organized by Distretto delle Alpi Orientali

LIFE LAGOON REFRESH. Ecological restoration in Venice Lagoon (Italy): concrete actions supported by numerical modeling and stakeholder involvement.

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Alessandra Feola

LAGOON REFRESH LIFE

ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale

Sistema Nazionale per la Protezione dell'Ambiente

Regione del Veneto

Ministero Infrastrutture e Trasporti Provveditorato Interregionale OO.PP. Veneto-Trentino Alto-Adige Friuli Venezia Giulia

Università Ca'Foscari Venezia

IPROS INGEGNERIA AMBIENTALE


CQWM
2nd International Conference
VENICE
2018
November
27-30
Citizen Observatories
for natural hazards and
Water Management

PARTNERSHIP, BUDGET AND DURATION

Coordinator

ISPRA – Italian National Institute for Environmental Protection and Research

Partners

Veneto Region - Environmental Protection Department

Interregional Superintendency for Public Works in Veneto, Trentino Alto Adige, Friuli Venezia Giulia

University Cà Foscari of Venice

IPROS Environmental Engineering s.r.l

Budget info

Total amount: 3'315'130 Euro

Eligible budget: 3'286'630 Euro

% EC Co-funding: 74,13% of total eligible budget

Duration

Start: 01/09/2017

End: 31/08/2022

Location

Venice Lagoon

ITALY

PROJECT BACKGROUND: DIFFERENT NATURAL AND ANTHROPOGENIC PRESSURES

First modern hydrographic map based on surveys of 1809 and 1811

D'Alpaos, 2010. *Morphological evolution of the Venice Lagoon through historical and hydrographic maps*

SEVERE REDUCTION OF THE ECOTONAL TRANSITION ZONE BETWEEN LAND AND LAGOON, CHARACTERIZED BY A MARKED SALINE GRADIENT

DIFFERENT NATURAL AND ANTHROPOGENIC PRESSURES

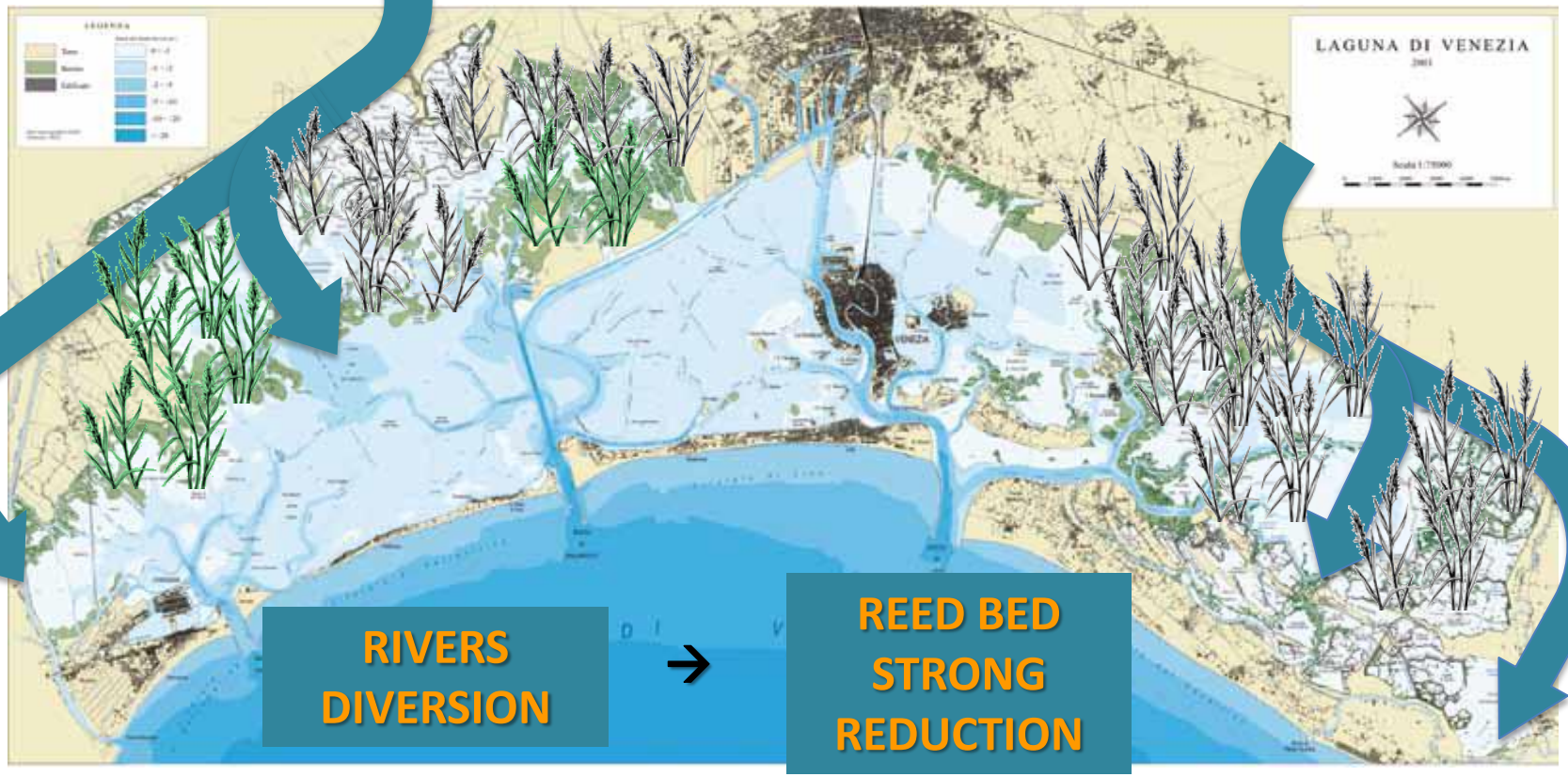
Hydrographic map based on surveys of 2000

PROJECT BACKGROUND: RIVERS DIVERSION

VENICE LAGOON: 550 Km^2

SALT MARSHES: 170 Km^2 (1901)

47 km^2 (2003)



Hydrographic map based on surveys of 2000

PROJECT MAIN OBJECTIVES

RECREATE THE **TYPICAL OLIGO-MESOHALINE** ENVIRONMENTS OF ESTUARINE TYPE

- to improve the **Degree of Conservation of Habitat 1150** * - Coastal lagoons in the Northern Lagoon of Venice, SCI IT3250031
- to reduce the **degree of eutrophication**, thanks to reed phytoremediation function;
- to improve the **status of bird species** included in annex I of Dir. 2009/147/EC, that use the reed environment during the winter period and /or for breeding, foraging or nesting;
- to increase the **presence of fish species** attracted by the presence of low-salinity environments;

POLICY IMPLICATIONS

"HABITAT DIRECTIVE" 92/43/CEE / "BIRDS DIRECTIVE" 2009/147/EC

improvement of **conservation degree of habitat and species** of Community interest

"WATER FRAMEWORK DIRECTIVE" 2000/60/EC

improvement of the trophic state of the habitat 1150* in order to contribute to the **achievement of the good Ecological status** in two water bodies within the Venice lagoon

2020 BIODIVERSITY STRATEGY

restoration of salt gradient and reed bed surfaces in order to contribute to the **increase of biodiversity** in the project area. Increasing of species included in Habitat and Birds Directives and other bird species of special conservation interest

PROJECT KEY ACTIONS

- ✓ diversion of a **freshwater flow** (1.000 l/s) from the river Sile into the lagoon;
- ✓ restoration of the **intertidal morphology** to sustain the reed development;
- ✓ planting of ***Phragmites australis*** and transplantation of ***Ruppia cirrhosa*** and ***Zostera noltei;***
- ✓ establishment of a protected zone of 70 ha in order to manage/reduce hunting and fishing pressure;
- ✓ **monitoring** of the project impact;
- ✓ stakeholder **involvement**;
- ✓ actions of **dissemination** and **replication** of project's results.

MAIN FOCUSES OF THIS PRESENTATION

✓NUMERICAL MODELS USED A SUPPORTING TOOL FOR HYDRAULIC AND MORPHOLOGICAL INTERVENTIONS

✓STAKEHOLDERS INVOLVEMENT IN CONCRETE ACTIONS AND IN MONITORING ACTIVITIES

NUMERICAL MODELLING AS SUPPORTING TOOL

NUMERICAL MODELLING WAS USED AS A SUPPORTING TOOL:

- TO REACH PROJECT GOALS
  - TO DEFINE THE EXTENSION OF THE AREA OF INFLUENCE (1900 ha)
  - TO DEFINE THE MOST SUITABLE PROJECT CONFIGURATION IN TERMS OF SALINITY DIFFUSION AND HYDRAULIC EFFECTS

  → 2D- 3D MODEL OF LAGOON

- TO VERIFY PROJECT POSSIBLE IMPACTS ON SILE RIVER (WATER LEVEL, DISCHARGE, SALINE WEDGE INTRUSION)

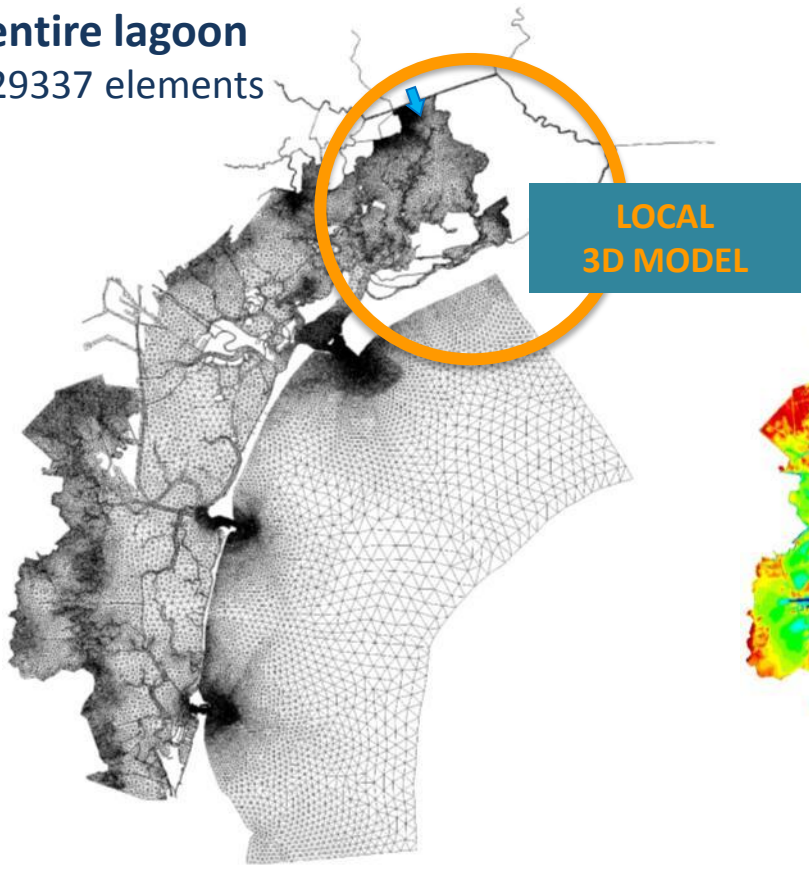
  → 2D- 3D MODEL OF RIVER SYSTEM

DETAILS OF SETUP, CALIBRATION AND RESULTS WILL BE PRESENTED

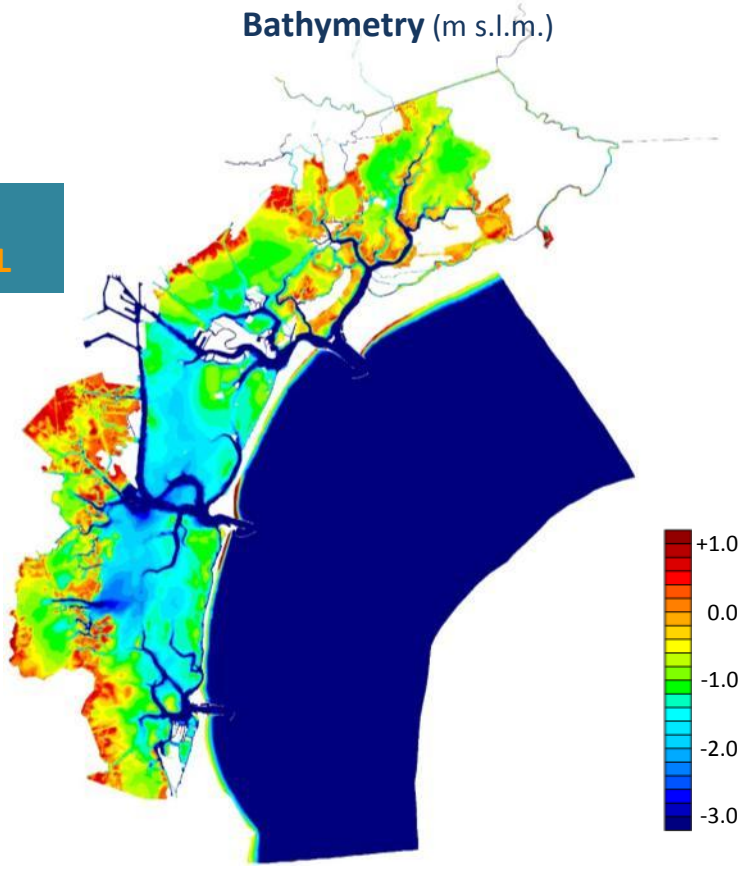
2D HYDRODINAMIC MODEL FOR THE ENTIRE VENICE LAGOON

Mesh for the entire lagoon

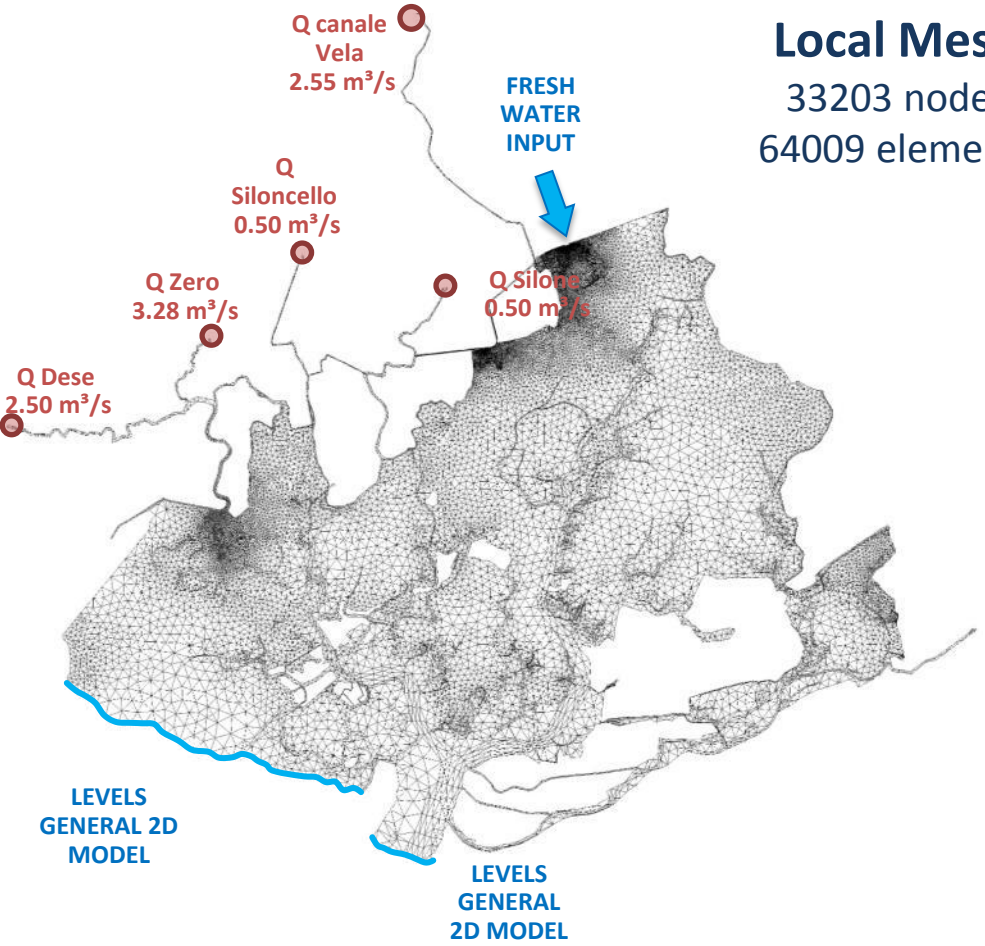
68171 nodes – 129337 elements



Bathymetry (m s.l.m.)



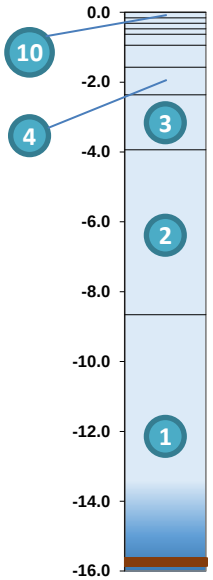
3D HYDRODINAMIC MODEL - NOTHERN PART OF THE VENICE LAGOON



Local Mesh

33203 nodes

64009 elements

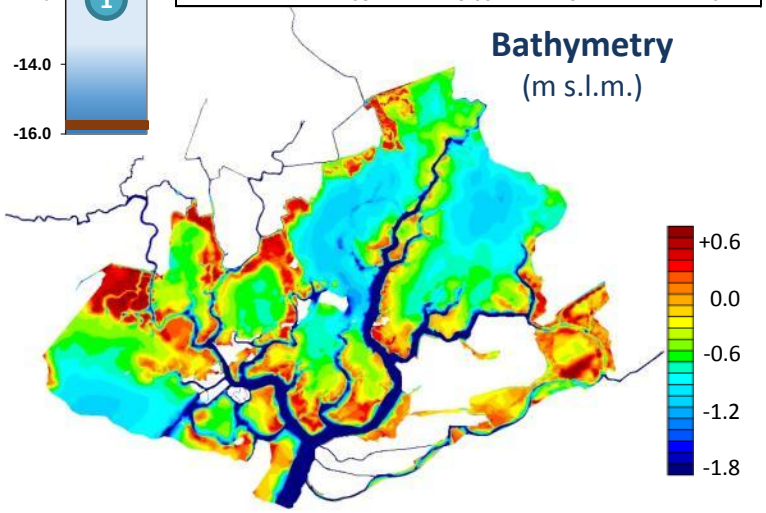


Vertical layers

LAYER N	THICK. (m)	FROM (m)	TO (m)	MEAN DEPTH (m)
10	0.16	0.00	0.16	0.08
9	0.16	0.16	0.31	0.24
8	0.16	0.31	0.47	0.39
7	0.16	0.47	0.63	0.55
6	0.31	0.63	0.94	0.79
5	0.63	0.94	1.57	1.26
4	0.79	1.57	2.36	1.97
3	1.57	2.36	3.94	3.15
2	4.72	3.94	8.66	6.30
1	7.08	8.66	15.74	12.20

Bathymetry

(m s.l.m.)

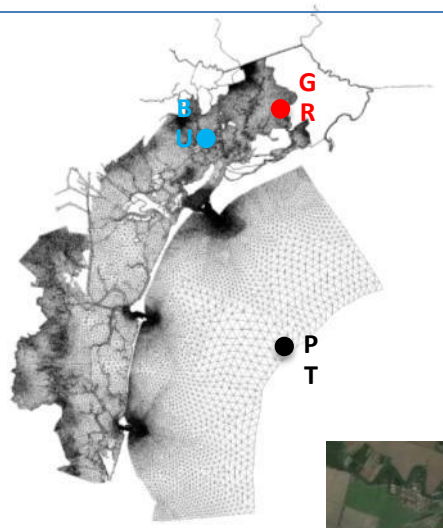


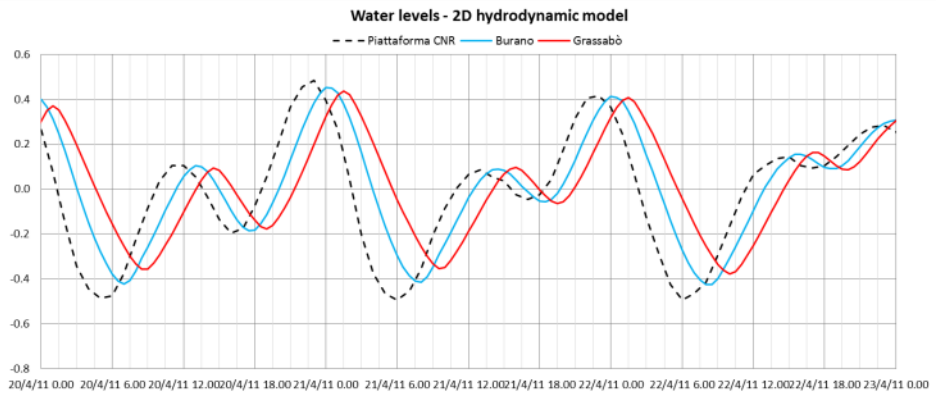
HYDRODINAMIC MODEL: TYPE OF RESULTS

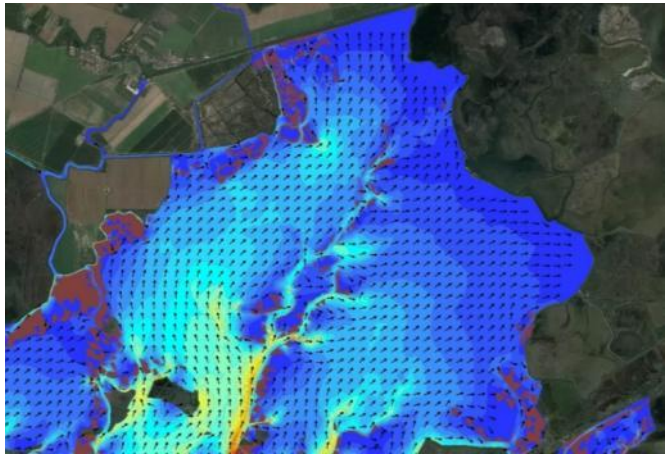
WATER LEVEL

CURRENT SPEED

SALINITY



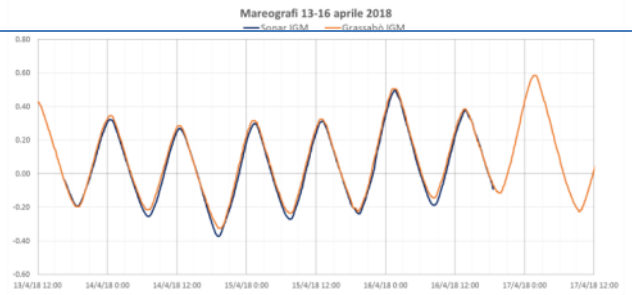




HYDRODINAMIC MODEL: CALIBRATION

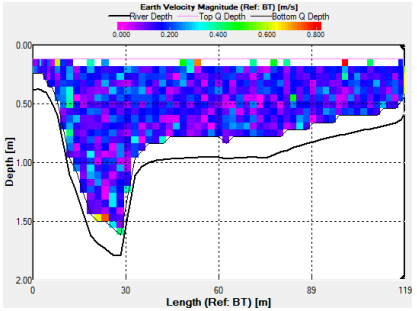
WATER LEVEL

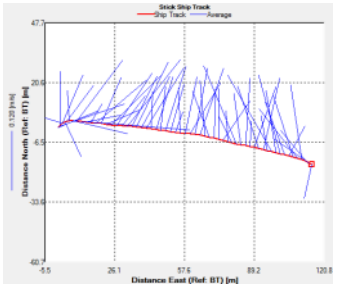
TIDE LEVEL STATIONS



CURRENT SPEED

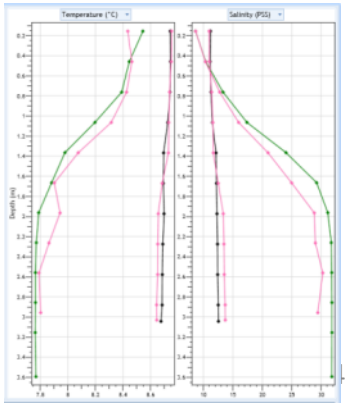
ADCP FIELD CAMPAIGNS





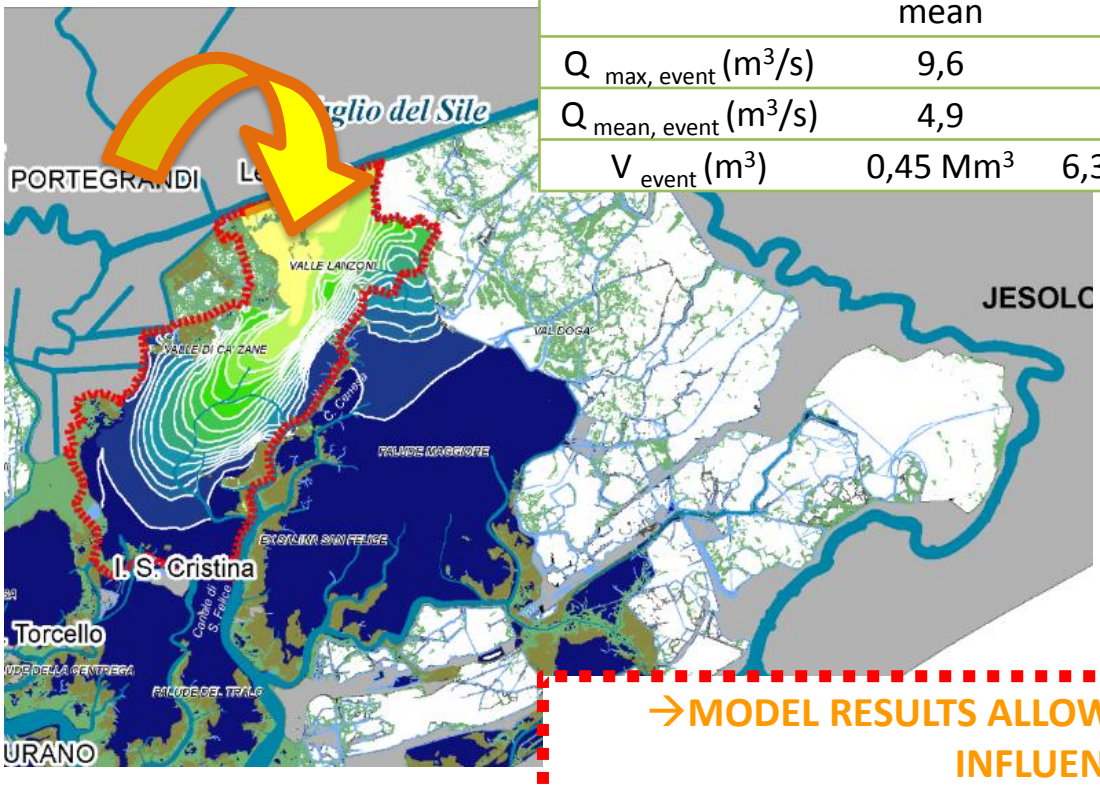
SALINITY

CTD FIELD CAMPAIGNS -FIXED STATIONS



NUMERICAL MODEL USED TO DEFINE THE EXTENSION OF THE AREA OF INFLUENCE

CURRENTLY, DURING FLOOD EVENTS, **WATER SPILLS FROM SILE RIVER INTO THE LAGOON**, WITHOUT BUFFER ZONE ABLE TO REDUCE NUTRIENT LOADS



	mean	max
$Q_{max,\ event}$ (m^3/s)	9,6	71,6
$Q_{mean,\ event}$ (m^3/s)	4,9	23,0
V_{event} (m^3)	0,45 Mm^3	6,33 Mm^3

THE PROJECT WILL INCREASE THE ENVIRONMENTAL SUSTAINABILITY OF EXISTING FLOOD PROTECTION INFRASTRUCTURES (SPILLWAY, FLOODS DIRECTIVE 2007/60/CE).

IN PARTICULAR, **RESTORATION OF MORPHOLOGY** AND **REED BEDS** WILL INCREASE THE **SELF-PURIFYING CAPACITY**, REDUCING THE RISK OF EUTROPHICATION.

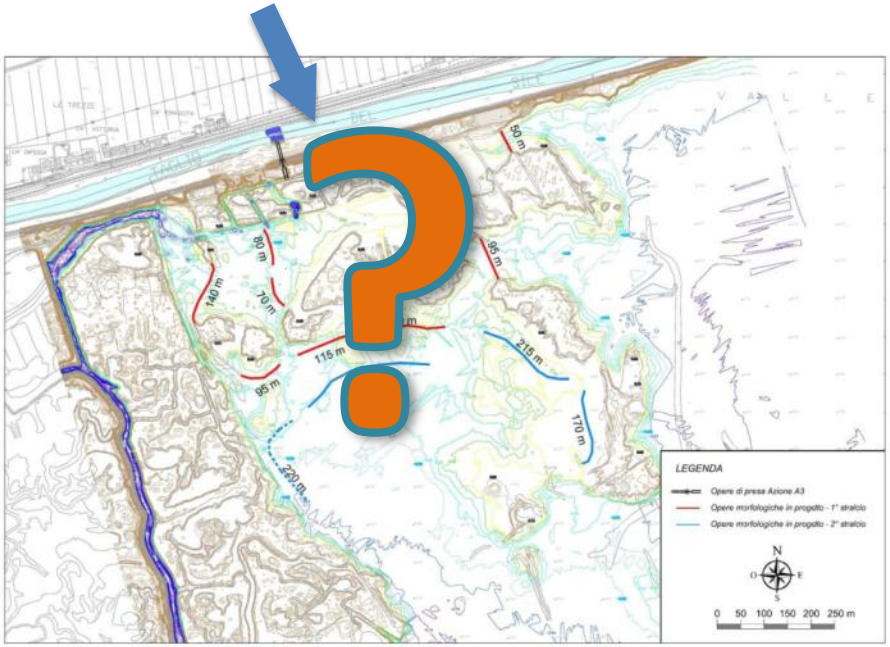
→MODEL RESULTS ALLOW TO IDENTIFY THE AREA OF POSITIVE INFLUENCE OF THE PROJECT

CONCRETE ACTIONS SUPPORTED BY NUMERICAL MODELLING

DIVERSION OF A FRESHWATER FLOW FROM THE SILE RIVER INTO THE LAGOON

HYDRAULIC WORK

WHICH DISCHARGE?



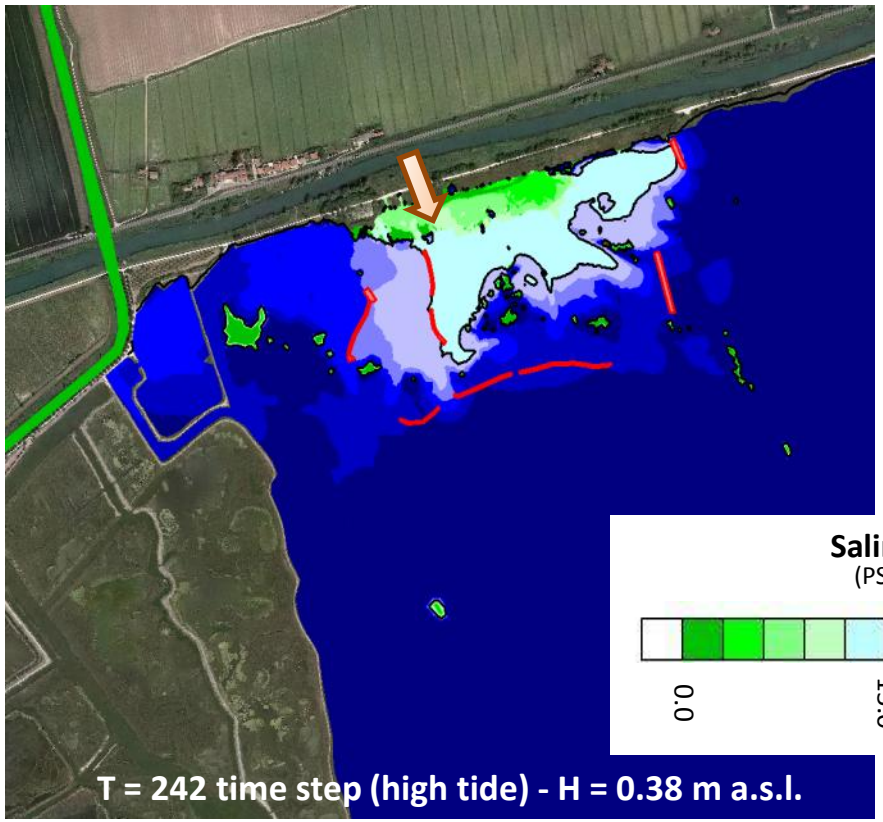
STRUCTURES PROPERLY ARRANGED IN ORDER TO SLOW DOWN THE FRESH WATER DISPERSION AND TO FAVOR THE REED DEVELOPMENT ACCORDING TO THE PROJECT CONFIGURATION

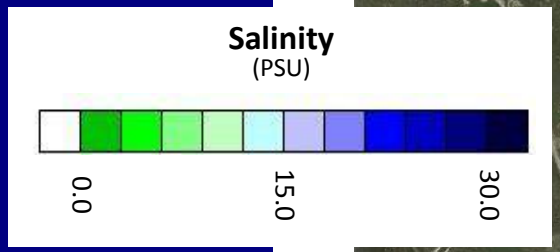
MORPHOLOGIC WORK

WHICH CONFIGURATION?

NUMERICAL MODEL USED TO EVALUATE DISCHARGE VARIATION IN TERMS OF SALINITY DIFFUSION

Configuration: BIO 1° step – Q = 300 l/s

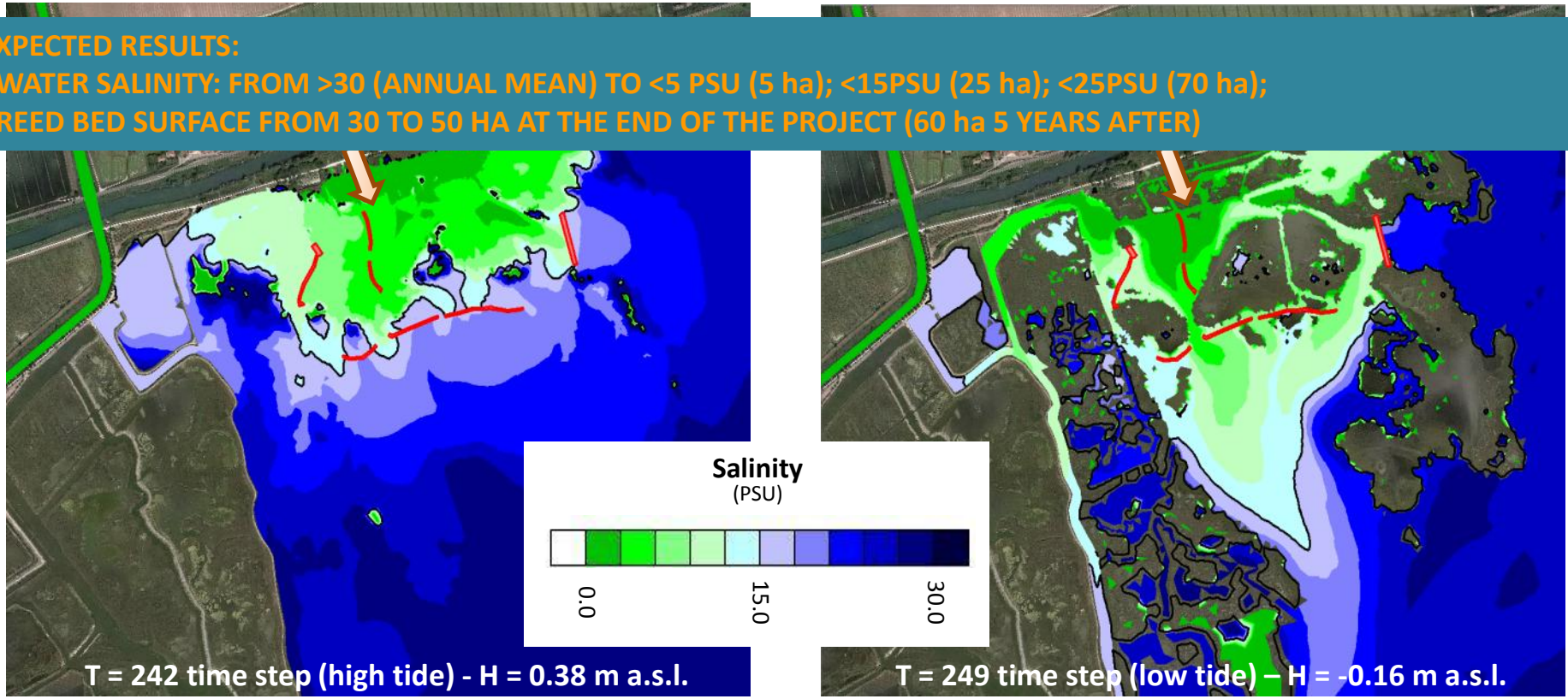




NUMERICAL MODEL USED TO EVALUATE DISCHARGE VARIATION IN TERMS OF SALINITY DIFFUSION

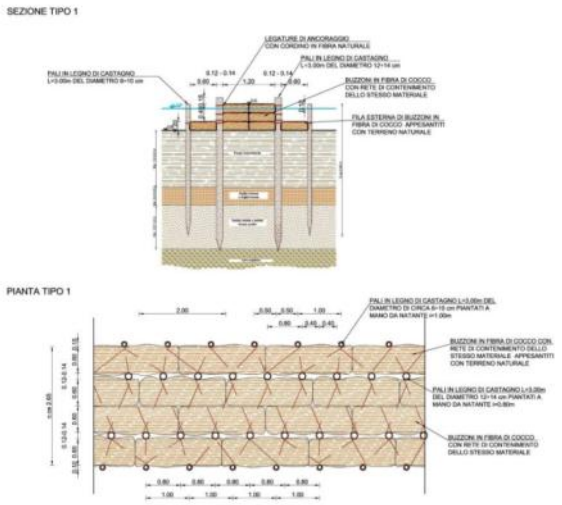
Configuration: BIO 1° step – Q = 1000 l/s

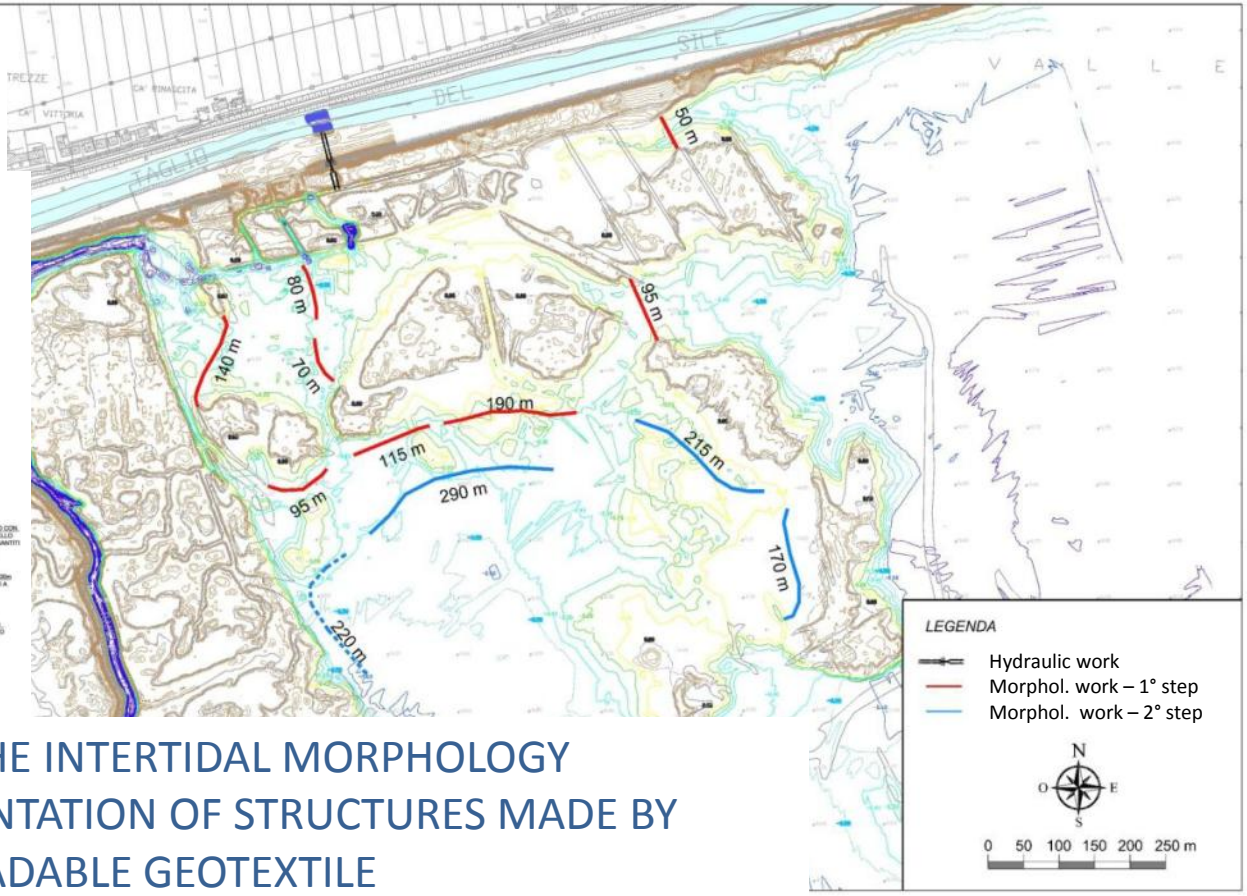
EXPECTED RESULTS:
- WATER SALINITY: FROM >30 (ANNUAL MEAN) TO <5 PSU (5 ha); <15PSU (25 ha); <25PSU (70 ha);
- REED BED SURFACE FROM 30 TO 50 HA AT THE END OF THE PROJECT (60 ha 5 YEARS AFTER)



MORPHOLOGIC WORK

BIODEGRADABLE GEOTEXTILE
Dimension: 2.40 m
Top: 0.15 m a.s.l.

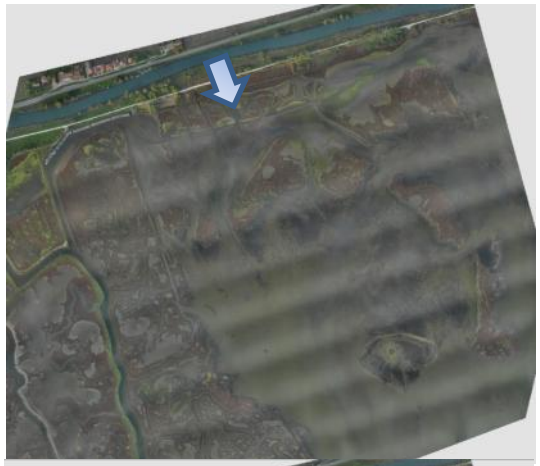




RESTORATION OF THE INTERTIDAL MORPHOLOGY THROUGH THE IMPLEMENTATION OF STRUCTURES MADE BY BIODEGRADABLE GEOTEXTILE

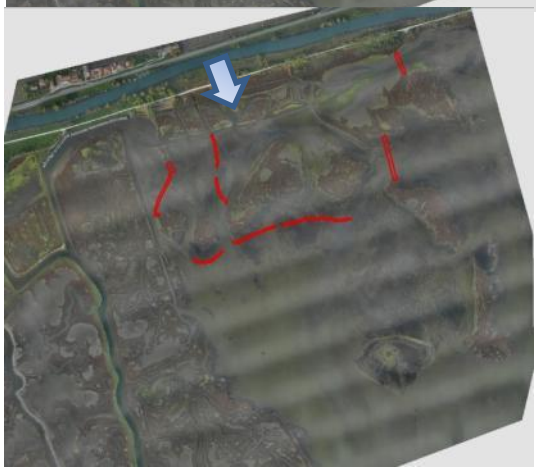
MORPHOLOGIC WORK - PROJECT SETUP – DIFFERENT CONFIGURATIONS

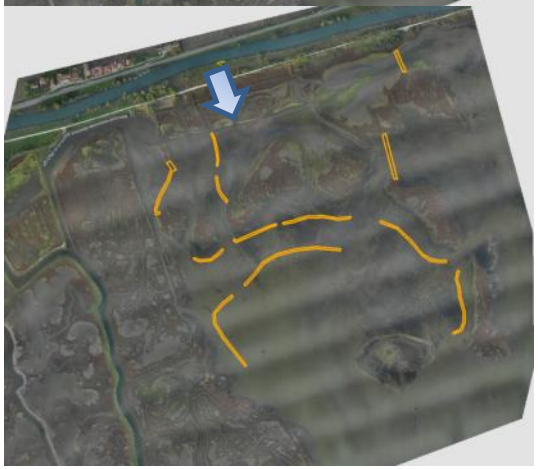
Configuration ZERO



Configuration C2 Top elevation: +0.1 m a.s.l.

Configuration BIO 1° step Top elevation: +0.1 m a.s.l.

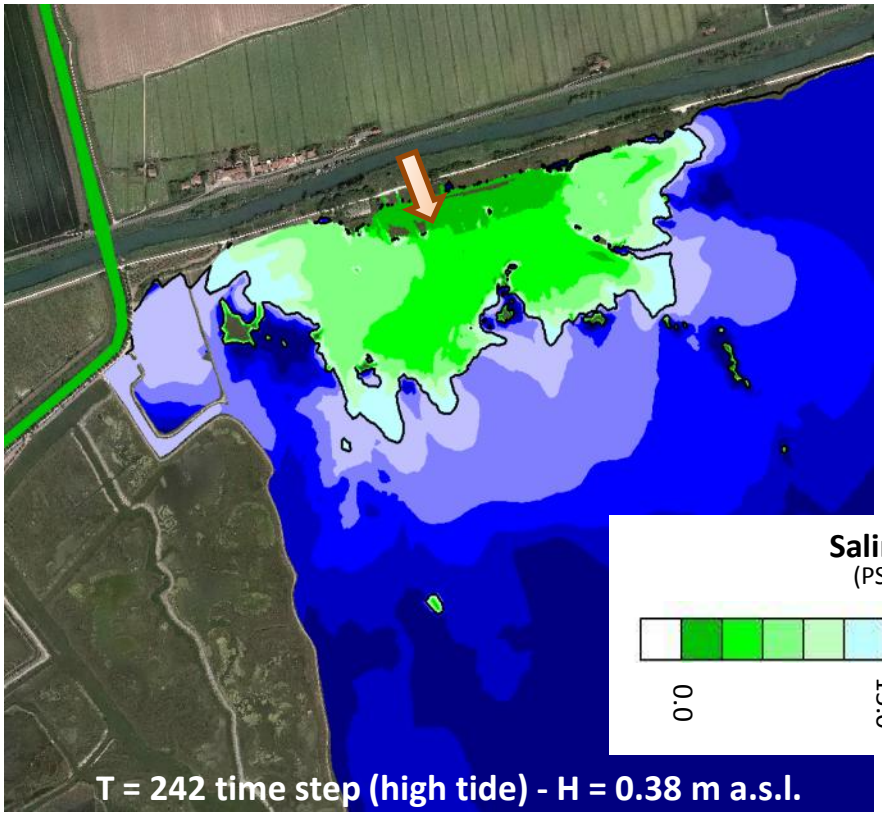


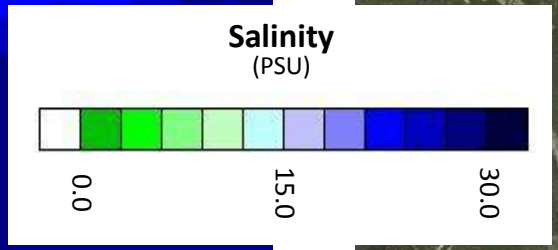


Configuration BIO 2° step Top elevation: +0.1 m a.s.l.

NUMERICAL MODEL USED TO COMPARE PROJECT MORPHOLOGICAL CONFIGURATION

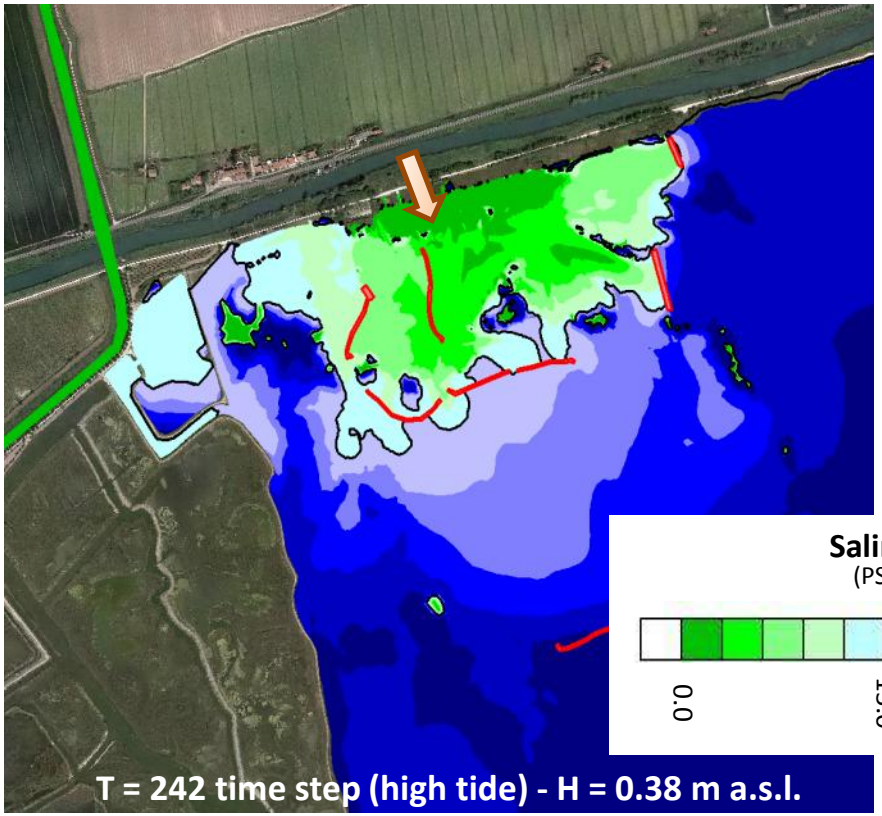
Configuration: ZERO – Q = 1000 l/s

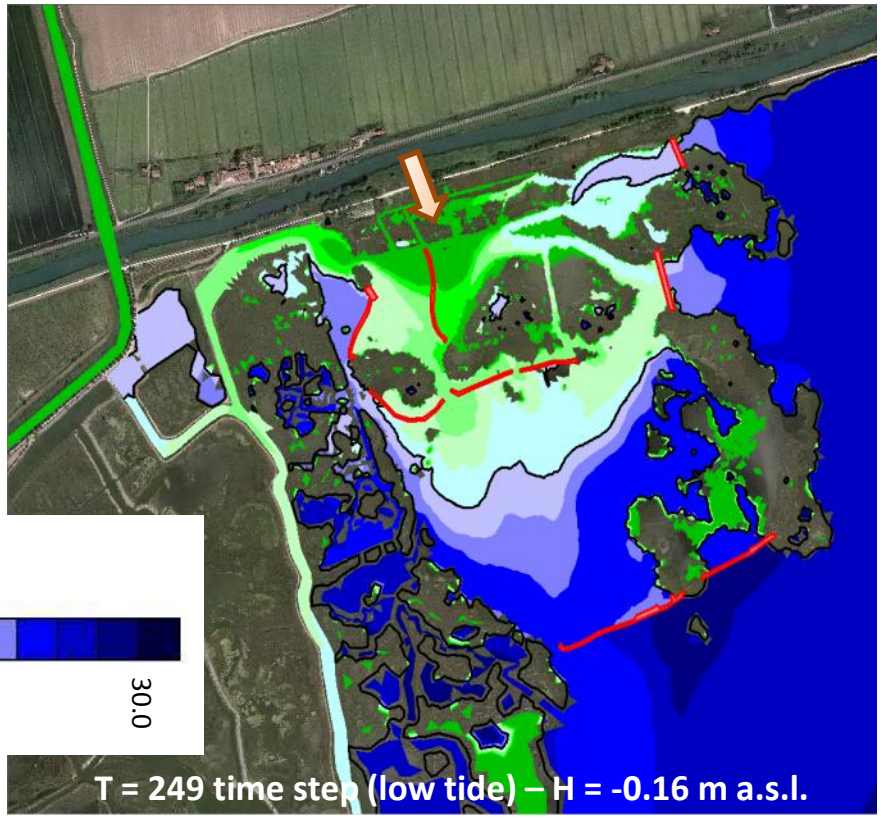


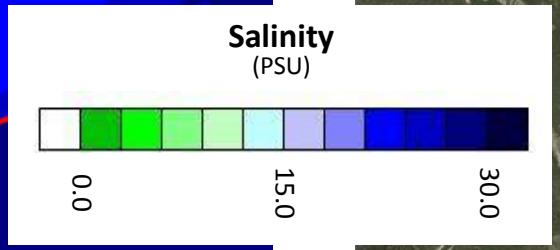


NUMERICAL MODEL USED TO COMPARE PROJECT MORPHOLOGICAL CONFIGURATION

Configuration: C2 – Q = 1000 l/s

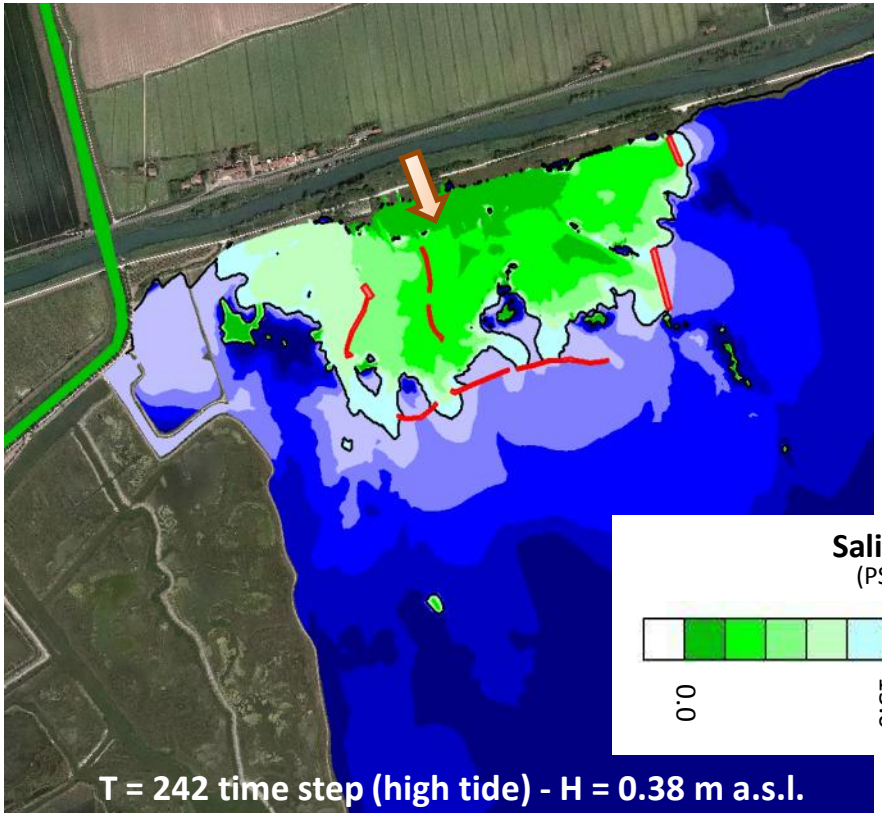


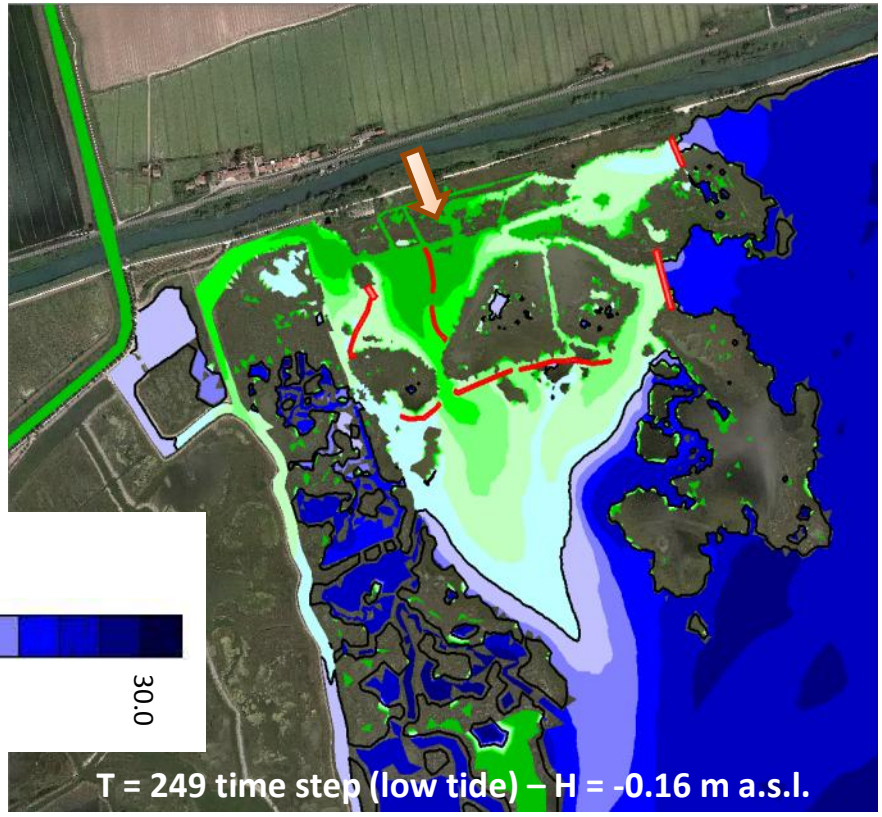




NUMERICAL MODEL USED TO COMPARE PROJECT MORPHOLOGICAL CONFIGURATION

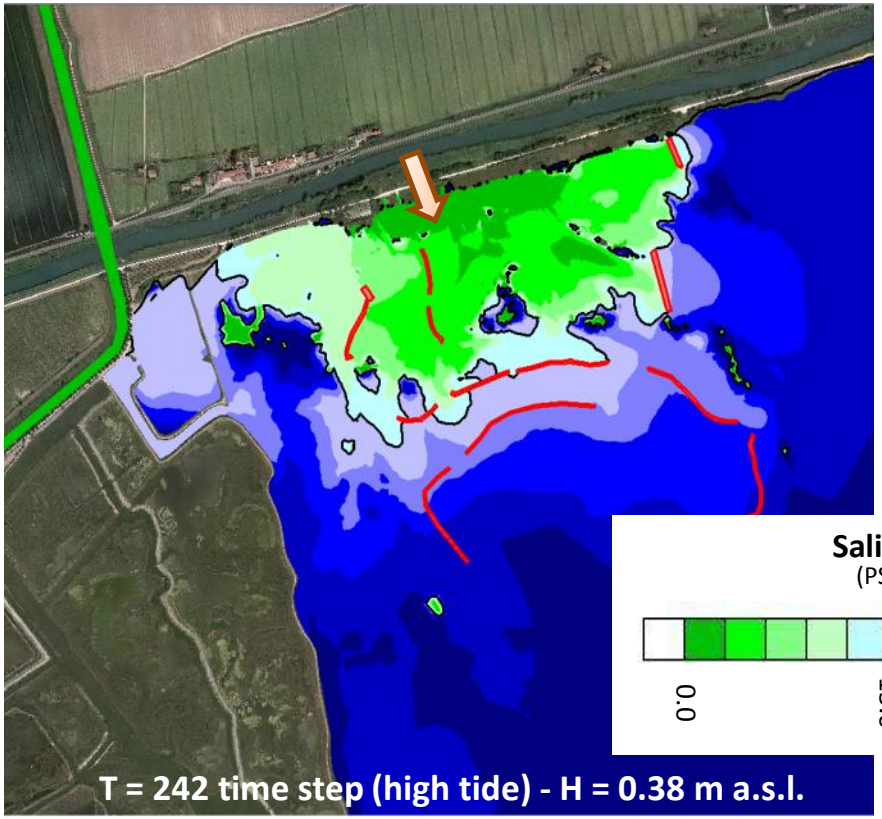
Configuration: BIO 1° step – Q = 1000 l/s

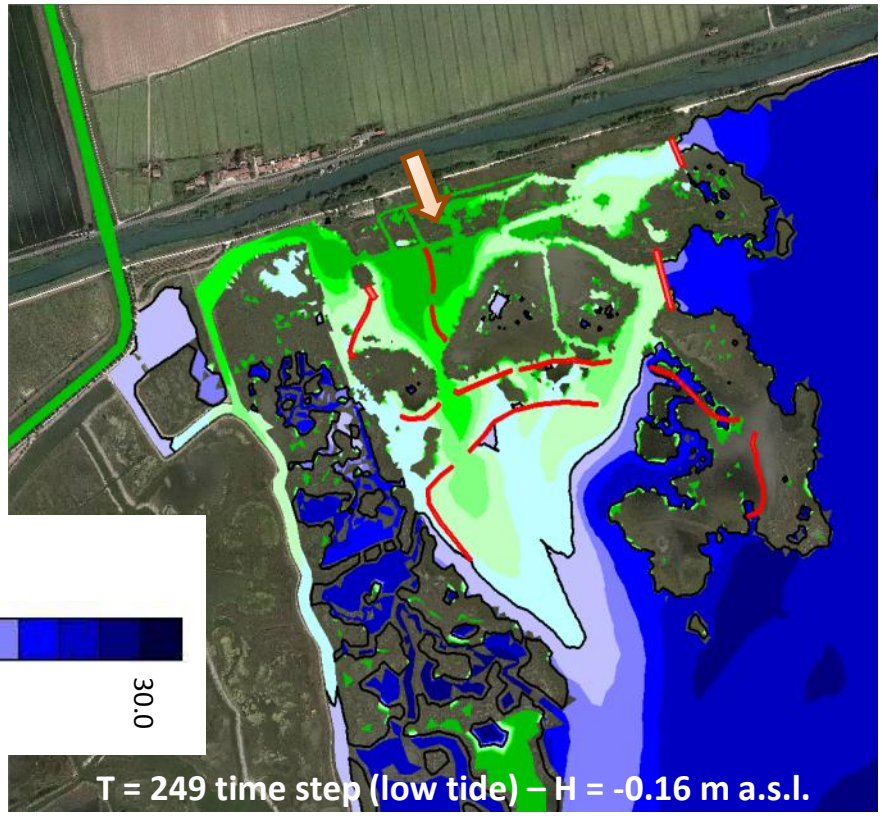




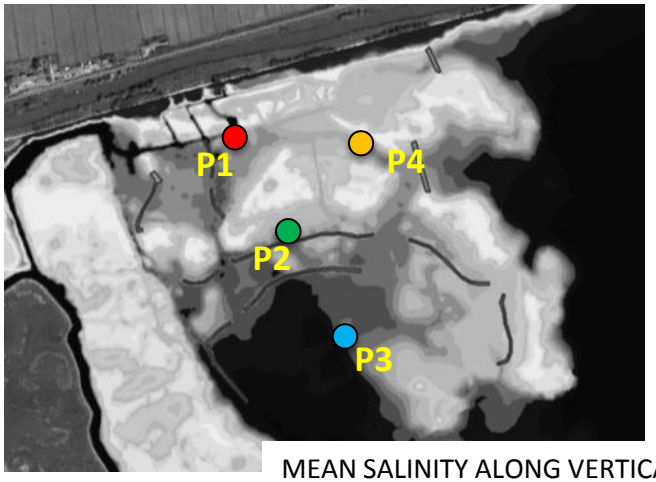
NUMERICAL MODEL USED TO COMPARE PROJECT MORPHOLOGICAL CONFIGURATION

Configuration: BIO 2° step – Q = 1000 l/s





NUMERICAL MODEL USED TO COMPARE PROJECT MORPHOLOGICAL CONFIGURATION

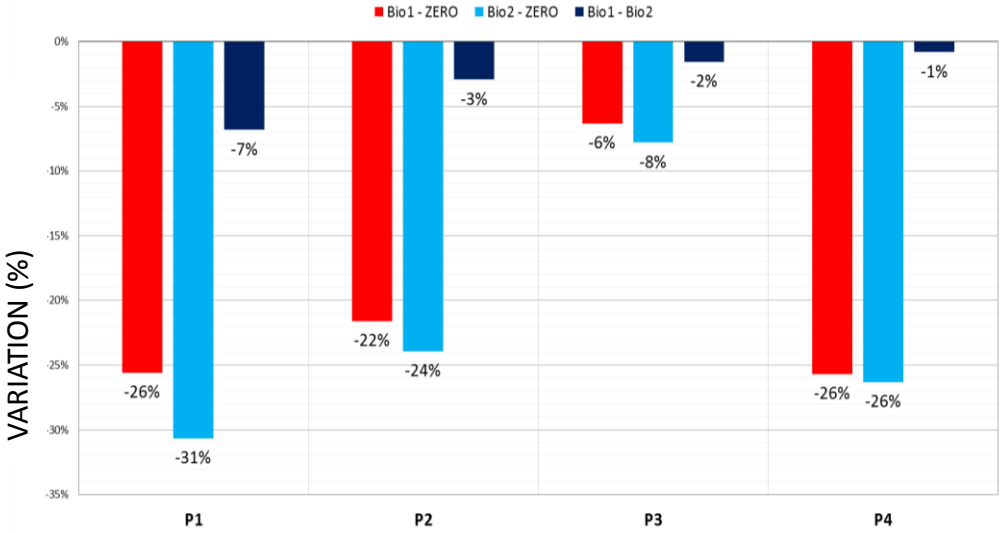


MEAN SALINITY ALONG VERTICAL PROFILE

	P1	P2	P3	P4
ZERO	1.8	16.6	23.2	8.6
Bio1	1.3	13.0	21.8	6.4
Bio2	1.2	12.6	21.4	6.3
delta % Bio1-ZERO	-26%	-22%	-6%	-26%
delta % Bio2-ZERO	-31%	-24%	-8%	-26%
delta % Bio2-Bio1	-7%	-3%	-2%	-1%

FRESH WATER DIFFUSION COMPARISON BETWEEN DIFFERENT PROJECT CONFIGURATIONS

SURFACE SALINITY - DAILY MEAN VALUES CONFIG ZERO VS CONFIG BIO2



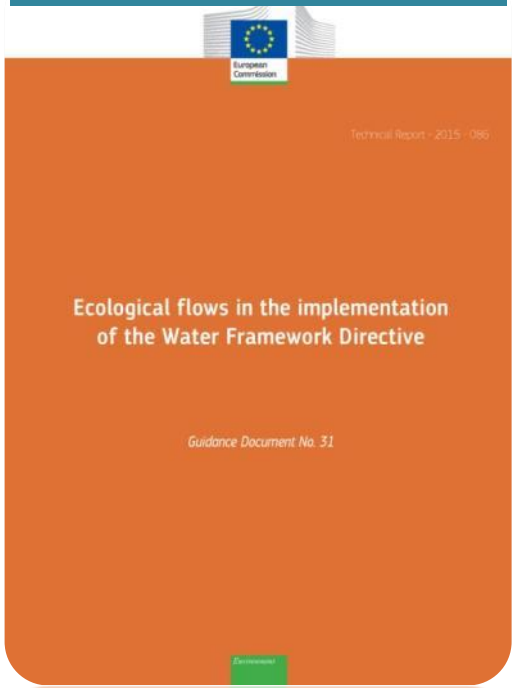
NUMERICAL MODEL USED TO VERIFY PROJECT POSSIBLE IMPACTS ON SILE RIVER

DRINKING WATER USE

IRRIGATION

....

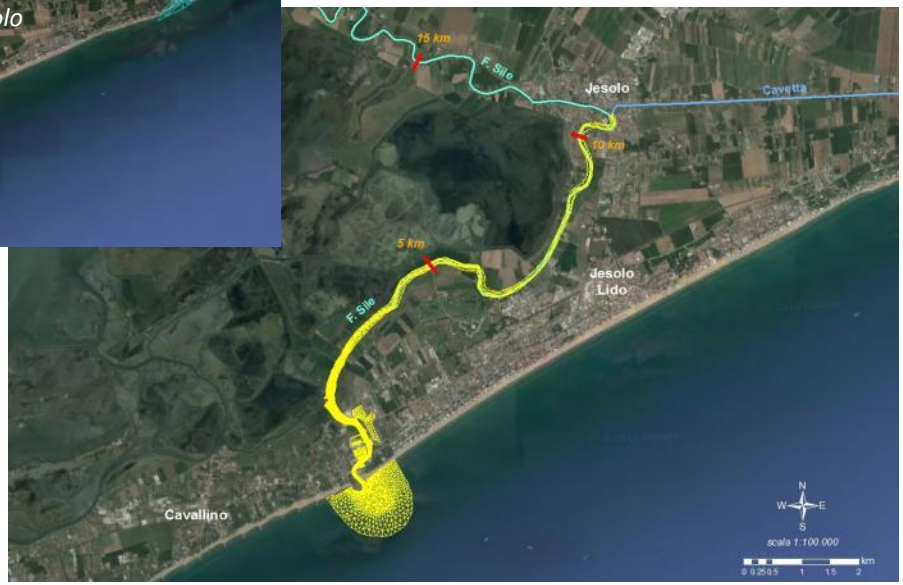
ECOLOGICAL ASPECTS



SOCIO-ECONOMIC
AND ENVIRONMENTAL CONCERN
OF DIFFERENT STAKEHOLDERS

SALINE WEDGE INTRUSION ON SILE RIVER - NUMERICAL MODELLING - SETUP

2D MODEL OF RIVER SYSTEM Sile-Piave-Piave Vecchia-Cavetta



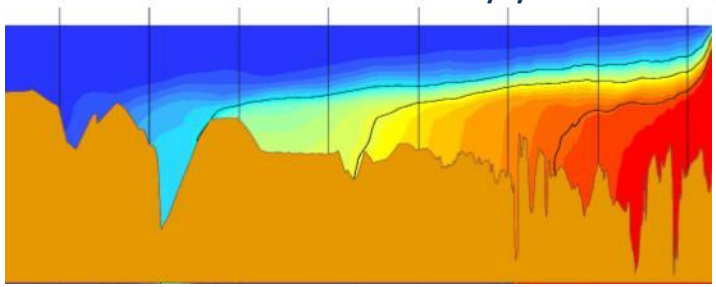
WATER LEVEL DISCHARGE SALINE WEDGE INTRUSION

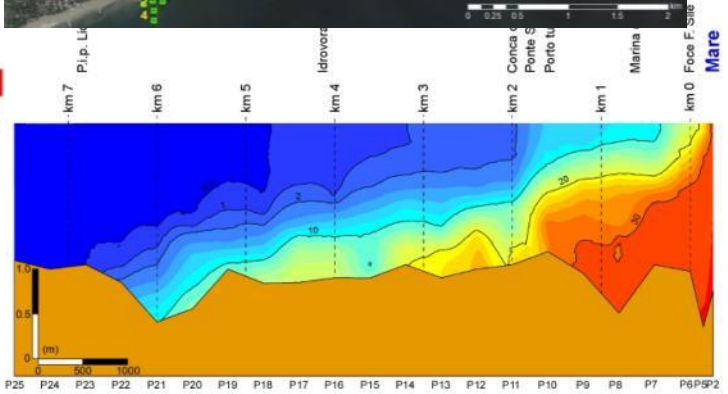
3D MODEL OF RIVER MOUTH

SALINE WEDGE INTRUSION ON SILE RIVER - NUMERICAL MODELLING – FIELD CAMPAIGNS

3D MODEL + FIELD CAMPAIGN (15/02/2018)

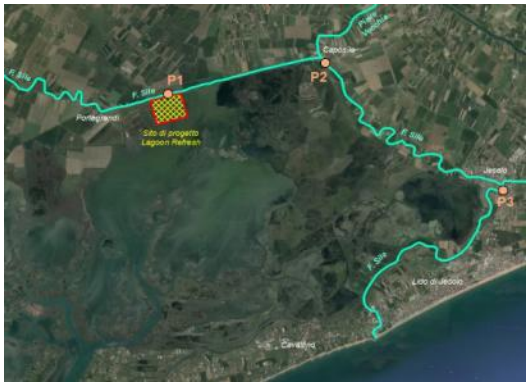
3D MODEL – EBB TIDE 15/2/2018





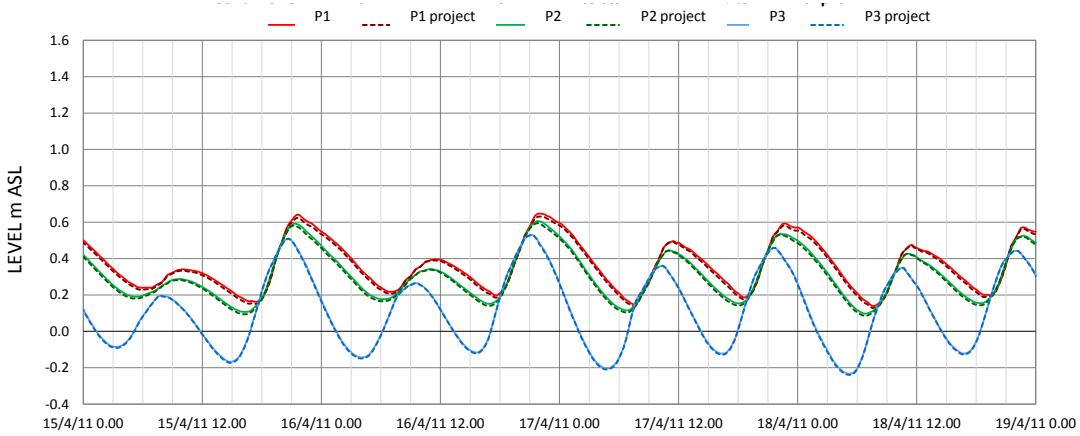
SALINE WEDGE INTRUSION ON SILE RIVER - NUMERICAL MODELLING - PROJECT EFFECTS EVALUATION

WATER LEVEL AND DISCHARGE VARIATIONS

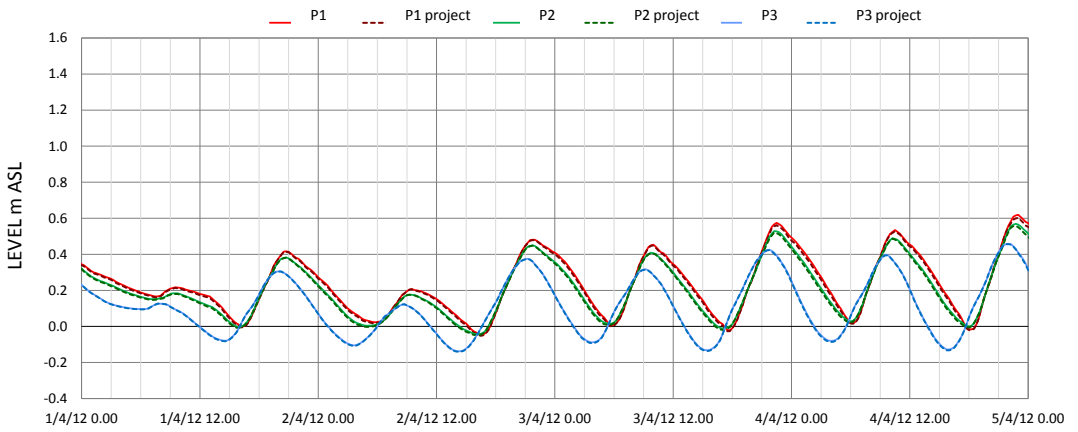


	section	Dry period	Normal period	Flood period
Level mean differences (m)	P1	0.007	0.010	0.019
	P2	0.006	0.009	0.017
	P3	0.003	0.004	0.006
Discharge mean differences (m^3s^{-1})	P1	0.8	1.0	1.6
	P2	0.8	1.0	1.5
	P3	0.6	0.7	1.0

Normal condition



Dry condition



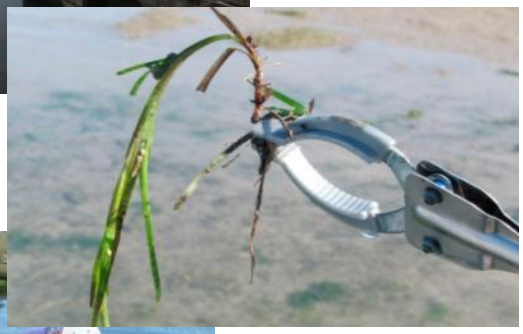
STAKEHOLDERS INVOLVEMENT – FISHERMEN AND HUNTERS - 1

WHO? FISHERMEN AND HUNTERS, WHO REGULARLY FREQUENT THE SCI IT3250031

HOW? THEY WILL BE INVOLVED IN THE **REED AND SEAGRASS TRANSPLANT ACTIONS** AFTER A TRAINING COURSE

WHY? TO GET INVOLVEMENT AND RAISE AWARENESS ON THE CONSERVATION AND RESTORATION OF HABITATS AND SPECIES

WHAT WE GET?
- ✓ CONCRETE ACTIONS
- ✓ PARTECIPATION



STAKEHOLDERS INVOLVEMENT – FISHERMEN AND HUNTERS - 2

WHO? FISHERMEN AND HUNTERS, WHO REGULARLY FREQUENT THE SCI IT3250031

HOW? THEY WILL BE INVOLVED IN THE **MONITORING ACTIVITY**

WHY? TO EVALUATE THE PROJECT IMPACT IN TERM OF CULTURAL (TRADITIONAL FISH ACTIVITY AND HUNTING) AND PROVISIONING (FISH PRODUCT) ECOSYSTEM SERVICES

WHAT WE GET?

✓ LESS SCIENTIFIC DATA BUT LARGE SCALE AND HIGER FREQUENCY IN DATA COLLECTION

✓ STAKEHOLDER POINT OF VIEW

STAKEHOLDERS INVOLVEMENT – GENERIC PUBLIC - 1

WHO? PUBBLIC WITH SOME INTEREST ON AVIFAUNA

HOW? TRAINING COURSE ON BIRDS SPECIES RECOGNITION AND PHOTOGRAFY HUNTING

WHY? TO INCREASE KNOWLEDGE OF ENVIRONMENT AND FOR INVOLVEMENT AND SHARING OF PROJECT OBJECTIVES AND RESULTS

STAKEHOLDERS INVOLVEMENT – GENERIC PUBLIC - 2

WHO? GENERIC PUBBLIC

HOW? DISSEMINATION WITH PUBBLIC EVENT, LABORATORIES, ETC.

WHY? INVOLVEMENT AND SHARING OF PROJECT OBJECTIVES AND RESULTS

CONCLUSIONS

- LIFE "LAGOON REFRESH" PROJECT AIMS TO **RECREATE THE TYPICAL OLIGO-MESOHALINE ENVIRONMENT OF ESTUARINE TYPE** AND TO **ACHIEVE RELATED ENVIRONMENTAL BENEFICIAL EFFECTS**

- **NUMERICAL MODELS WERE IMPLEMENTED AND USED**, IN DIFFERENT STAGES OF PROJECT PLANNING, **AS SUPPORTING TOOL TO**
  - → **REACH PROJECT GOALS**
  - → **VERIFY POSSIBLE IMPACTS**

- **STAKEHOLDERS WILL BE INVOLVED IN CONCRETE ACTIONS AND IN MONITORING ACTIVITIES**

- **STAKEHOLDERS WILL BE INVOLVED IN DISSEMINATION ACTIONS**

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