



# Neural Networks for SAR Oil Spill Detection

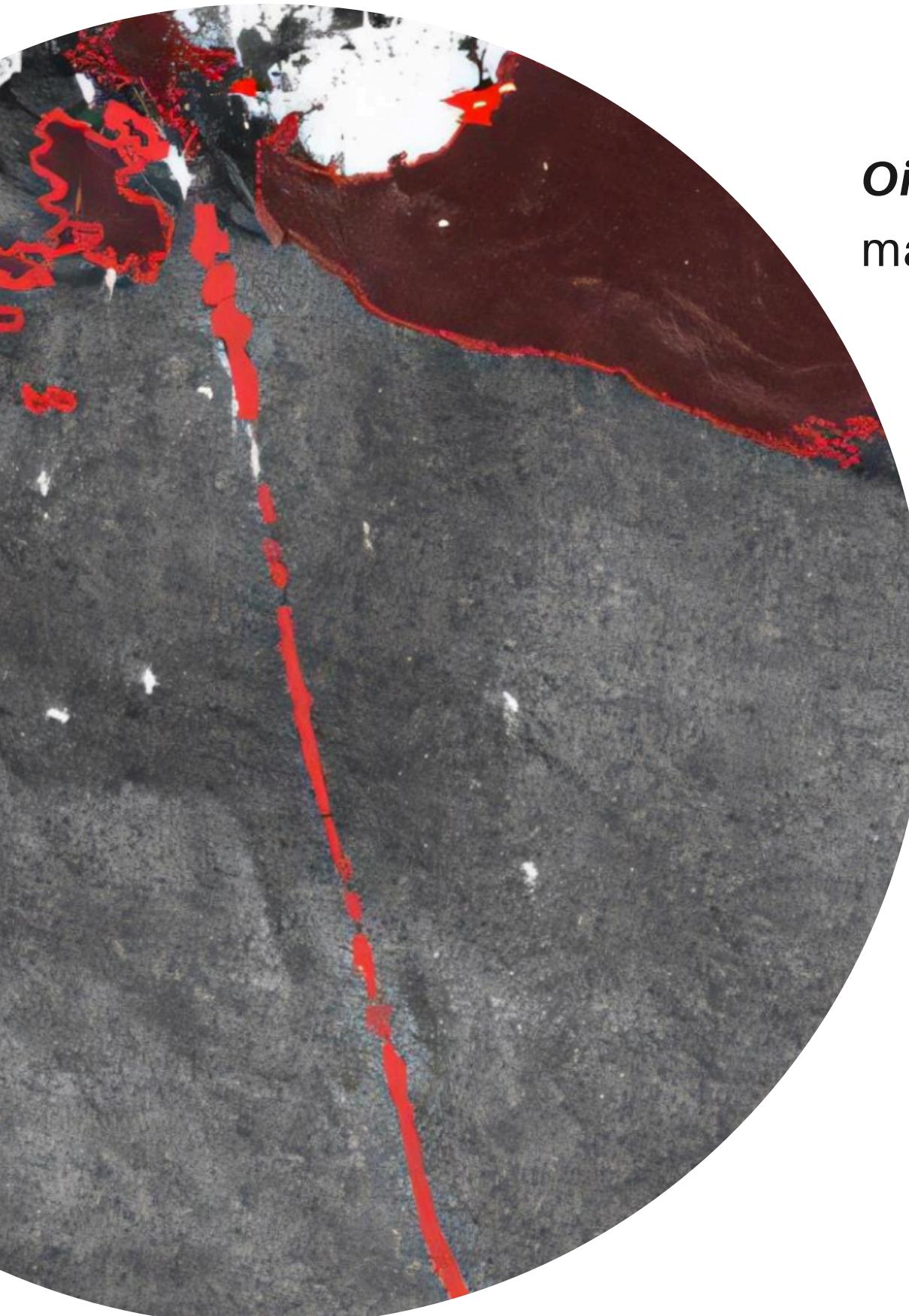
Applied Data Science Project

Bianca Bartoli - s322799

Carlo Marra - s334220

Alessandro Valenti - s328131

# THE PROBLEM



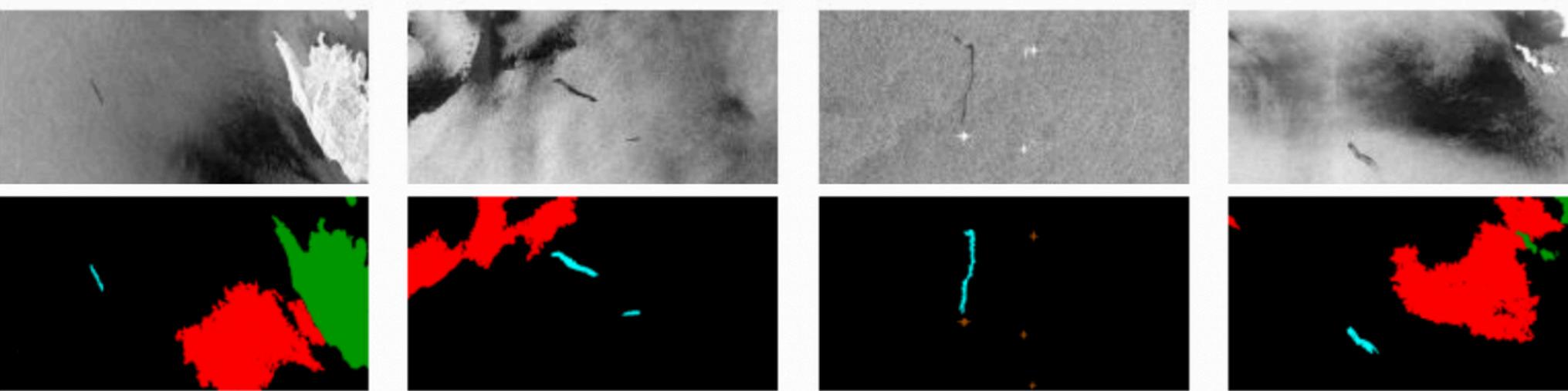
***Oil spills*** pose a significant threat to marine ecosystems



Continuous **monitoring** and precise **detection** of oil spills are essential for mitigating their catastrophic effects

## HOW:

**Segmentation** of **Synthetic Aperture Radar (SAR)** images provided by the European Space Agency



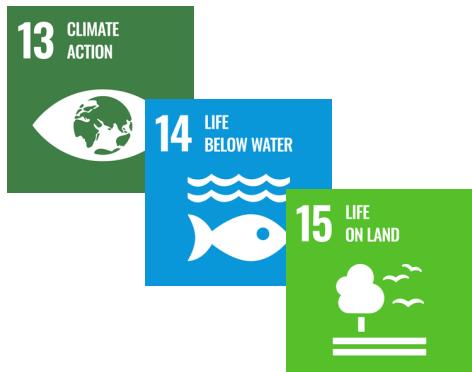
SAR images

Segmentation mask



# VALUE PROPOSITION

Accurate and timely detection of oil spills is crucial for mitigating their environmental impact



## Environmental Impact

Faster response times can significantly reduce the environmental damage caused by oil spills



## Response Efficiency

Early detection and response help contain the spill, reducing the resources needed to manage its spread



## Scalability

The developed system can be applied to any marine environment with SAR imaging availability, offering potential for global deployment



# OBJECTIVES

## OBJECTIVE 1

Analyse the provided SAR images dataset

## OBJECTIVE 2

Implement and test various neural network models for segmentation tasks

## OBJECTIVE 3

Evaluate each model using metrics such as Intersection over Union (IoU)

## OBJECTIVE 4

Deploy the selected model in a real-time monitoring system

# BENEFITS

## Increased Accuracy

Advanced machine learning models provide greater accuracy than traditional methods

## Efficiency

Reduction of time and resources for detecting and responding to oil spills

## Research Contribution

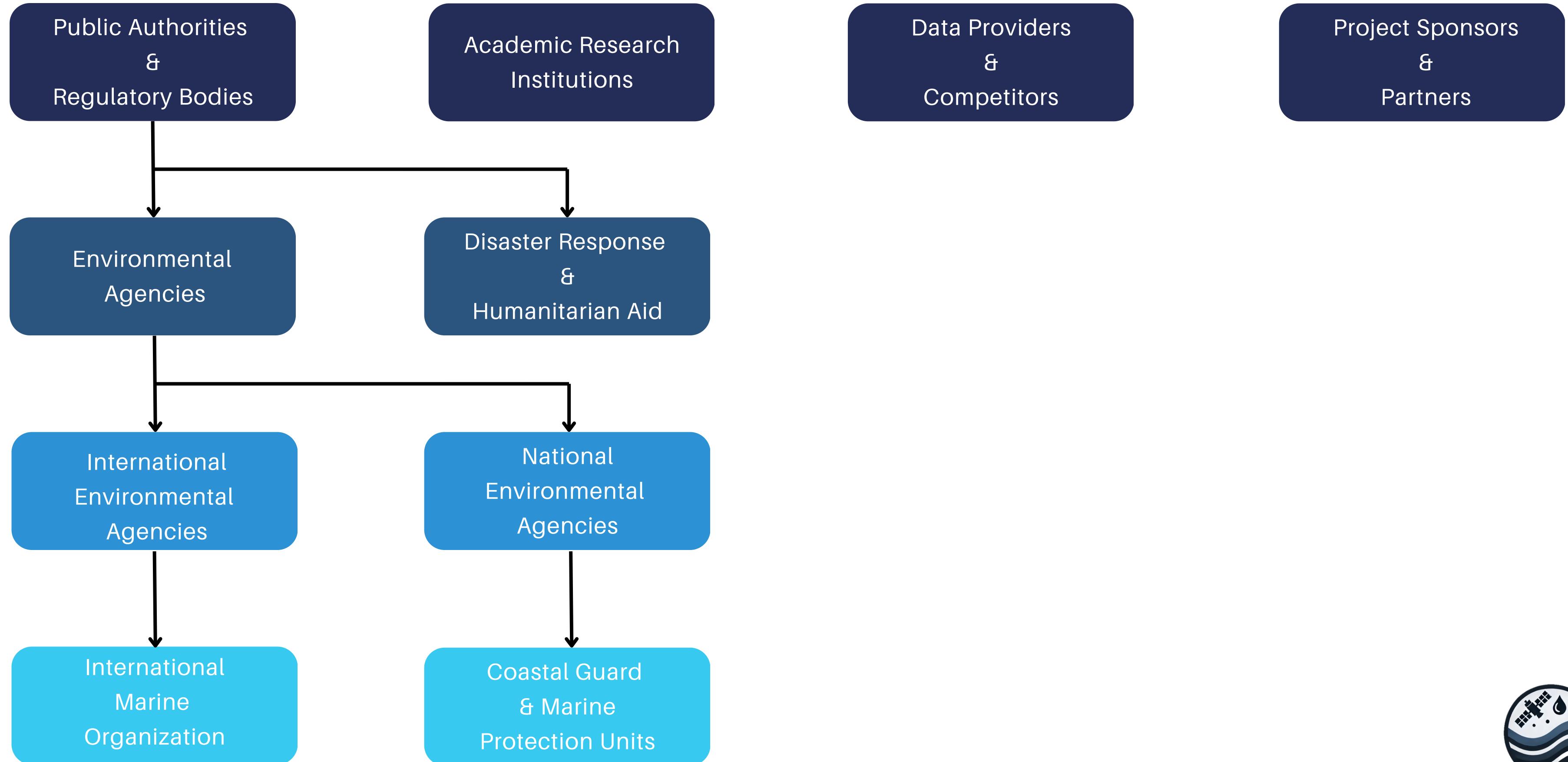
Contributes to AI-based environmental monitoring research using neural networks

## Enhanced Monitoring

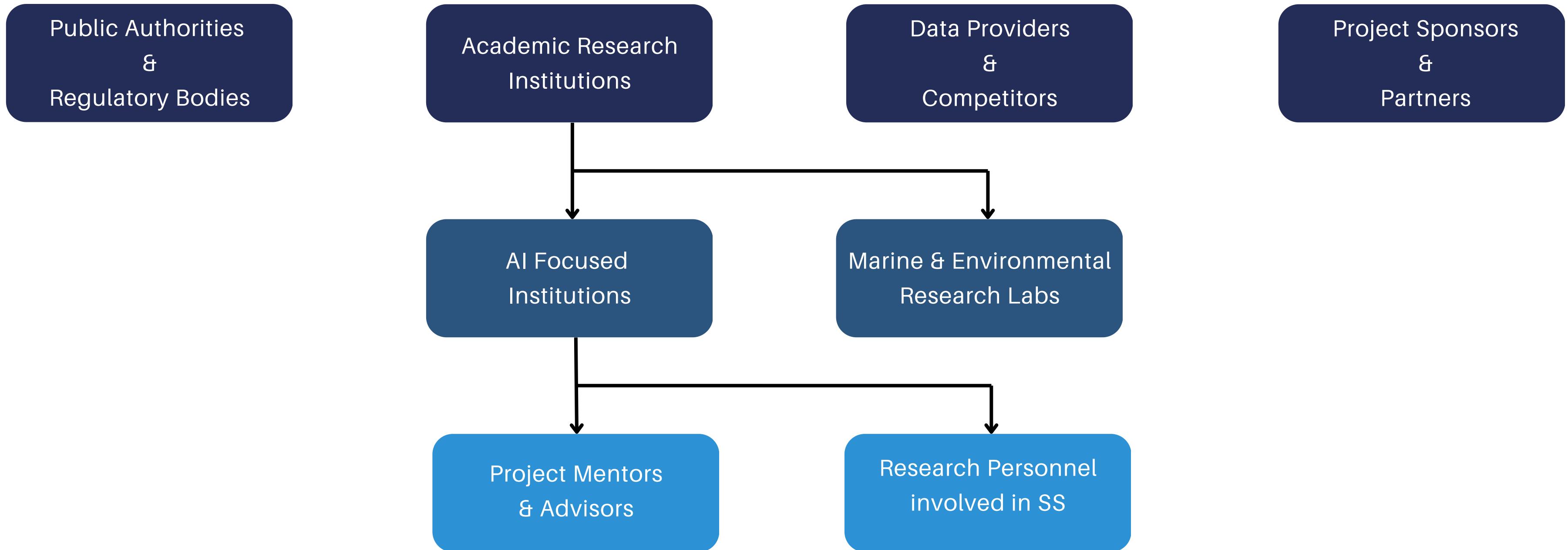
SAR imagery enables consistent and reliable monitoring by competent authorities



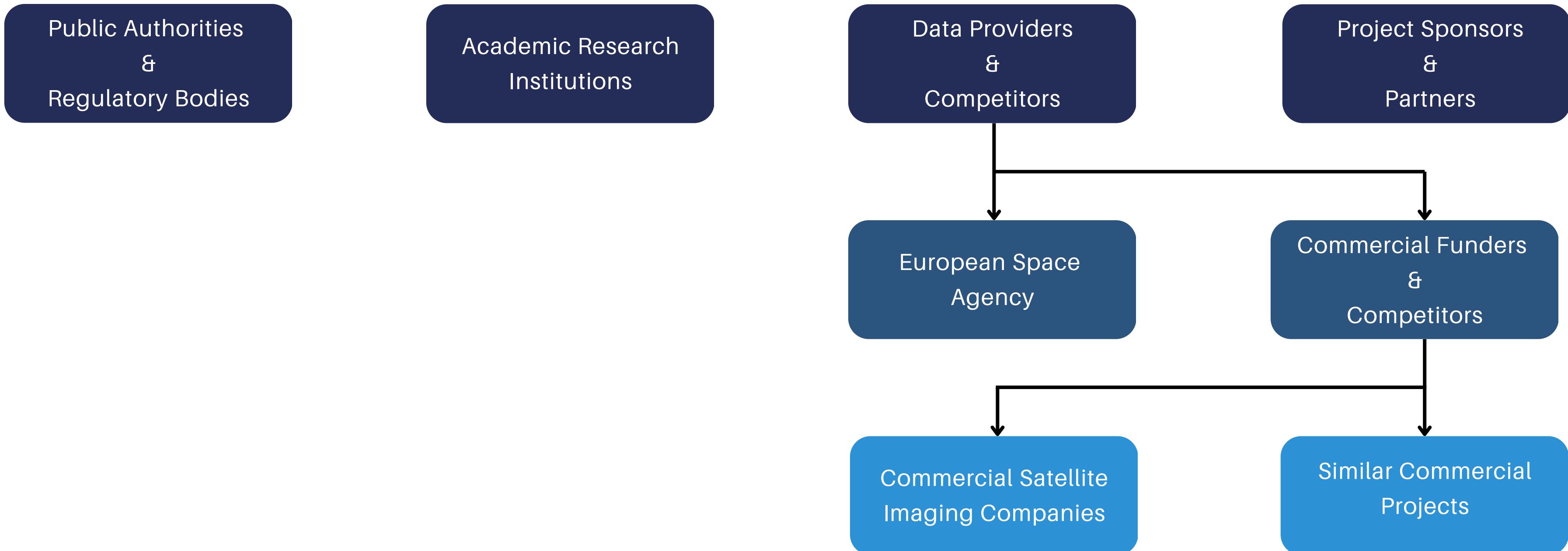
# STAKEHOLDERS



# STAKEHOLDERS



# STAKEHOLDERS



# STAKEHOLDERS

Public Authorities  
&  
Regulatory Bodies

Academic Research  
Institutions

Data Providers  
&  
Competitors

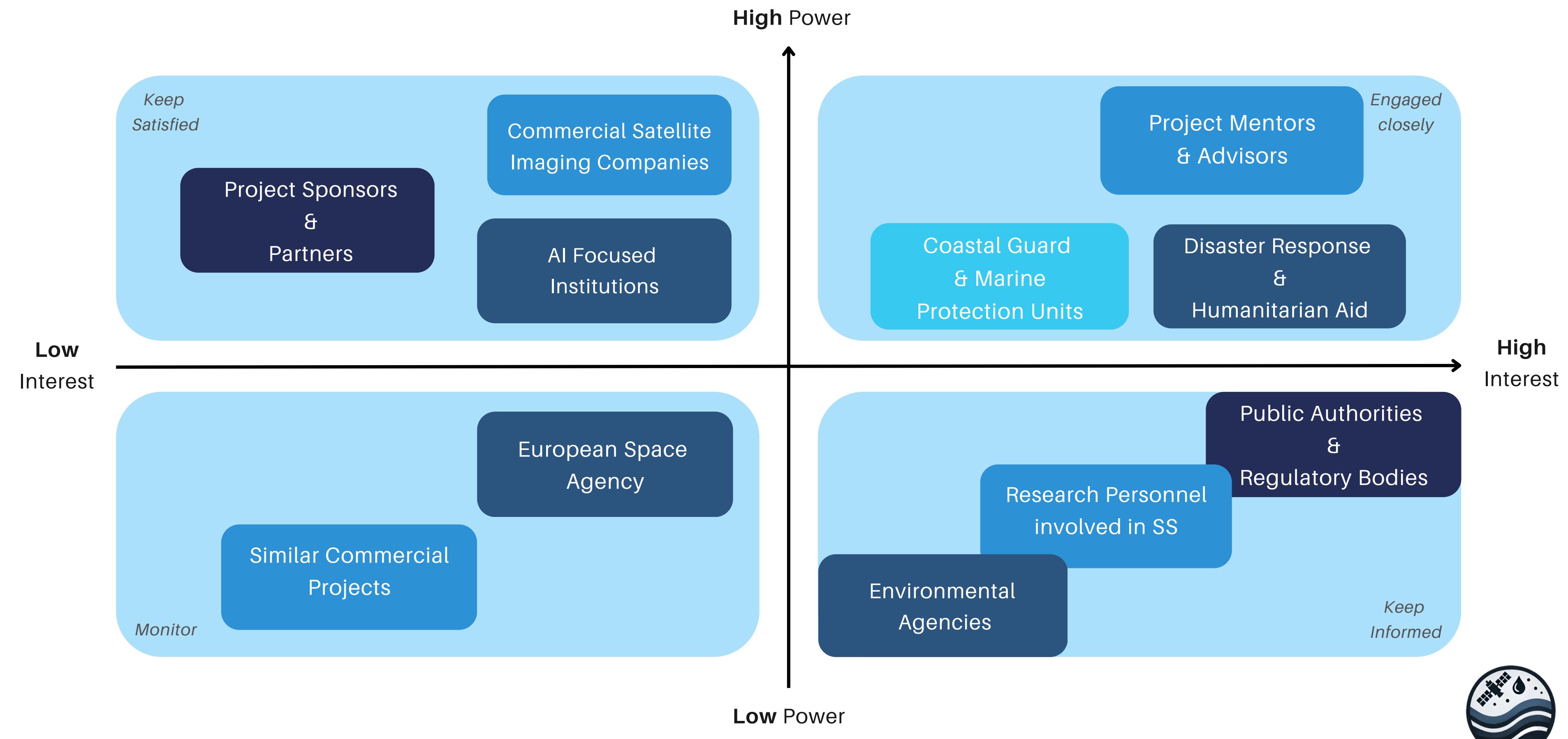
Project Sponsors  
&  
Partners

Links Foundation

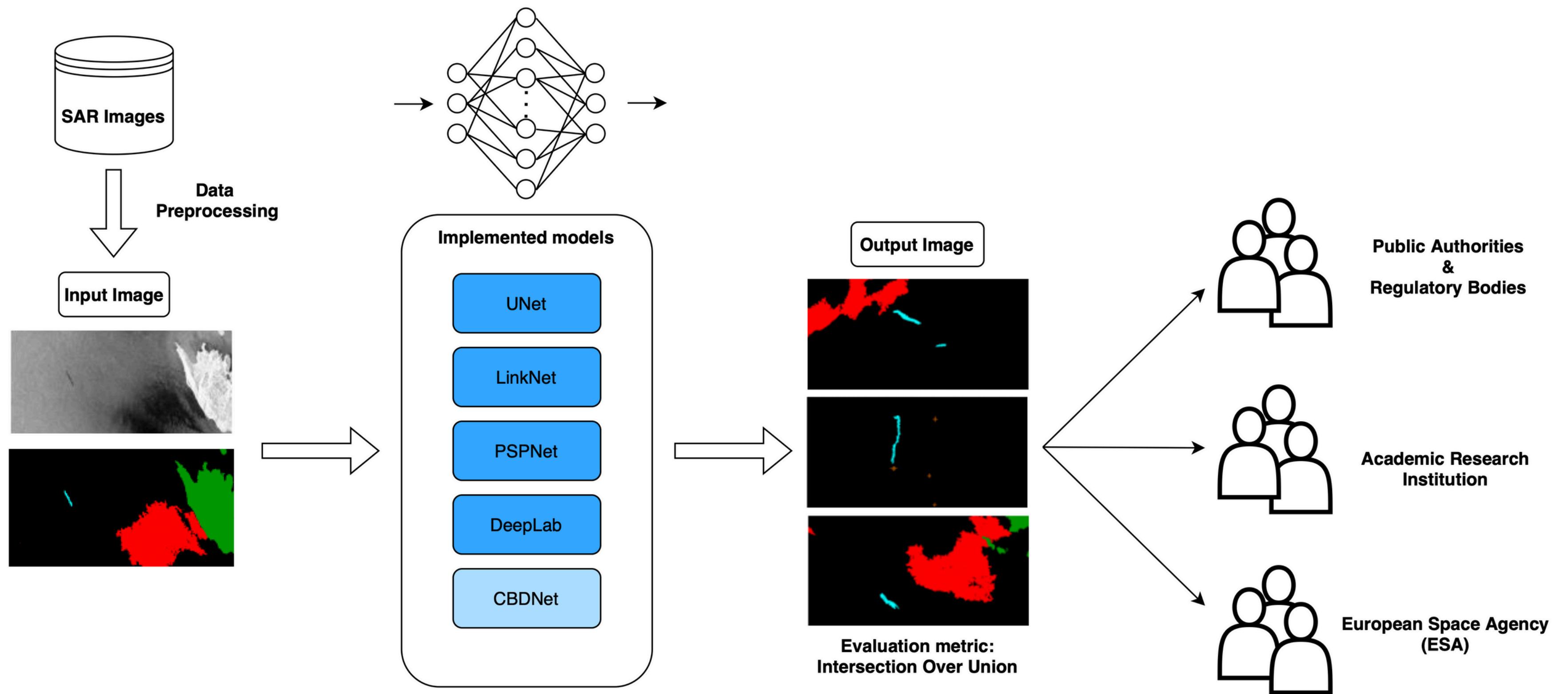
MARIS  
Project  
Consortium



# INTEREST - INFLUENCE MATRIX



# FUNCTIONAL DIAGRAM



# USER PERSONAS

**Maria**

Environmental Supervisor



## Pain-Points & Frustrations

- Struggles with delayed or inaccurate data, which can hinder timely response to oil spill incidents

## Needs & Goals

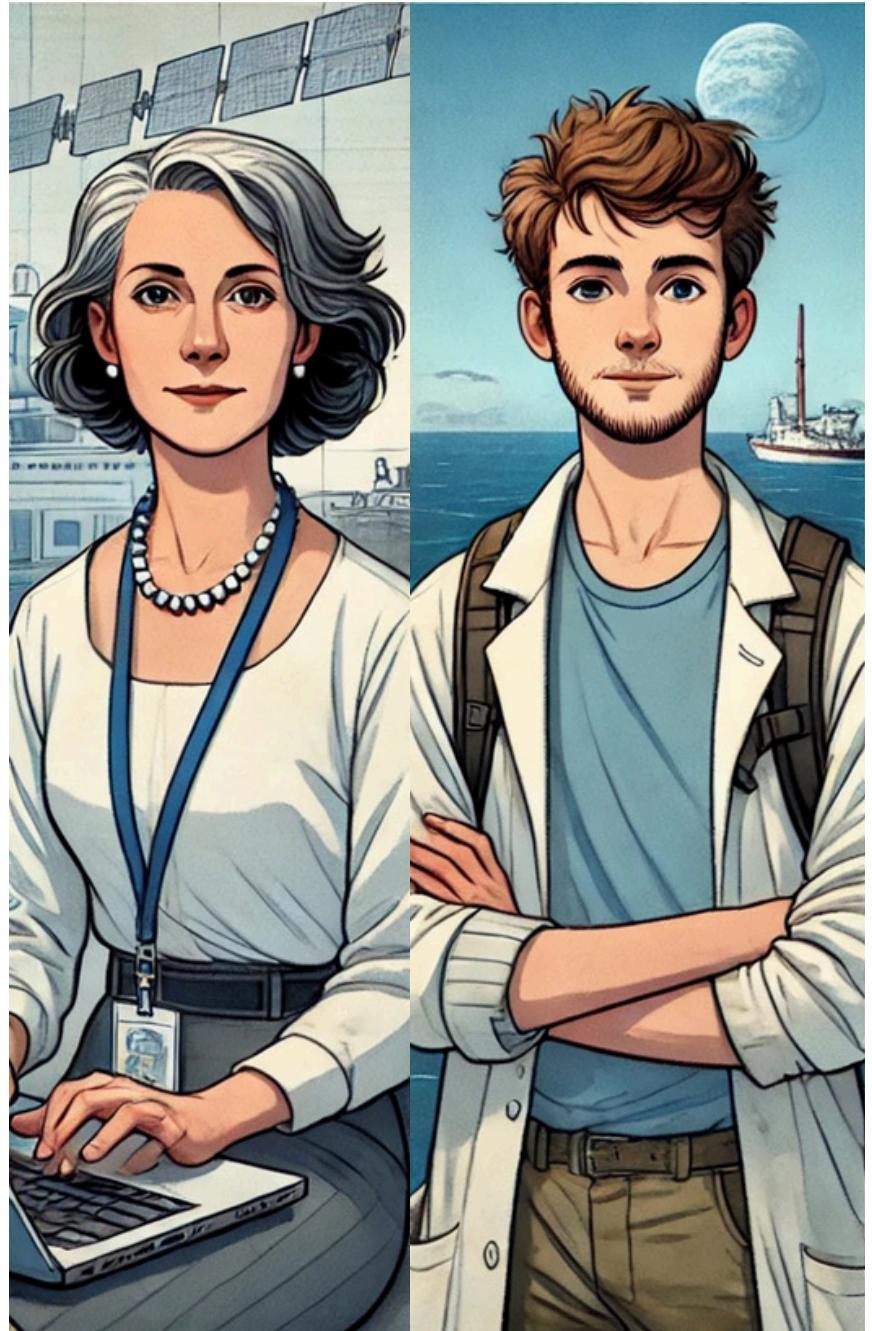
- Requires accurate, real-time oil spill detection tools to support quick decision-making and minimize environmental harm
- Seeks data visualization tools that simplify complex satellite data for easy interpretation by non-technical stakeholders



# USER PERSONAS

**Adam**

Biomarine Researcher



## Pain-Points & Frustrations

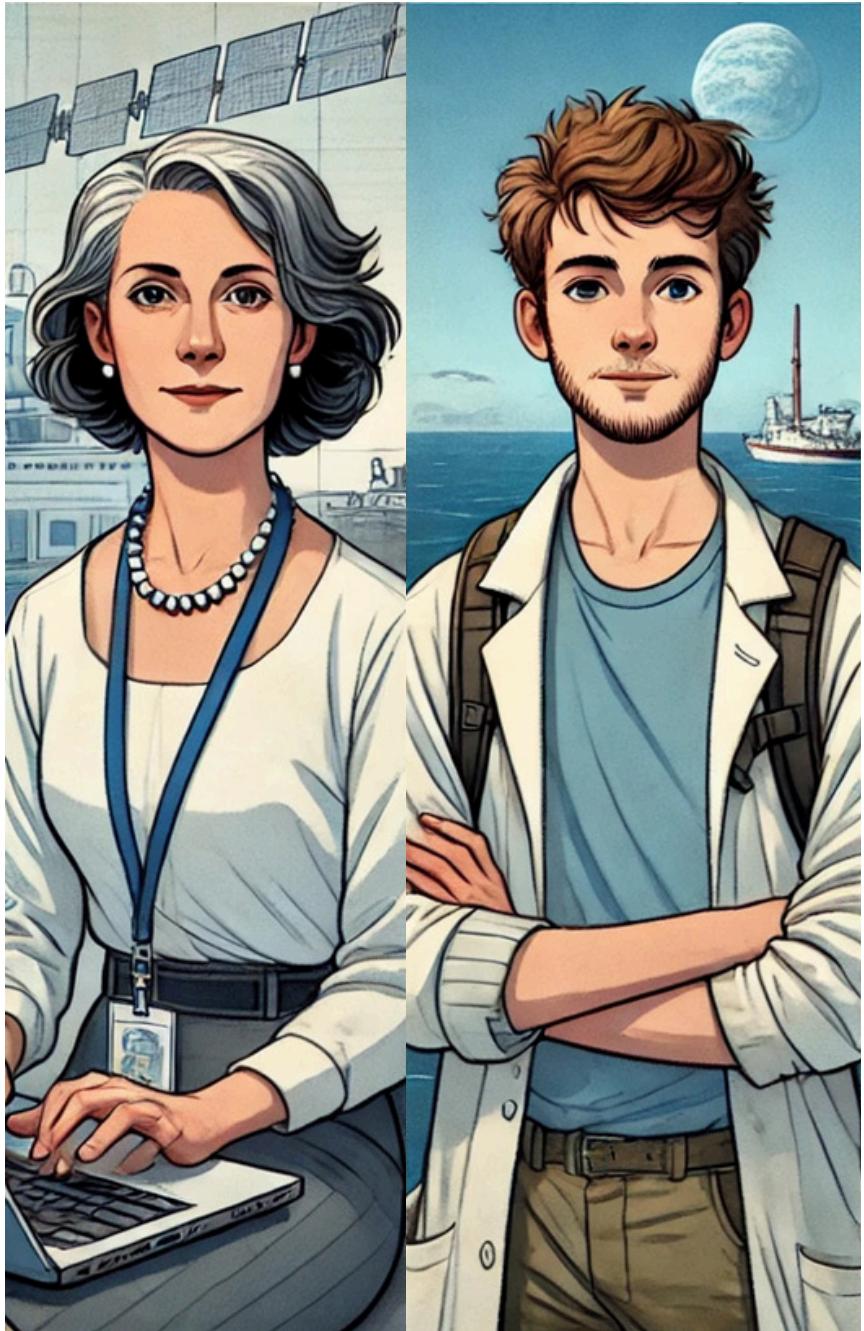
- Limited access to high-quality, segmented images that precisely identify oil spill boundaries.
- Difficulty in locating and assessing the impact on specific ecosystems due to vague localization of marine pollution events

## Needs & Goals

- Requires highly accurate segmentation data to pinpoint oil spill locations and assess ecosystem impacts.
- Values precise data that enables the identification of specific habitats and species at risk, facilitating conservation efforts



# USER PERSONAS



Future Work:



**Thomas**  
ESA Project Manager

## Pain-Points & Frustrations

- Faces pressure to ensure data accessibility and reliability, especially for high-priority projects like oil spill detection

## Needs & Goals

- Needs efficient, reliable SAR data processing and distribution channels to support projects on environmental protection
- Seeks partnerships to increase satellite data usage



# USER STORIES



## Maria, Environmental Regulator

As an Environmental Regulator, I **want** real-time alerts on detected oil spills, **so that** I can initiate a rapid response to minimize environmental damage



As an Environmental Regulator, I **want** access to historical oil spill data, **so that** I can analyze trends and improve future preventative measures



As an Environmental Regulator, I **want** a clear visualization of oil spill locations and sizes, **so that** I can assess the severity and prioritize response efforts

## Adam, Marine Research Scientist

As a Biomarine Disaster Researcher, I **want** access to high-quality, segmented SAR data **so that** I can precisely locate oil spill boundaries and assess their impact on vulnerable marine ecosystems



## Thomas, ESA Project Manager

As an ESA Project Manager, I **want** insights into how our satellite data is used by various stakeholders, **so that** I can demonstrate the value of ESA's contributions



As an ESA Project Manager, I **want** to track the accuracy and impact of SAR-based oil spill detection, **so that** I can justify continued investment in similar data projects



# WBS

WP No.	WP Title	Lead Name	PM	Start Month	End Month
1	Project Management	B. Bartoli	0.5	November	November
2	Research & Familiarization	C. Marra	0.5	November	November
3	Data Exploration & Preprocessing	A. Valenti	0.75	November	December
4	Model Implementation & Training	C. Marra	2	December	January
5	Evaluation & Comparison	B. Bartoli	1.25	January	January
6	Documentation & Communication	A. Valenti	1	January	January



# GANTT

Task	Assigned To	Progress	Start	End	Task	Assigned To	Progress	Start	End
<strong>1. Project Management</strong>					<strong>4. Model Implementation and Training</strong>				
1.1 Define Project Objectives	C. Marra	100%	10/28/24	10/31/24	4.1 Implement UNet model	B. Bartoli	0%	11/26/24	12/6/24
1.2 Project Design	B. Bartoli	100%	10/31/24	11/5/24	4.2 Implement LinkNet model	A. Valenti	0%	11/26/24	12/3/24
1.3 Develop Project Plan	A. Valenti	100%	11/5/24	11/9/24	4.3 Implement PSPNet model	B. Bartoli	0%	11/26/24	12/6/24
1.4 Project Presentation	Entire Team	0%	11/10/24	11/14/24	4.4 Implement DeepLabv2 model	C. Marra	0%	11/26/24	12/3/24
<strong>2. Research and Familiarization</strong>					4.5 Implement CBDNet model	Entire Team	0%	12/7/24	12/12/24
2.1 Literature Review on SAR Segmentation	C. Marra	100%	11/5/24	11/9/24	<strong>5. Evaluation and Comparison</strong>				
2.2 Analyze models for segmentation	A. Valenti	20%	11/10/24	11/15/24	5.1 Evaluate UNet model	B. Bartoli	0%	12/7/24	12/10/24
2.3 Study dataset characteristics	B. Bartoli	40%	11/15/24	11/18/24	5.2 Evaluate LinkNet model	A. Valenti	0%	12/4/24	12/7/24
2.4 Identify key evaluation metrics	A. Valenti	0%	11/19/24	11/21/24	5.3 Evaluate PSPNet model	B. Bartoli	0%	12/7/24	12/10/24
<strong>3. Data Exploration &amp; Preprocessing</strong>					5.4 Evaluate DeepLabv2 model	C. Marra	0%	12/4/24	12/7/24
3.1 Explore SAR Dataset	A. Valenti	0%	11/16/24	11/19/24	5.5 Evaluate CBDNet model	Entire Team	0%	12/13/24	12/18/24
3.2 Data Augmentation	B. Bartoli	0%	11/20/24	11/25/24	<strong>6. Documentation &amp; Communication</strong>				
3.3 Data split for Training/Validation/Testing	C. Marra	0%	11/25/24	11/26/24	6.1 Document Methods and Results	C. Marra	0%	12/20/24	12/23/24
					6.2 Prepare Final Presentation Slides	B. Bartoli	0%	12/22/24	12/24/24
					6.3 Organize Project Files and Code Repository	A. Valenti	0%	12/28/24	12/30/24
					6.4 Final Project Report	Entire Team	0%	1/3/25	1/13/25
					6.5 Review and Submit Documentation	A. Valenti	0%	1/14/25	1/16/25

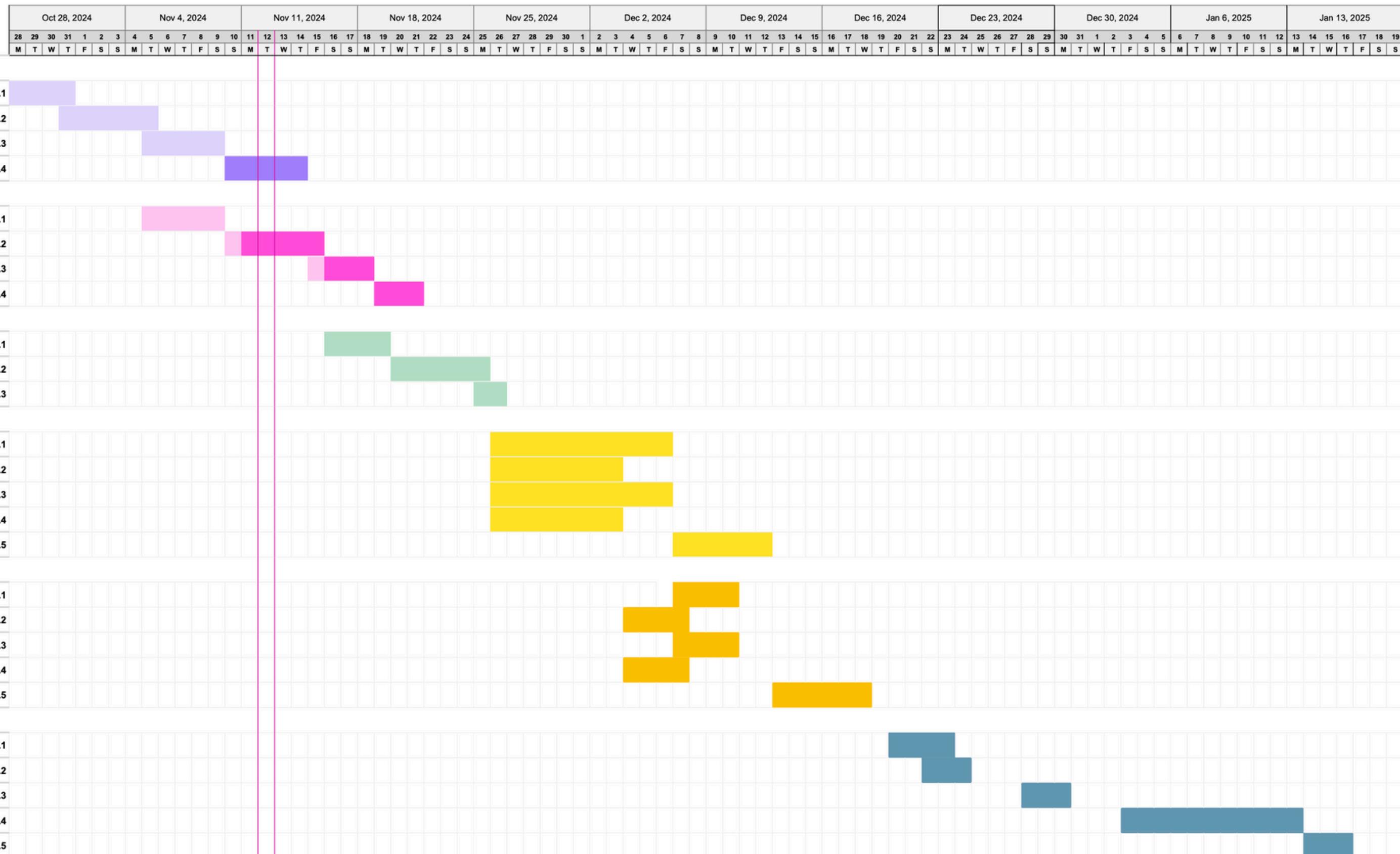


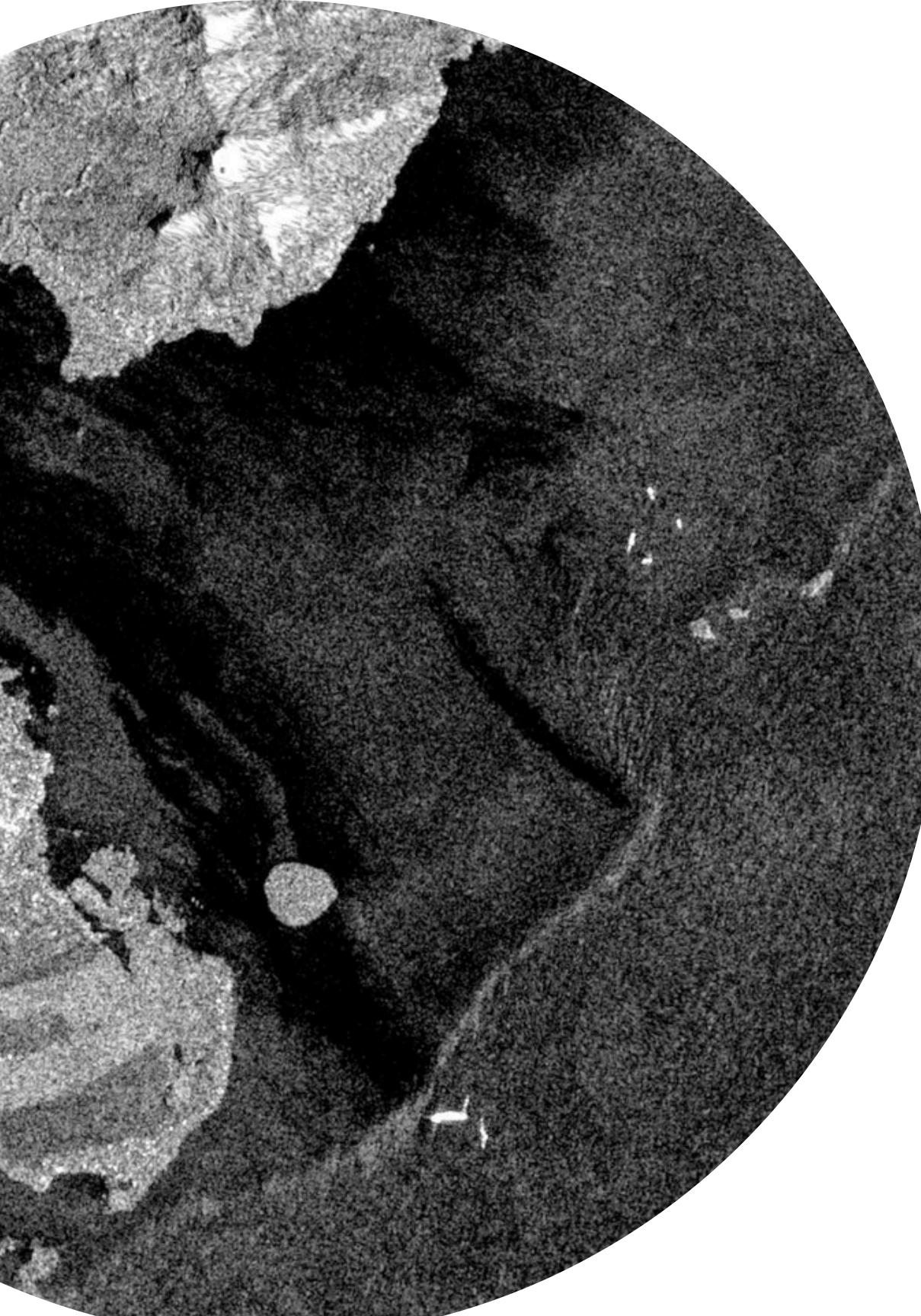
# GANTT (UPDATED)

	October 2024	November 2024	December 2024	January 2025
<b>Project Management</b>				
<b>Research and Familiarization</b>				
<b>Data Exploration &amp; Preprocessing</b>				
<b>Model Implementation and Training</b>				
<b>Evaluation and Comparison</b>				
<b>Documentation &amp; Communication</b>				



Task	Assigned To	Progress	Start	End
<strong>1. Project Management</strong>				
1.1 Define Project Objectives	C. Marra	100%	10/28/24	10/31/24
1.2 Project Design	B. Bartoli	100%	10/31/24	11/5/24
1.3 Develop Project Plan	A. Valenti	100%	11/5/24	11/9/24
1.4 Project Presentation	Entire Team	0%	11/10/24	11/14/24
<strong>2. Research and Familiarization</strong>				
2.1 Literature Review on SAR Segment	C. Marra	100%	11/5/24	11/9/24
2.2 Analyze models for segmentation	A. Valenti	20%	11/10/24	11/15/24
2.3 Study dataset characteristics	B. Bartoli	40%	11/15/24	11/18/24
2.4 Identify key evaluation metrics	A. Valenti	0%	11/19/24	11/21/24
<strong>3. Data Exploration &amp; Preprocessing</strong>				
3.1 Explore SAR Dataset	A. Valenti	0%	11/16/24	11/19/24
3.2 Data Augmentation	B. Bartoli	0%	11/20/24	11/25/24
3.3 Data split for Training/Validation/Te	C. Marra	0%	11/25/24	11/26/24
<strong>4. Model Implementation and Training</strong>				
4.1 Implement UNet model	B. Bartoli	0%	11/26/24	12/6/24
4.2 Implement LinkNet model	A. Valenti	0%	11/26/24	12/3/24
4.3 Implement PSPNet model	B. Bartoli	0%	11/26/24	12/6/24
4.4 Implement DeepLabv2 model	C. Marra	0%	11/26/24	12/3/24
4.5 Implement CBDNet model	Entire Team	0%	12/7/24	12/12/24
<strong>5. Evaluation and Comparison</strong>				
5.1 Evaluate UNet model	B. Bartoli	0%	12/7/24	12/10/24
5.2 Evaluate LinkNet model	A. Valenti	0%	12/4/24	12/7/24
5.3 Evaluate PSPNet model	B. Bartoli	0%	12/7/24	12/10/24
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<strong>6. Documentation &amp; Communication</strong>				
6.1 Document Methods and Results	C. Marra	0%	12/20/24	12/23/24
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6.3 Organize Project Files and Code Re	A. Valenti	0%	12/28/24	12/30/24
6.4 Final Project Report	Entire Team	0%	1/3/25	1/13/25
6.5 Review and Submit Documentation	A. Valenti	0%	1/14/25	1/16/25





# **Thank you for your attention**

**Questions?**

**Bianca Bartoli - s322799**

**Carlo Marra - s334220**

**Alessandro Valenti - s328131**

