



VIII CLGE Conference of the European Surveyor “BLUE SURVEYING”

The Mose a technological and innovative defence system

Luciana Colle, Institutional Relation Manager for the
Extraordinary Commissioner for Mose



Sevilla (Spain) 27th October 2022 Hotel Barceló Sevilla Renacimiento



The Venice Lagoon



Venice

Lagoon

Chioggia

Chioggia inlet

Malamocco inlet

Lido inlet

Adriatic Sea



Floods / Sea storms / Erosion / Pollution

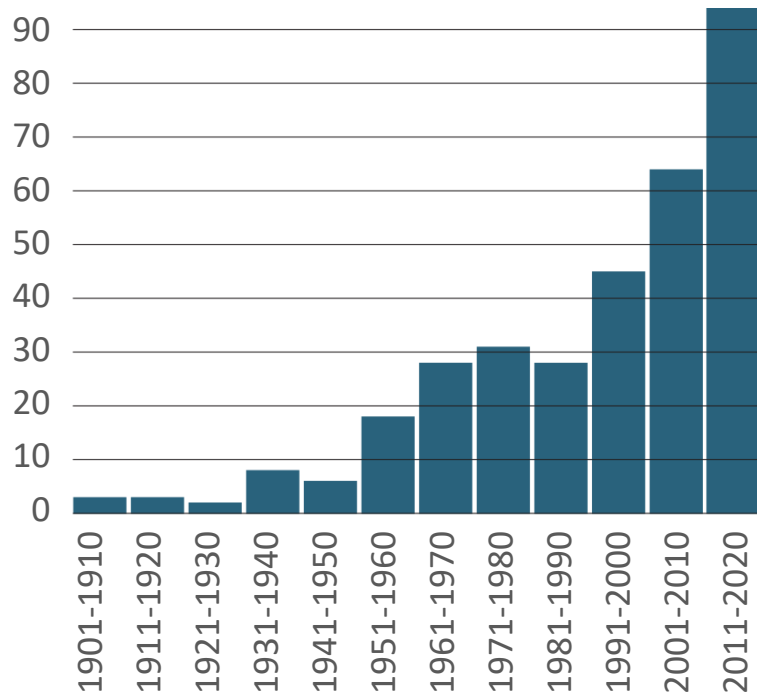
A multiplicity of problems to be addressed



The problems tackled

The floods

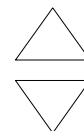
Increase in the frequency of floods ≥ 110 cm between 1901 and 2020



The ten highest floods recorded in Venice



4 November 1966	194 cm
12 November 2019	187 cm
22 December 1979	166 cm
1 February 1986	159 cm
1 December 2008	156 cm
29 October 2018 (h 14,40)	156 cm
15 November 2019	154 cm
12 November 1951	151 cm
17 November 2019	150 cm
11 November 2012	149 cm
29 October 2018 (h 20,25)	148 cm



«High Waters in Venice



4.11.1966	194 cm
12.11.2019	187 cm
22.12.1979	166 cm
1.2.1986	159 cm
1.12.2008	156 cm
*29.10.2018	156 cm
15.11.2019	154 cm
12.11.1951	151 cm
17.11.2019	150 cm
11.11.2012	149 cm
*29.10.2018	148 cm

Flood
12 november 2019



187 cm



The Mose defence system

An integrated solution for a complex environment

Environmental protection



Improved environmental resilience



Protection from floods
Urban defence



Management and maintenance



Protection from floods
The Mose barriers



Protection from sea storms



The Venice lagoon defence measures

What has been done

Reinforcement of the coastal littoral

56 km of reconstructed and protected beaches

12 km of restored and naturalized coastal dunes

11 Km of reinforced breakwaters

Urban local defence

100 km of urban and lagoon embankments raised and reinforced

Environmental protection

40 km of industrial canal banks secured

7 former dumps secured

39 hectares of phytobiopurification areas recreated

Improvement of the environmental resilience

39 km of protected salt marshes

12 minor islands recuperated

16 km² of reconstructed and naturalized salt marshes



Protection from sea storms

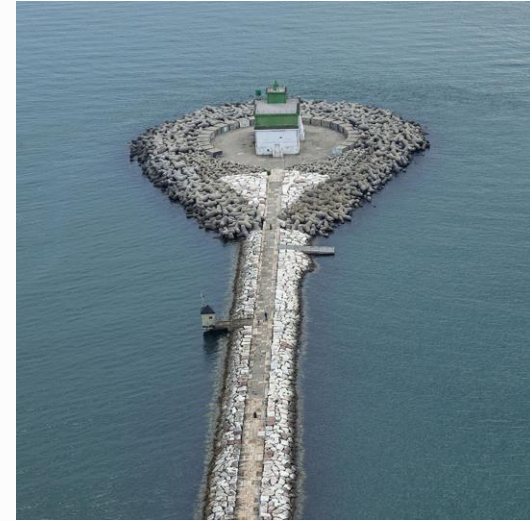
What has been done



56 km
of reconstructed
and protected beaches



12 km
of restored and naturalized
coastal dunes

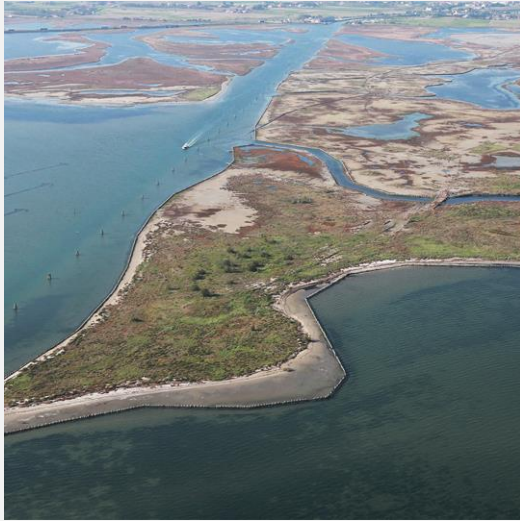


11 km
of reinforced
breakwaters



Improved environmental resilience

What has been done



16 km²
of reconstructed
and naturalized salt
marshes



39 km
of protected
salt marshes



12
minor islands
recuperated



Environmental protection

What has been done



40 km
of industrial canal banks
secured



7
former dumps
secured



39 hectares
of phytobiopurification areas
recreated



Urban defence and improvement

What has been done



100 km
of urban and lagoon embankments
raised and reinforced



Mobile barriers

Work progress

4 rows of floodgates

(Lido Nord 420 m; Lido Sud 400 m; Malamocco 380 m; Chioggia 360 m)

1,6 km total extension of the barriers

78 floodgates in total

(Lido Nord 21 floodgates; Lido Sud 20 floodgates; Malamocco 19 floodgates; Chioggia 18 floodgates)

Work progress 97%



Mobile barriers

A flexible answer to constraints, addresses, design criteria

The defense barriers from the “high water” are the core of the Mose system. These are **extremely complex** works that have responded in terms of **innovation** and high **technology** to the constraints imposed by a territory of great historical and environmental value and to a series of **guidelines and design criteria**:



The high water defense system should not introduce significant changes in the **water exchanges** at the lagoon inlets; it should not interfere with the **landscape**; it should not interfere with the **Port economic activities**.

When the barriers are not in function they are totally invisible in the seabed.



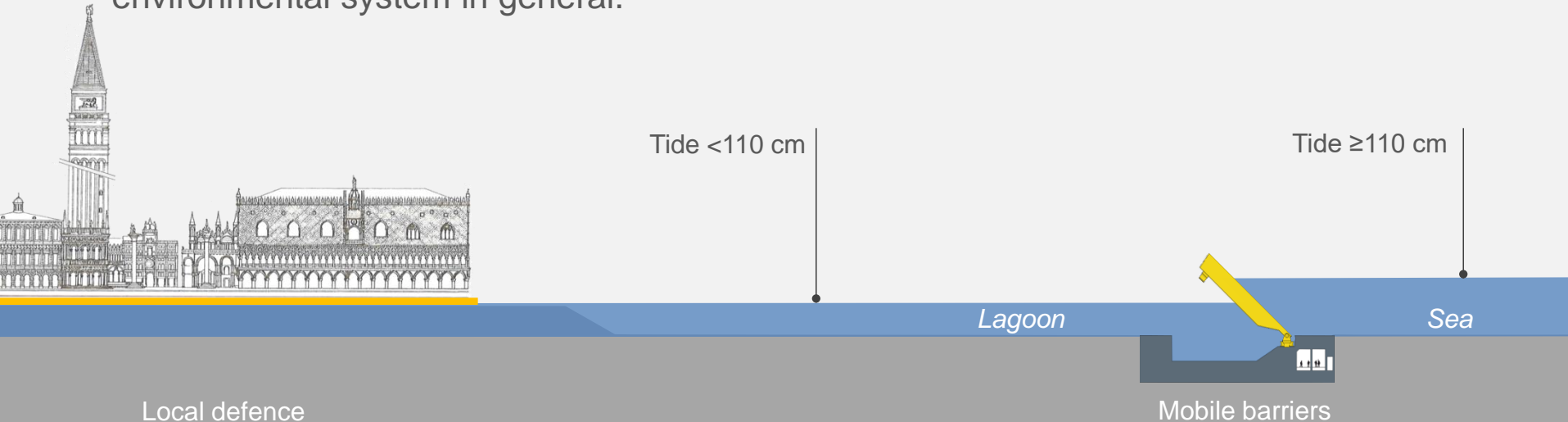
An integrated defense from high waters

Mobile barriers at the inlets / "local defense" interventions



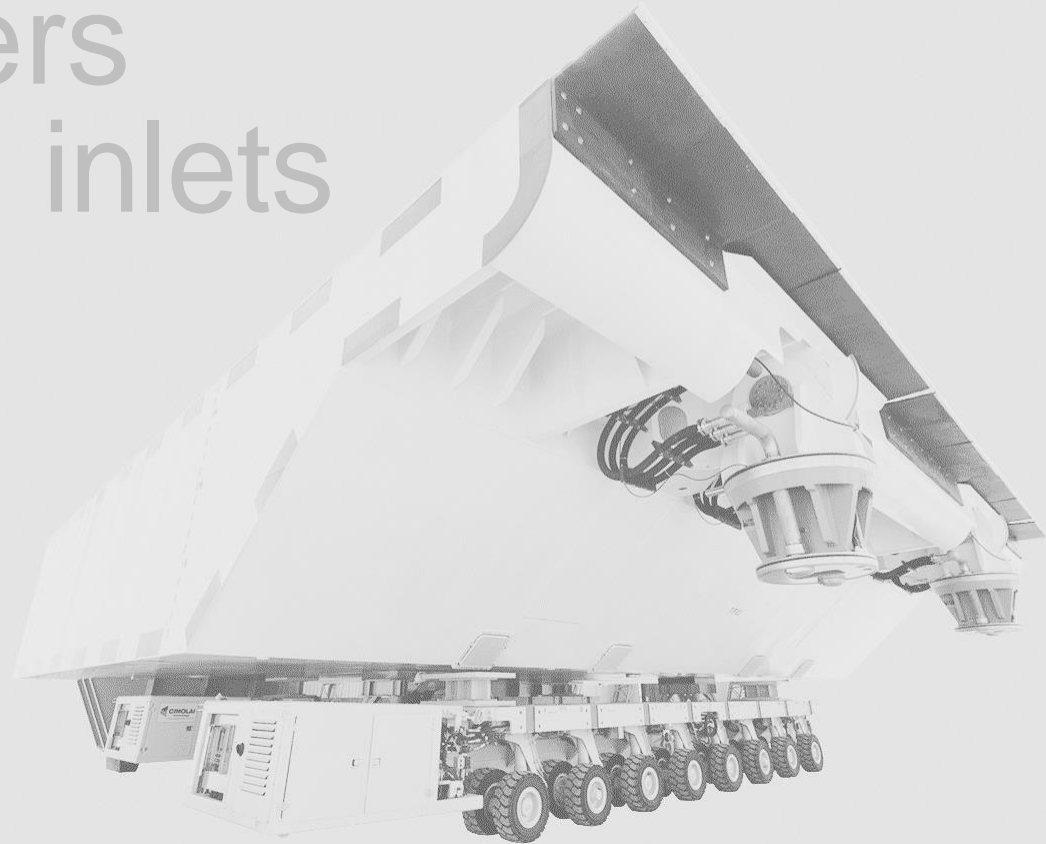
The implemented solution consists of an integrated system of works that includes **mobile barriers**, for tides ≥ 110 cm, and widespread interventions of "**local defense**" in the historic lagoon centers, for tides < 110 cm.

This strategy allows to reduce the raising of barriers, limiting interference with port activities and reducing the effects on sea / lagoon water exchanges and on the environmental system in general.



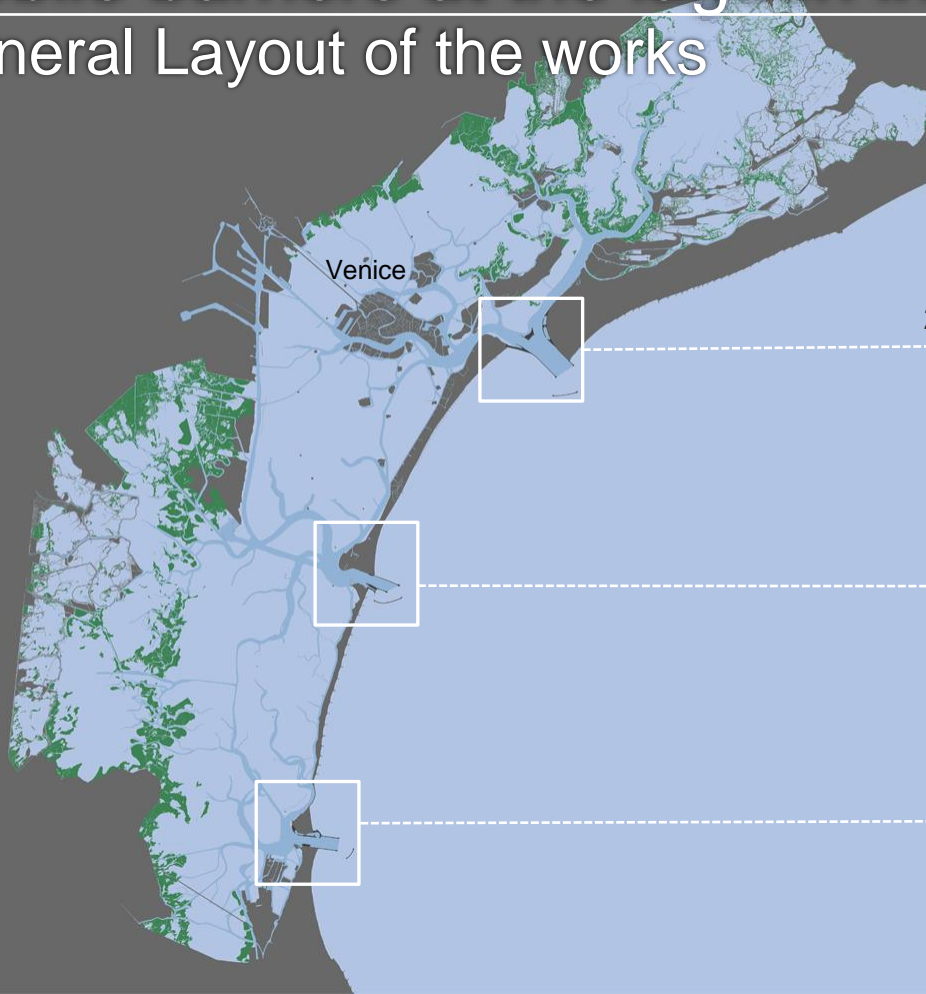
Mobile barriers
at the lagoon inlets

Generale layout



Mobile barriers at the lagoon inlets

General Layout of the works



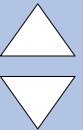
Lido Inlet
2 barrier (41 gates)



Malamocco Inlet
1 barrier (19 gates)



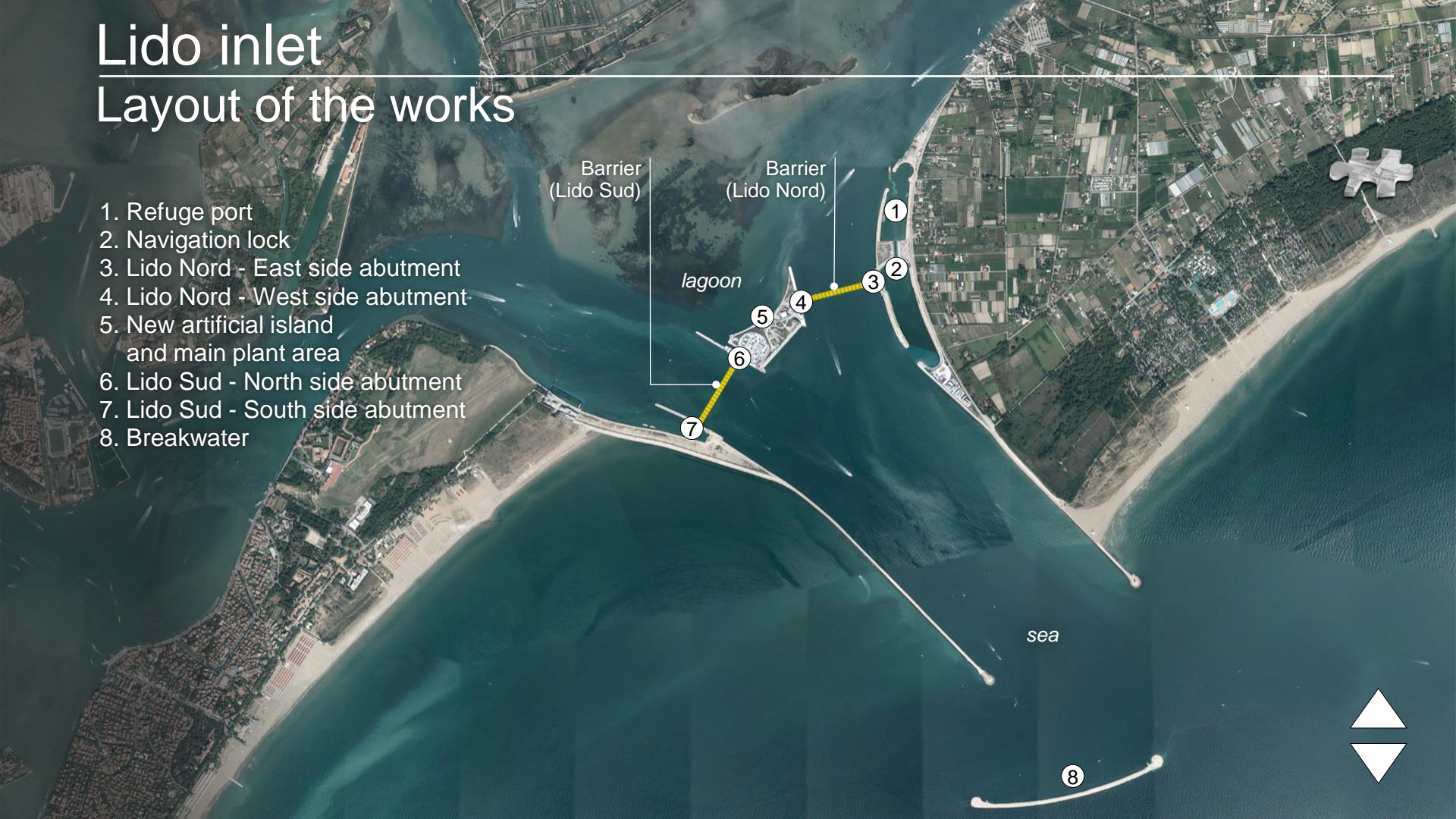
Chioggia Inlet
1 barrier (18 gates)



Lido inlet

Layout of the works

1. Refuge port
2. Navigation lock
3. Lido Nord - East side abutment
4. Lido Nord - West side abutment
5. New artificial island and main plant area
6. Lido Sud - North side abutment
7. Lido Sud - South side abutment
8. Breakwater



Malamocco inlet

Layout of the works

1. North side abutment
2. South side abutment and main plant area
3. Navigation lock
4. Temporary work area
5. Breakwater

lagoon

Barrier

sea



Chioggia inlet

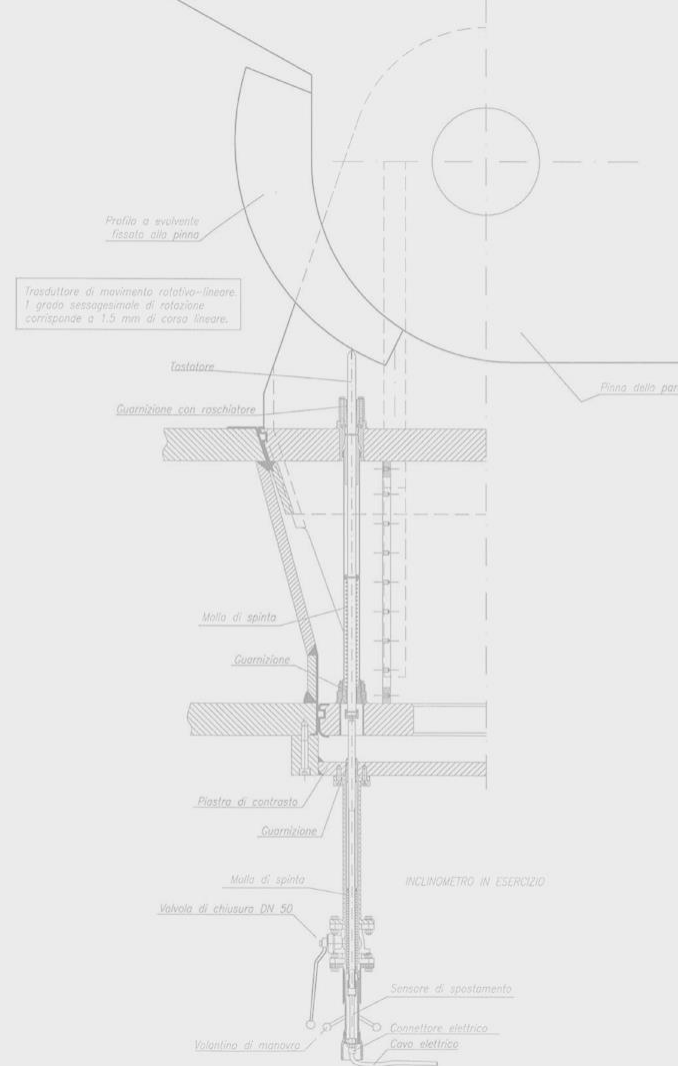
Layout of the works

1. Refuge port
2. Navigation locks
3. North side abutment
4. South side abutment
5. Main plant area
6. Breakwater



Mobile barriers at the lagoon inlets

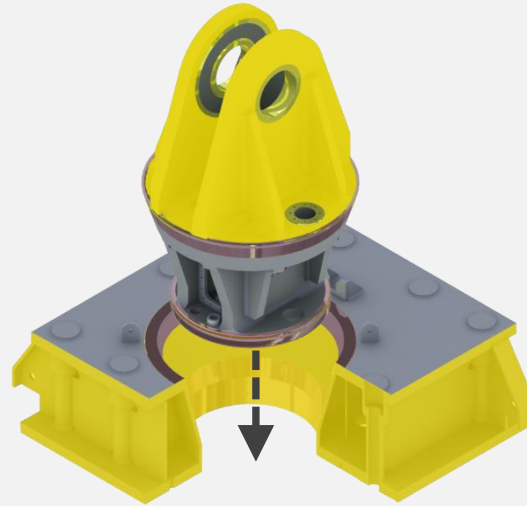
Main components of the system



Main components of the system



Gate housing caisson
and abutment caisson



Hinges



Floodgates



Main components of the system

Gate housing caissons. Construction



Malamocco

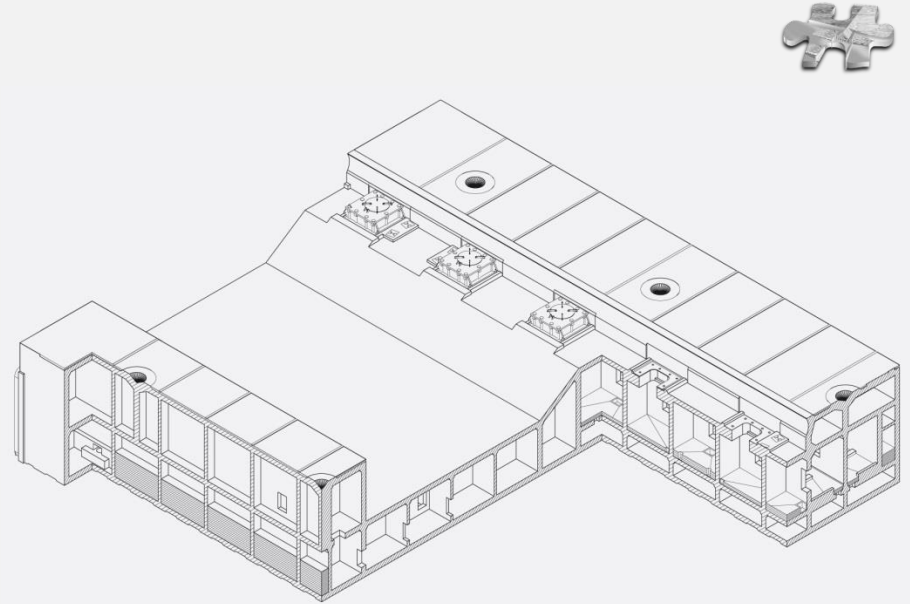
Gate housing caissons:
w. 59 m / l. 48 m / h. 11,5 m

Abutment caissons:
w. 24 m / l. 63 m / h. 28 m



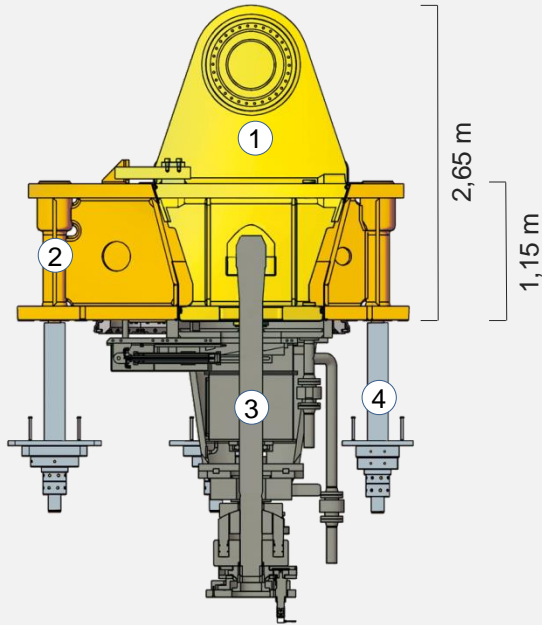
Main components of the system

Gate housing caissons

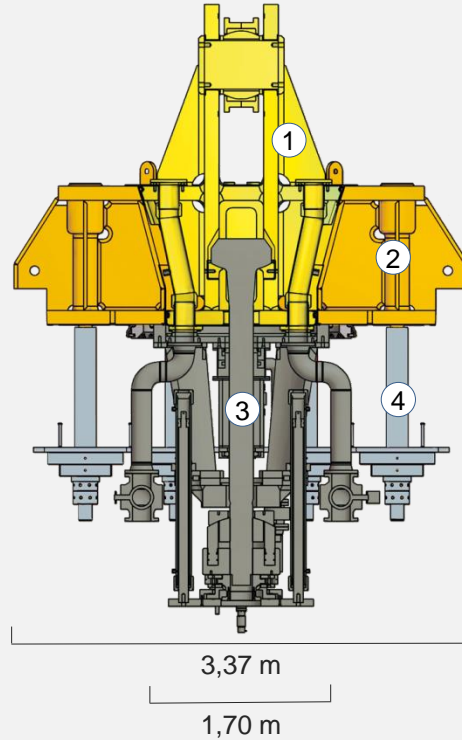


Main components of the system

Hinges



Cross section



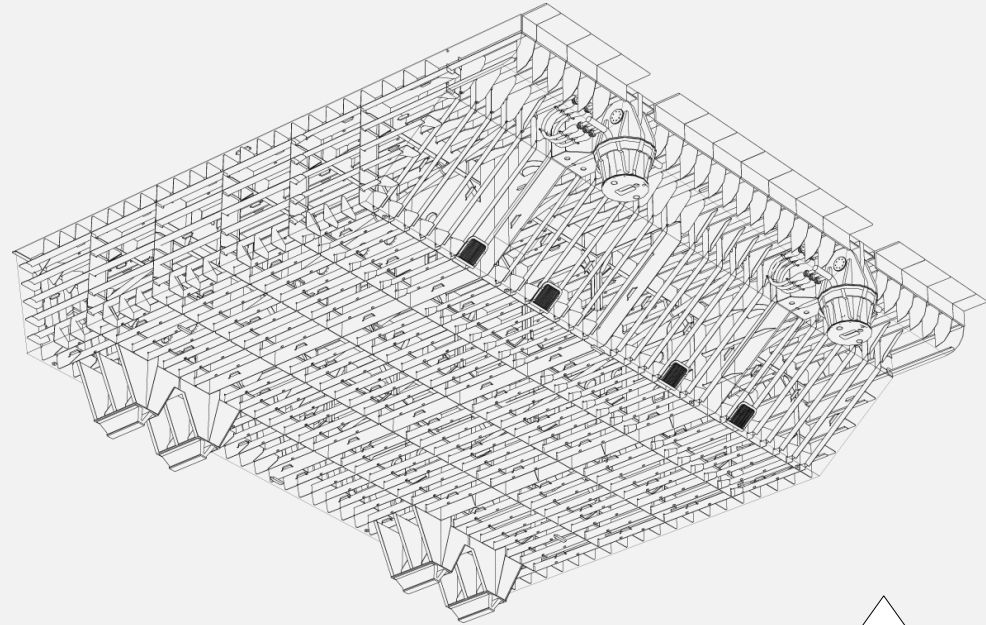
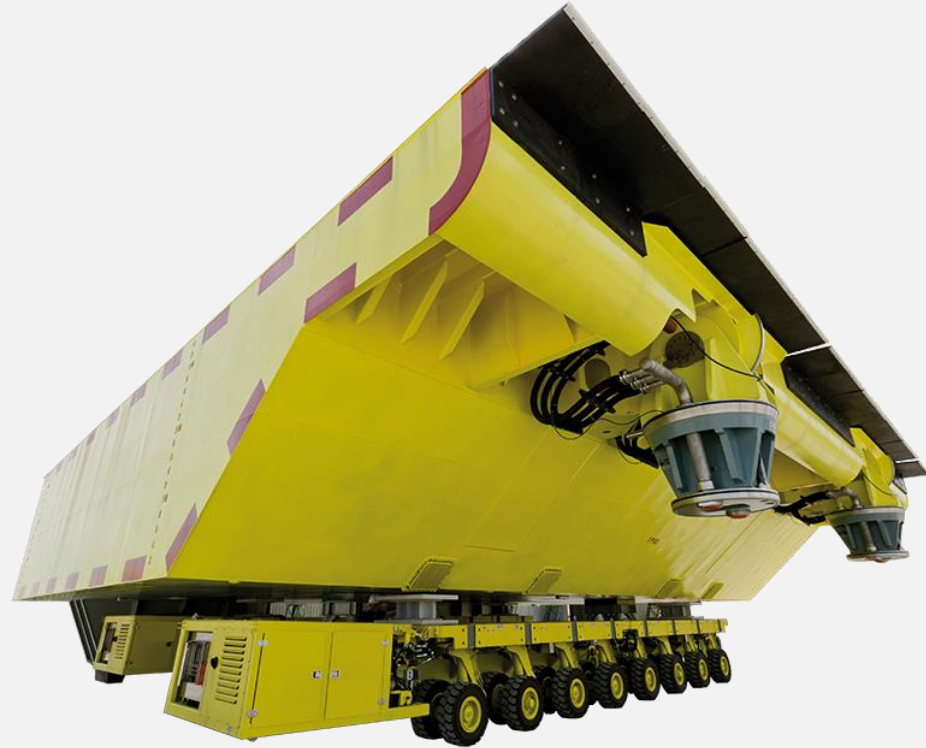
Longitudinal section

- ① **Male element**
(hooked to the floodgate)
- ② **Female element** (jointed to the housing caisson)
- ③ **Coupling group**
(for the connection between the male and the female element of the hinge)
- ④ **Anchor bars**
(to link the female element to the caisson)



Main components of the system

Floodgates



Main components of the system

Floodgates



Main components of the system

Floodgates. Installation – Jack up

Lido sud barrier



Plant areas

Example (Lido inlet)



Electromechanical plant system



Main plants

- Pneumatic system (process air)
- Compressor cooling water system
- Electrical system and generators
- Control system

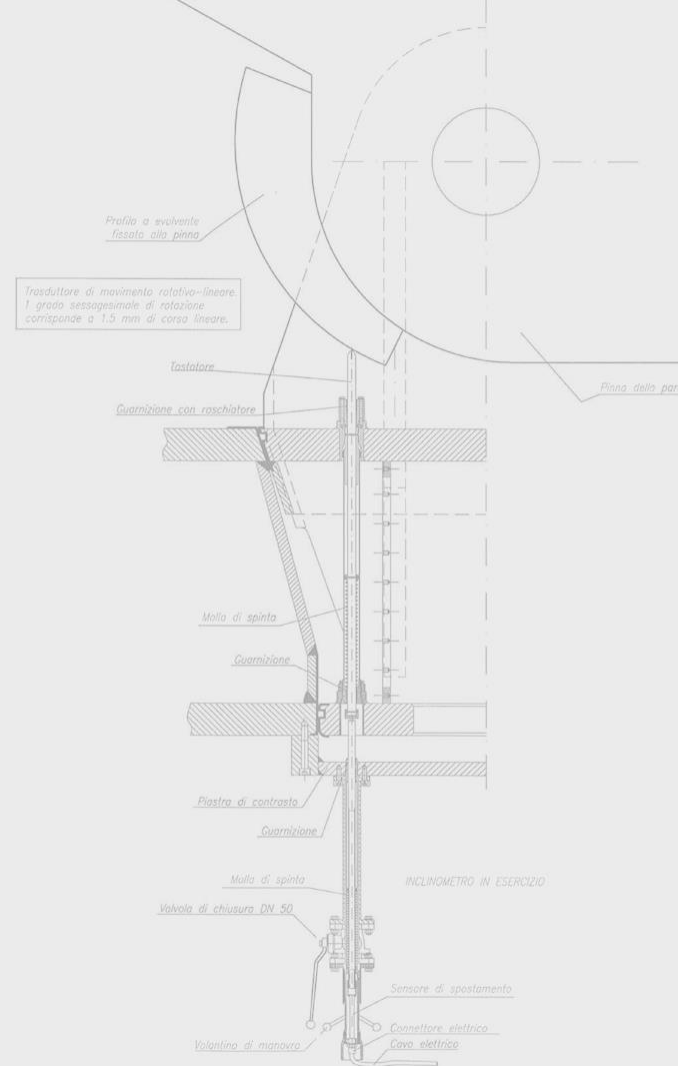
Auxiliary system

- HVAC system (ventilation and air conditioning)
- Flushing system (washing lines and hinges)
- Diesel system (serving the generators)
- Special fire-fighting system
- Fire detection and extinguishing
- Other



Mobile barriers at the lagoon inlets

How do they work



Mobile barriers

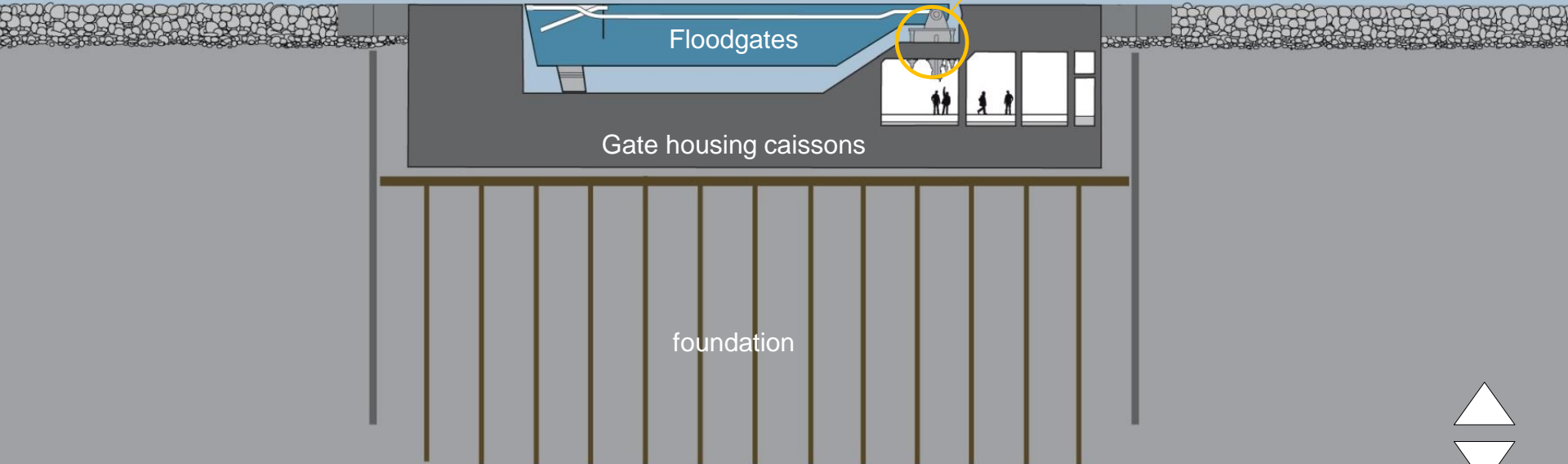
How do they work



< Lagoon

Hinge

Sea >



foundation

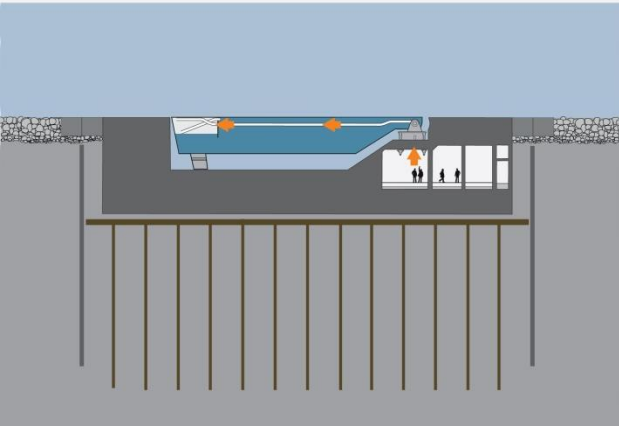


Mobile barriers

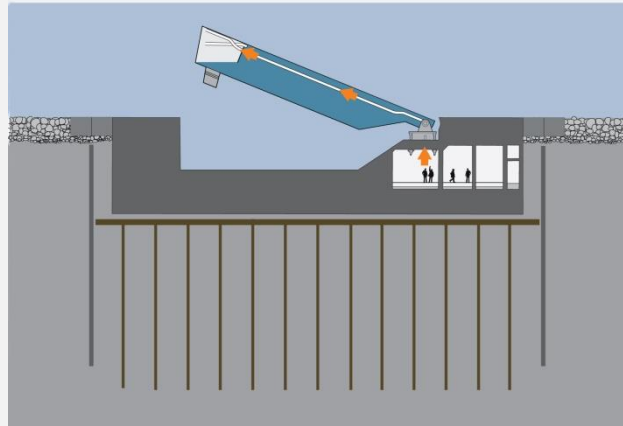
How do they work



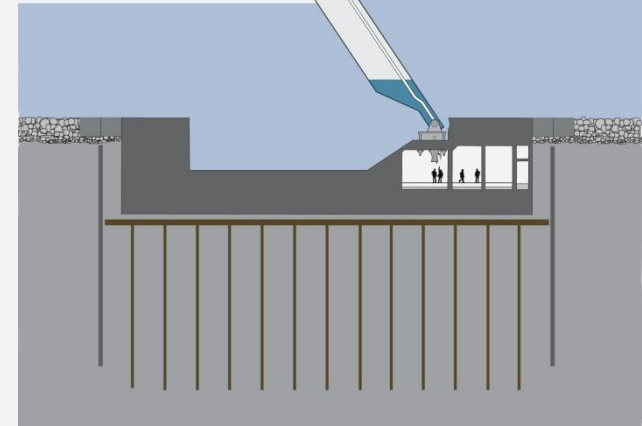
Immission of compressed air
And expulsion of water



Starting of the raising operations



Raising of the gates to the emerge position

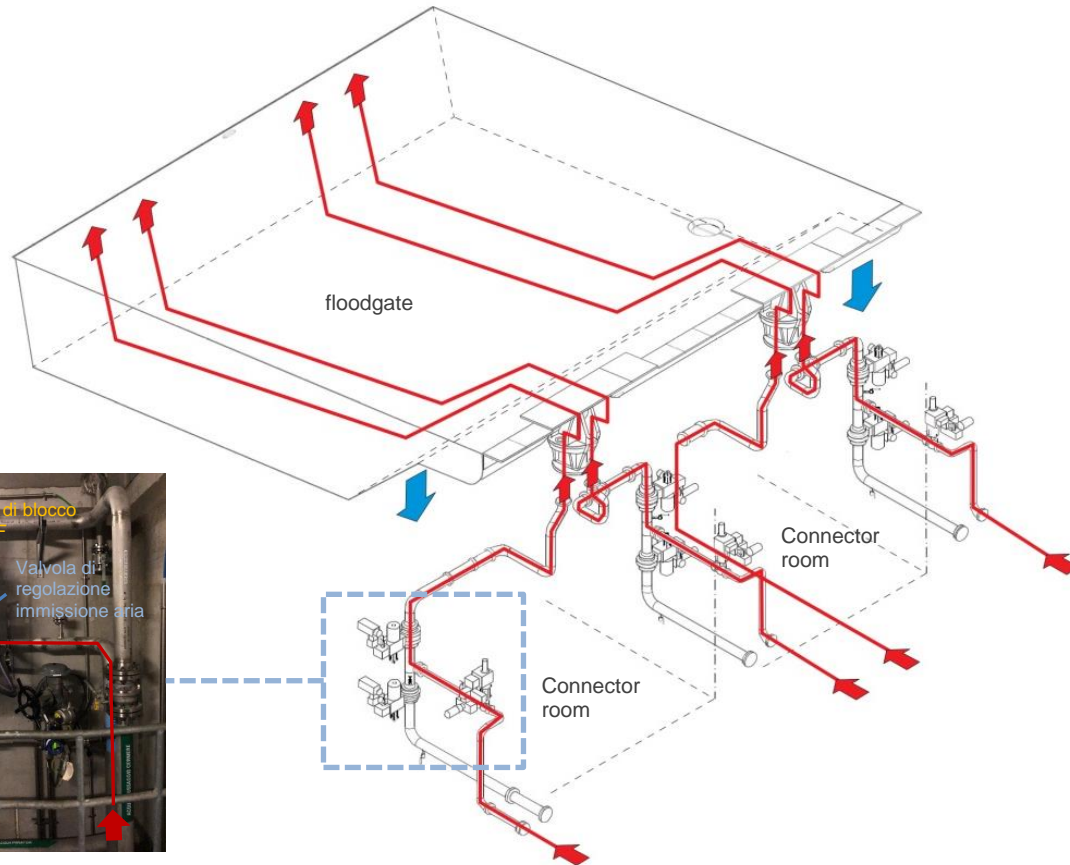


Working position and tide tracking

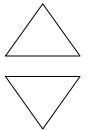
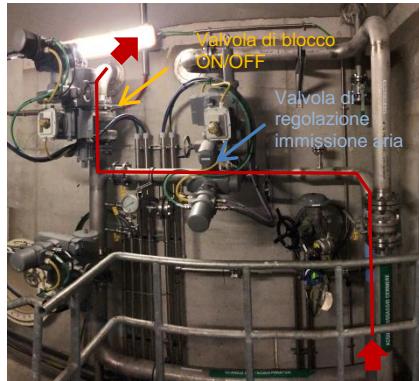


Mobile barriers

Pneumatic system



- ↑ Air inlet
- ↓ Water outlet



An aerial photograph showing a long, narrow mobile barrier structure extending from the right side of the frame towards the center. The barrier is composed of several parallel concrete or metal panels. The water on either side of the barrier is a light, rippled grey. The text is overlaid on the left side of the image.

Mobile barrier
at the lagoon inlet
Barriers raising

Procedures for raising the barriers

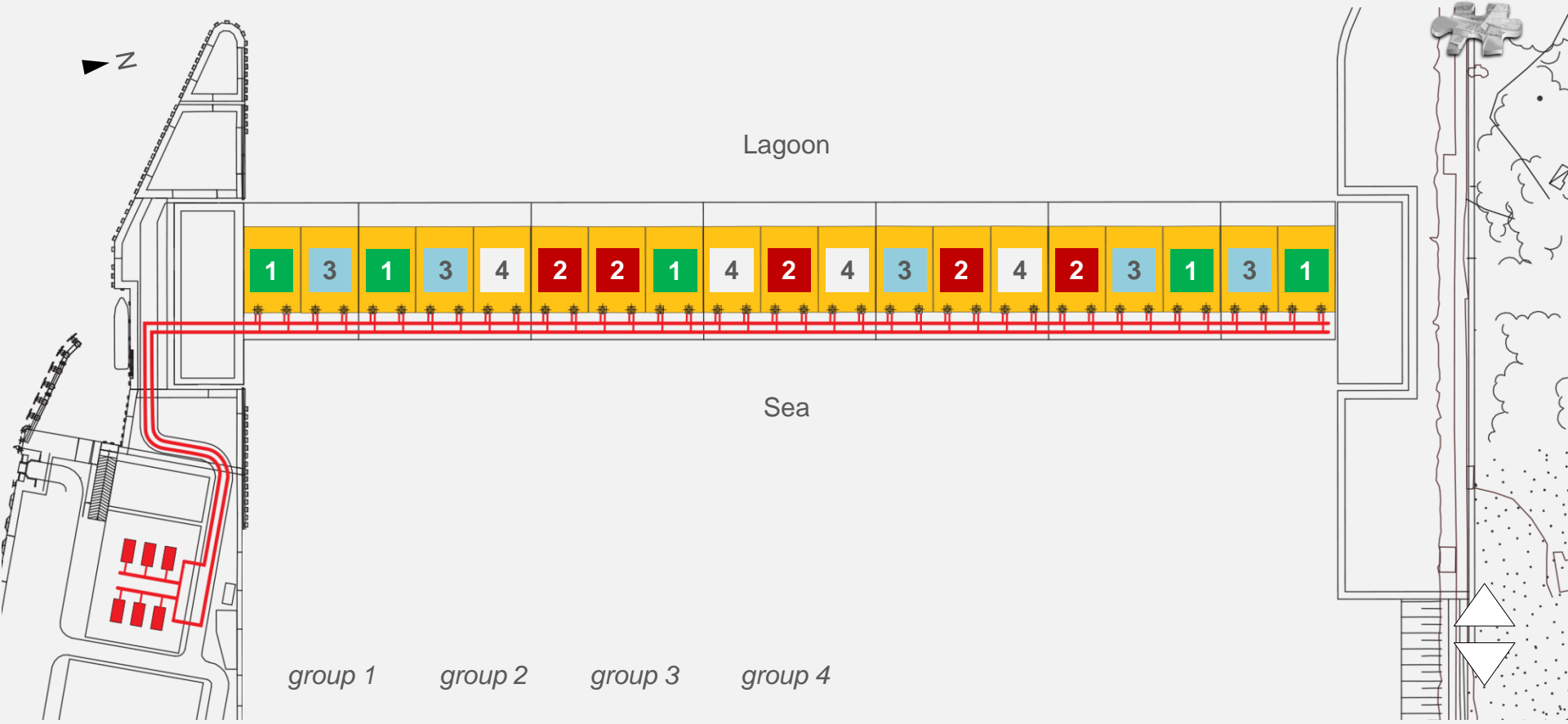
Example of the Malamocco barrier

- Start of raising operations and emerging of the floodgates per groups
- Raising of the floodgates from the emerge position to the working position
- Maintaining the working position (tide tracking)
- Lowering of the floodgates from the working position to the emerge position
- Lowering of the floodgates from the emerge to the recess position
- Return of the floodgates in the recesses, completion of air emptying
- Final activities



Mobile barriers

Raising of the floodgates (Malamocco)



Functional tests

Barriers raisings partial or complete



Lido



Malamocco



Chioggia



Barrier raisings to defend from high water (33 events)

Lido



Barrier raisings to defend from high water (33 events)

Malamocco



Barrier raisings to defend from high water (33 events)

Chioggia



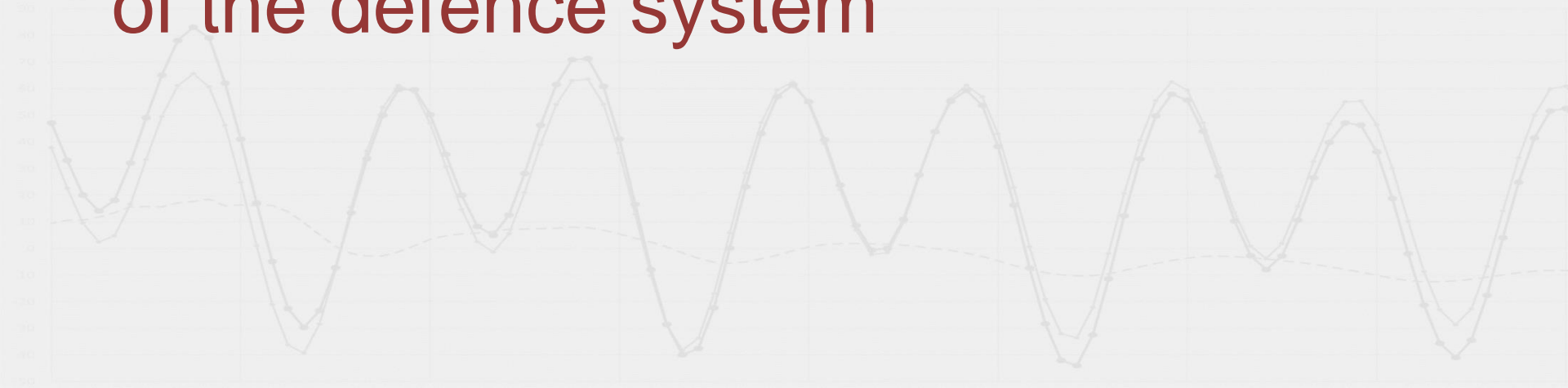
Barrier raisings to defend from high water (33 events)

Lido. Control Room



Mobile barriers at the lagoon inlets

Management of the defence system



Management of the defence system

Operational and decision making room. Main activities



- Measurements and forecasts of meteorological and hydronimic parameters
- Monitoring of environmental components
- Monitoring of port activity and nautical traffic
- Definition of the methods of operation of the barriers based on the characteristics of the individual tidal events;
- Issue of the order to maneuver the barriers;
- Communications with the competent bodies



Management of the defence system

Operational and decision making room (back up, operationally)

Venice
Northern Arsenale area.





The MOSE system. Resulted achieved

- **Venice protected** from floods and from negative effects of climate change;
- Improvement in the **quality of the environment** and increase in the **biodiversity** of the ecosystem;
- Development of a vast system of **multi-disciplinary knowledge** and expertise;
- Venice the owner of top-level know-how, can become a **reference for other countries** facing sea level rise;
- An example of synergistic and olistic approach to **manage a complex ecosystem**;
- Great **flexibility of the system** thanks to possibility to operate also with partial and differentiated raising of the barriers.

