Topic: Sea level rise in a low-lying (sinking) island: Venice's problems and its solution, the Mose (Modulo Sperimentale Elettromeccanico)

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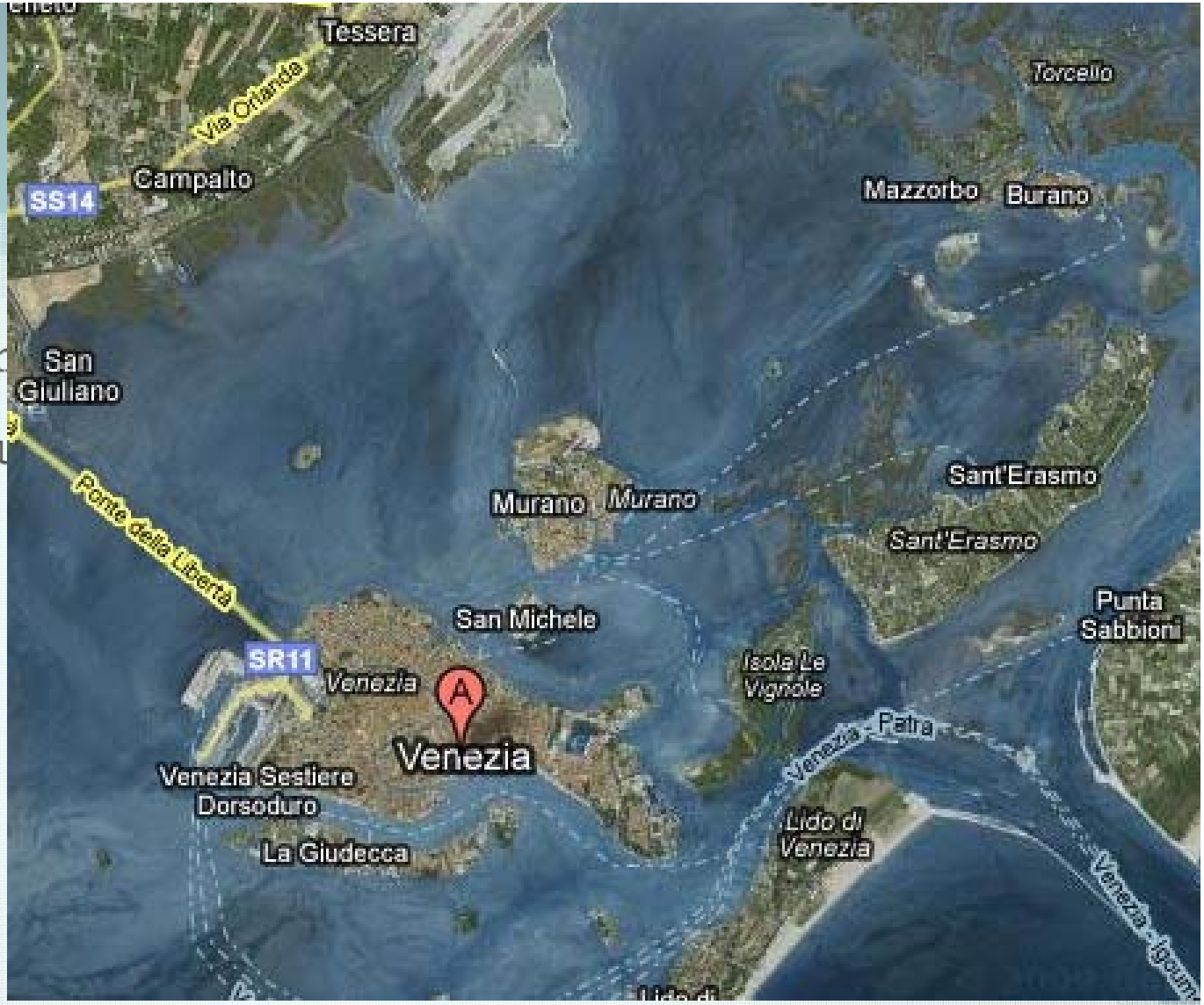
Introduction

Background

Venice

- NE of Italy
- 118 islands
- Major maritir
- Historical vau



Background

- Landmark!!
  - → Canal (155)
  - → Bridge (400)

The Bridge of Sighs

Background

- Sights

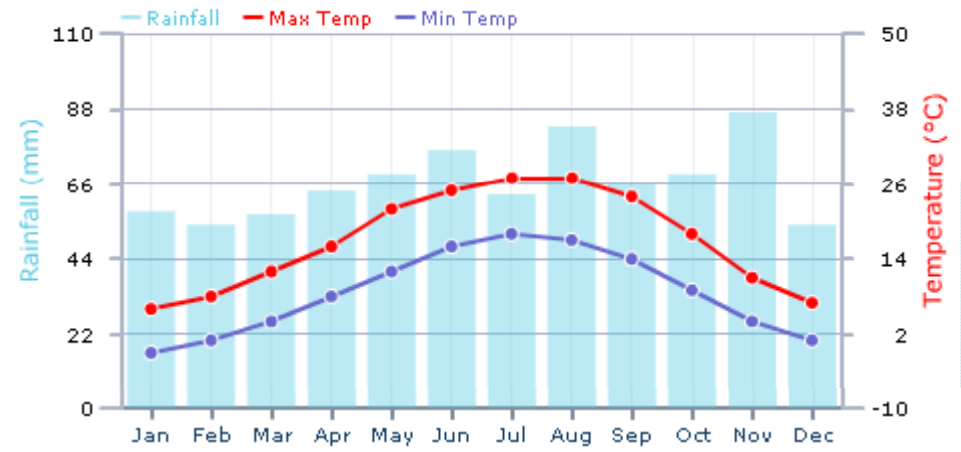
→Venetian Lagoon

→Island – Burano & Murano

Background

- Climate

→Mediterranean climate



MONTH(2008)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation mm	58	53	58	63	68	76	63	83	66	68	86	53

Source: weather.com, 2008

Causes of Sinking of Venice

Causes of Sinking of Venice

(A) The intensification of the global warming

(B) The loss of the natural balance of the lagoon

(C) The decreasing water holding capacity of the lagoon

(D) Pumping of aquifers in 15-16th century and the construction of artesian wells during the 20th century

(E) Loss of Wetland and increased erosion

Causes of Sinking of Venice

1. The intensification of the global warming

- More ice cap melt
- Rise in Sea level
- More Flooding during high tide seasons

Causes of Sinking of Venice

2. The loss of the natural balance of the lagoon

- Shallow lagoon→ high tides partially blocked by the outlet
- Dredging of deep shipping channels in the 20th century → More strong high water and flooding

Causes of Sinking of Venice

3. The decreasing water holding capacity of the lagoon

- Large areas of the Lagoon have been reclaimed from 1892 to 1967
  - E.g. the industrial zone at Porto Marghera was built on a huge landfill
- Decrease in 15 square kilometres (6 square miles) area for high tides to expand → more floods

Causes of Sinking of Venice

4. Pumping of aquifers in 15-16th century and the construction of artesian wells during the 20th century

→ Create a deeper lagoon

→ More strong high water

5. Loss of Wetland and increased erosion

- A moderator of regulating the tidal flats
- increased erosion → loss of wetland
- more floods and land subsidence

Problem of rising sea level in Venice

Venice

"Water has been Venice's source of life, but it could also well spell its death"

Indroduction

- Named as the "City of Water" and "City of Bridges"
- Tens of thousands of tourists visit this city annually
- “Water has been Venice’s source of life, but it could also well spell its death.”
- Facing the problem of sea level rise and land sinking

How serious is the problem?

- Venice is 23 centimeters further under water than it was 100 years ago
- Rising water levels in the lagoon account for 10cm of the total and 13cm come from subsidence
- Venice will "almost certainly" be uninhabitable by 2100

How serious is the problem?

- the St Mark's Square is being flooded about 100 times each year, compared with 10 times in 1900
- Venice's population has fallen from 150,000 in the 1950s to 58,000 today

Reasons

- Many artesian wells sunk into the periphery of the lagoon→ to draw water for local industry
- The buildings of Venice are constructed on closely spaced wood piles
- Global warming→ sea level rise
- Acqua alta

What is Acqua alta?

- The exceptional tide peaks that occur periodically in the northern Adriatic Sea
- Causes partial flooding of Venice and Chioggia
- The phenomenon occurs mainly between fall and spring → reinforced by the prevailing seasonal winds
- The flooding caused by the acqua alta is not uniform throughout the city of Venice

Tide magnitude	Percentage flooded
up to 90 cm	0,29%
up to 100 cm	3,56%
up to 110 cm	11,74%
up to 120 cm	35,18%
up to 130 cm	68,75%
up to 140 cm	90,19%
up to 150 cm	96,33%
up to 160 cm	99,27%
up to 170 cm	99,74%
up to 180 cm	99,86%
> 180 cm	100,00%

The 1966 big Venice flood

- More than 130 persons lost their lives
- Florence and Venice, suffered tremendous damage
- Flood more than 90% of the town
- The peak level was 1.94 meter above the nominal sea level

Video

http://www.youtube.com/watch?gl=US&v=01I-Ox2PYbs

The 2008 Venice flood

- Occurred on 1st December 2008
- High water reached one of the highest-ever levels – 156 cm above the average mid-tide measurement
- The wind direction and overnight rain had added to an already-high lunar tide
- This was the highest tide for 20 or 30 years

Solution

- Sea level rise --> possibility of flooding
- Aqua Alta
- 2008, largest flood in 40 years
- Apart from the MOSE
- What are the other solutions adopted by the Italian government?

Source:
http://news.bbc.co.uk/chinese/trad/hi/newsid_4380000/newsid_4380500/4380512.stm

Solutions

A. Hardware

(1) Construction of dams

- E.g. The Vaiont Dam
- Failure

Solutions

(2) Construction of embankments

- E.g. Embankments on the 2 sides of Tiber River

Solutions

(3) An efficient rescue team

- E.g. In 2004, during flooding

--> a Tippecanoe County rescue team

Solutions

B. Software

(1) Warning signal

- E.g. In 2008, during flooding
- Sea level rises to 160 cm within few hours
- Evacuation

Solutions

(2) Flood-plain zoning

- E.g. The Piemont Region
- Careful flood management
- Exchange of information

Solutions

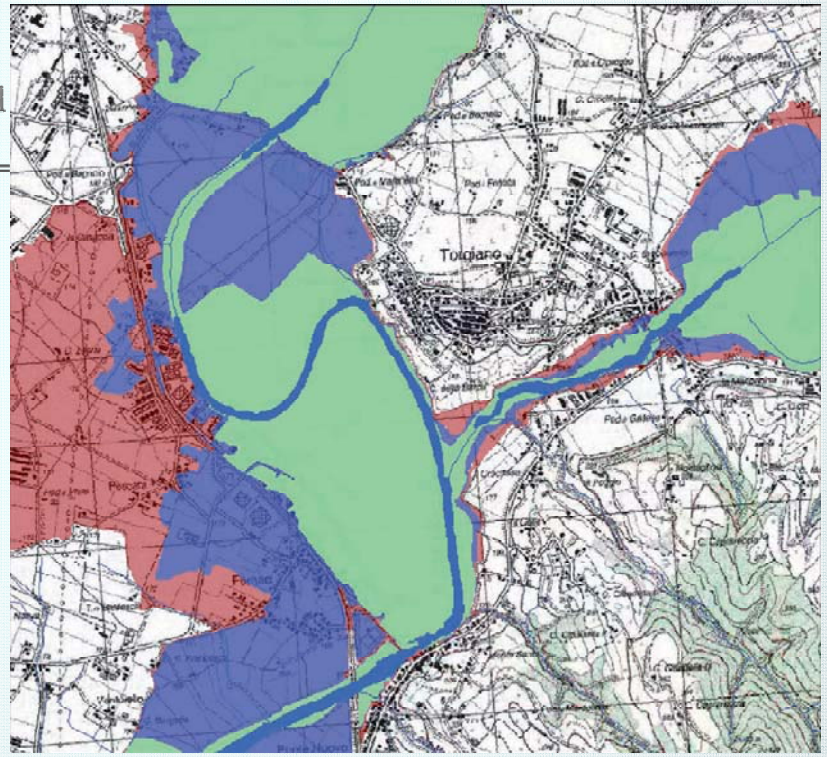
- (3) Insurance

Legend of the map:

Green return period =

Blue return period =

Red return period =



http://ec.europa.eu/environment/water/flood_risk/flood_atlas/pdf/flood_maps_ch6.pdf

Solutions

(4) Education

- What do during when flooding occurs
- Protect water resources

Solutions

(5) Research

- Working with partners from University of Essex on a rainfall research
- To ensure more accurate forecasting

Solution

Possibility of work?

- Most effective way is to find the underlying causes
- Global warming
- Thus--> Reduce carbon emission
- One example: afforestation

Solution

Some critical factors

- To determine the successfulness of the measures
- Some important factors

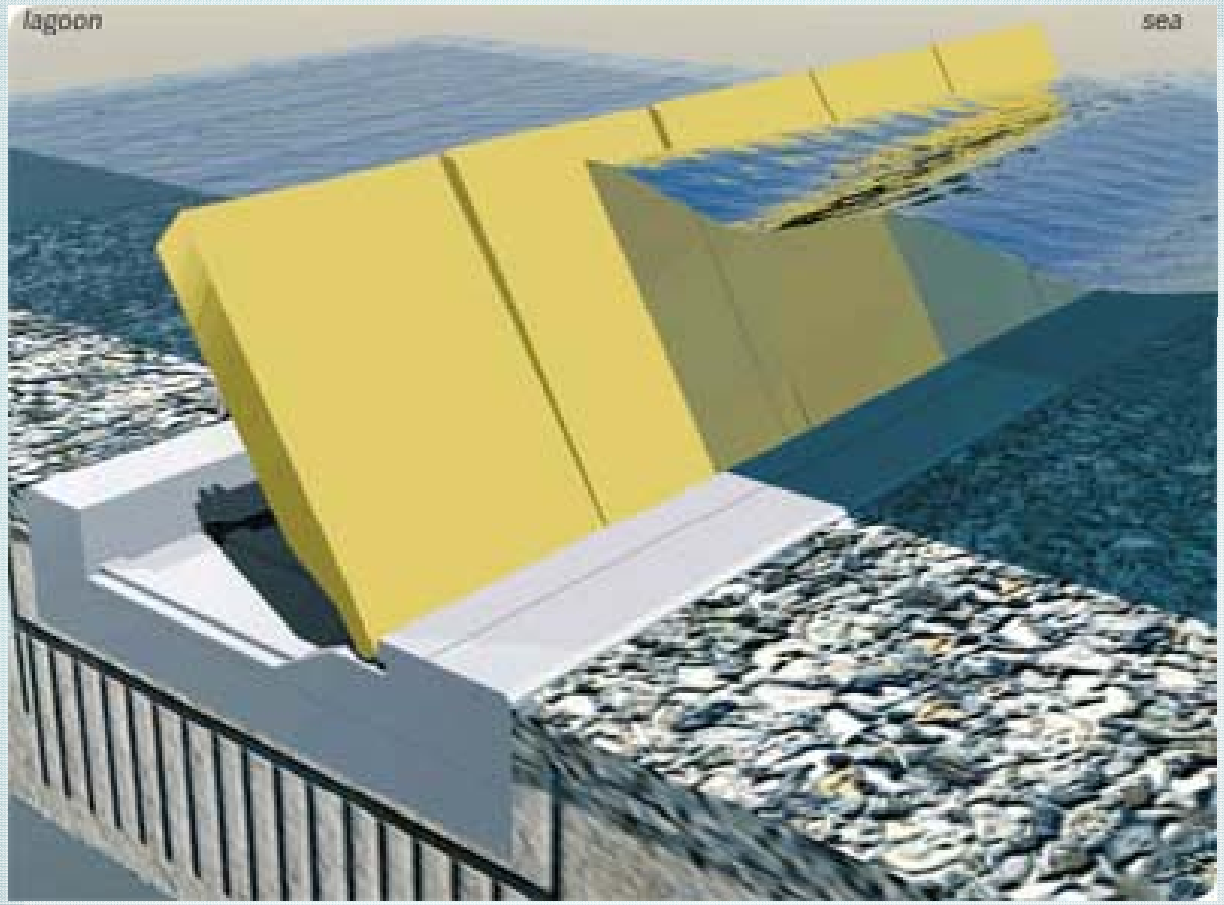
i) Capital

ii) Technology

iii) Support from the government

The MOSE

Operation


lagoon
sea

Operation

- consists of mobile barriers
- temporarily separate the lagoon from the sea
- constructed at the lagoon inlets of Lido, Malamocco and Chioggia

Source: http://www.salve.it/uk/eco/destra/images/lagunasat.jpg

Operation

- mobile barriers consist of rows of gates full of water
- lie on lagoon bed
- invisible in normal tidal conditions
- high tide:

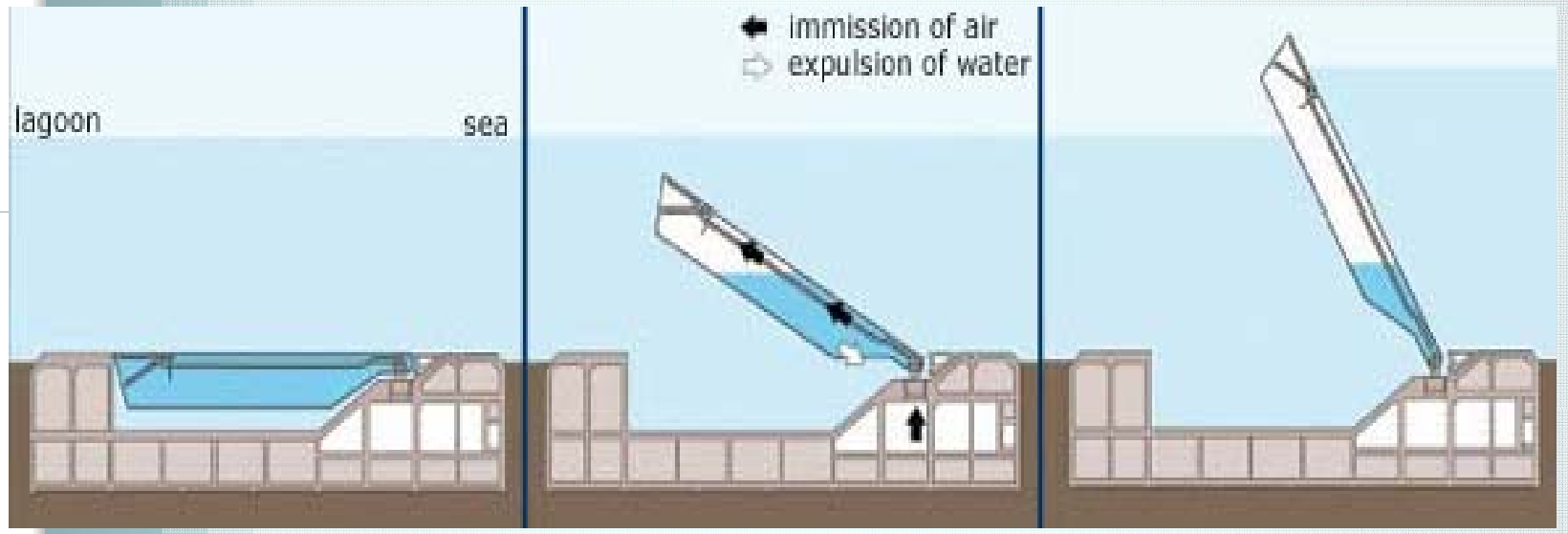
→ compressed air is pumped into the gates to empty them of water

→ gates rise above the surface

→ a continuous barrier dividing the sea and the lagoon

Operation

- Detail of a row of gates in action



Source: http://www.salve.it/uk/soluzioni/acque/images/3stati.jpg

The MOSE

Pros

Pros of MOSE

1. Employment

- create job opportunities
- E.g. currently 700 people are employed directly
- E.g. work sites will guarantee a total of about 1.500 direct jobs
- E.g. 10000 jobs over 10 years (including indirect jobs)

Pros of MOSE

2. Control flooding by defending from high waters and sea storms

- Acts as a flood barrier system
- prevent water from entering the Venice lagoon when high tides are forecast
- protects people, properties and cultural heritage

The MOSE

Cons

Cons of MOSE

1. Expensive cost

- Building cost:5 billion Euro
- yearly routine maintenance cost:9 million Euro
- Venice government: budget deficit
- Makes money: auctions selling13 cultural heritages which were built in Renaissance, such as Palazzo Nani

Palazzo Nani is being auctioned by the Venice government

Source: Wenweipo

Cons of MOSE

2. Affect Venice's lagoon ecosystem

- Lagoon bed will be dredged and replaced by rock and concrete → threaten the ecology of the lagoon, one of the Mediterranean's most important wetlands
- Anodes protecting the gates from corrosion will release toxic zinc → destroy food chain
- When the gates are closed, industrial and agricultural pollution and the city's untreated sewage are trapped → bad water quality

Cons of MOSE

3. Arouse controversies

- 30 years of debate
- Opposition to the MOSE
- Venetians: lost their patience and confidence to the government and half of them have left their homeland since 1966
- Environmentalists
- Conservationists

Cons of MOSE

4. Vulnerable to political change

- E.g. Silvio Berlusconi, who is the Prime Minister of the Italian Republic in 2001 to 2006 and 2008 to now~> supports and carries out the MOSE project

E.g. Romano Prodi, who is the Prime Minister of the Italian Republic in 2006 to 2008~> stopped the MOSE project even though the it reached 25% of completion

Effectiveness of MOSE

Only moderately effective!!!!

- Effective: control floodings causing by the influx of graet sea storms
- Not effective: Cons>pros + followings

Effectiveness of MOSE

1. Sea storms that are likely to pose threat to Venice occur infrequently,

e.g. since 1936, only 12 sea storms had a chance to cause flooding in Venice

→not worthy to spend too much on MOSE as it is infrequently useful

Effectiveness of MOSE

2. MOSE plan underestimates the likely rate of sea-level rise during the coming century

- Scientist: 50cm sea level rise in the coming century on average
- MOSE plan: 22cm
- floodgates will stand for a long time in the future → heavy rain
  → excess water cannot be diverted to the sea →flooding

Effectiveness of MOSE

3. MOSE paln is for great floodings

- designed according to the great flooding in 1966
- flooding scale which is as large as that in 1966 happens every 165 years
- not effective in preventing the frequent and small-scale floodings

Effectiveness of MOSE

4. Venice faces the problem of rise in sea level and sinking of island

- Sinking of island:overtaking of underground water and gas field exploitation
- In the last century, Venice has been sinking by 23cm
- floodgates cannot solve the problem of sea storms influx
- floodgates cannot completely solve the problem of sea storms influx

Conclusion

- Global sea level rise → 3.1mm/yr
- Venice → 23cm under the water compared with 100 years ago
- Main reason… Global warming!!
- Conservation eg. Mose… effective?
- Prompt action →protect heritage!

~END~