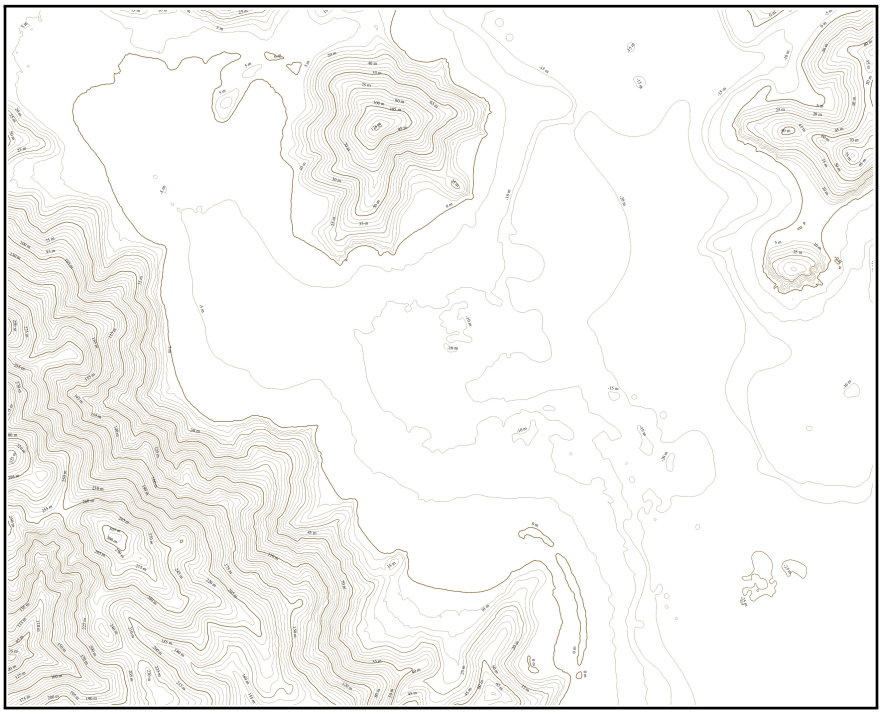


Figure 39: Site 12 Contour Imagery

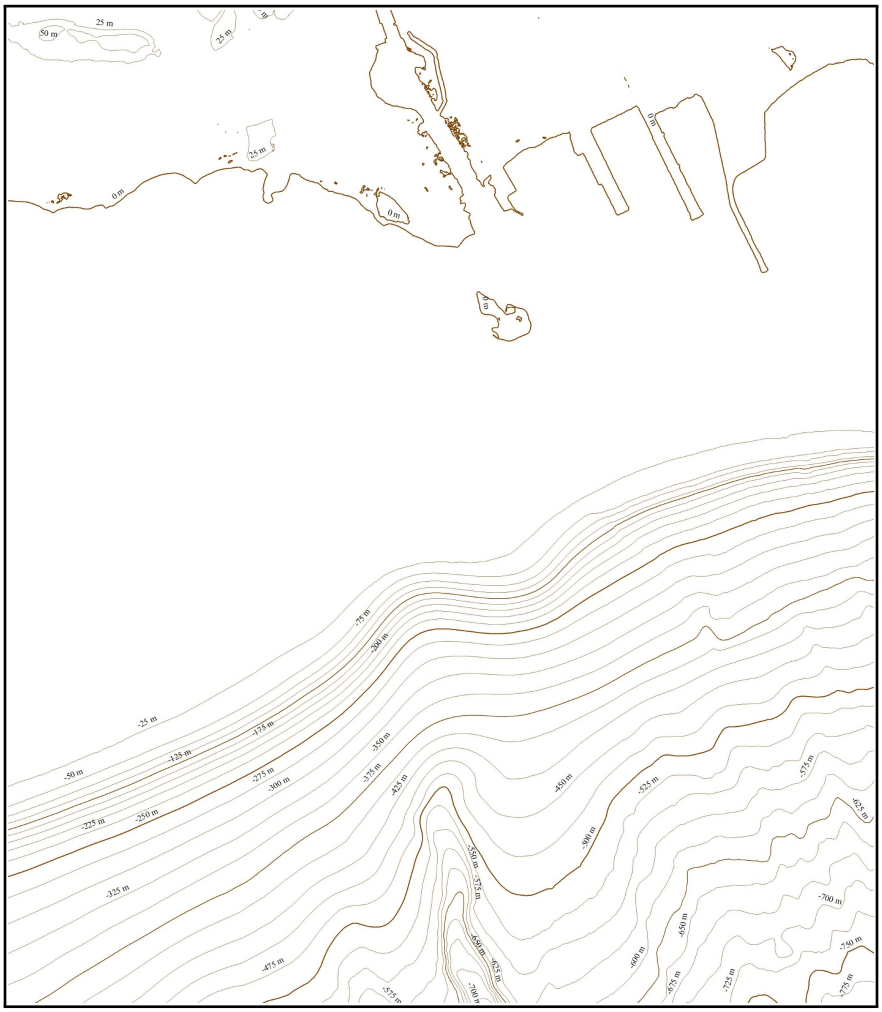


Figure 40: Site 13 Contour Imagery

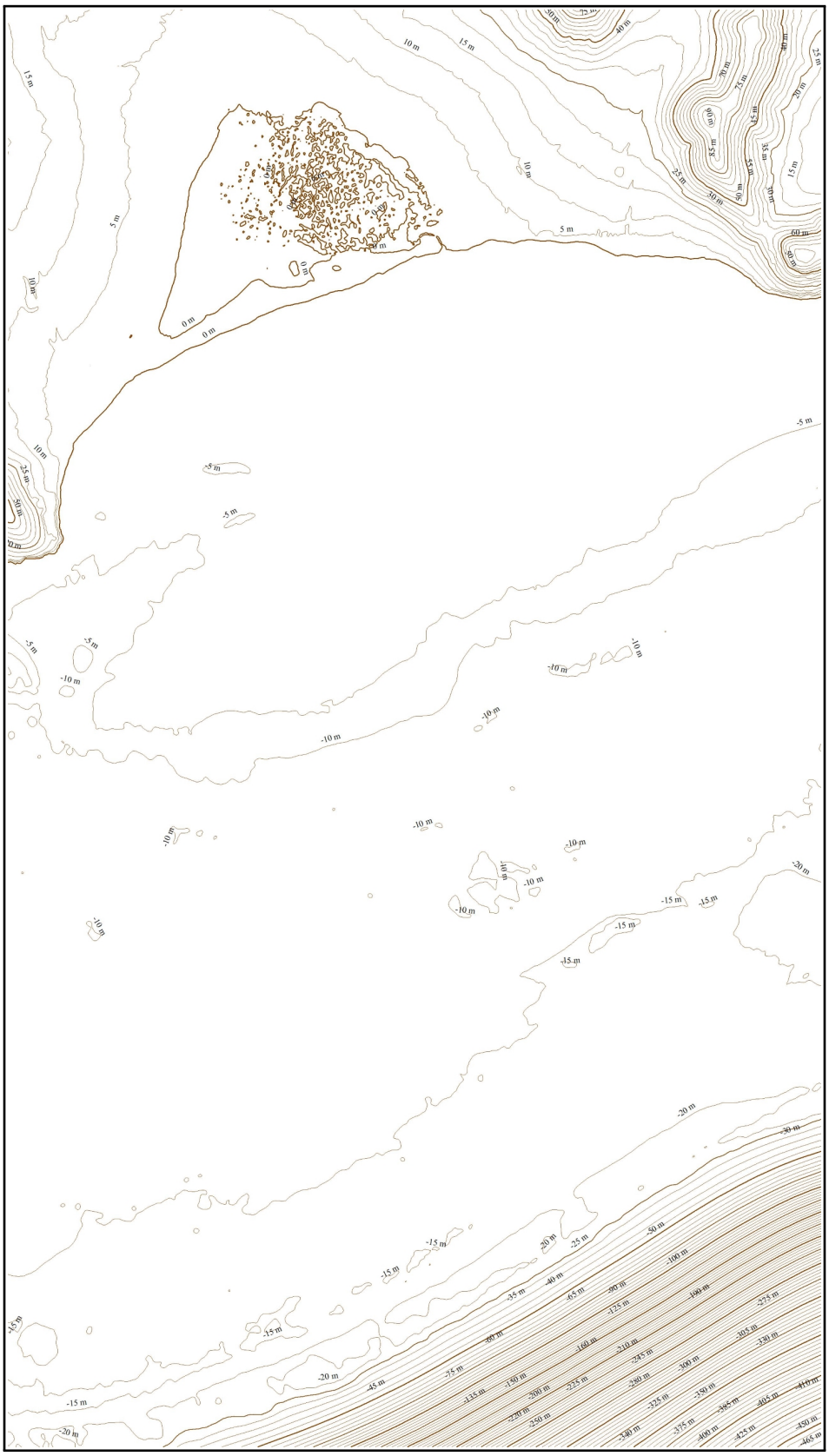


Figure 41: Site 14 Contour Imagery

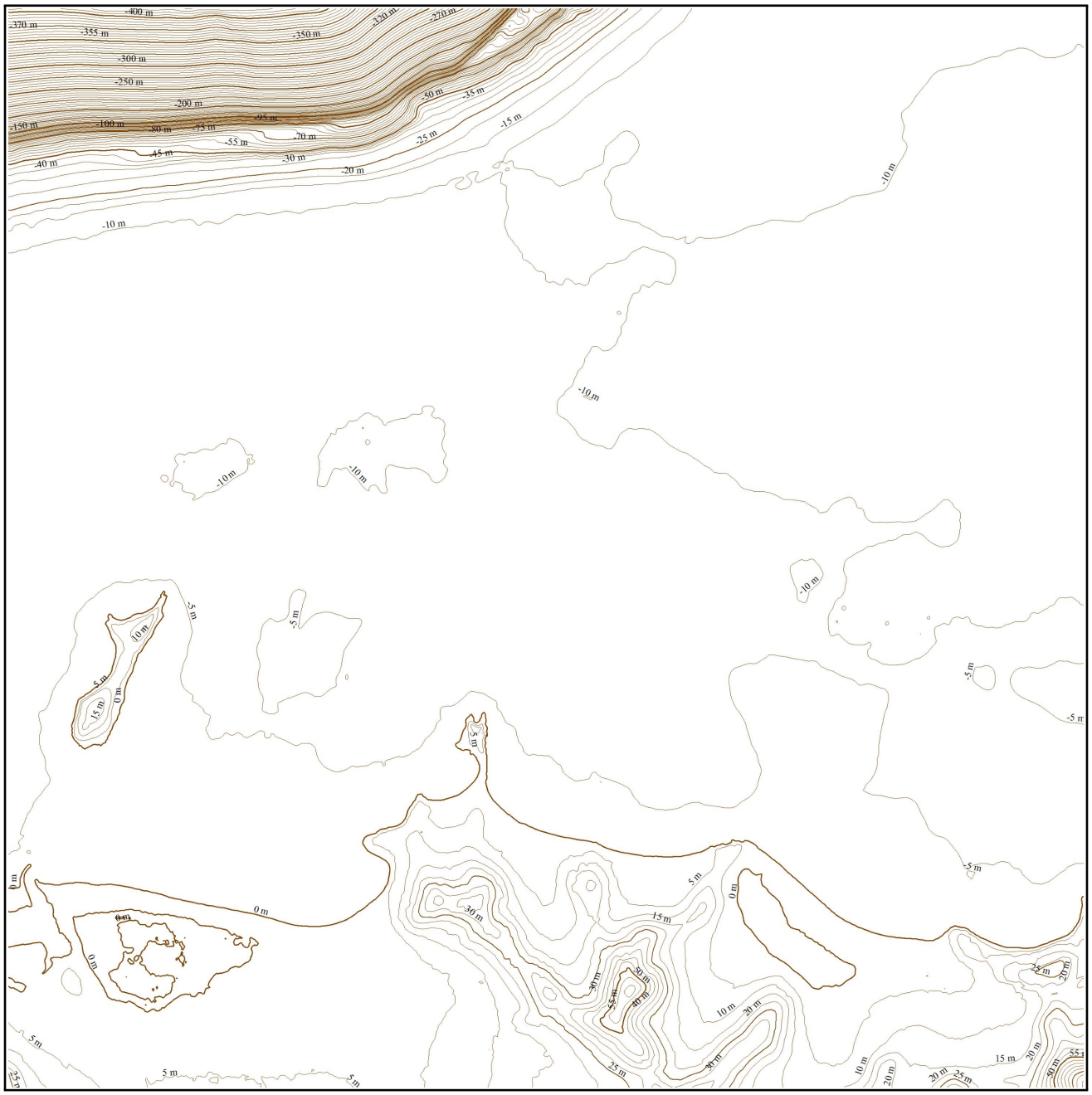


Figure 42: Site 15 Contour Imagery

Appendix D - Raster Reclassifications

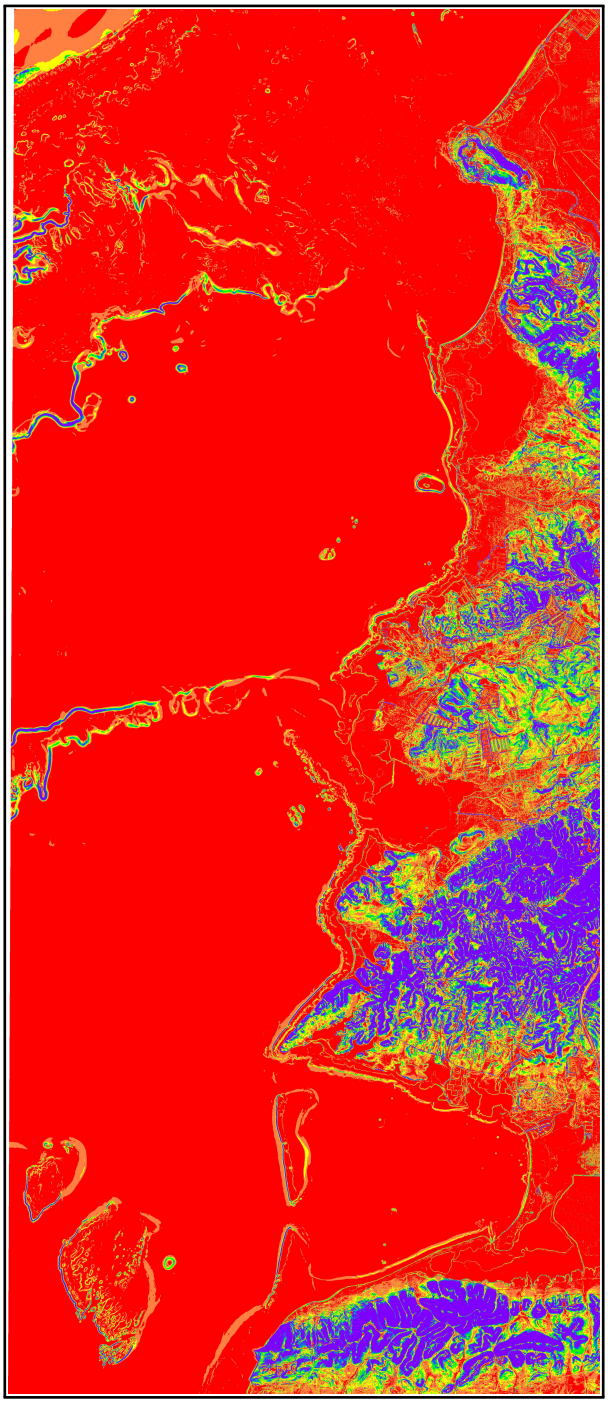


Figure 43: Site 1 Raster Reclassification Imagery

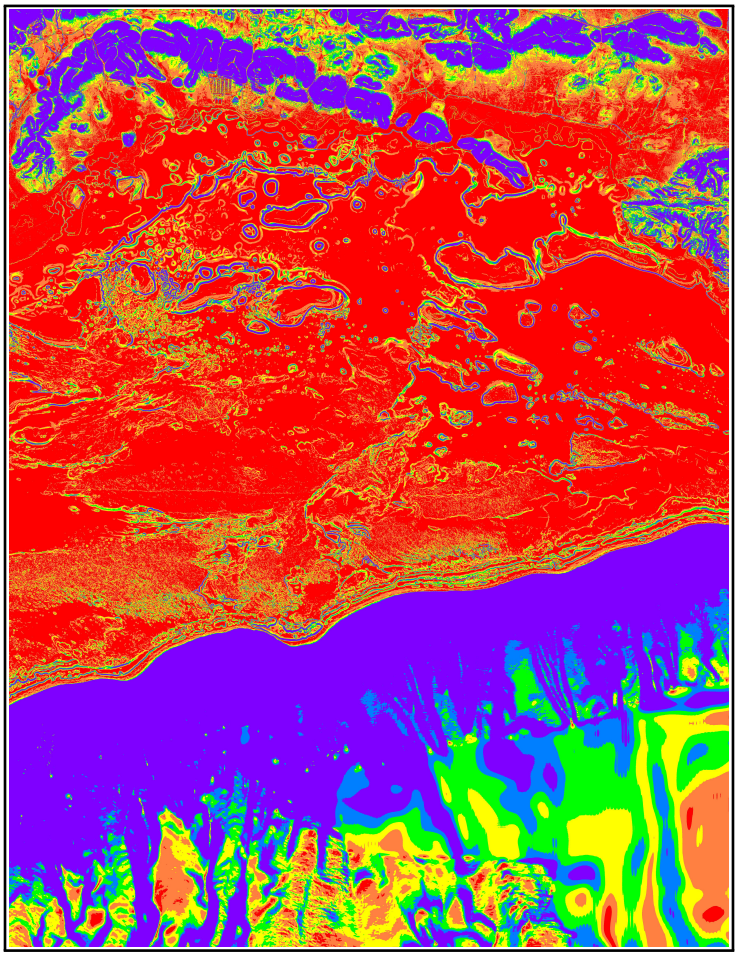


Figure 44: Site 2 Raster Reclassification Imagery

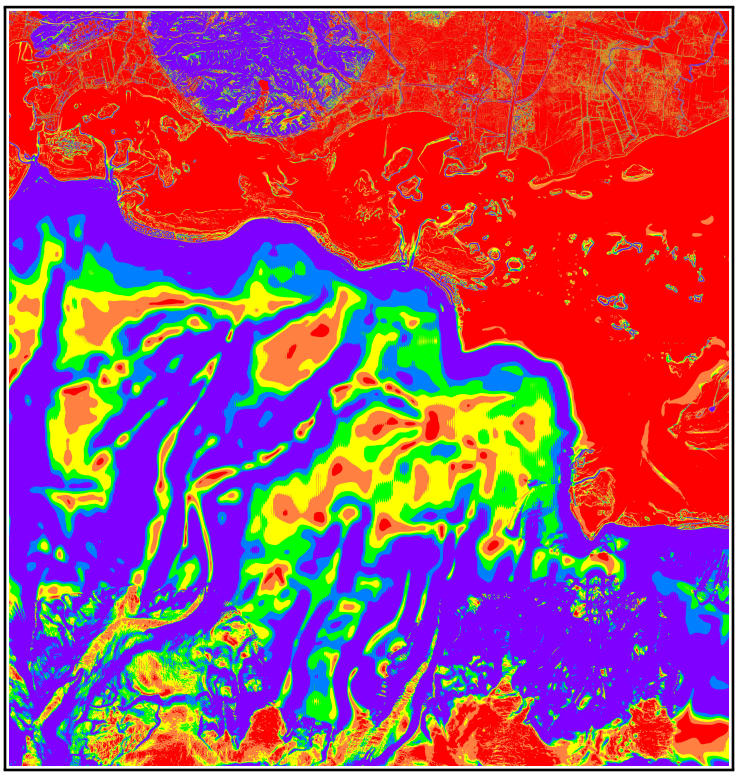


Figure 45: Site 3 Raster Reclassification Imagery

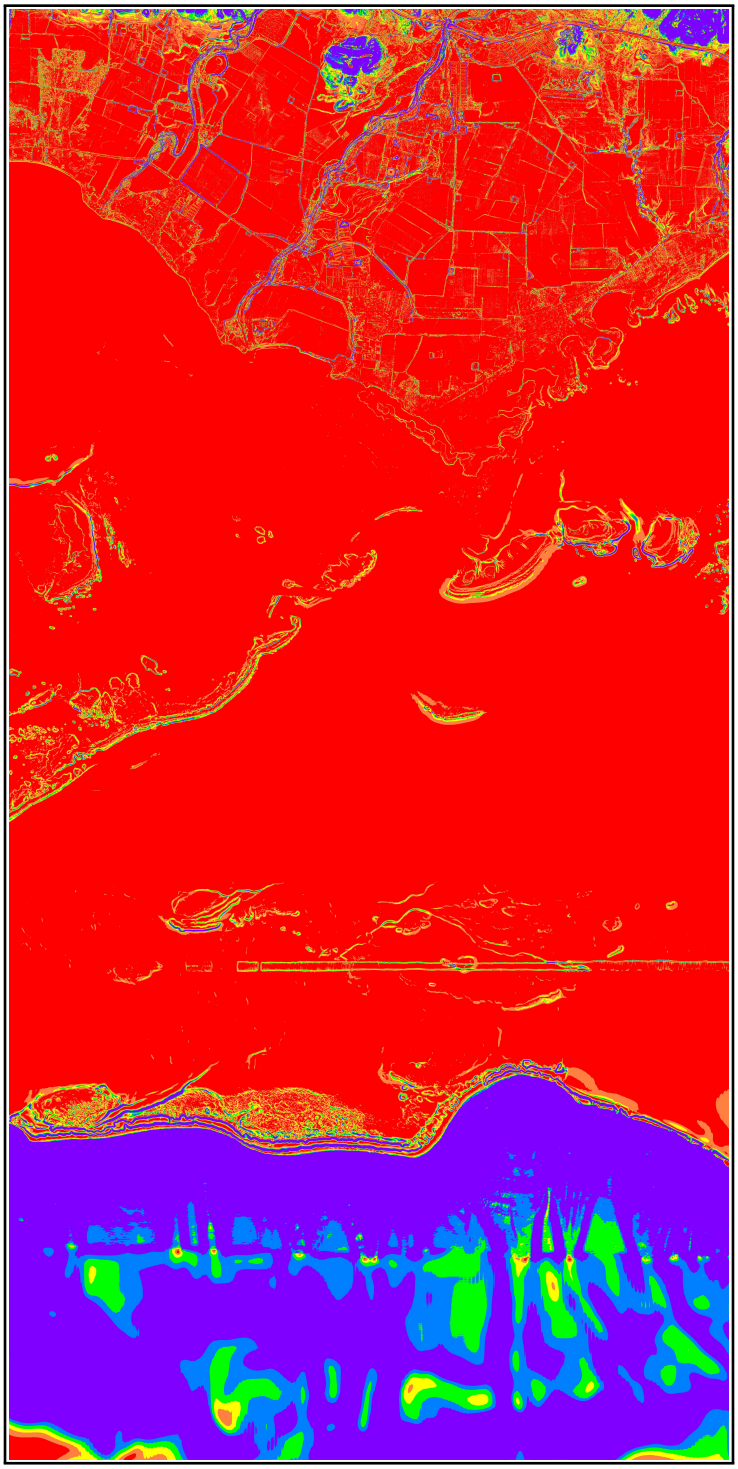


Figure 46: Site 4 Raster Reclassification Imagery

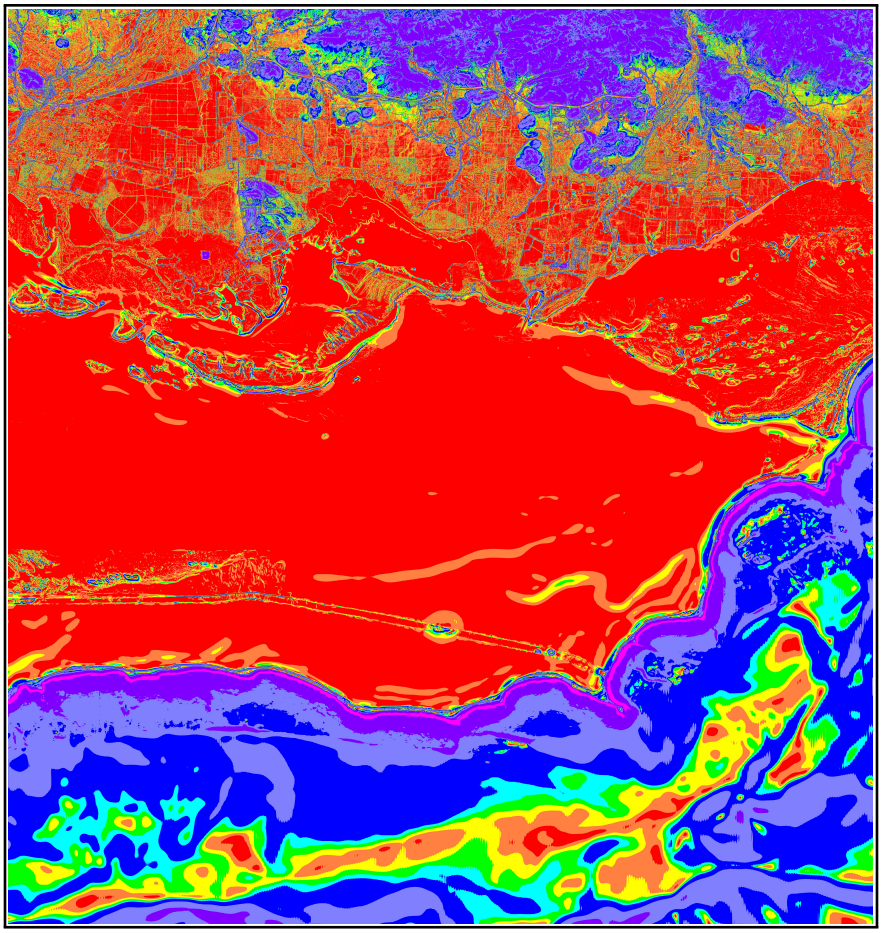


Figure 47: Site 5 Raster Reclassification Imagery

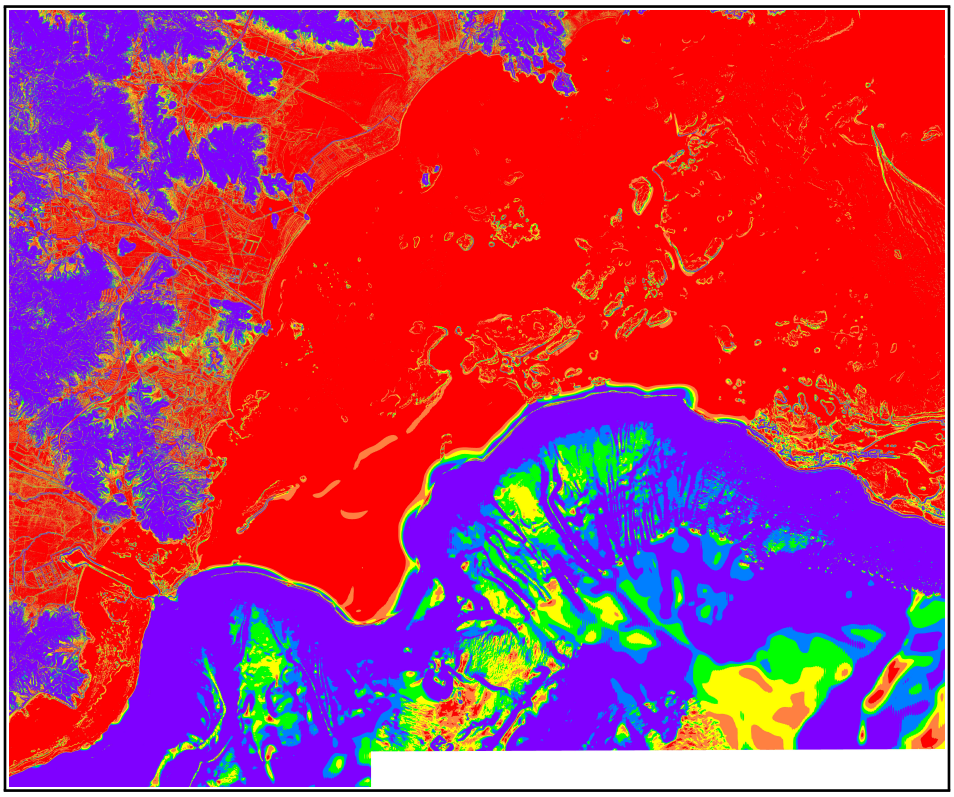


Figure 48: Site 6 Raster Reclassification Imagery

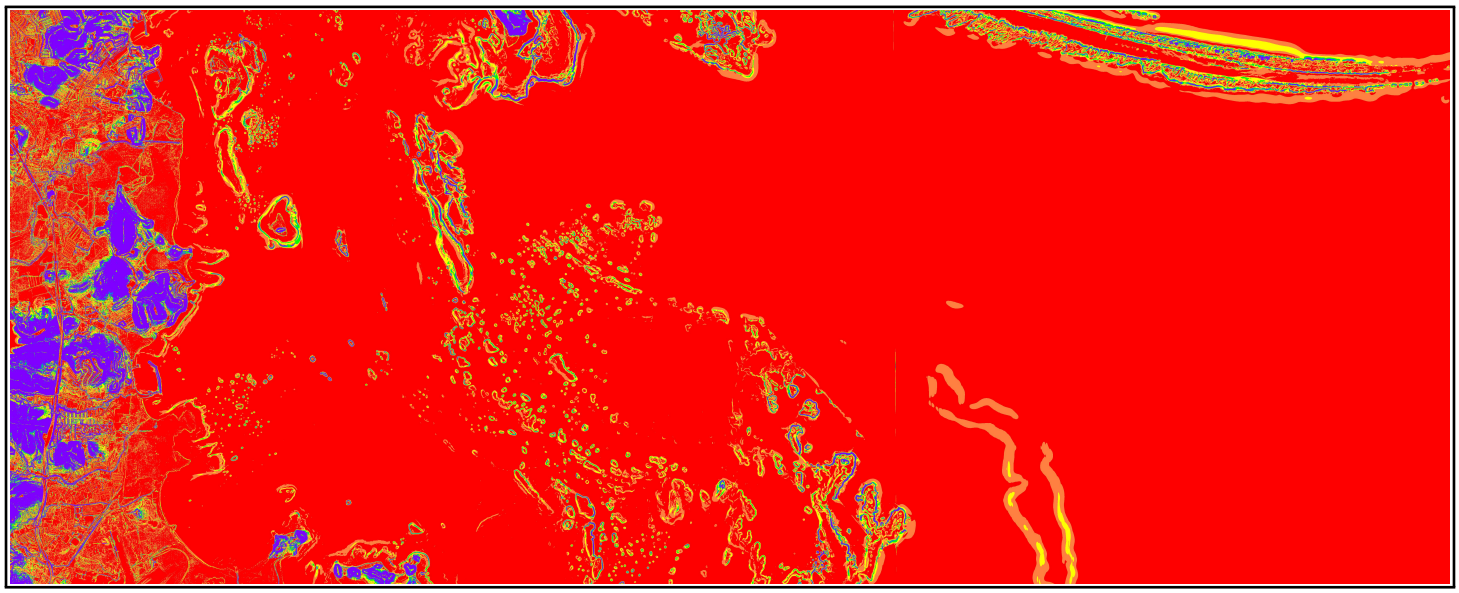


Figure 49: Site 7 Raster Reclassification Imagery

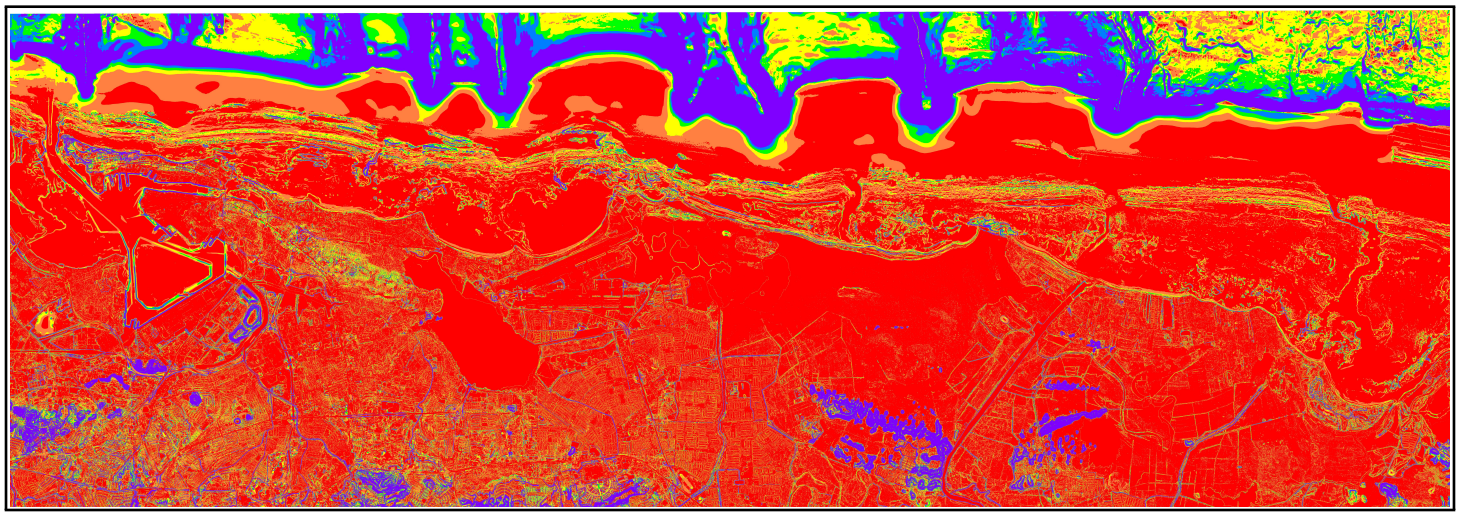


Figure 50: Site 8 Raster Reclassification Imagery

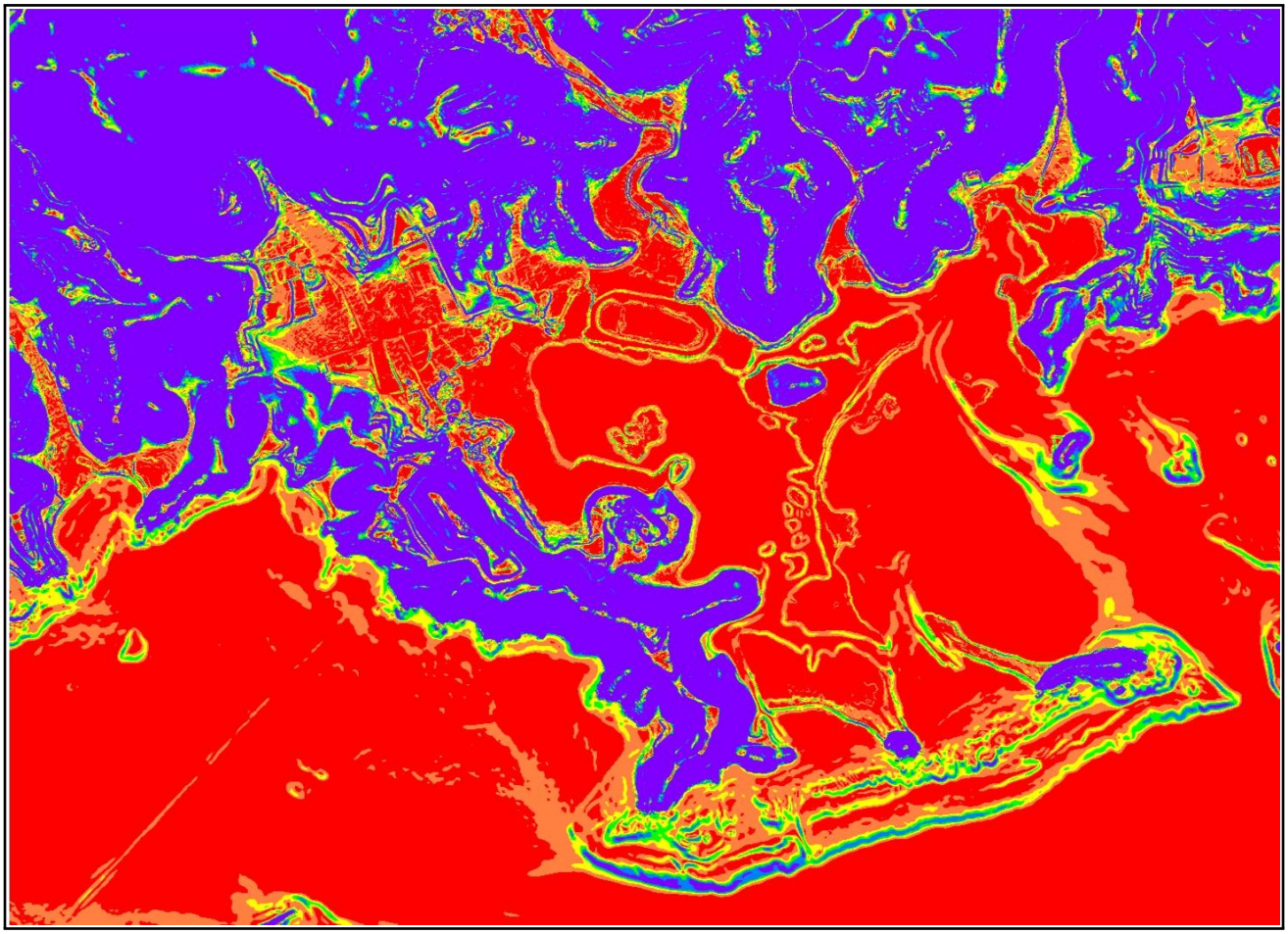


Figure 51: Site 9 Raster Reclassification Imagery

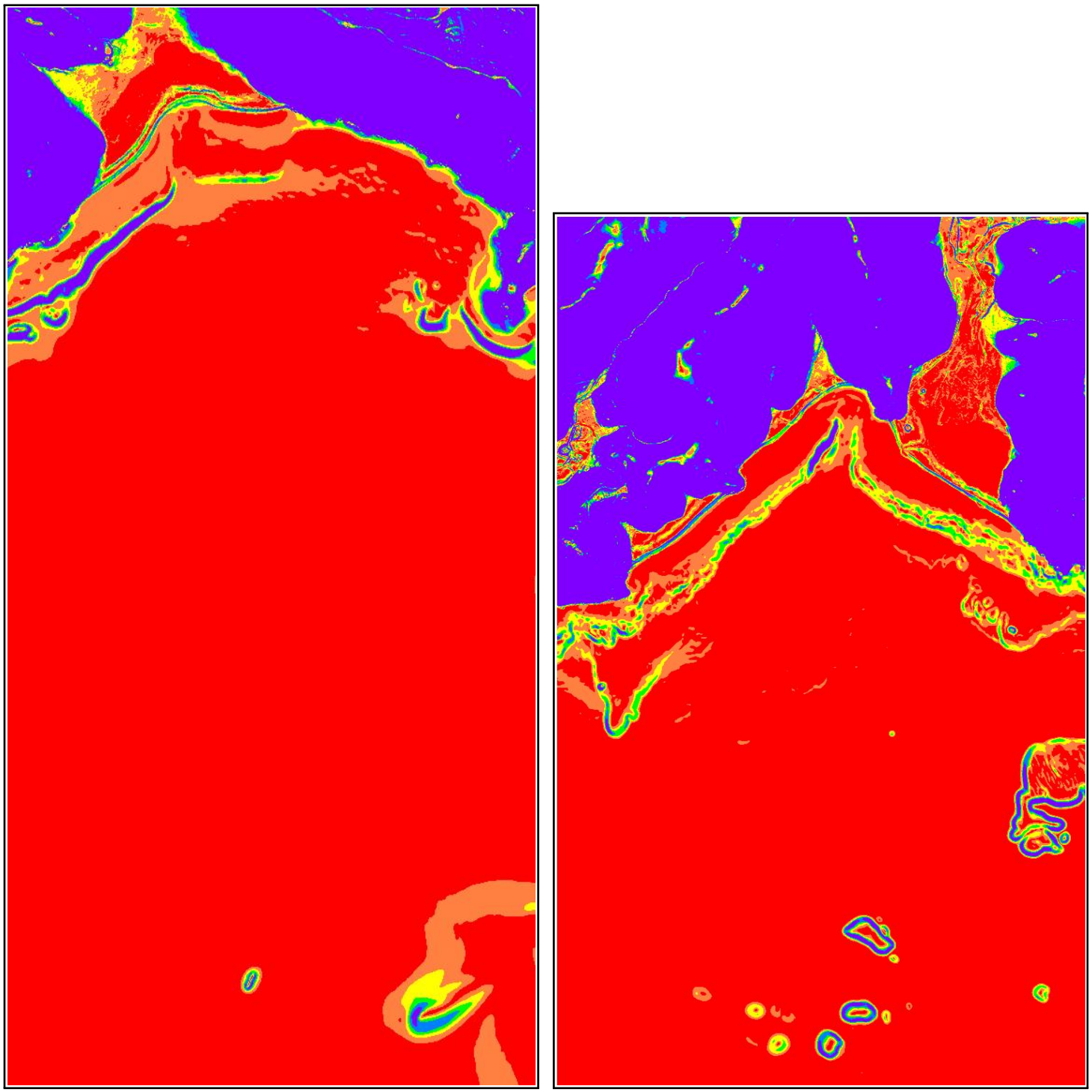


Figure 52: Sites 10 and 11 Raster Reclassification Imagery

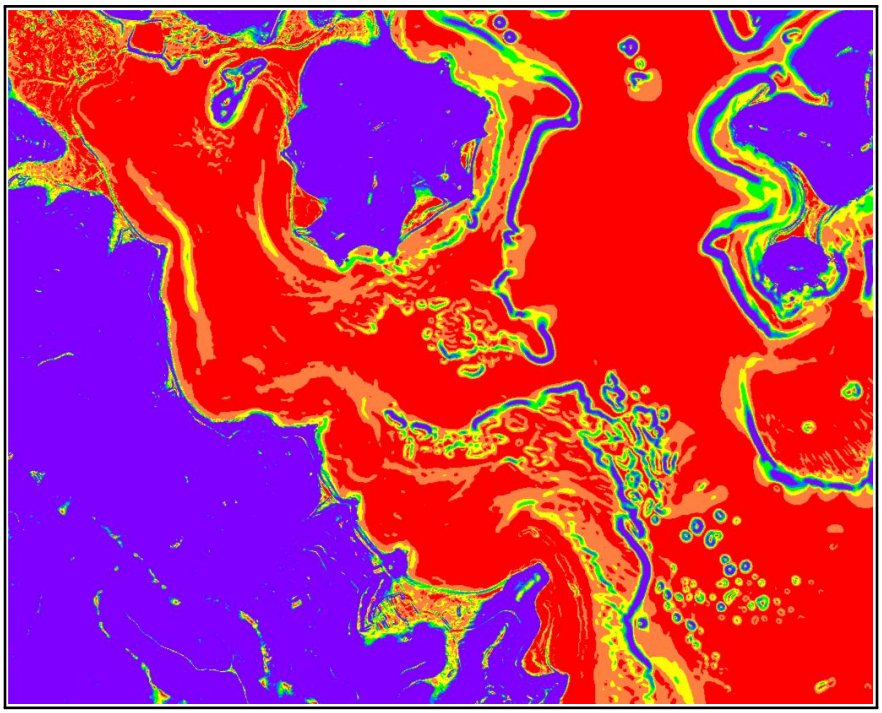


Figure 53: Site 12 Raster Reclassification Imagery

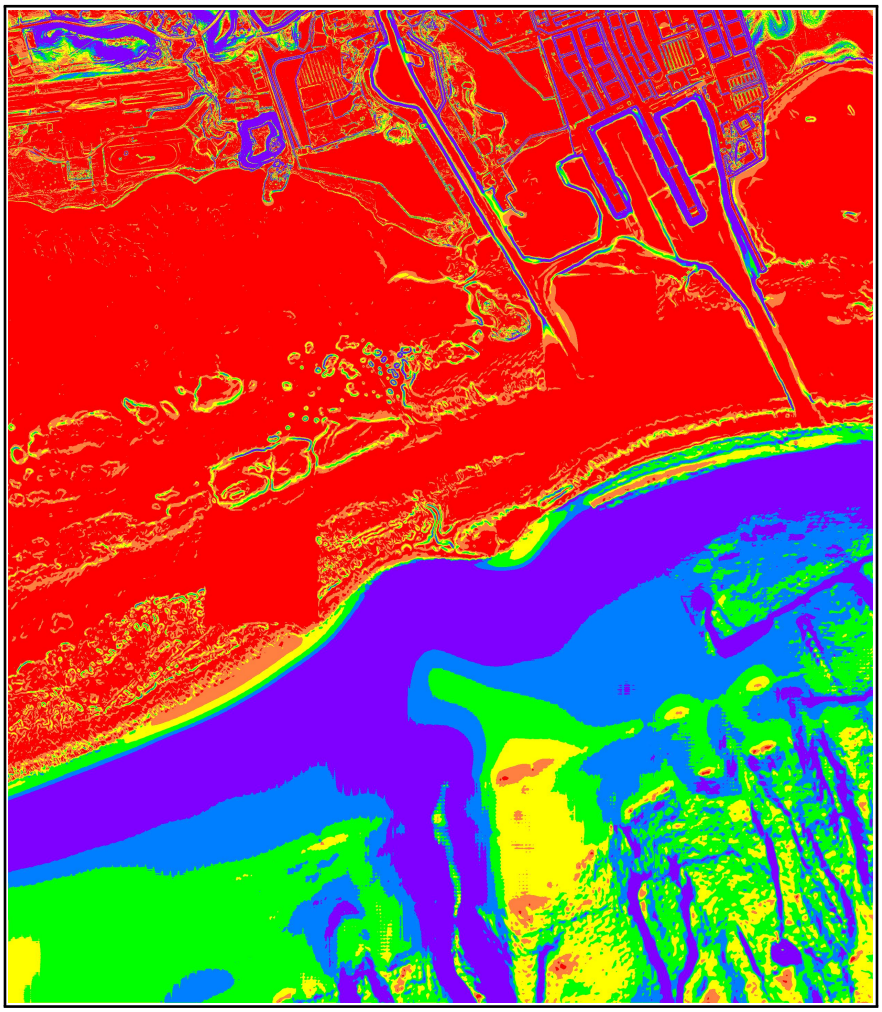


Figure 54: Site 13 Raster Reclassification Imagery

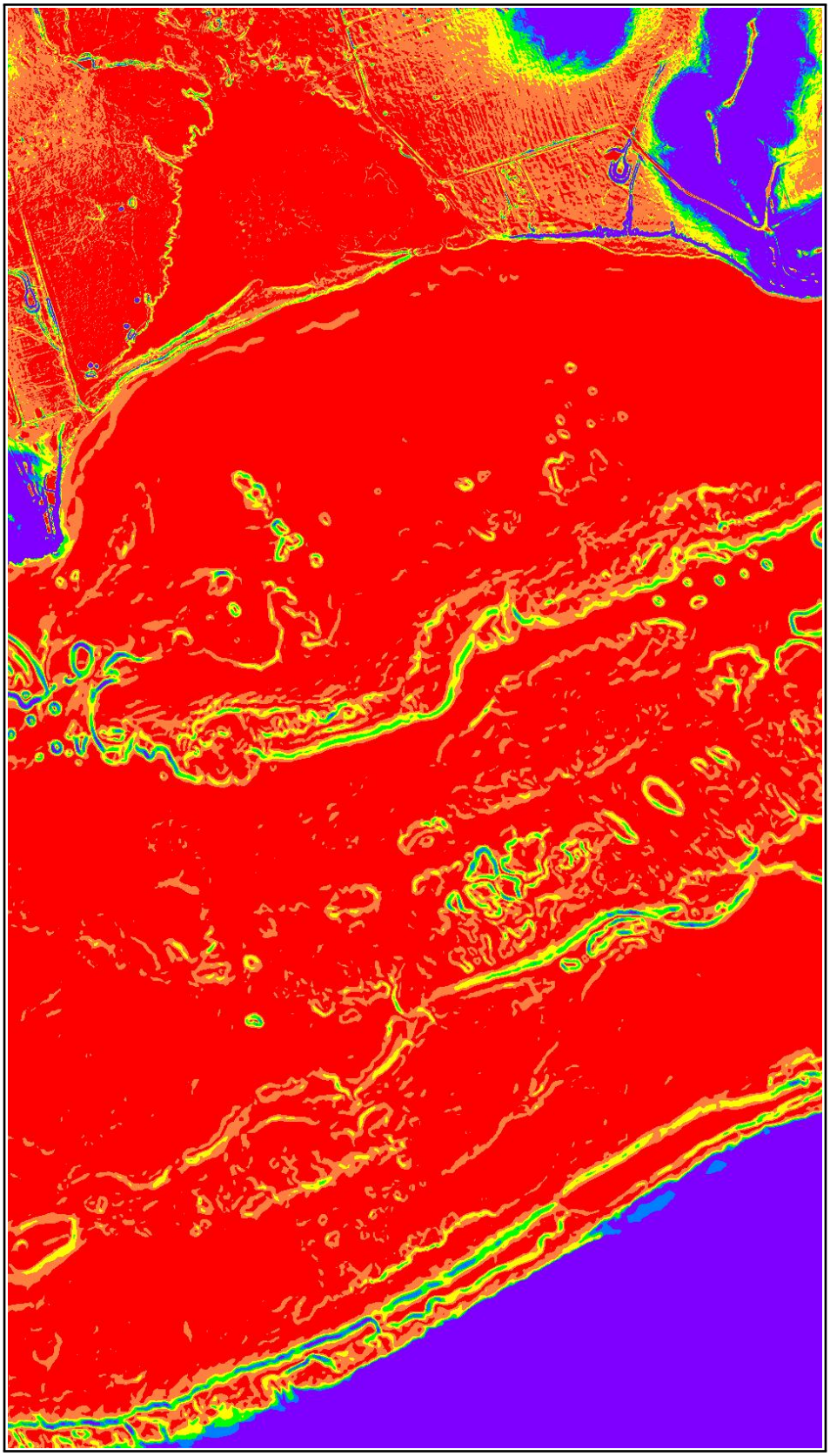


Figure 55: Site 14 Raster Reclassification Imagery

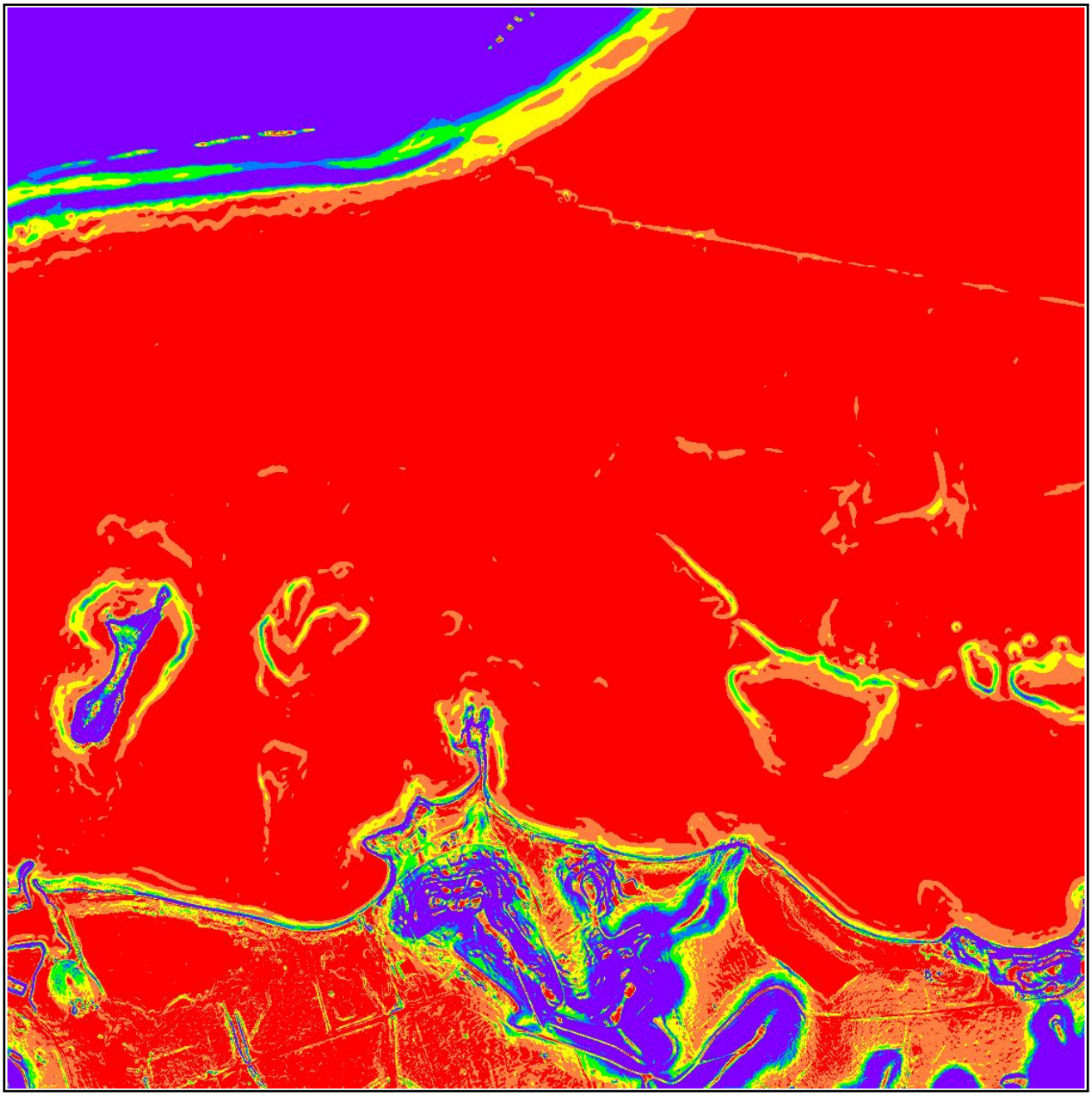
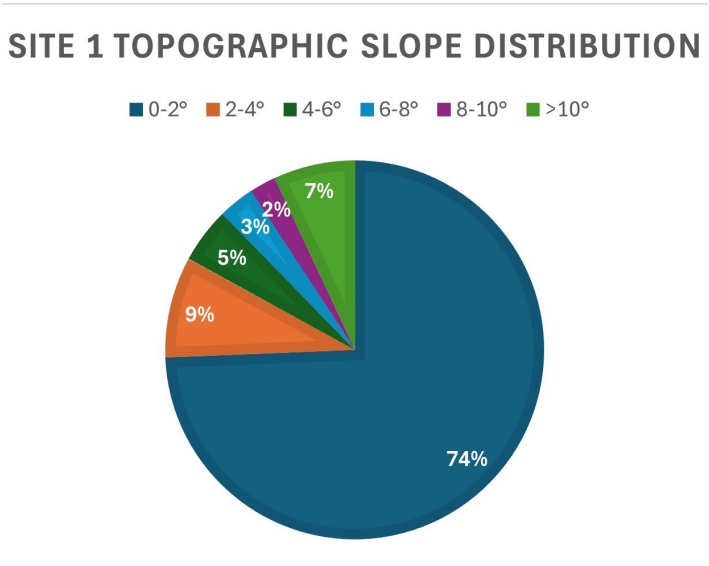


Figure 56: Site 15 Raster Reclassification Imagery

Appendix E - Slope Distributions



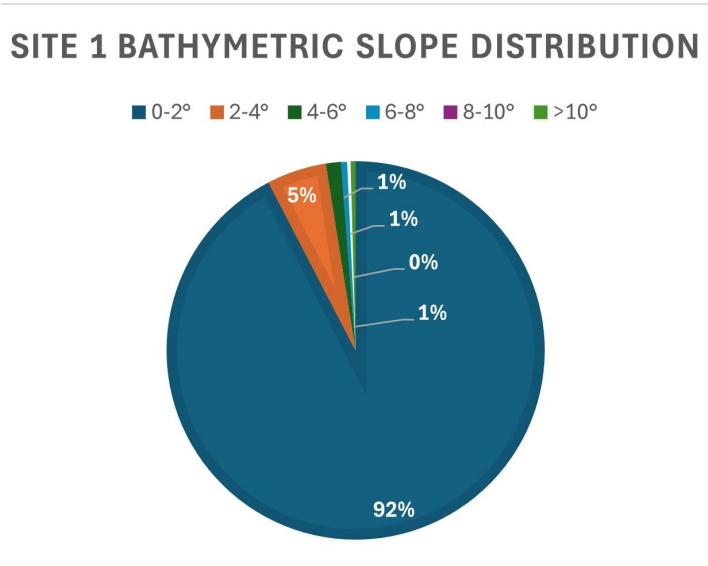
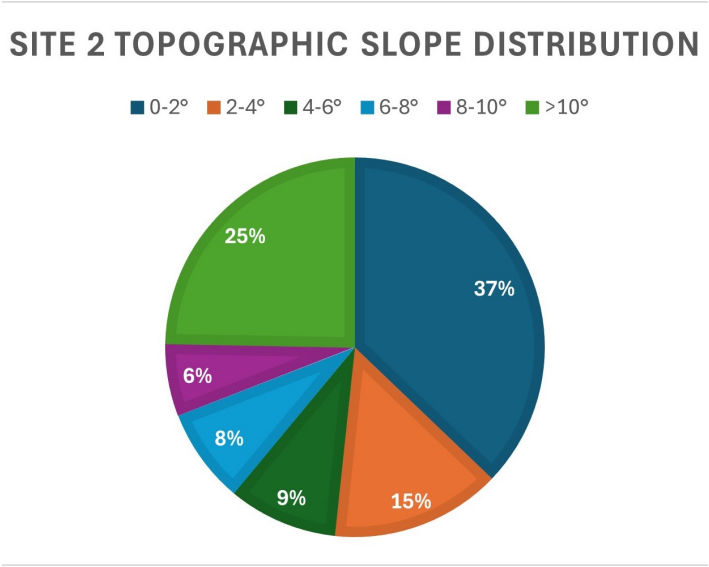


Figure 57: Site 1 Slope Distributions



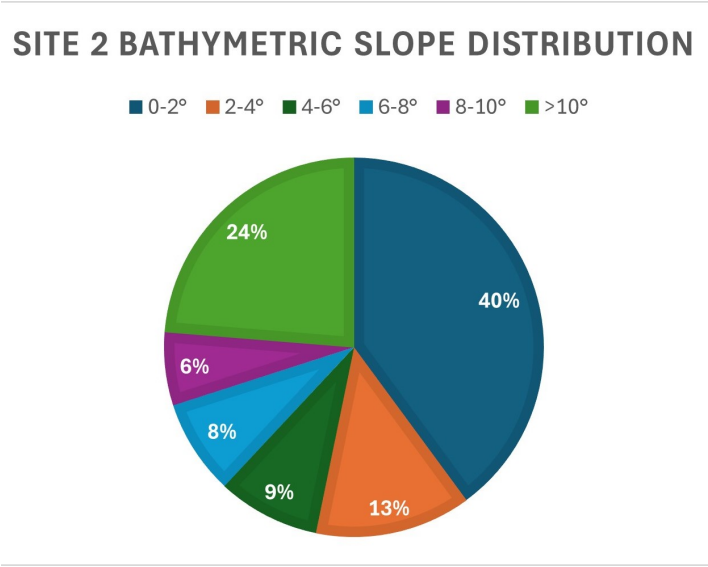
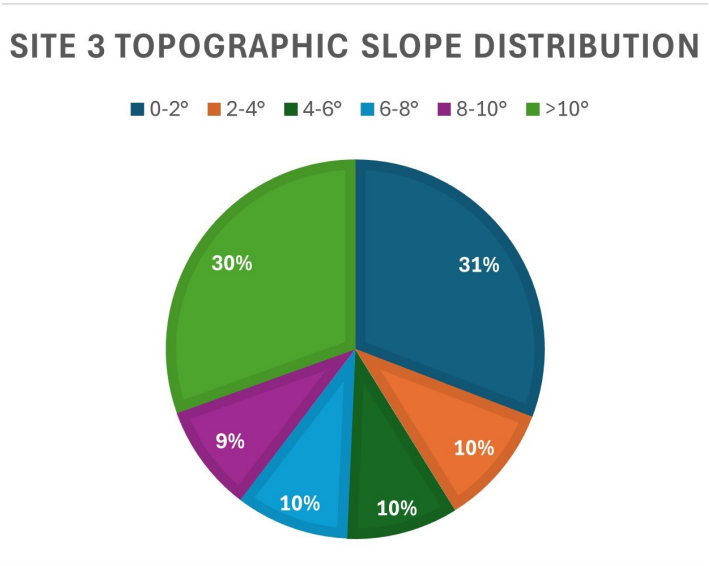


Figure 58: Site 2 Slope Distributions



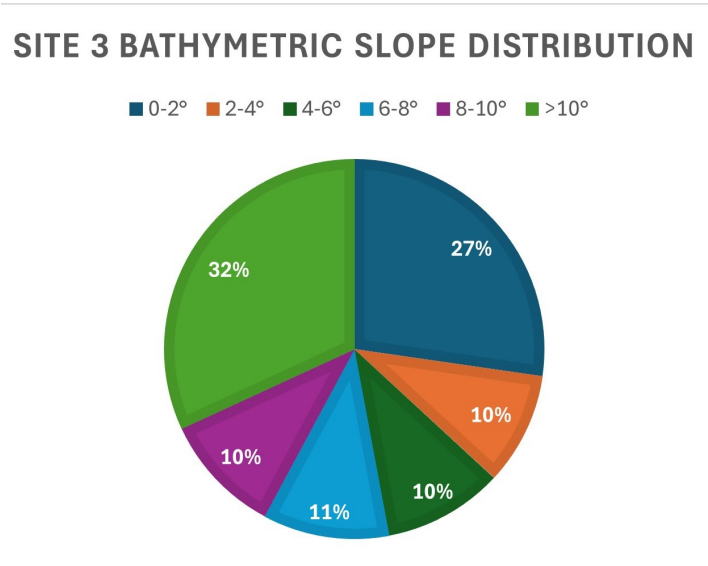
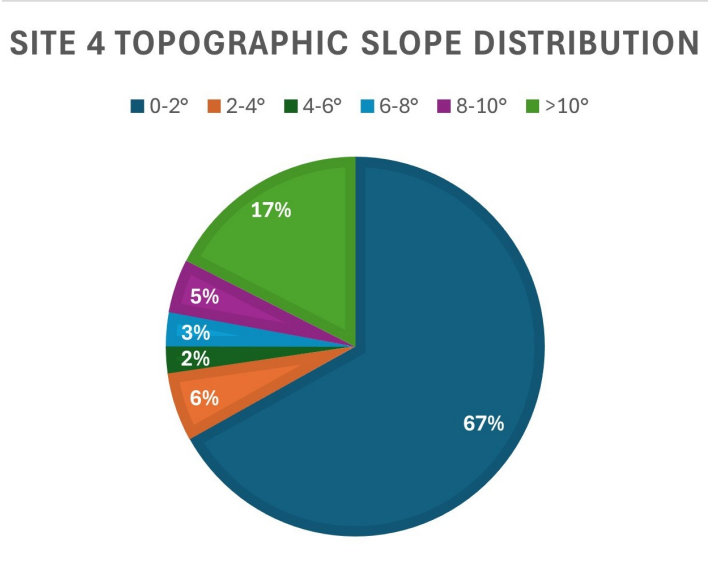


Figure 59: Site 3 Slope Distributions



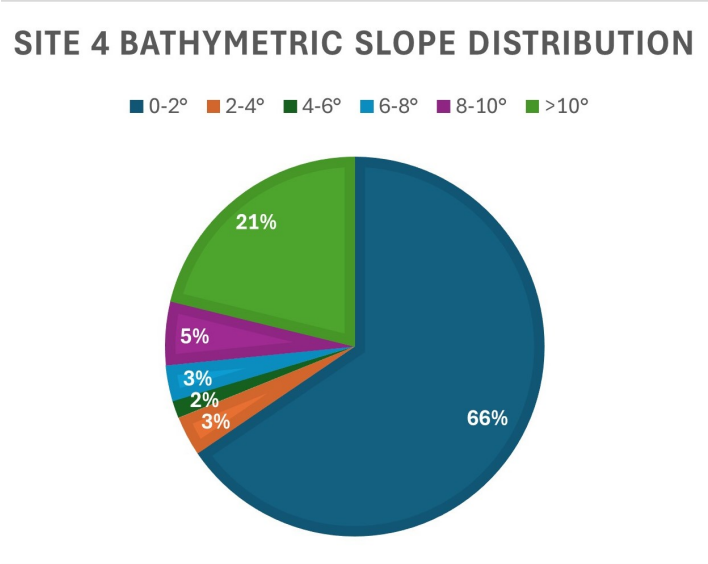
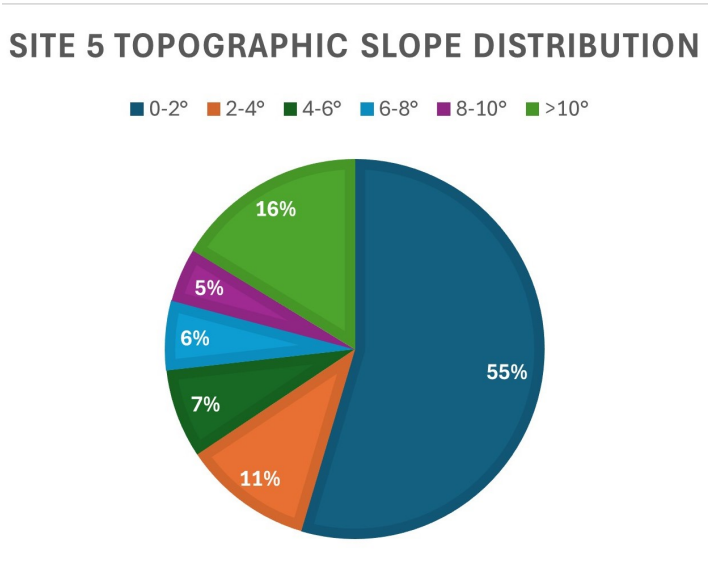


Figure 60: Site 4 Slope Distributions



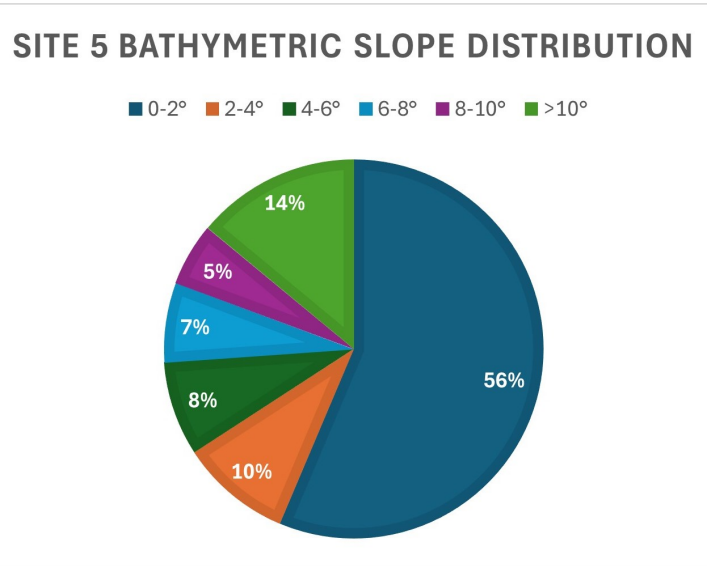
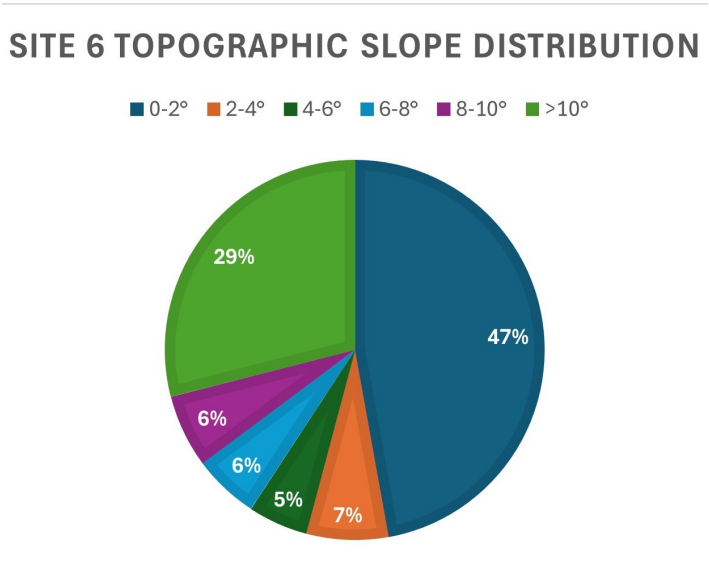


Figure 61: Site 5 Slope Distributions



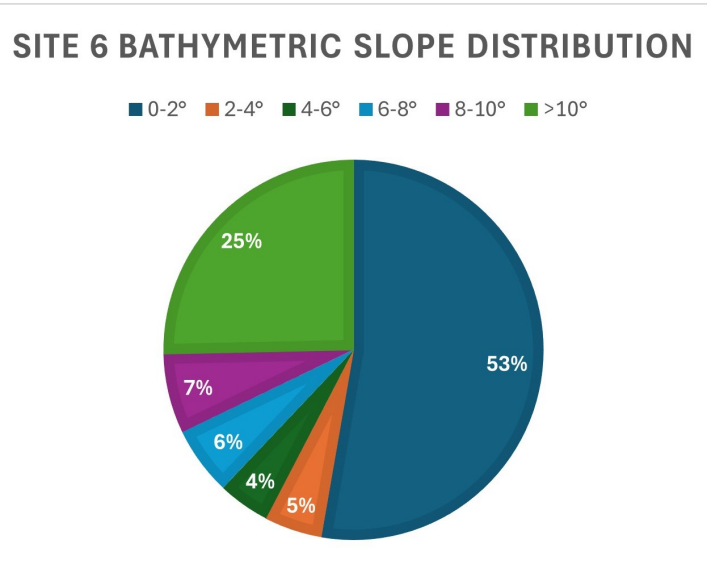
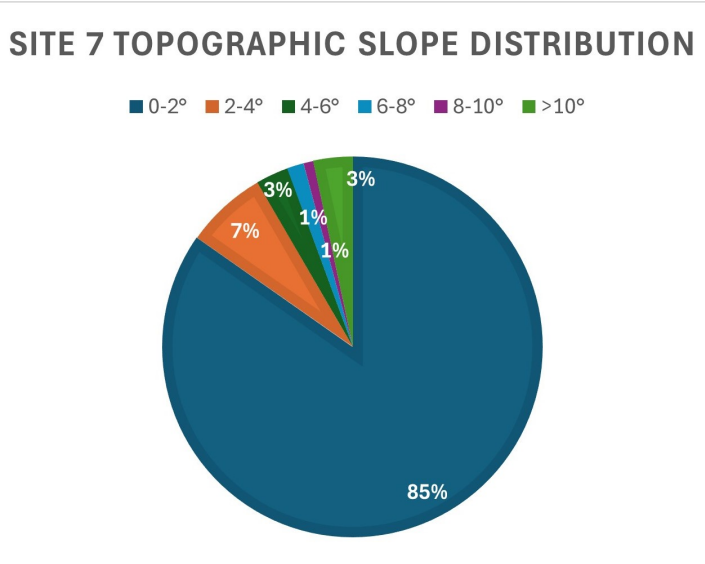


Figure 62: Site 6 Slope Distributions



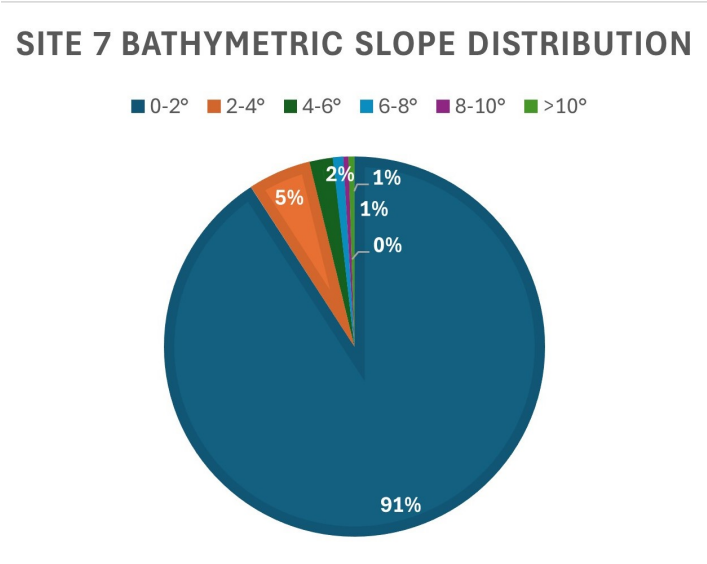
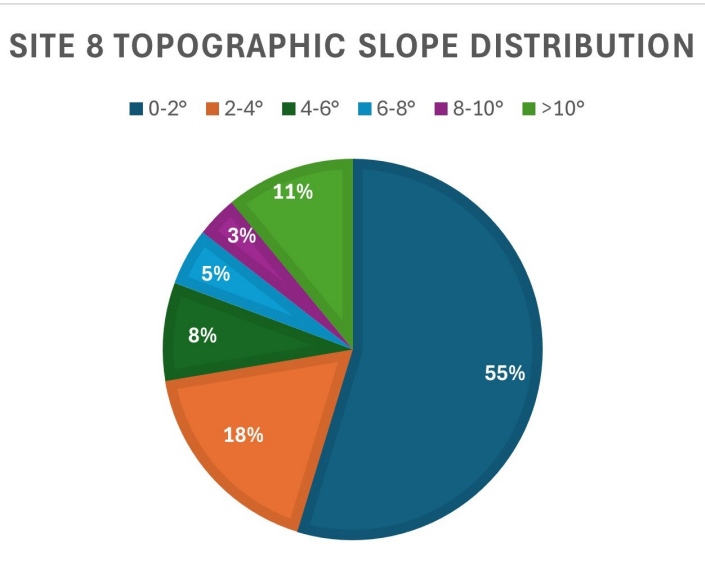


Figure 63: Site 7 Slope Distributions



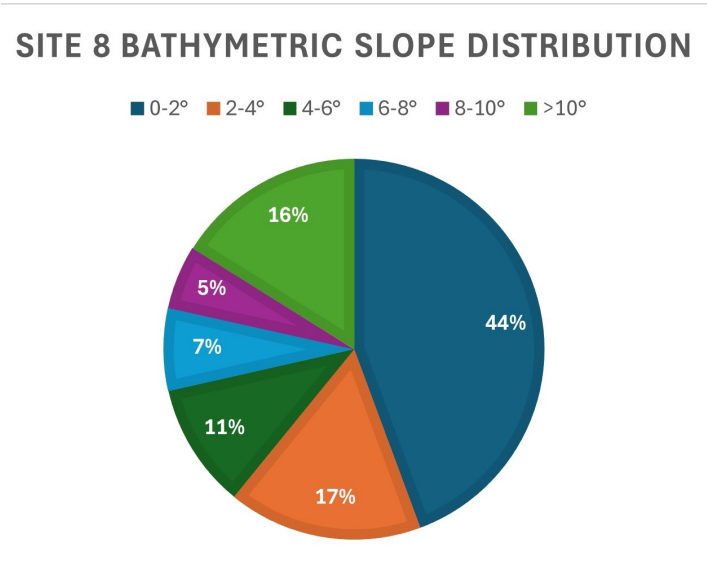
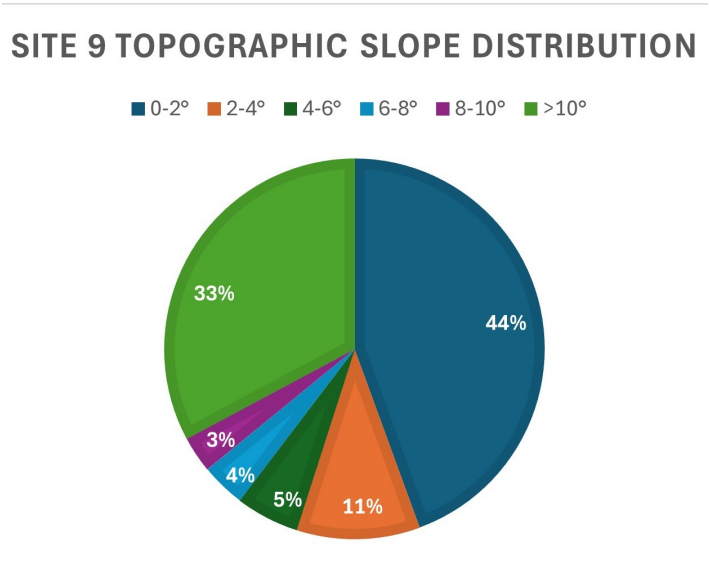


Figure 64: Site 8 Slope Distributions



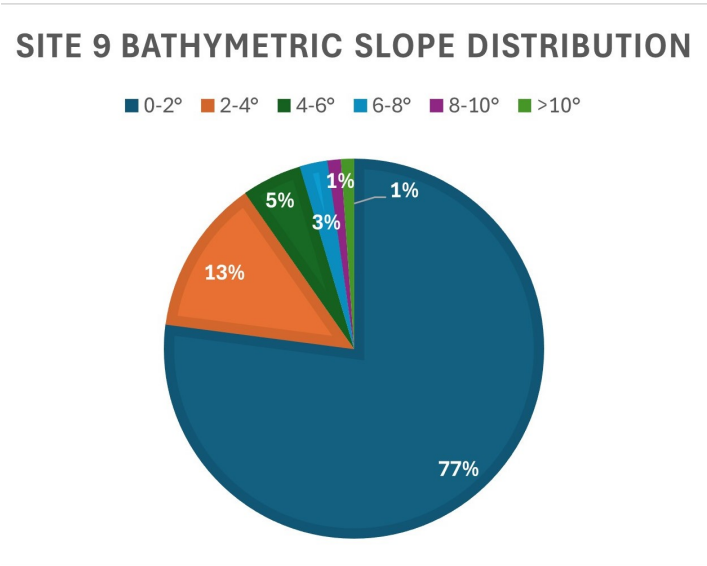
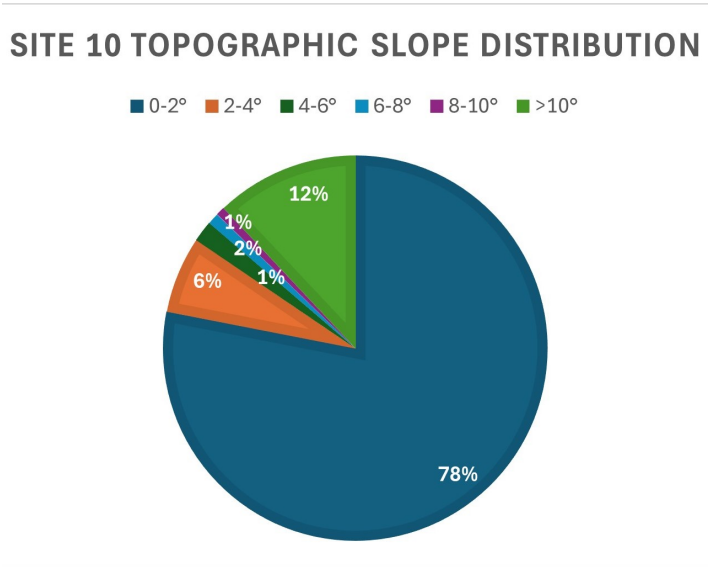


Figure 65: Site 9 Slope Distributions



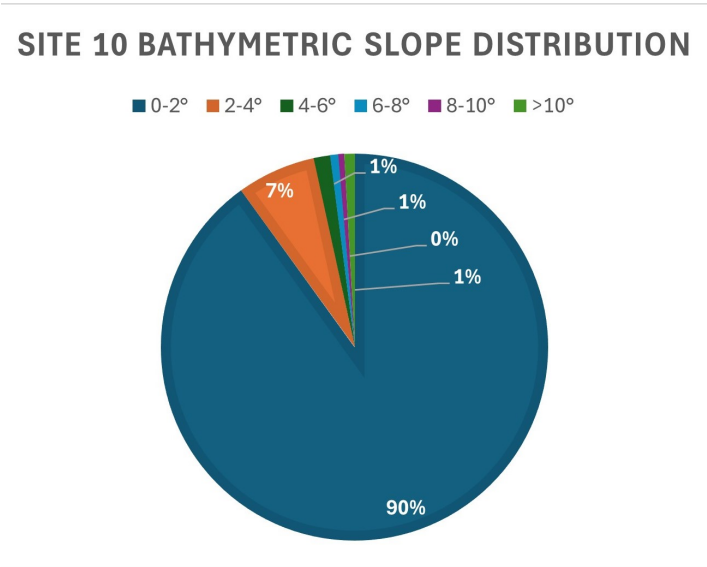
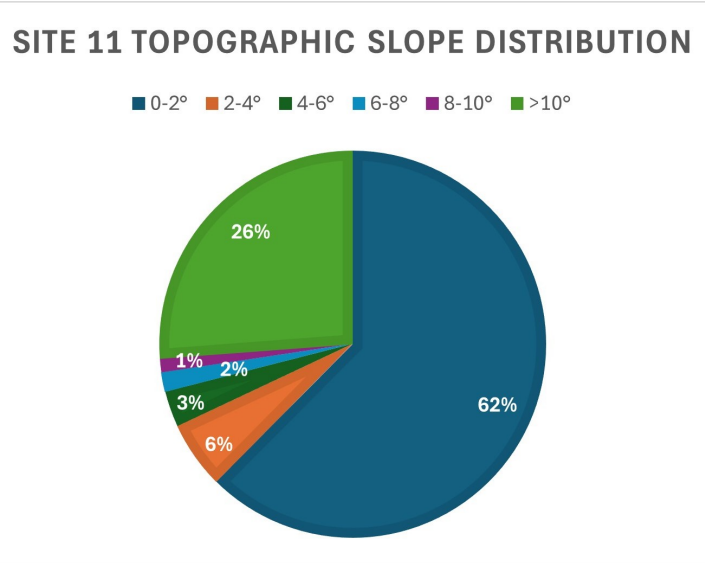


Figure 66: Site 10 Slope Distributions



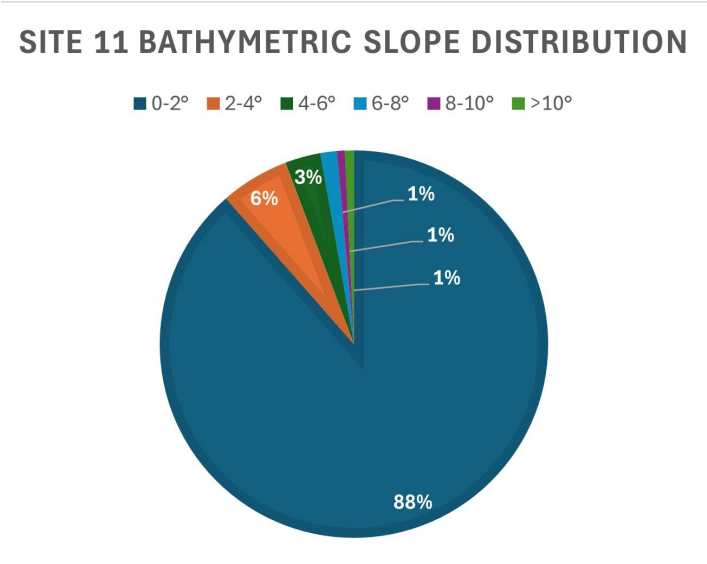
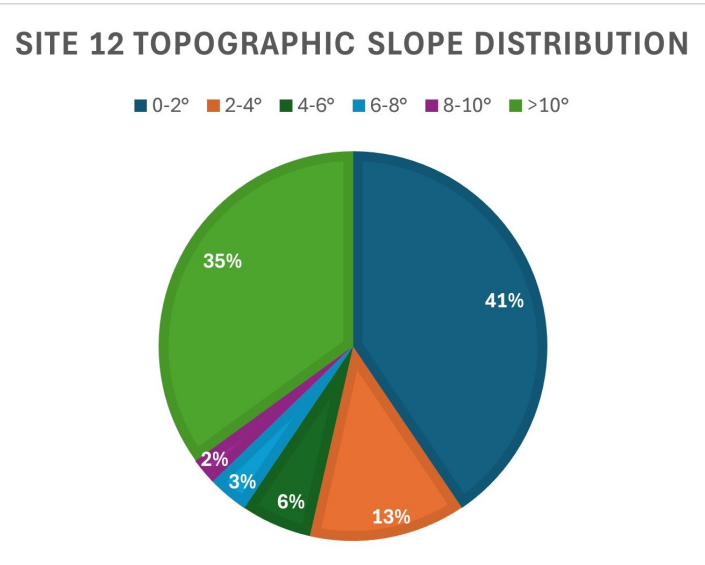


Figure 67: Site 11 Slope Distributions



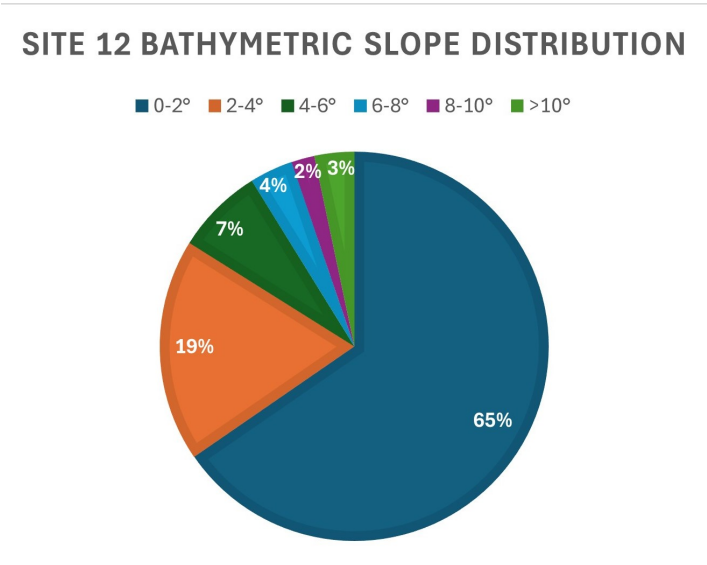
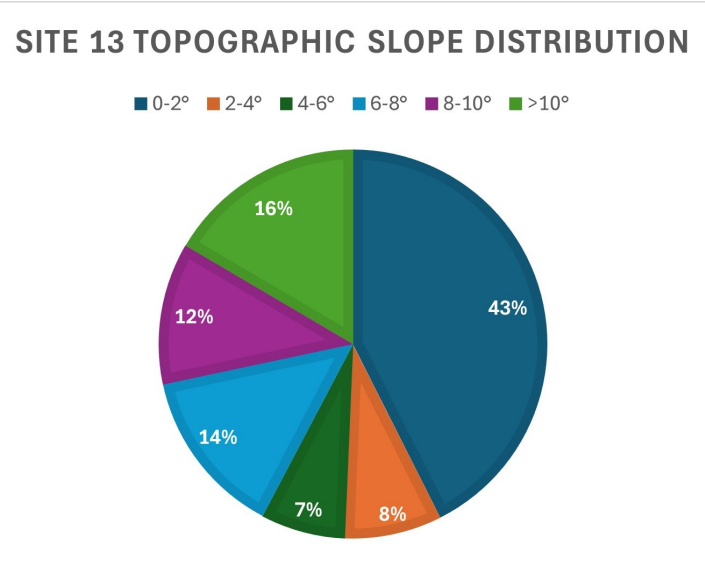


Figure 68: Site 12 Slope Distributions



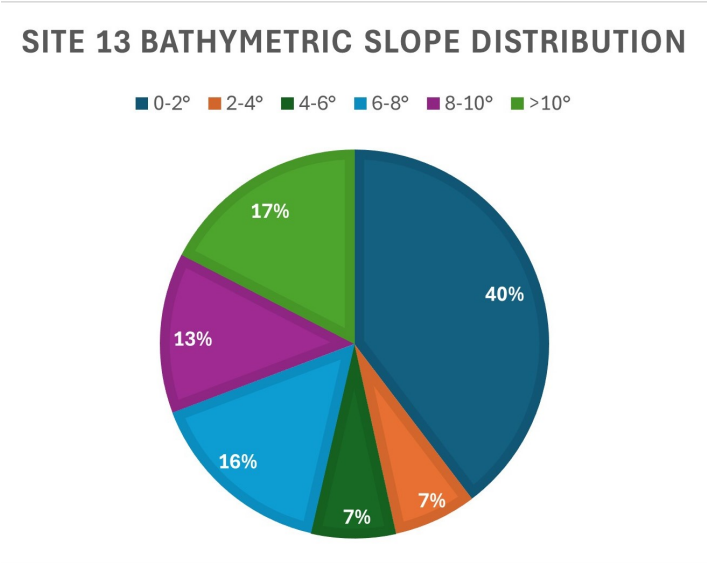
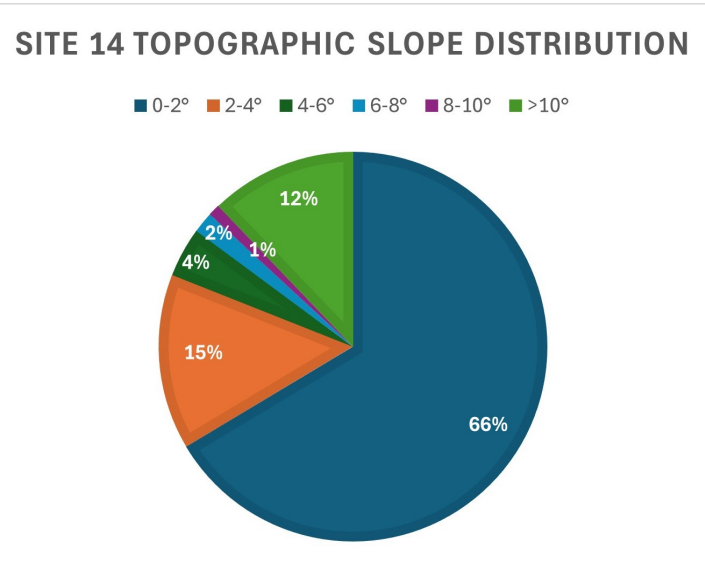


Figure 69: Site 13 Slope Distributions



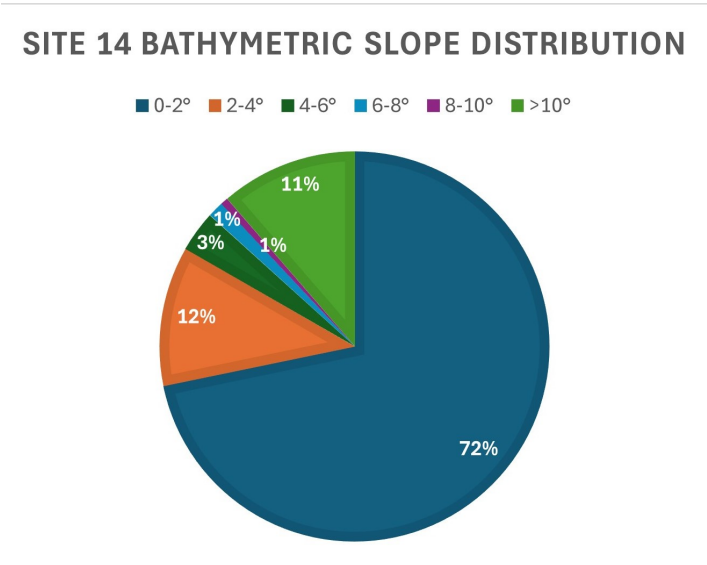
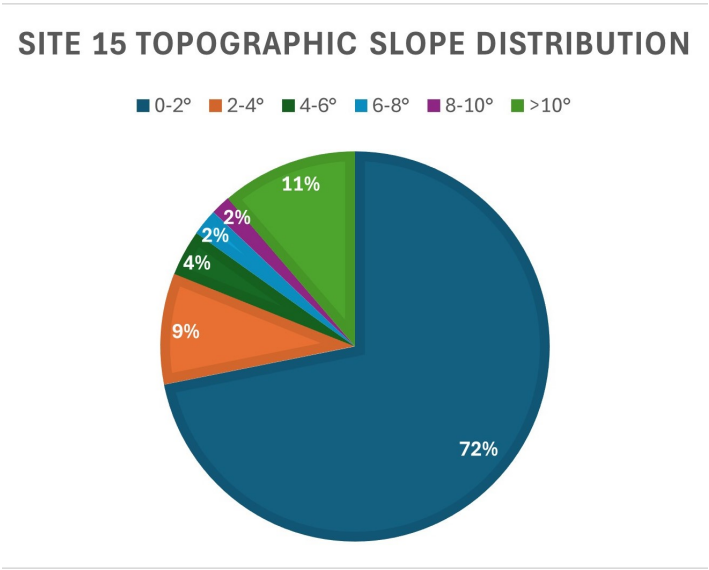


Figure 70: Site 14 Slope Distributions



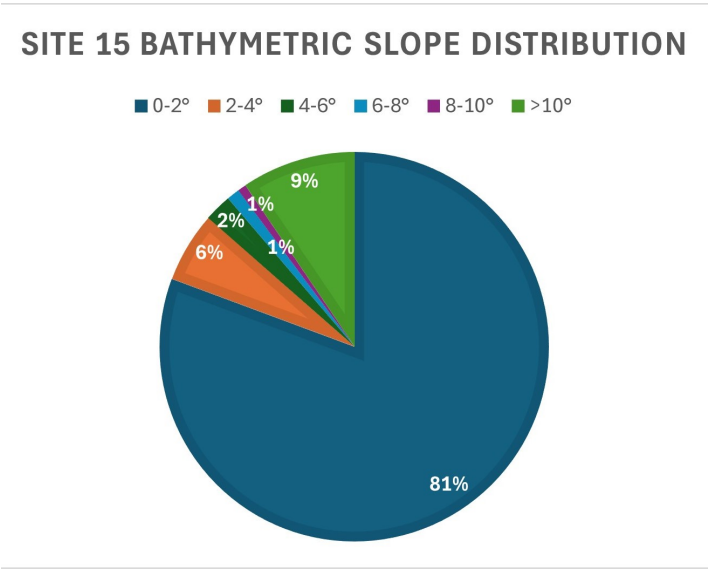


Figure 71: Site 15 Slope Distributions

Appendix F - Miscellaneous

Table 1: Buoy Locations and IDs

Site	Buoy Location	ID
1. Cabo Rojo	Mayaguez	MGZP4
2. Lajas	Lajas	MGIP4
3. Ponce & 4. Santa Isabel	Southeast of Ponce	42085
5. Salinas	Jobos Bay Reserve	JOQP4
6. Humacao	Yabucoa Harbor	YABP4
7. Fajardo	Fajardo	FRDP4
8. Carolina	San Juan	41053
9. Bovoni Lagoon	Charlotte Amalie	CHAV3
10. Perseverance Bay & 11. Reef Bay	10 km south of St. Thomas	41051
12. Coral Bay	Lameshur Bay	LAMV3
13. Canegarden	Limetree Bay	LTBV3
14. Great Pond Bay	Fareham	41141
15. Chenay & Coakley	Christiansted Harbor	CHSV3

Table 2: Median Household Income Comparisons

Location	Site	Median Household Income by Tract	Average	Percent Difference from Island Average	Average Percent Difference per Site
Puerto Real	1	18,796; 13,666; 17,385	16,616	-30.8%	-35.9%
Boquerón	1	17,385; 17,692; 9,776	14,951	-41.0%	
La Parguera	2	13,549	13,549	-50.4%	-50.4%
South Ponce	3	35,650; 13,637; 17,422; 9,006; 27,778; 25,869; 11,504	20,124	-11.9%	-7.5%
Potala Pastillo	3	14,935; 29,520; 21,550	22,002	-3.0%	
Playita Cortada	4	13,778	13,778	-48.8%	-11.7%
South Santa Isabel	4	17,744; 19,722	18,733	-19.0%	
Jauca	4	31,542	31,542	32.7%	
Coastal Salinas	5	11,996; 16,525	14,261	-45.5%	-24.5%
San Felipe	5	16,578	16,578	-31.0%	
Punta Pozuelo	5	23,370	23,370	3.0%	
Punta Santiago	6	21,506	21,506	-5.3%	-5.3%
Puerto Real	7	19,154; 19,688	19,421	-15.4%	-15.4%
Loíza y Mediana Alta	8	10,269; 16,690; 15,399; 22,375; 10,679; 11,250; 16,689	14,764	-42.2%	-38.1%
Piñones	8	17,037	17,037	-28.4%	
Cataño Pueblo	8	18,145; 10,938; 15,636; 14,717; 4,560; 12,341; 25,436	14,539	-43.7%	

Table 3: Vulnerable Population Percentage Comparisons

Location	Site	Vulnerable Population Percentage	Average	Percent Difference from Total Average	Average per Site
Puerto Real	1	42.6; 34.5; 40.8	39.3	0.4%	-0.9%
Boquerón	1	40.8; 44.7; 25.0	36.8	-2.1%	
La Parguera	2	41.6	41.6	2.7%	2.7%
South Ponce	3	33.0; 37.8; 37.5; 49.6; 46.8; 40.6; 44.2	41.4	2.5%	0.8%
Potala Pastillo	3	38.0; 39.6; 36.0	37.9	-1.0%	
Playita Cortada	4	32.5	32.5	-6.4%	-4.2%
South Santa Isabel	4	41.4; 41.2	41.3	2.4%	
Jauca	4	30.2	30.2	-8.7%	
Coastal Salinas	5	38.4; 38.1	38.3	-0.6%	-2.0%
San Felipe	5	35.2	35.2	-3.7%	
Punta Pozuelo	5	37.2	37.2	-1.7%	
Punta Santiago	6	35.6	35.6	-3.3%	-3.3%
Puerto Real	7	45.1; 43.7	44.4	5.45%	5.5%
Loíza y Mediana Alta	8	36.4; 42.5; 38.7; 33.0; 44.6; 46.6; 43.4	40.7	1.8%	-1.5%
Piñones	8	31.9	31.9	-7.0%	
Cataño Pueblo	8	32.8; 38.2; 42.0; 47.1; 39.4; 40.6; 37.6	39.7	0.8%	

```python
import numpy as np

def process_data_file(file_path):
    # Initialize lists to hold the data for specific columns (7, 9, 13)
    selected_columns = {6: [], 8: [], 12: []}  # Columns are 0-based indexed (6 -> 7th, 8 -> 9th, 12 -> 13th)
    # Mapping of column indices to descriptive names and units
    column_info = {
        6: {"name": "Wind Speed", "unit": "m/s"},
        8: {"name": "Wave Height", "unit": "m"},
        12: {"name": "Pressure", "unit": "hPa"}
    }

    # Define a set of irregular values to ignore
    irregular_values = {99, 99.0, 99.00, 999, 999.0, 9999, 9999.0}

    # Read the file and process the data
    with open(file_path, 'r') as file:
        lines = file.readlines()

        # Skip the first two rows (column names and units)
        data_lines = lines[2:]

        # Split each line into columns and convert to floats
        for line in data_lines:
            values = line.strip().split()  # Split by whitespace

            # Iterate through specific columns (7, 9, 13)
            for i in selected_columns.keys():
                if i < len(values):  # Ensure the column index exists in the current row
                    try:
                        # Convert value to float
                        num_value = float(values[i])
                        # Check if the value is an irregular value
                        if num_value not in irregular_values:
                            selected_columns[i].append(num_value)
                    except ValueError:
                        # Handle any value that cannot be converted to float (e.g., missing or invalid data)
                        continue
```

```python

    # Calculate statistics for the selected columns
    statistics = {}
    for idx, col_data in selected_columns.items():
        column_name = column_info[idx]["name"]  # Get the human-readable column name
        unit = column_info[idx]["unit"]  # Get the unit for the column
        if col_data:  # Check if the column has any valid data
            col_array = np.array(col_data)
            statistics[column_name] = {
                'Average': f"{np.mean(col_array):.2f} {unit}",
                'Maximum': f"{np.max(col_array):.2f} {unit}",
                'Minimum': f"{np.min(col_array):.2f} {unit}"
            }
        else:
            # Handle the case where there is no valid data in the column
            statistics[column_name] = None

    # Display results with custom messages for unavailable data
    for column_name, stats in statistics.items():
        if stats is None:
            print(f"{column_name} data is unavailable.")
        else:
            print(f"{column_name} Statistics:")
            print(f"  Average: {stats['Average']}")
            print(f"  Maximum: {stats['Maximum']}")
            print(f"  Minimum: {stats['Minimum']}")
            print()
```

Figure 72: Python Buoy Data Analysis Program

Number	Row Type	Group	Wind Speed (m/s)	Wave Height (m)	Pressure (hPa)	(°C)	Group	Wind Speed (m/s)	Wave Height (m)	Pressure (hPa)	(°C)
1	Average		2.22	Data Unavailable	Data Unavailable	28.98		3.56	Data Unavailable	1008.49	Data Unavailable
	Maximum		10.6			32		26.6		1014.9	
	Minimum		0			26.6		0.1		977.1	
2	Average		1.85	Data Unavailable	1014.88	28.03		3.21	Data Unavailable	1011.06	29.53
	Maximum		12.7		1022.4	30.9		19.7		1015.8	30.8
	Minimum		0		1006.6	25.1		0		993.4	27.2
3 & 4	Average		6.14	1.05	1014.51	27.97		6.14	1.21	1009.36	29.32
	Maximum		16.8	2.5	1020.9	30.8		25.5	2.1	1013.7	30.1
	Minimum		0.3	0.3	1006.4	25.9		2.3	0.6	983	28.4
6	Average		2.31	Data Unavailable	Data Unavailable	28.25		3.97	Data Unavailable	Data Unavailable	Data Unavailable
	Maximum		12.3			33.8		36.4			
	Minimum		0			25.2		0			
7	Average		4.18	Data Unavailable	1017.6	26		8.41	Data Unavailable	Data Unavailable	Data Unavailable
	Maximum		13.7		1023.3	29.8		32.2			
	Minimum		0		1009.2	23.4		1.1			
8	Average		5.36	1.33	1014.9	27.64		7.57	1.36	1008.02	27.9
	Maximum		14.1	3.5	1021.9	30.4		25.5	5.6	1014.4	29.8
	Minimum		0.4	0	1006.7	24.6		0.5	0.6	981.5	24.8
9	Average		1.95	Data Unavailable	1015.75	27.5		2.93	Data Unavailable	Data Unavailable	30.19
	Maximum		7.9		1022.6	33.1		28.5			30.5
	Minimum		0		1007.1	27.5		0.2			29.1
10	Average		6.32	0.91	1015.67	28.13		6.42	0.92	1015.15	28.08
**	Maximum		24.7	1.9	1021.1	30.5		20	3	1021.1	30
	Minimum		0	0.3	1007.5	25.9		0.1	0.3	1006.8	26.4
11 & 12	Average		Data Unavailable	Data Unavailable	1015.51	28.08		Data Unavailable	Data Unavailable	Data Unavailable	29.52
	Maximum				1022.8	31.7					31.3
	Minimum				1006.8	25.3					27.9
13	Average		3.48	Data Unavailable	1014.95	28.15		5.3	Data Unavailable	1011.17	29.73
	Maximum		13.4		1021.3	31		21.4		1016.7	30.9
	Minimum		0		1006.4	24.7		0		996.4	28.6
14	Average		Data Unavailable	1.27	Data Unavailable	26.35		Data Unavailable	1.14	Data Unavailable	28.92
***	Maximum			2.26		27.2			3.64		32.1
	Minimum			0.57		25.6			0.4		26.1
15	Average		2.39	Data Unavailable	1014.84	28.56		4.78	Data Unavailable	1010.25	29.6
	Maximum		11.6		1020.2	31.1		16.9		1015.9	30.7
	Minimum		0		1006.6	25.8		0.2		995	28.7

Figure 73: Sites 1-15 Buoy Data Analysis

Percent Change: Wind Speed	Percent Change: Wave Height	Percent Change: Pressure	Percent Change: Sea Surface Temp
60.36036036	Data Unavailable	Data Unavailable	Data Unavailable
150.9433962			
N/A			
73.51351351	Data Unavailable	-0.37639918	5.351409204
55.11811024		-0.645539906	-0.323624595
N/A		-1.311345122	8.366533865
0	15.23809524	-0.507634227	4.826599928
51.78571429	-16	-0.705260065	-2.272727273
666.6666667	100	-2.325119237	9.652509653
71.86147186	Data Unavailable	Data Unavailable	Data Unavailable
195.9349593			
N/A			
101.1961722	Data Unavailable	Data Unavailable	Data Unavailable
135.0364964			
N/A			
41.23134328	2.255639098	-6.88	0.26
80.85106383	60	-7.5	-0.6
25	N/A	-25.2	0.2
50.25641026	Data Unavailable	Data Unavailable	2.69
260.7594937			-2.6
N/A			1.6
1.582278481	1.098901099	-0.051197732	-0.177746178
-19.02834008	57.89473684	0	-1.639344262
N/A	0	-0.069478908	1.930501931
Data Unavailable	Data Unavailable	Data Unavailable	5.128205128
			-1.261829653
			10.27667984
52.29885057	Data Unavailable	-0.37243214	5.612788632
59.70149254		-0.450406345	-0.322580645
N/A		-0.9936407	15.78947368
Data Unavailable	-10.23622047	Data Unavailable	9.753320683
	61.0619469		18.01470588
	-29.8245614		1.953125
100	Data Unavailable	-0.452288045	3.641456583
45.68965517		-0.421485983	-1.286173633
N/A		-1.152394198	11.24031008

Figure 74: Sites 1-15 Measurement Percent Difference