INSTITUTO DE PESQUISAS TECNOLÓGICAS

COMUNICAÇÃO TÉCNICA

Nº 177834

Debris removal system in the Tietê River, Brazil: a case study

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Palestra apresentada no THE INTERNATIONAL ASSOCITION FOR HYDRO-ENVIRONMENT ENGINEERING AND RESEARCH (IAHR) WORD CONGRES, 39., 2022, Granada, Spain. 18 slides

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39th IAHR WORLD CONGRESS
GRANADA, SPAIN 2022
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19-24 June 2022

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Debris Removal System in the Tietê River – Brazil – A Case Study

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Organized by:

IAHR International Association for Hydro-Environment Engineering and Research
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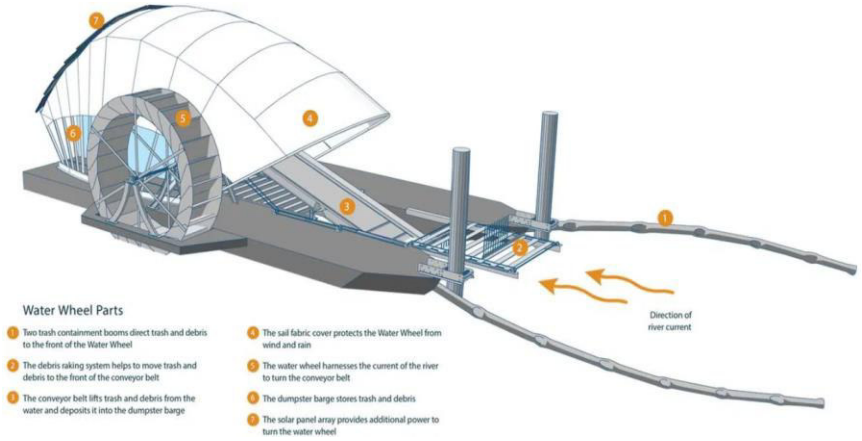
This Research and Development Project is being developed by IPT (Institute for Technological Research) and EMAE (Metropolitan Water and Energy Company).

Introduction

- Small Hydroelectric Plants (SHPs) and Large Hydroelectric Plants (LHPs) = over 60% of generated energy in Brazil (UDOP, 2021);
- Growth of cities surrounding SHPs increases river pollution;
- Consequences: Clogging of SHPs intake grid + accumulation of debris in the turbines (possible damage to them) + decreased energy efficiency;
- Problem seen in the operation of SHPs installed in the High Tietê hydrographic basin;

Introduction

- Existing solutions lack means to quickly transport debris to the shore;
- **Objectives**:
- Develop an automatic debris collection and removal system to reduce the quantity of floating debris along the Tietê River;
- Sollution must be <u>versatile</u> (adaptable to other points of the river and to different rivers altogether), and remain in its installation spot.

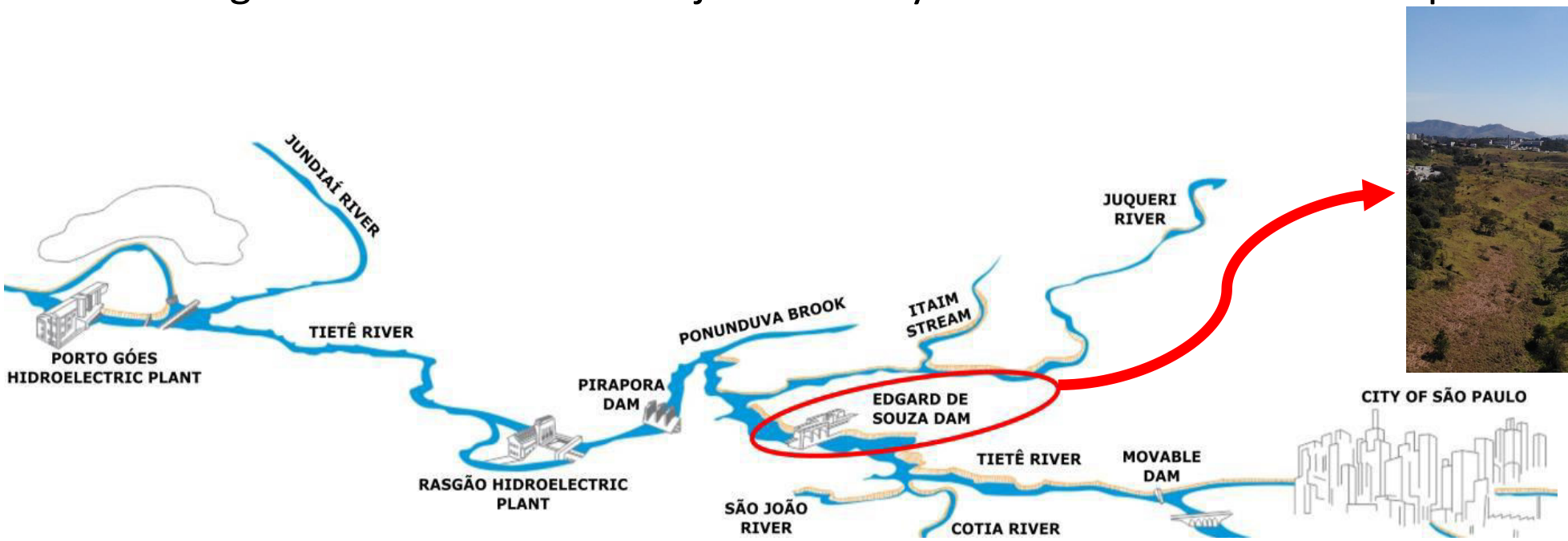


Mr. Trash Wheel (Source: Tagliani, 2017)

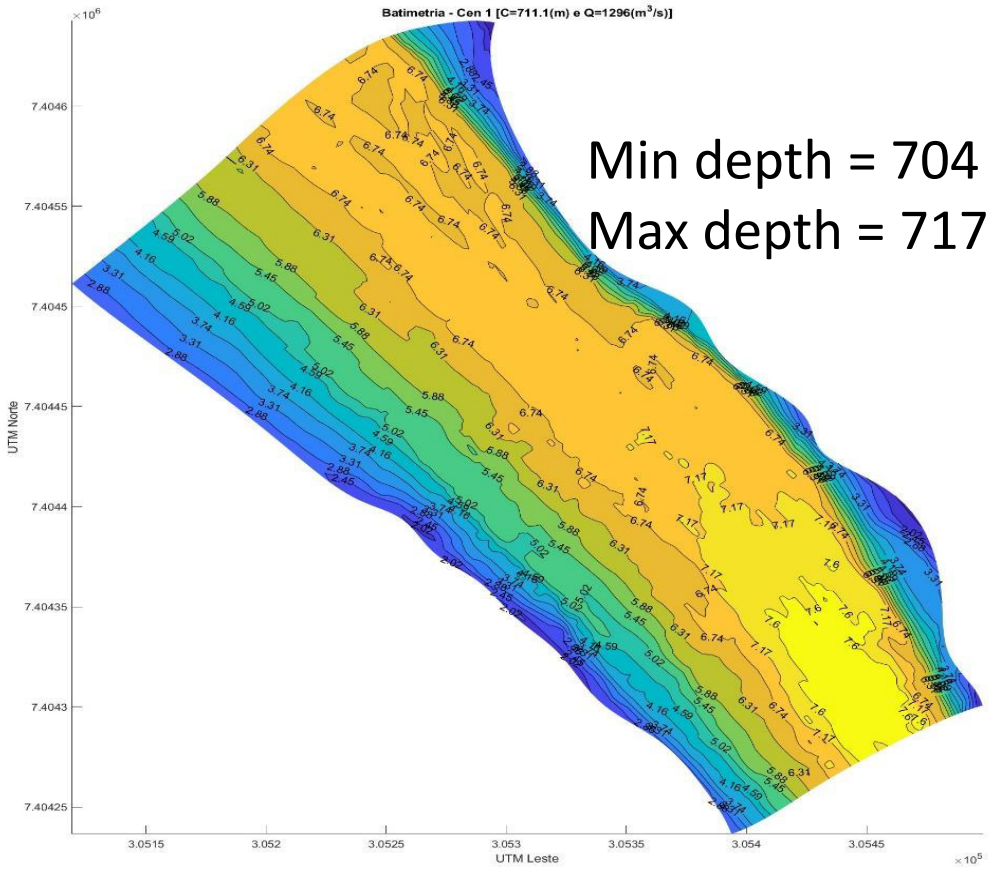
The Interceptor (Source: The Ocean Cleanup, 2020)

The High Tietê Hydrographic Basin – general details

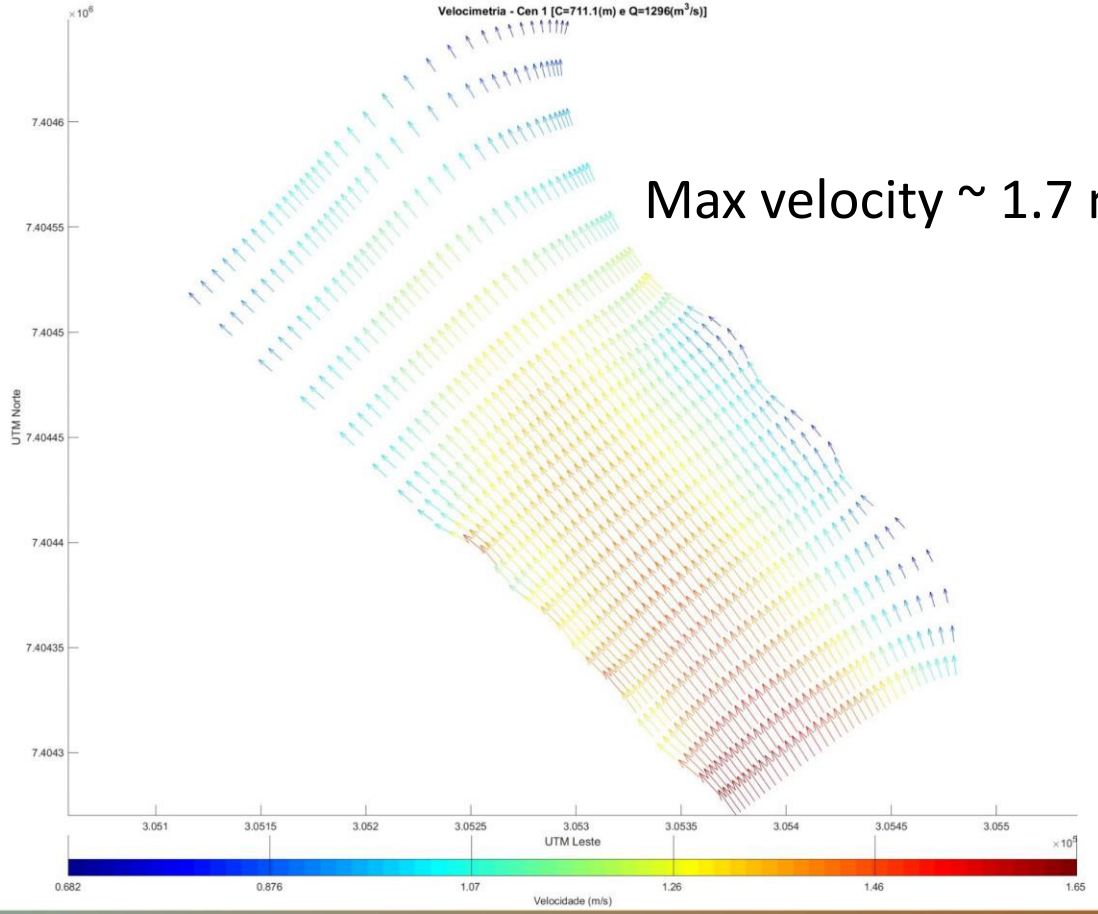
- ≈ 250 km of extension and ≈ 350 m of unevenness from the river source to the Pirapora Dam (downstream from the Edgard de Souza Dam);
- Edgard de Souza Dam = Object of study for the debris barrier's implementation;



The High Tietê Hydrographic Basin - Bathymetrical and Velocimetry Data

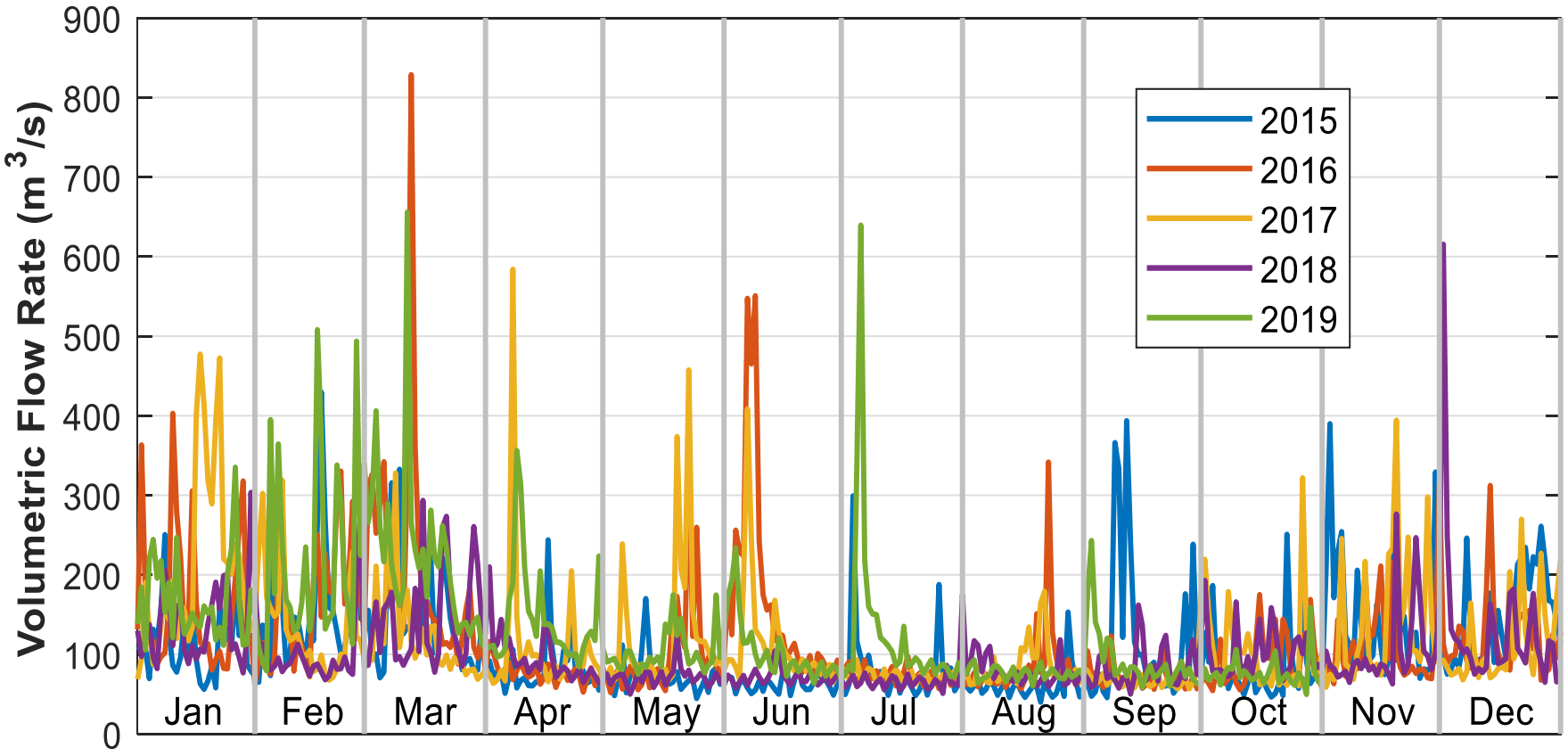


Min depth = 704 m
Max depth = 717 m



Max velocity ~ 1.7 m/s

The High Tietê Hydrographic Basin - Flow Data



The High Tietê Hydrographic Basin - Debris

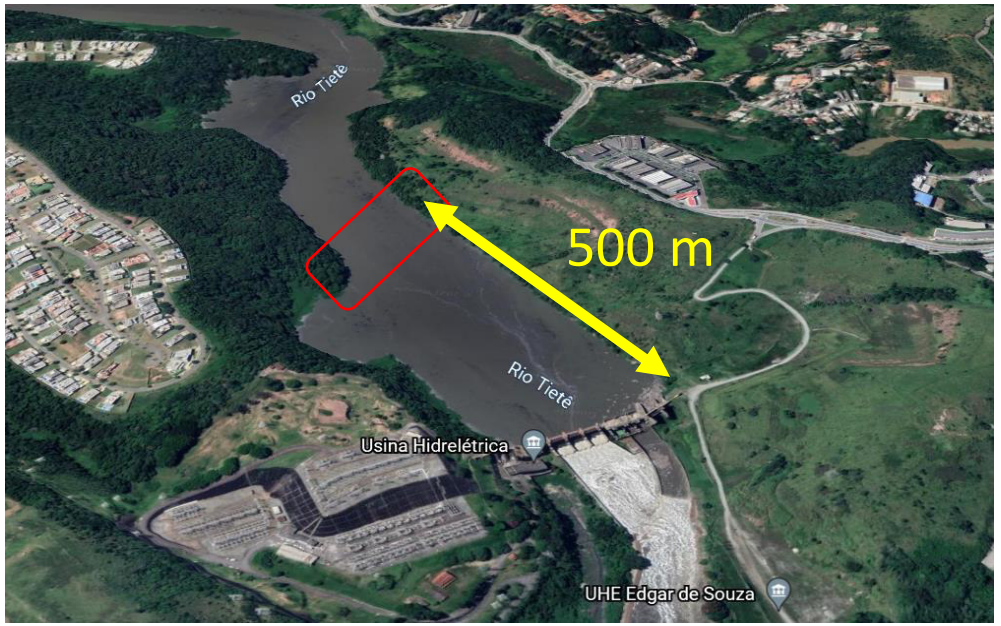
- Predominance of vegetation, plastic and paper;

- Edgard de Souza Dam has a large incidence of plastic, PET bottles, foam, tyres, furnitures and mattresses.

Project Description

Requirements

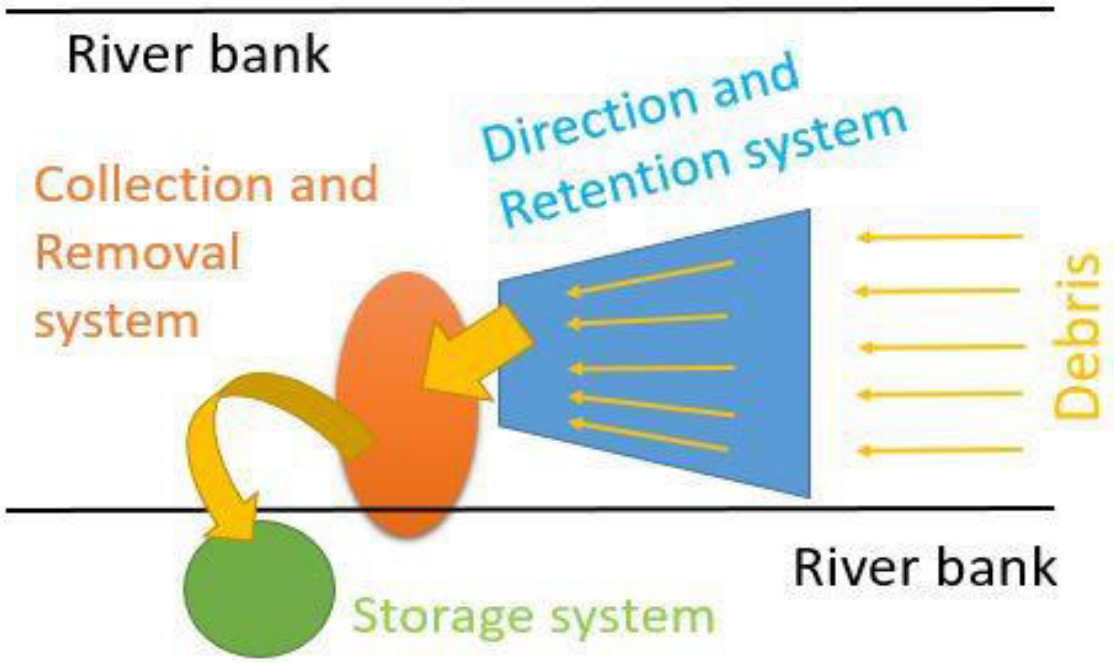
- Retain most of the floating debris transported by the High Tietê system;
- Max. debris removal efficiency between water levels of 710 m and 713 m, and flows up to 500 m³/s;
- Structural resistance to extreme environmental conditions;
- 200 m³ of retained debris storage (2 days of debris accumulation with extreme daily collection of 90 m³ or 5 days with an average 40 m³ of daily collection);
- Capability of being moved to other points of the Tietê River or even to other rivers.



Project Description

- **Design concept**

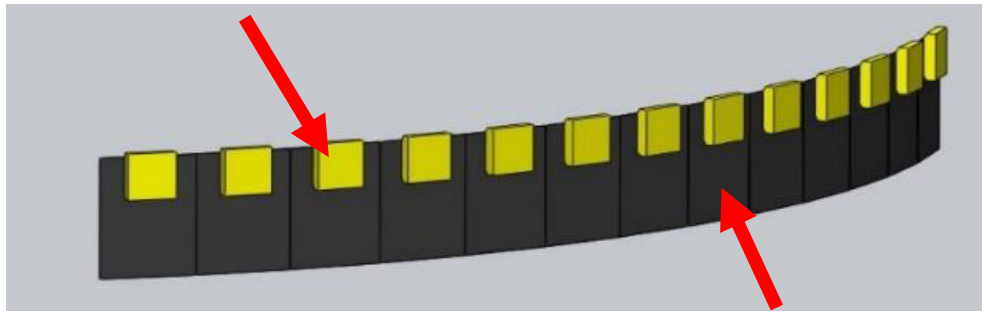
1. Direction and retention system (trash-boom);
2. Collection and removal system (floating vessel);
3. Storage and transporting system (storage area at river bank);
4. Fixation and mooring system.



Project Description

1. Direction and retention system:

- Trash-boom: floating passive barriers made of a rubber blanket with polyethylene floaters, connected to a segmented steel rod;
- Utilizes the river's flow to direct the debris to the collection and removal system, resisting the hydrodynamic loads.

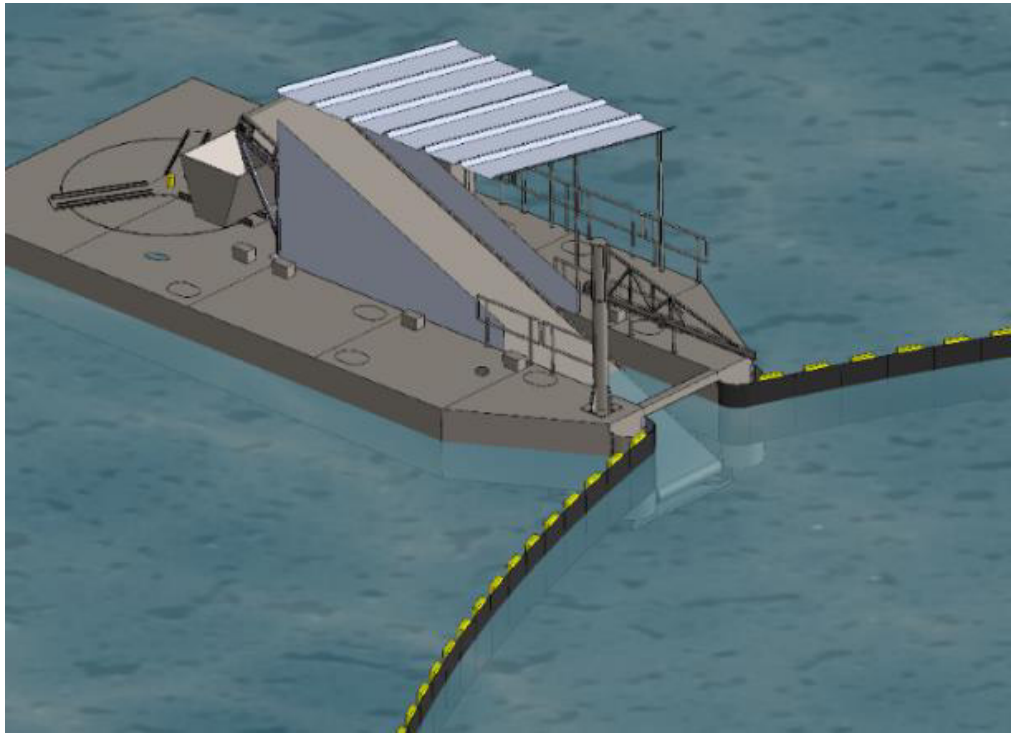


Source: Ecocoast Product Catalogue, 2021

Project Description

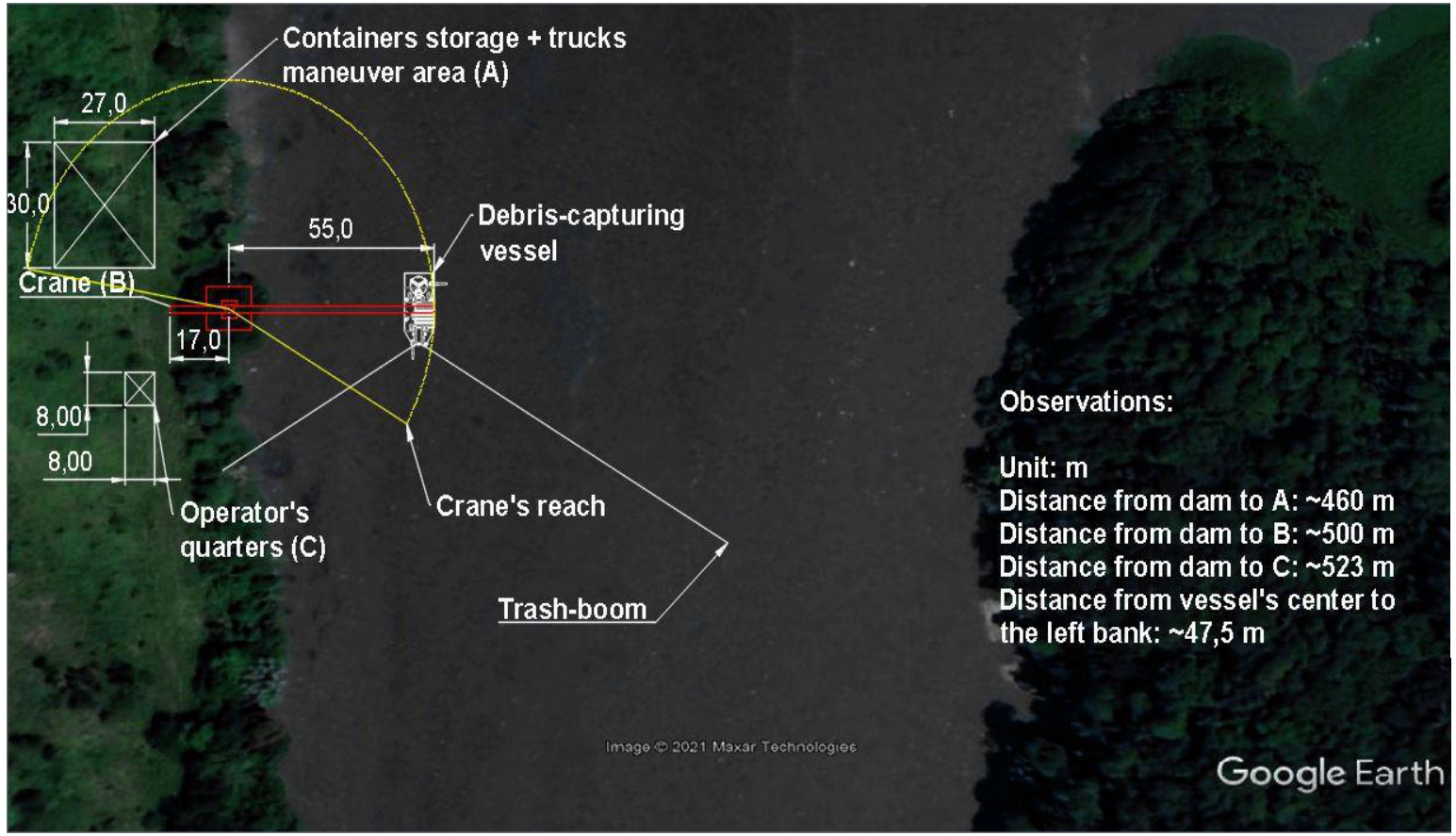
2. Collection and Removal System

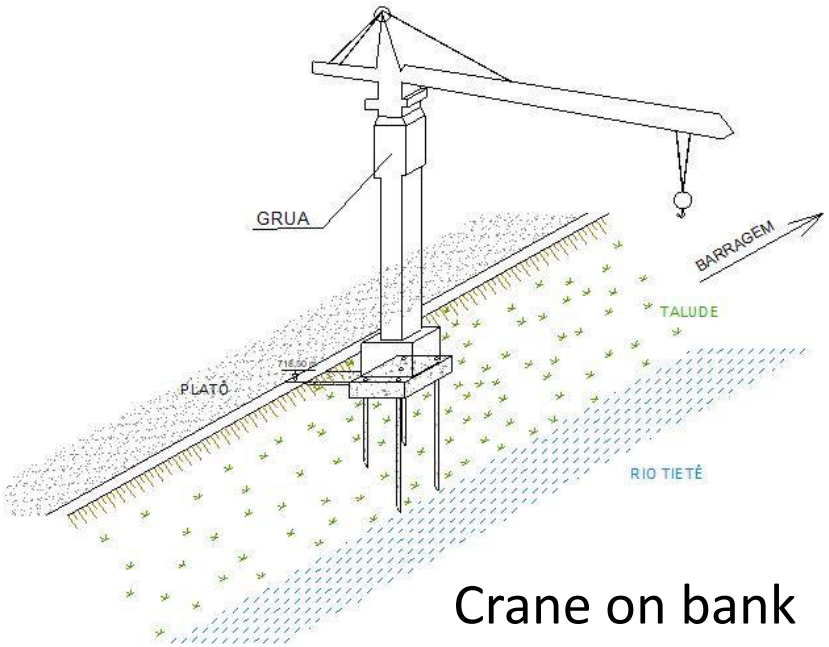
- Components: hull with metallic conveyor belt with draggers, a jib-crane, containers, turntable, and a rotating crane in the river bank;
- Draggers help removing debris from the water and prevent them from falling back to the river.



Project Description

2. Collection and Removal System



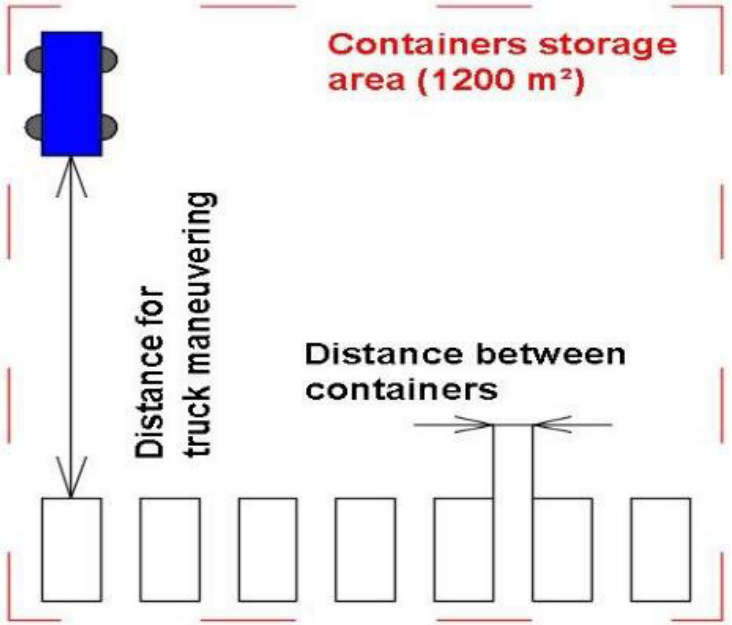


Crane on bank

Project Description

3. Storage and Transporting System

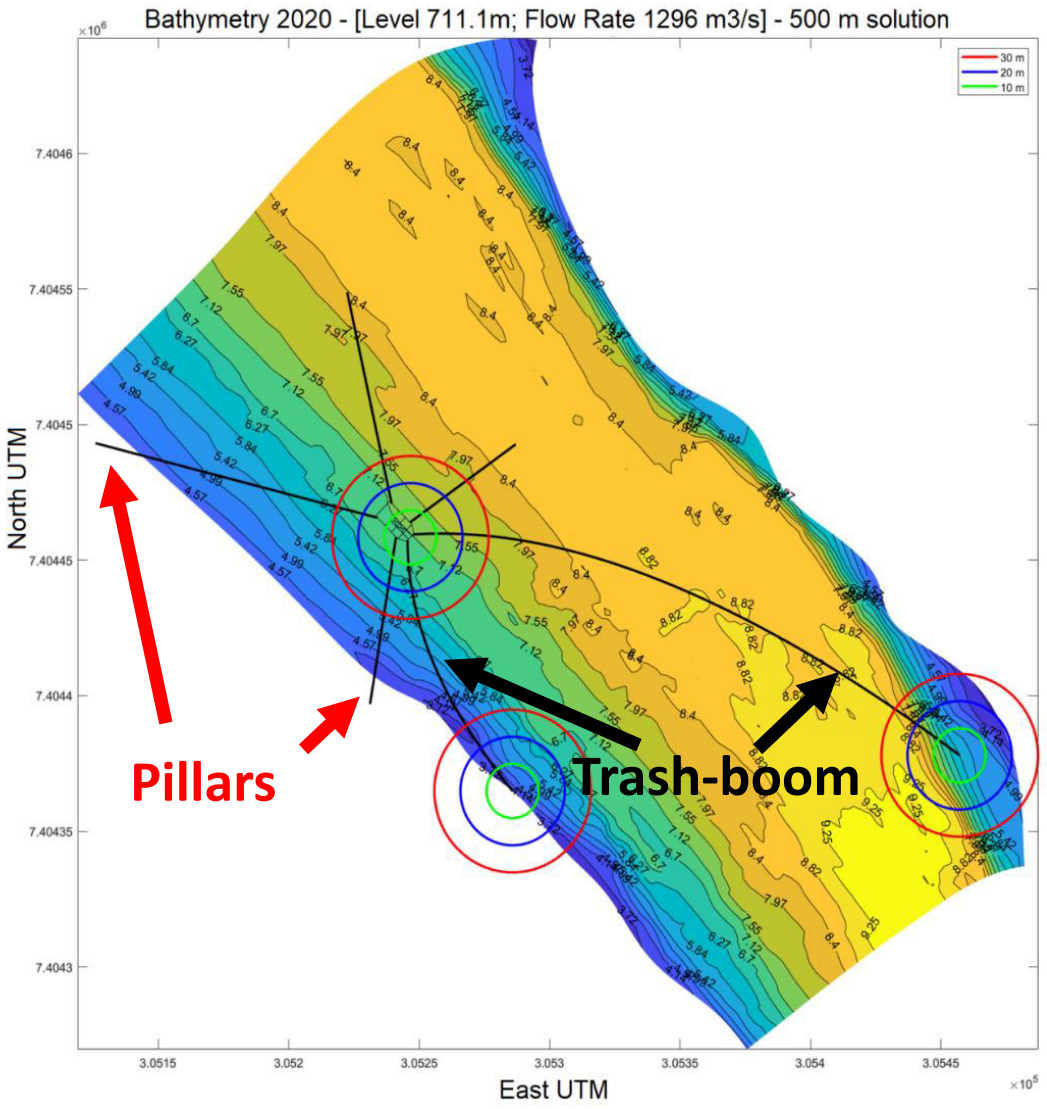
- Debris transferred to another container compatible with roll-on trucks;
- ~1200 m² for the storage of 7 containers.



Project Description

4. Fixation and Mooring System

- Two mooring lines anchored to pillars located in the right side of the hull;
- Two chains in the left side of the hull connected to anchors.



Conclusions

- Solution presented is an alternative to be applied at rivers of high flow rates with large volumes of debris transported;
- It's concept is viable thanks to the testing of hydrodynamic characteristics and collecting performance (Castro et al. 2022) + numerical simulations of the retention system (Queiroz et. al, 2022) and the behaviour of the debris flowing through the river (Mata et al. 2022)
- Future works: Simulation of the trash-boom with other conditions to check the resulting stresses + improvement of the numerical tools to test additional hydrodynamic conditions will also be further investigated and tested (Mata et al. 2022 ; Queiroz et al. 2022).

Acknowledgments

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ANEEL Agência Nacional de Energia Elétrica | Programa de Pesquisa e Desenvolvimento - P&D

emae

SÃO PAULO GOVERNO DO ESTADO

fipt fundação de apoio ao instituto de pesquisas tecnológicas

CAPES

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