Storm Surge Induced Flooding

Introduction

- What is storm surge
- What happened during Hurricane Katrina

http://www.pbs.org/wgbh/nova/sciencenow/dispatches/images/050901-katrina2-l.jpg

What is a Storm Surge?

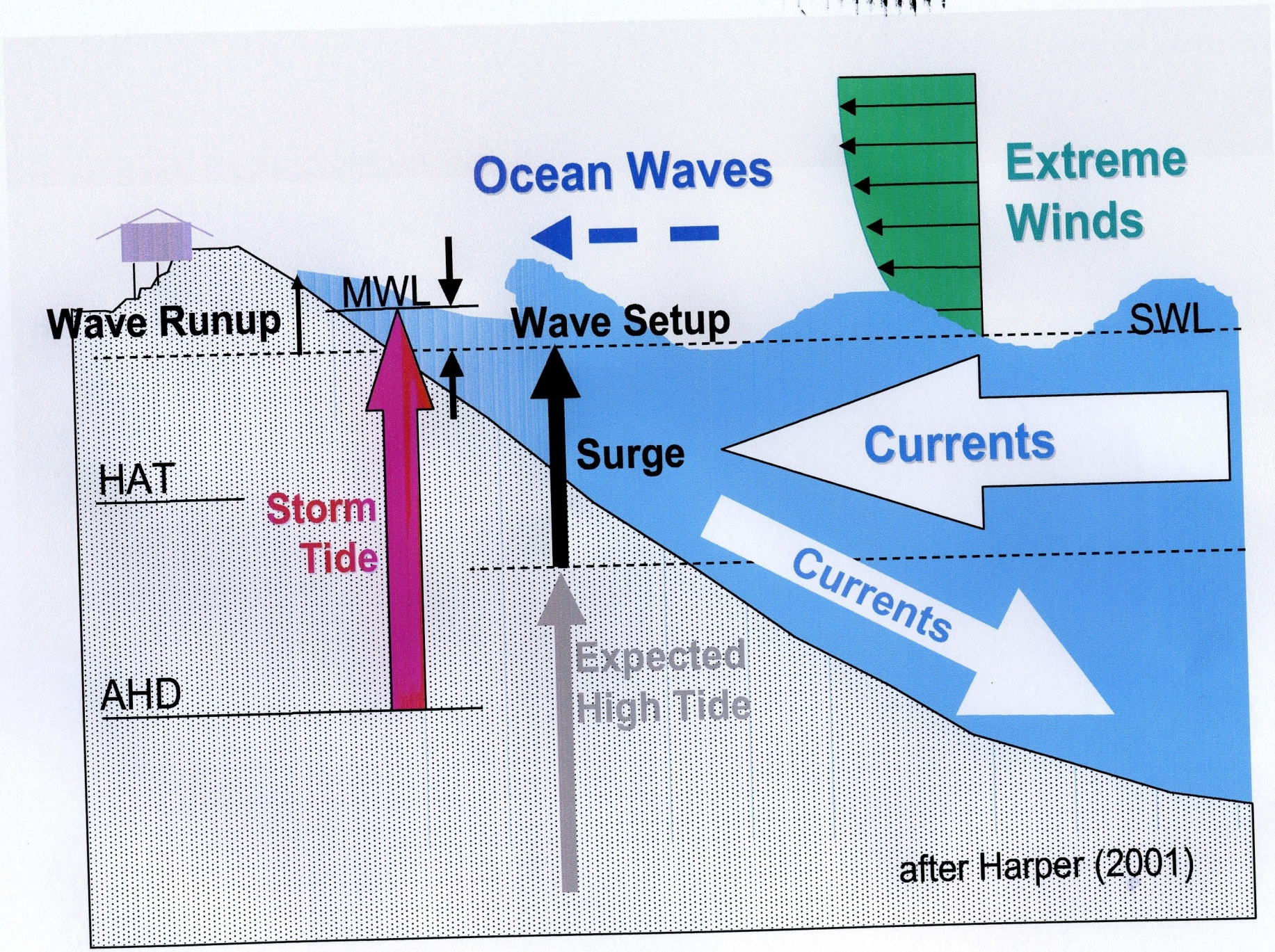
- “Meteorological Residual”
- Most dangerous phenomenon associated with hurricanes
- Accounts for 70-90% of death & damage

What is Storm Surge?

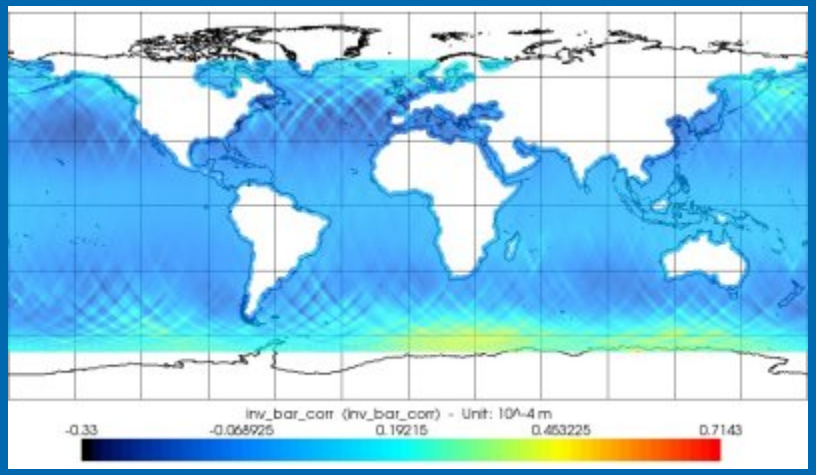
- Large change in sea level
- Generated by extreme weather conditions
- “Mound” of water driven toward shore by storm
- Waves on top of surge devastate area
  - Water weighs 1000 kg/m^3 – Immense potentially destructive power

Background

- General Factors Contribute to Storm Surge
  - Storm Winds
  - Wave Run-Up
  - Low Pressure inside the storm
  - Astronomical Tides
- Local Factors
  - Slope of Continental Shelf
  - Shape of Coastline
  - Elevation relative to sea level


Ocean Waves
Extreme Winds
Wave Runup
MWL
Wave Setup
SWL
Surge
Currents
HAT
Storm Tide
Currents
Expected High Tide
AHD
after Harper (2001)

The Inverse Barometer (IB) is the correction for variations in sea surface height due to atmospheric pressure variations (atmospheric loading). It can reach about ±15 cm and it is calculated from meteorological models.

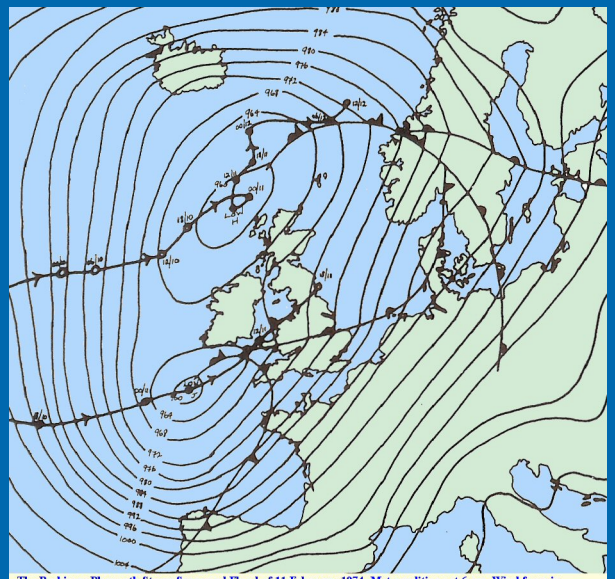


Amplitude in metres of Inverse Barometer correction computed from ECMWF atmospheric pressures during the Jason-1 cycle 223. This map is drawn using the Basic Radar Altimetry Toolbox from the Jason-1 GDR products. A Loess filter (value of 20) is applied to obtain a fully coloured plot but it makes some artificial data on coastal areas.

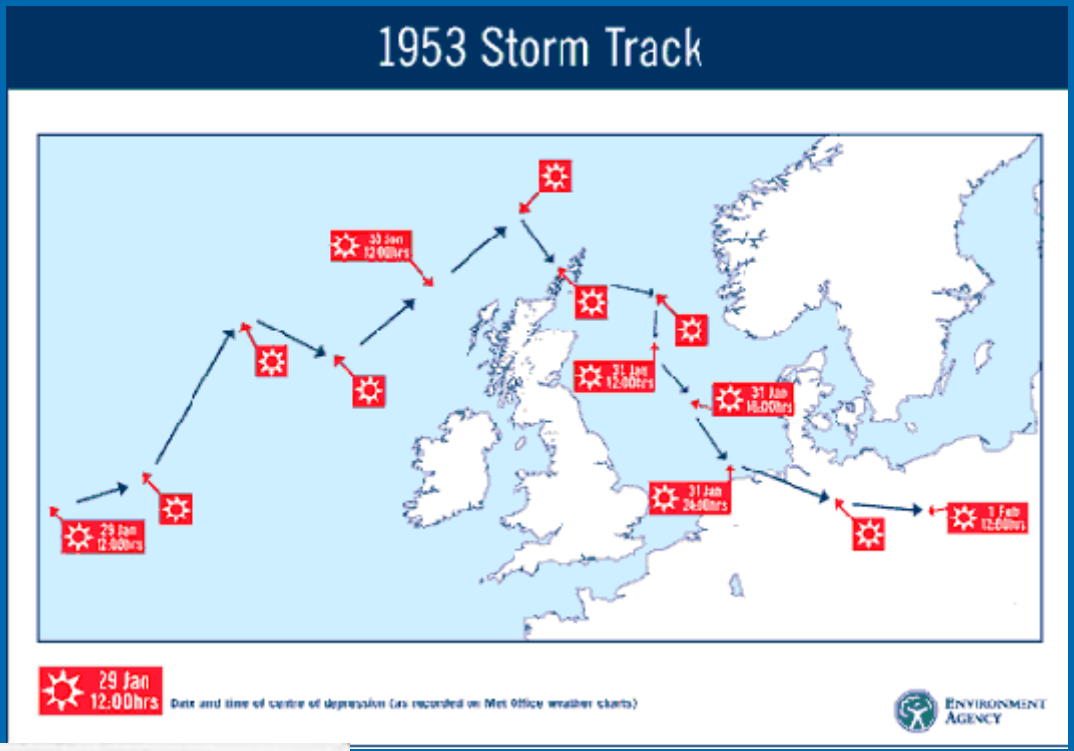
The response of the sea surface to changes in atmospheric pressure has a large effect on measured surface height. The simplest form for this correction is a purely local response of the sea surface to atmospheric pressure at the measurement point. The inverse barometer correction can be easily computed from the dry troposphere correction, by first computing sea level pressure Po:

IB (mm) = -9.948 * (ΔRdry (mbars) - 1013.3) [from Aviso and PoDaac User Handbook - IGDR and GDR Jason-1 Product, 2008].

At a 1 mbar atmospheric pressure change corresponds to a linear response of the sea level about 1 cm.



The Barbican, Plymouth Storm Surge and Flood of 11 February, 1974. Met conditions at 6 am. Wind force in SW England - 8 gale, backed from SW to S, before veering. Storm surge 0.8 metres over and above high water. Approximate model for 1824? *Modified after George and Thomas (1976). Ian West and Tonya West (c) 2005.*



In November 1966 pounding rain and an exceptional wind-swept tide flooded nearly all the city streets for 24 hours. The storm focused world attention on Venice. The reason? Venice had 'sunk'

Who decides in fact what to do

After a long trip a new organisation was constituted: the Consorzio Venezia Nuovo (the New Venice Consortium). The Italian government set up the Consortium 20 years ago as an 'exclusive concessionaire', with a mandate to safeguard Venice, and unite private and state-owned companies vying for what promised to be fat public works contracts to protect the city.

As exclusive concessionaire the consortium holds a monopoly on state-funded work to 'save' Venice and protect its lagoon. This covers everything from strategic planning to research, project design and construction. And since 1984 the Italian government has provided the consortium with € 3.2 million to study the lagoon's ecology and hydrology, rebuild sea walls along the lagoon's barrier islands, restore salt marshes and much more besides. All without any competitive bidding.

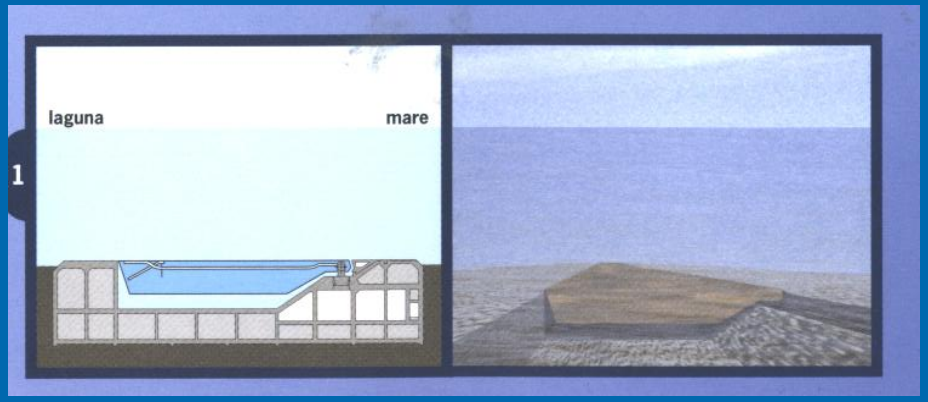
Behind the consortium (holding 40 per cent of its shares), is Impregilo spa – a Milan-based construction giant that builds dams, highways and power plants in over 40 countries.

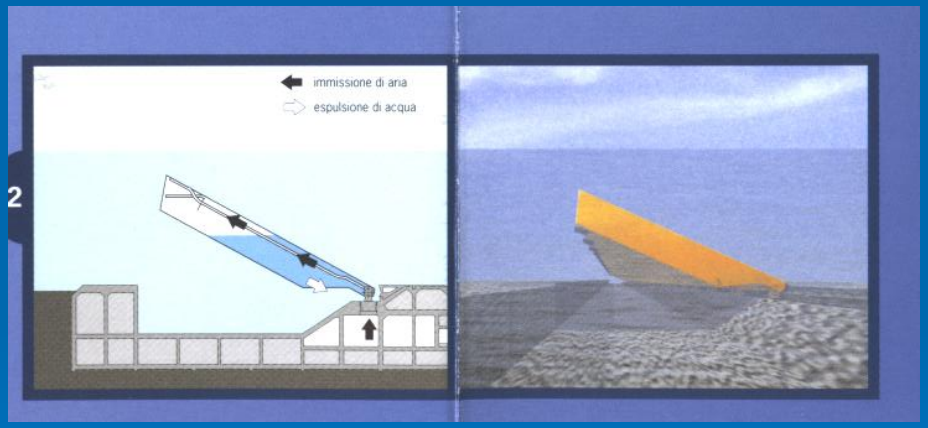
This images are taken from a dépliant of Consorzio Venezia Nuova

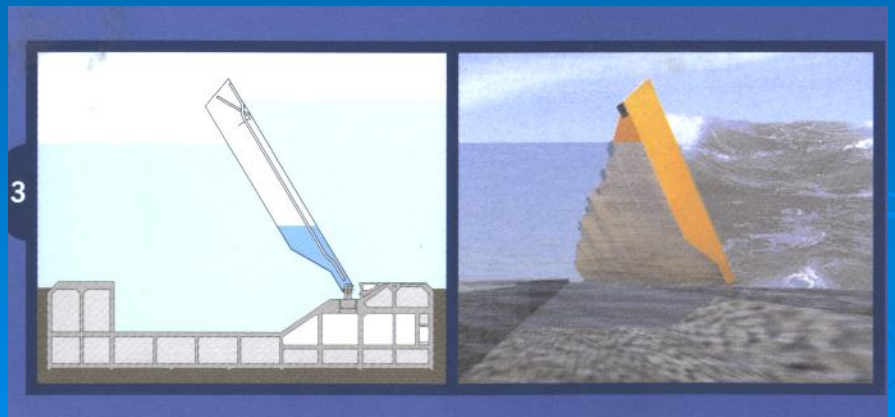
On the left you see the Lagoon of Venice and the three outlkets, where sea water and lagoon water exchange every 6 hours.

On the right the works prewiew in the three outlets

Il sistema del Mo.S.E.

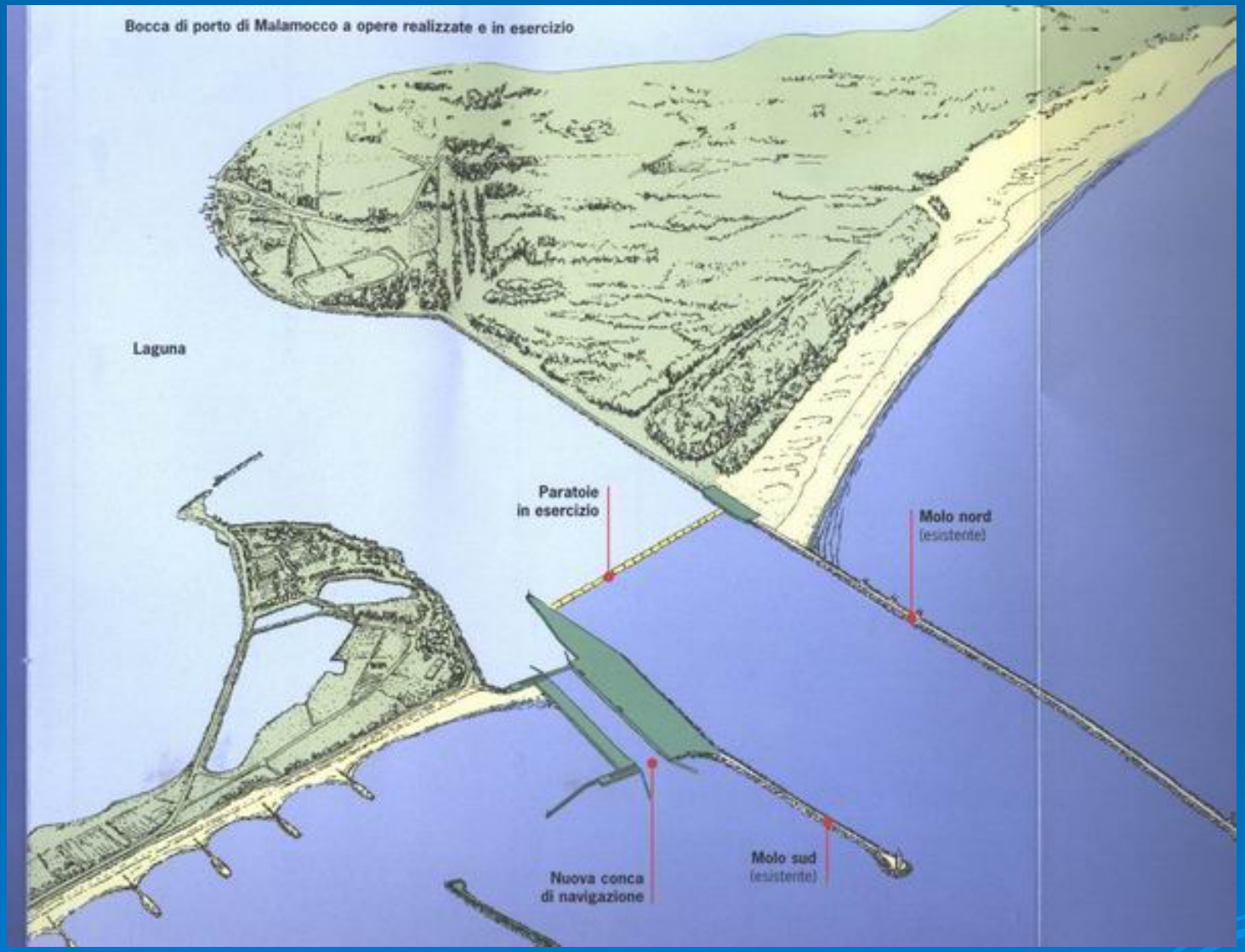






To stop the flooding, Consorzio Venezia Nuovo (the New Venice Consortium) has proposed a gigantic dam system: a line of 78 huge metal containers – each at least 20 by 20 meters in size – nestled in underwater foundations stretching across the three inlets between the Adriatic and the lagoon (each inlet is up to half a kilometer wide). For most of the time the hollow containers would be filled with water. To stop a storm surge from the Adriatic, air would be pumped into the containers – causing them to rise like enormous teeth across the inlets.

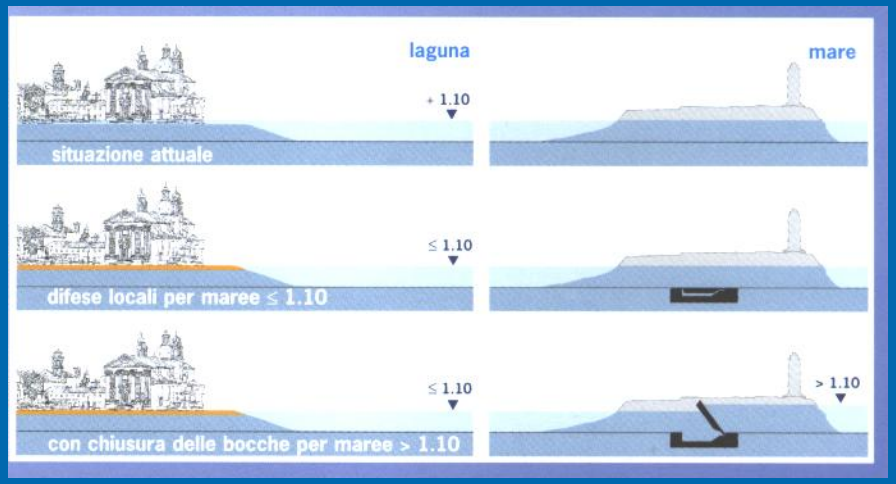
You see the elements in the three standard positions



Si osservi, a partire da sinistra, la nuova conca di navigazione, che dovrebbe consentire l'accesso alle navi quando le paratie sono sollevate (in giallo)

Look yhe big works in the inlets in the central part of the lagoon, leading to the Oil Cjannel

Schemes



I tre schemi illustrano tre situazioni differenti in relazione a diverse situazioni del dislivello tra altezza dell'acqua e quota del suolo. L'altezza esprime il livello raggiunto dalla mariea rispetto alla media (livello medio mare = l.m.m.). I pavimenti di Venezia variano da un'altezza di circa 60 cm (la zona di Piazza San Marco) a quasi 200 cm.

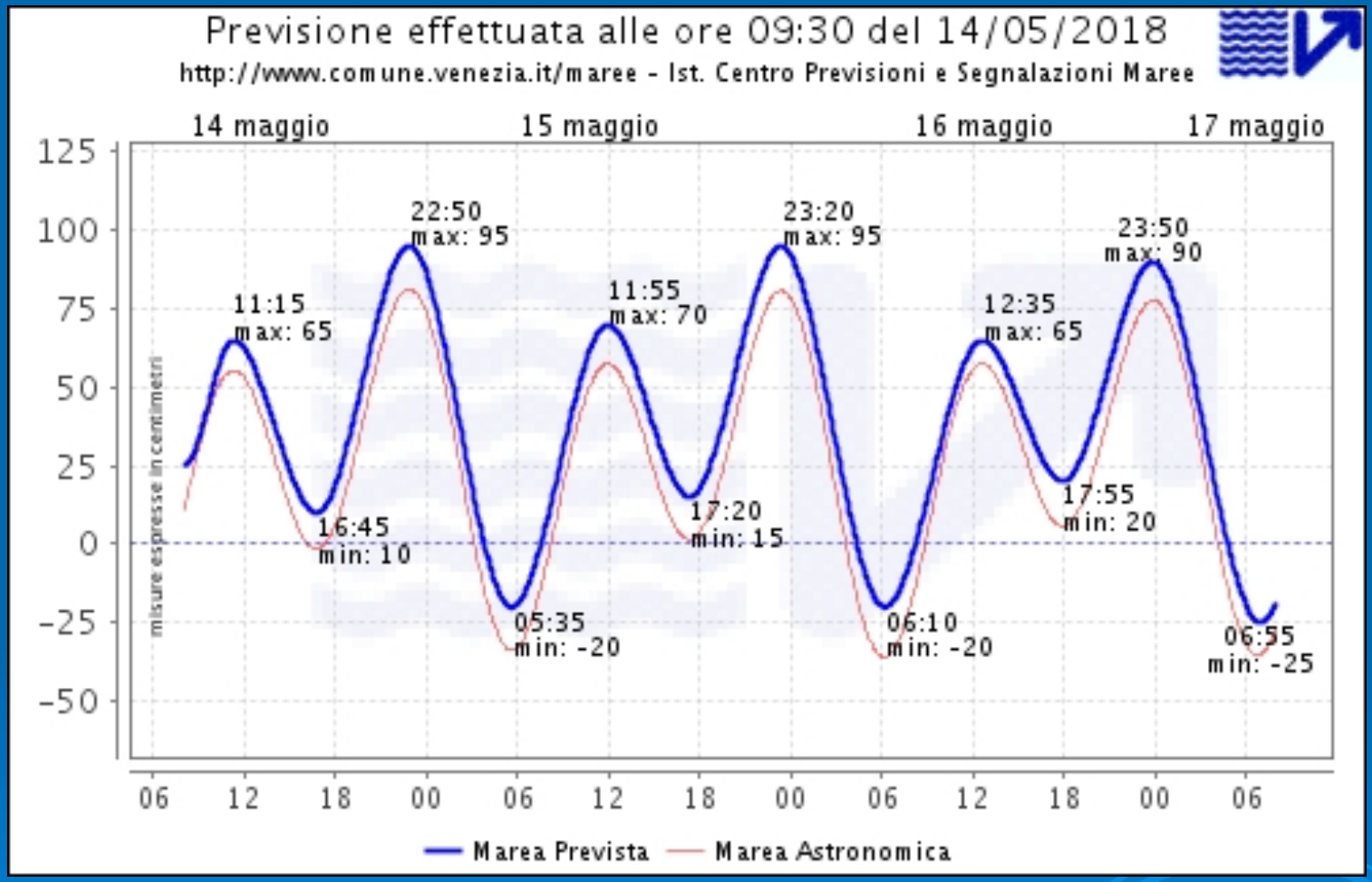
Il progetto complessivo prevede che tutto il suolo pubblico venga gradualmente portato ad almeno 110 cm sul l.m.m. (ma prevalentemente a cm. 130). La chiusura delle Bocche di porto dovrebbe avvenire quando l marea supera questo livello.

I 10 più alti livelli dal 1920:

11.2002: 147
11.2000: 144
12.1992: 142
02.1986: 159
11.1979: 166
01.1979: 140
11.1968: 144
11.1966: 194
10.1960: 145
11.1951: 151

Le fasi della marea sono di sei ore: quindi due volte al giorno l'acqua "entra" e altrettanto "esce".

Le acque alte superiori a 110 cm sono state, nell'ultimo mezzo secolo, da meno di 20 a più di 50 all'anno.


Previsione effettuata alle ore 09:30 del 14/05/2018
http://www.comune.venezia.it/maree - Ist. Centro Previsioni e Segnalazioni Maree
14 maggio
15 maggio
16 maggio
17 maggio
125
100
75
50
25
0
-25
-50
misure espresse in centimetri
11:15
max: 65
16:45
min: 10
22:50
max: 95
05:35
min: -20
11:55
max: 70
17:20
min: 15
23:20
max: 95
06:10
min: -20
12:35
max: 65
17:55
min: 20
23:50
max: 90
06:55
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Marea Prevista
Marea Astronomica