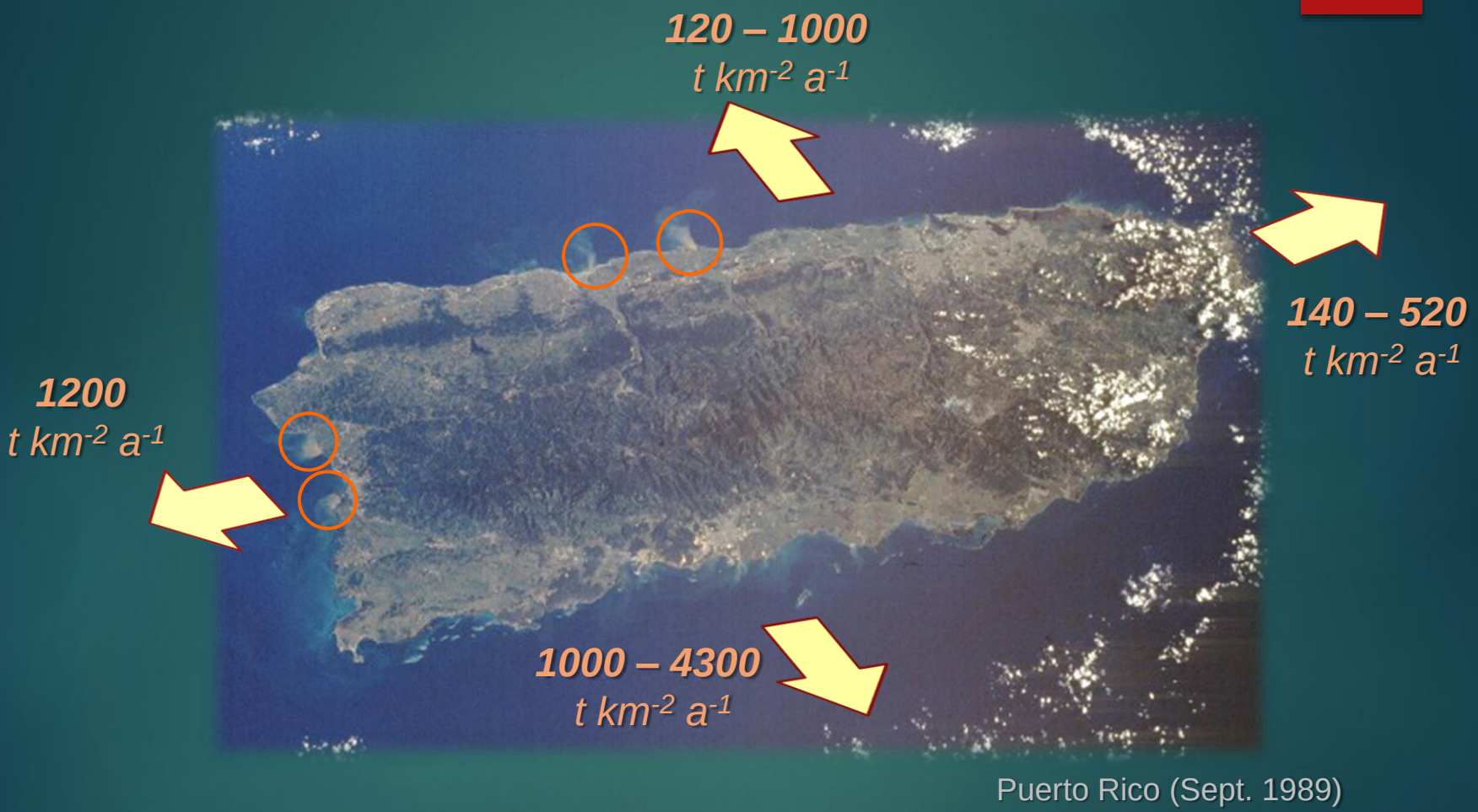
MAPPING THE FREQUENCY AND DISTRIBUTION OF THE RIO GRANDE DE AÑASCO PLUME USING MERIS

As Part of the Sea Grant Project:

Application of the Soil and Water Assessment Tool Model (SWAT) to Estimate Discharge and Sediment Yields from the Rio Grande de Añasco Watershed, Puerto Rico

Josue Aceituno, Fernando Gilbes, Carlos E Ramos-Scharrón, and Vilmaliz Rodriguez-Guzman (and Damaris Torres)

Land Use and its Consequences

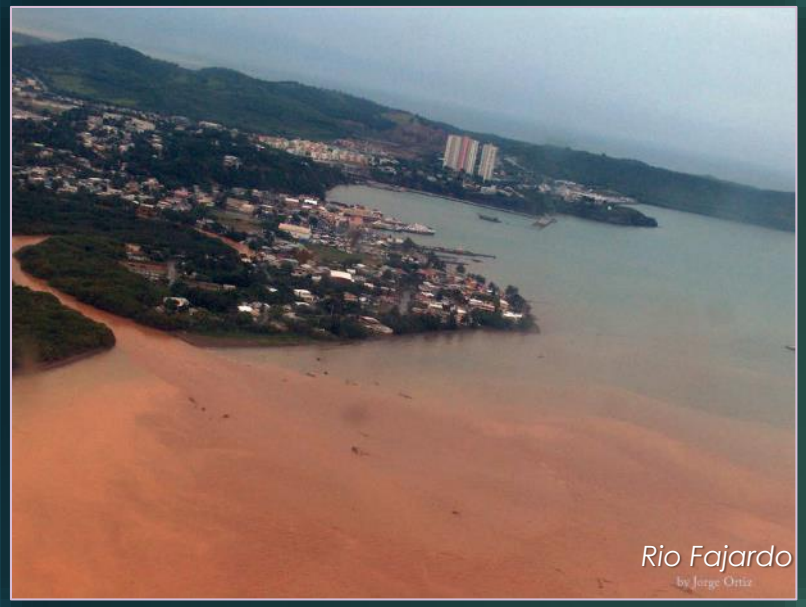


Puerto Rico (Sept. 1989)

Puerto Rico wide *(Larsen & Webb, 2009)*:

4786 km^2 & 2.7 – 9.0 Million tons a^{-1}, probably up to 10 times higher than natural pre-disturbance rates

Land Use and its Consequences



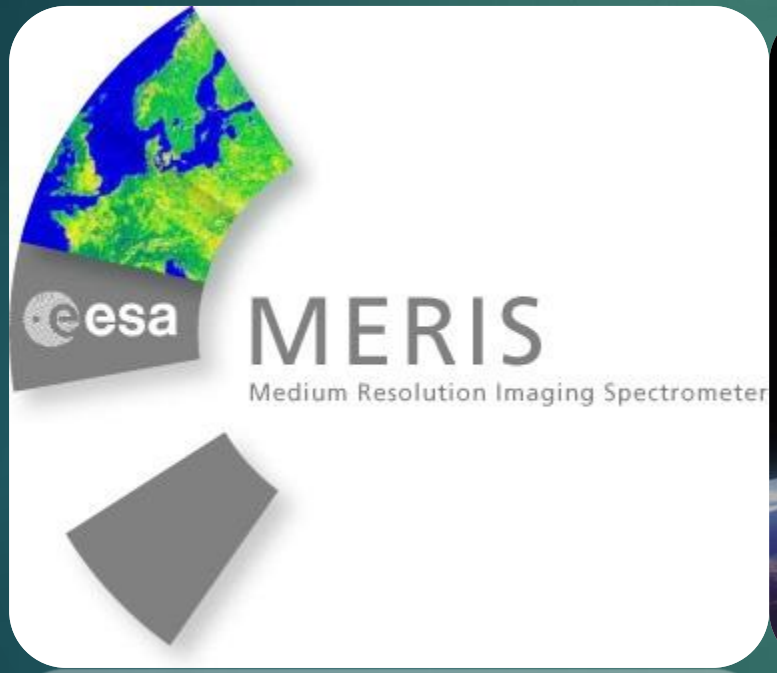
Reduced light penetration and increased nutrient concentration adversely affect corals and promote growth of macroalgae, St John-USVI & Culebra-PR (2006)

(photos by E. Delgado-UPR & C Rogers-USGS)

Objectives

- **Construct spatial frequency and distribution maps of the Añasco plume.**
- **Perform statistical analyses of the spatial and temporal variability of the Añasco plume using MERIS and ArcGIS.**
- **Compare the mapping estimates of Total Suspended Sediments with the Añasco River discharge data.**
- **Analyze the impact of the Añasco plume over the coral reefs communities of the Añasco Bay.**

Remote sensing of Suspended Sediments



MERIS Sensor

Spectral resolution: 15 bands selectable across range-390 nm to 1040 nm *(bandwidth programmable between 2.5 and 30 nm)*

Swath Width: 1150km, global coverage every 3 days

Mission Period: From 24 May 2002 to 08 April 2012

TSS are calculated using the 620 nm band.

Source: https://earth.esa

From: https://earth.esa.int/instruments/tour-index/hardware_img/x_Meris50.jpg

Image and Data Selection

307 MERIS images (2005-2011) were downloaded and processed from level 1 (raw image) to level 2 (final products) to obtain the concentration of total suspended matter or sediments (TSM or TSS) using BEAM.

Out of the 307, 128 were selected based on low cloud cover around the RGA plume area.

River Discharge Data

River discharge data collected by an inland USGS gauging station: USGS 50144000

The basin hydrological conditions considered includes cumulative flow from 4 to 72 hrs before the image was captured

Based on the distribution of the 24 hrs cumulative flow values, each image date was categorized as:

Low Flow, Moderate Flow, and High Flow

From Ramos and Gilbes (2012).

TSS Spatial Trends

Use of Cell Statistics (ArcGIS Tool) to calculate TSS trends under different river discharge conditions

High Flow
- Input: 6 Dates

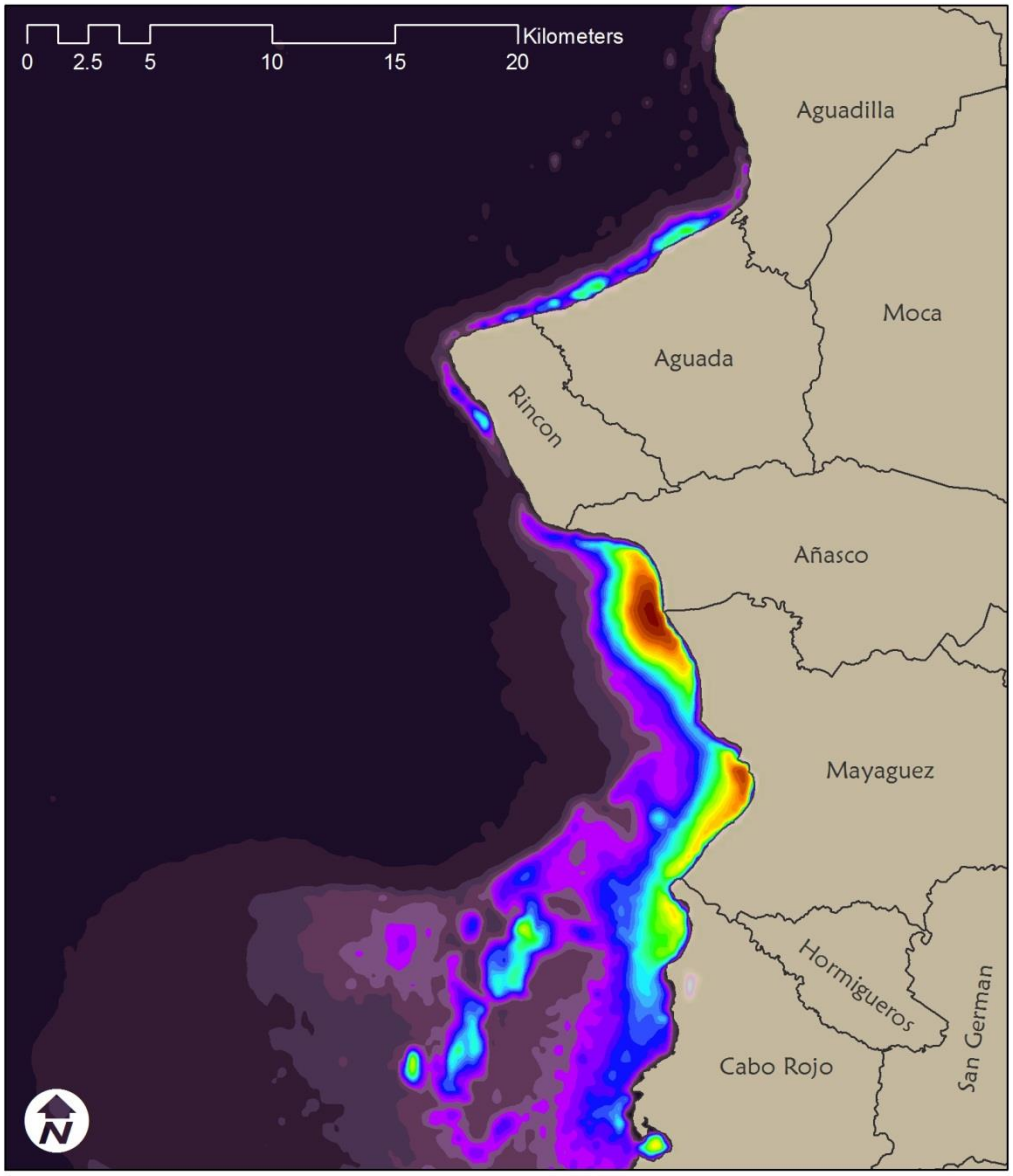
Moderate Flow
- Input: 87 Dates

Low Flow
- Input: 30 Dates

For each condition it was determined the Mean Value of the inputs on a cell-by-cell basis

TSS Spatial Trends

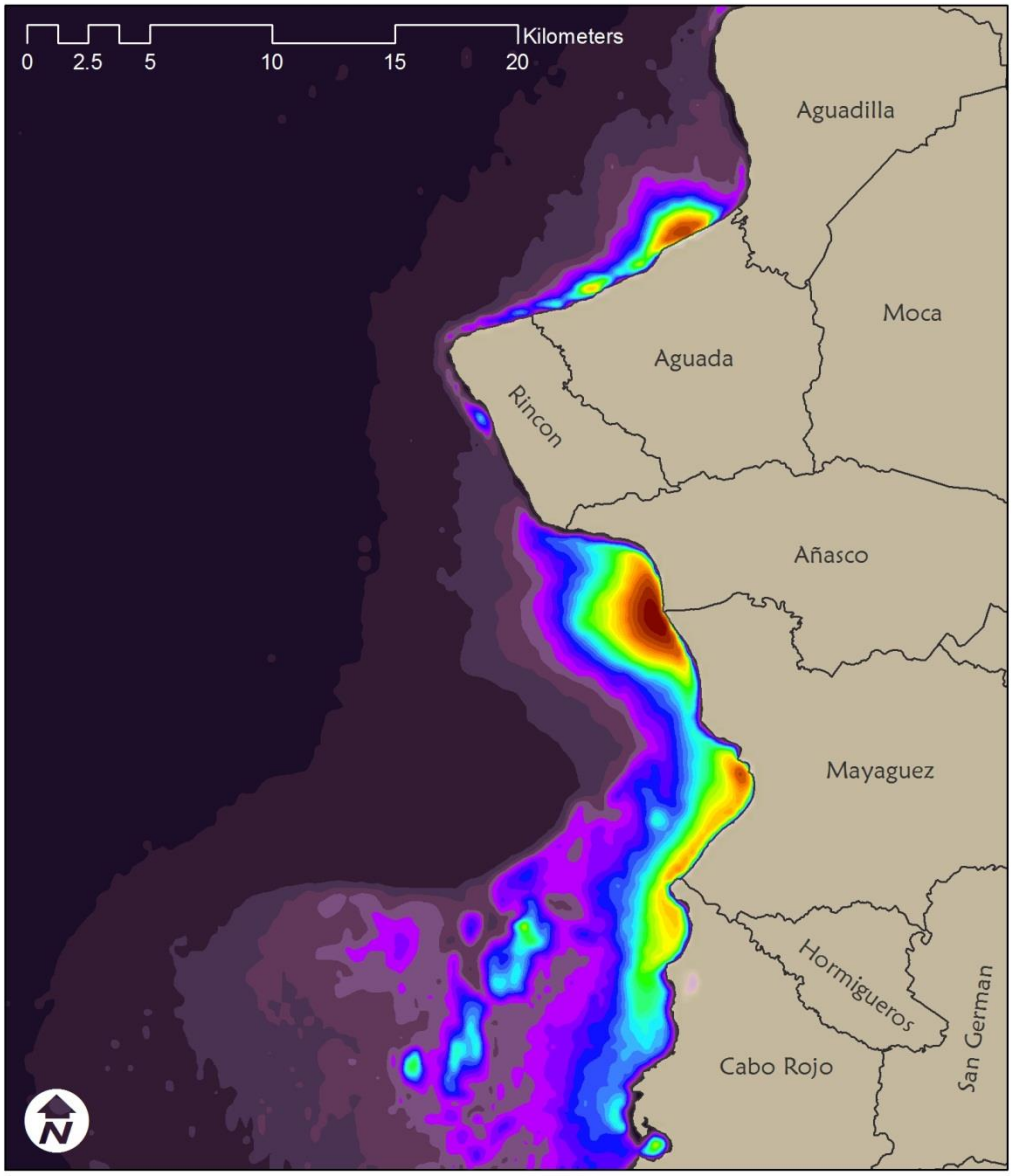
Low Flow



TSM (g/M^3)					
0.03	0.04 - 0.23	0.24 - 0.42	0.43 - 0.61	0.62 - 0.81	0.82 - 1.00
1.01 - 1.19	1.20 - 1.39	1.40 - 1.58	1.59 - 1.77	1.78 - 1.96	1.97 - 2.16
2.17 - 2.35	2.36 - 2.54	2.55 - 2.74	2.75 - 2.93	2.94 - 3.12	3.13 - 3.32
3.33 - 3.51	3.52 - 3.70	3.71 - 4.09	4.10 - 4.47	4.48 - 4.86	4.87 - 5.44
5.45 - 6.02	6.03 - 6.79	6.80 - 7.56	7.57 - 8.53	8.54 - 10.84	10.85 - 13.74
13.75 - 18.56	18.57 - 49.25				

TSS Spatial Trends

Moderate Flow



TSM (g/M^3)					
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	0.24 - 0.42		2.17 - 2.35		4.87 - 5.44
	0.43 - 0.61		2.36 - 2.54		5.45 - 6.02
	0.62 - 0.81		2.55 - 2.74		6.03 - 6.79
	0.82 - 1.00		2.75 - 2.93		6.80 - 7.56
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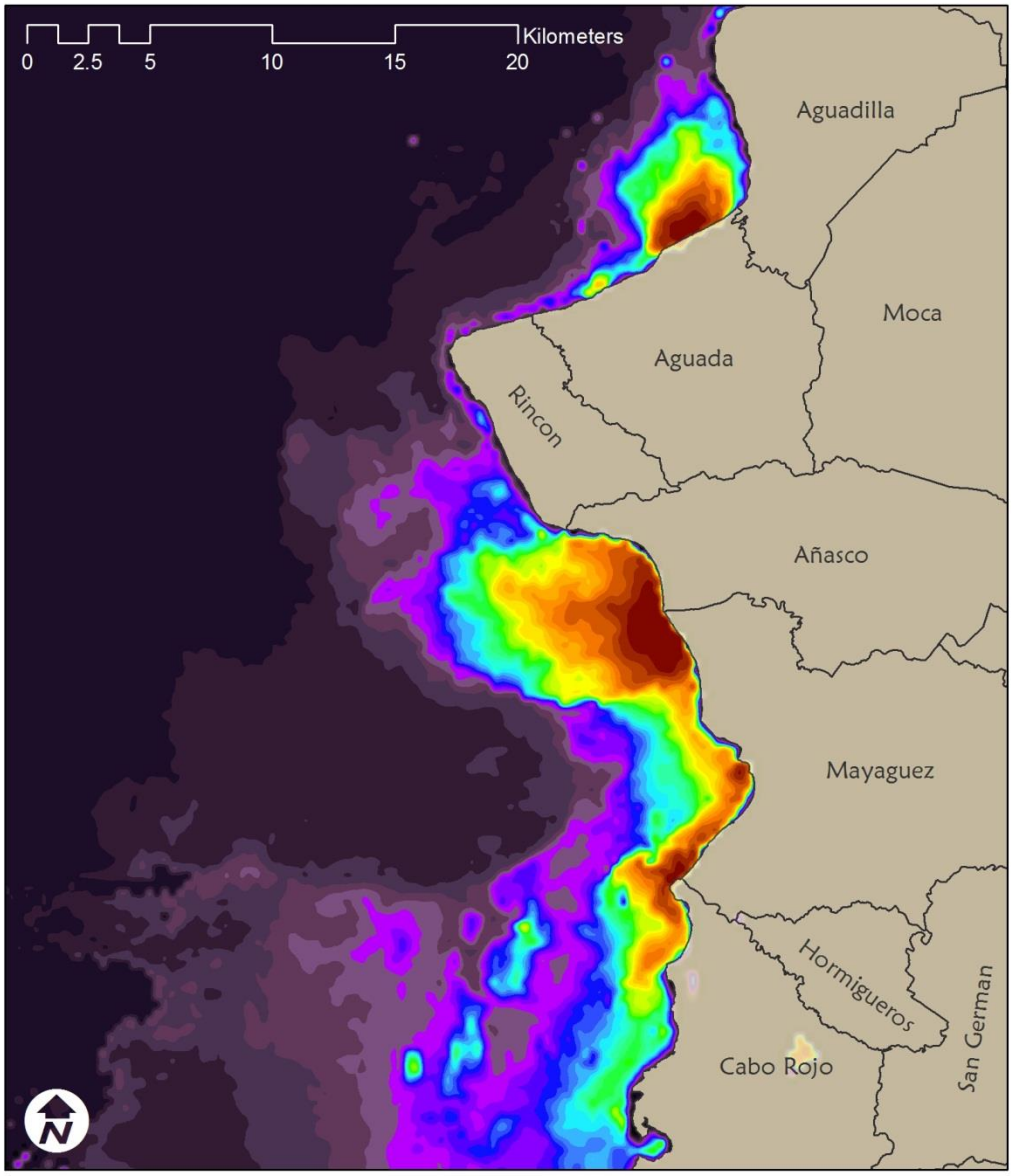
			3.71 - 4.09		18.57 - 49.25

TSS Spatial Trends

High Flow



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Plume Mapping using Model Builder

The plume was delimited for each date using a set of ArcGIS routines assemblage in Model Builder

The following criteria was used to defined all plumes using TSS products as the input

Input (Raster)

Output (Vector)

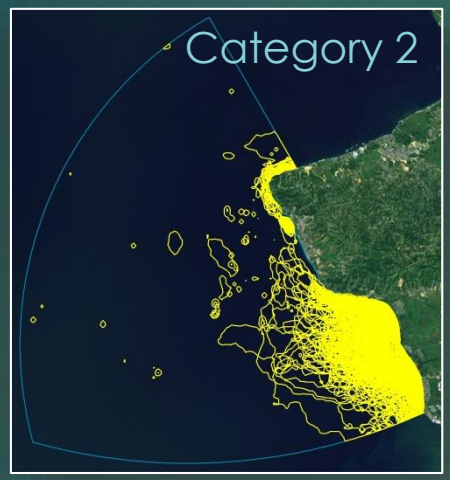
TSS Values (g/m^3)	Plume Category
7.111 - 60.000	1
2.671 - 7.110	2
0.721 - 2.670	3
0.000 - 0.720	No Plume

River Plumes Delimitation

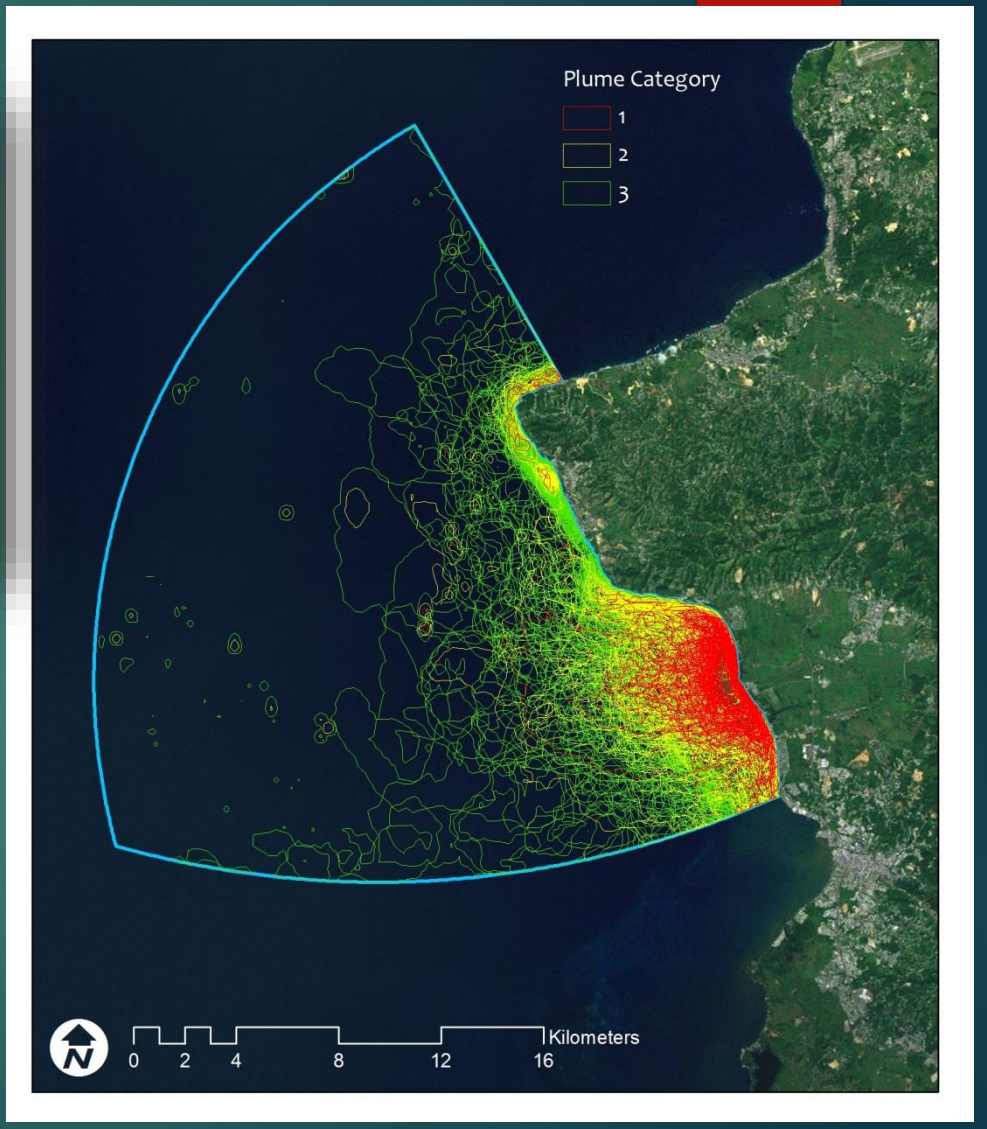
Analyzed Area

123 Delineated Plumes Combined

River Plumes Delimitation

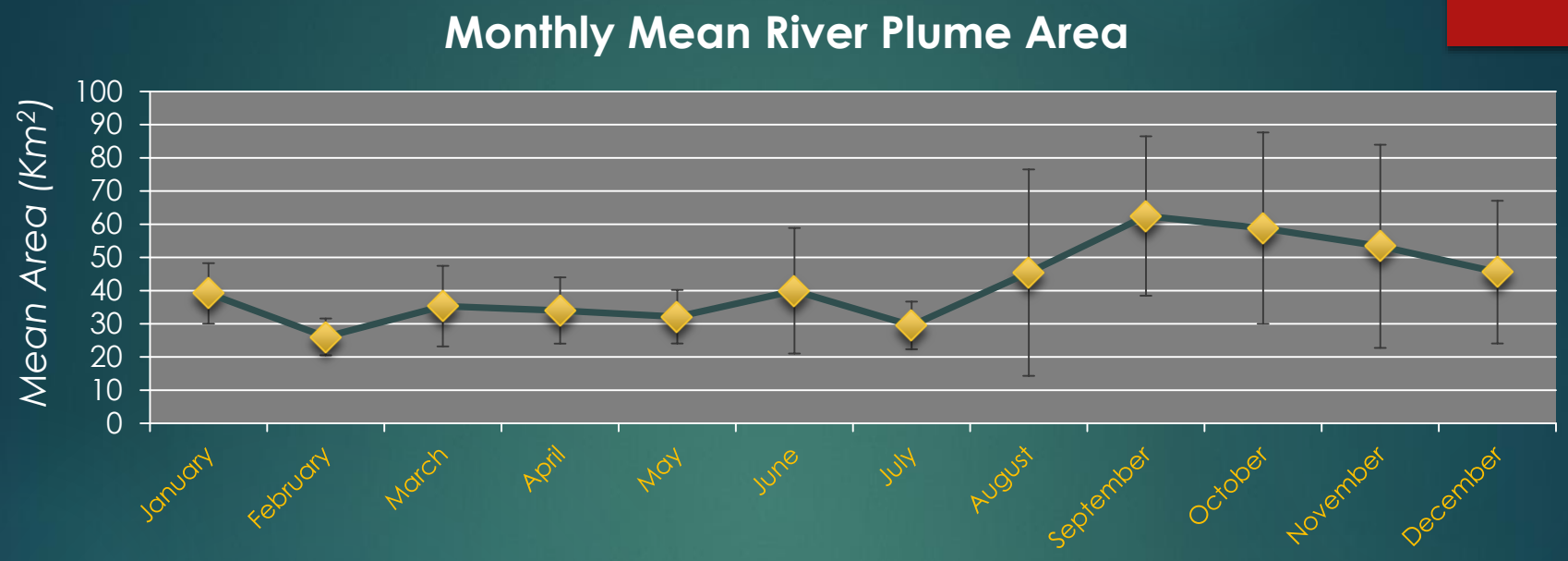


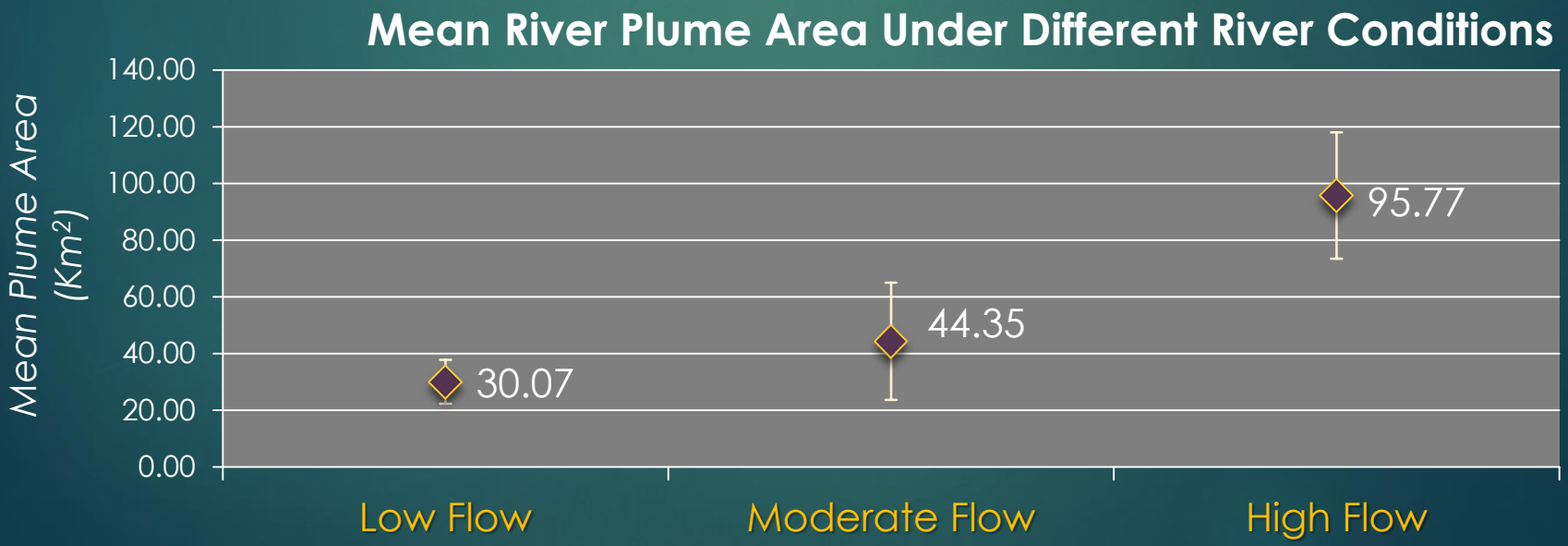
Plume Category (g/m^3)	Mean Area (Km^2)
1 (7.2–60)	6.25
2 (2.7-7.1)	9.05
3 (0.72-2.6)	28.37



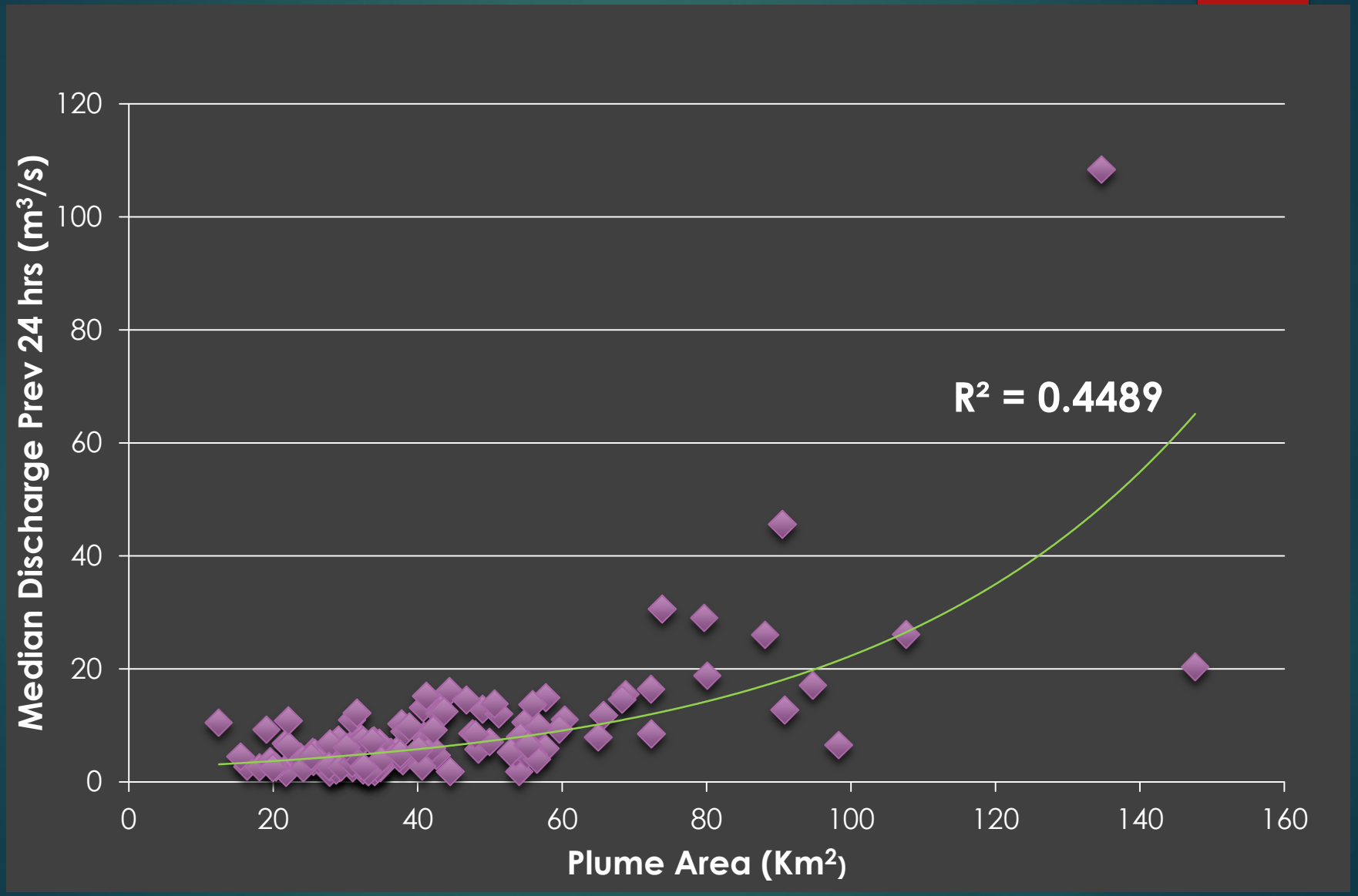
Plumes by Category

River Plume Area Extent





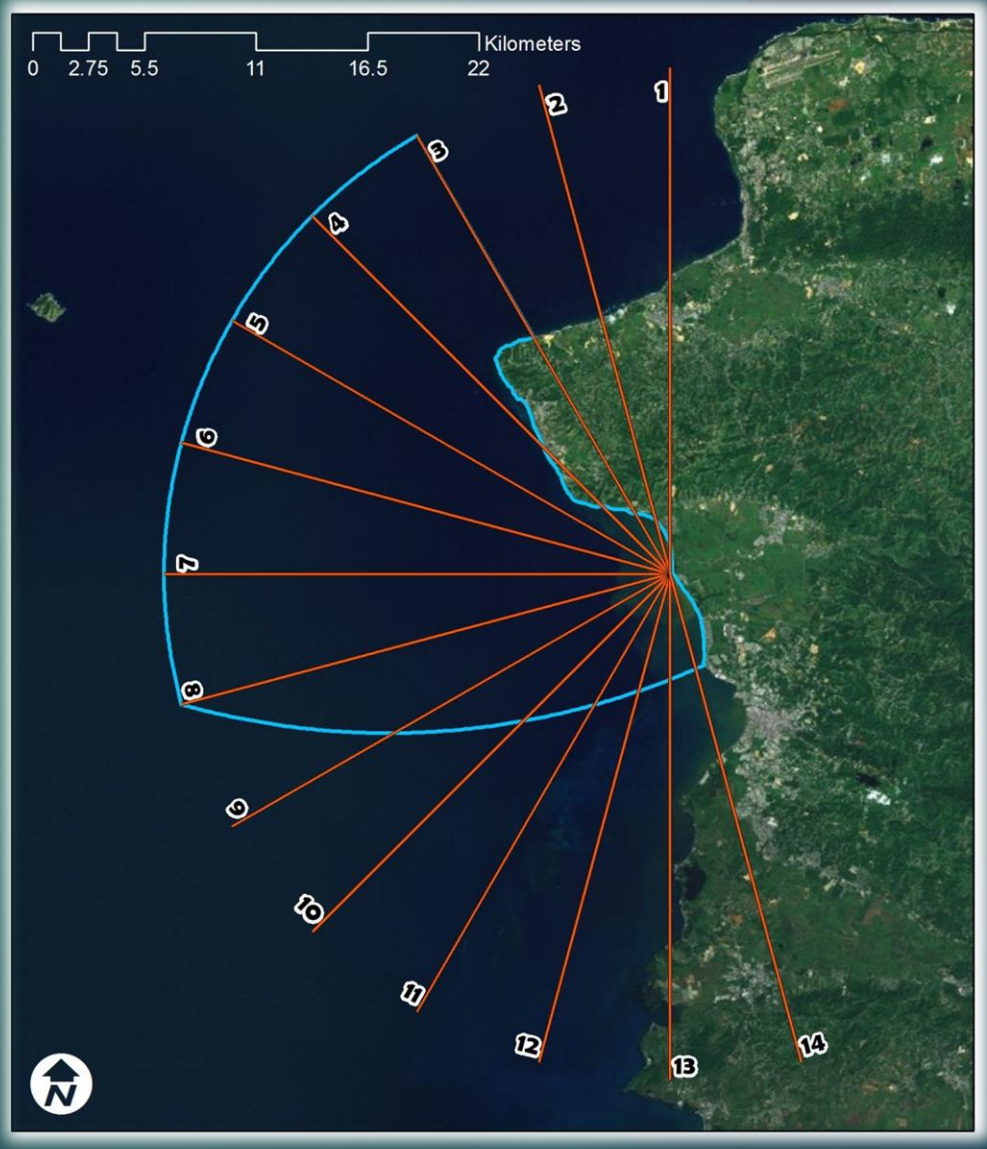
Plume Area Extent vs. River Discharge



Plume Direction Assessment

A total of 14 transects were delineated across the Bay to calculate Plume Mean Length at each direction

- Every 15°
- 25 Km long each



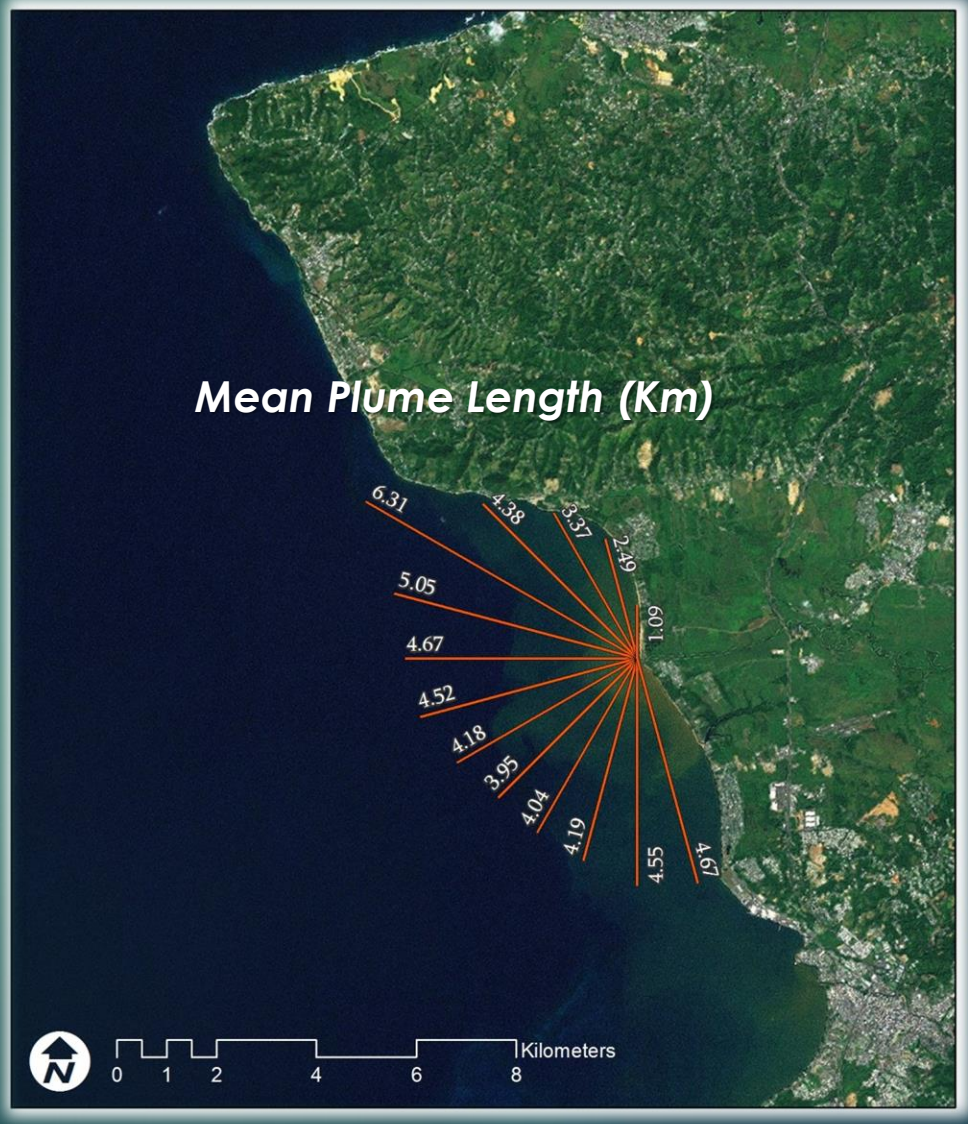
Plume Direction Assessment

Average Plume Length at each Transect

Based on 123 River Plumes

Clip and Measure all transects

Calculate average length for each transect



Closing Remarks
Remote Sensing Component

- MERIS proved to be a good sensor to study the dynamics of the Añasco River plume.
- Using Cell Statistics tool we were able to summarize TSS data under different river flow conditions. This analysis showed spatial variations in TSS abundance and extent in a cell-by-cell basis.
- A total of 123 river plumes were defined based on TSS values using a set of ArcGIS routines assemblage in Model Builder.
  - Temporal analysis showed higher plume areas extents from August to December
  - During high river flow conditions plume areas were significantly greater than under low and moderate river flow
  - An exponential trend was detected between Median Discharge (24 hrs. Prev. the image) and Plume Area Extent
- Mean plume length was calculated for 14 transects (every 15°)
  - Only Transect 5 (North-West) showed a slightly higher mean length, supporting a plume extent tendency to this direction.

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