



The Lagoon of Venice and Landscape ecology

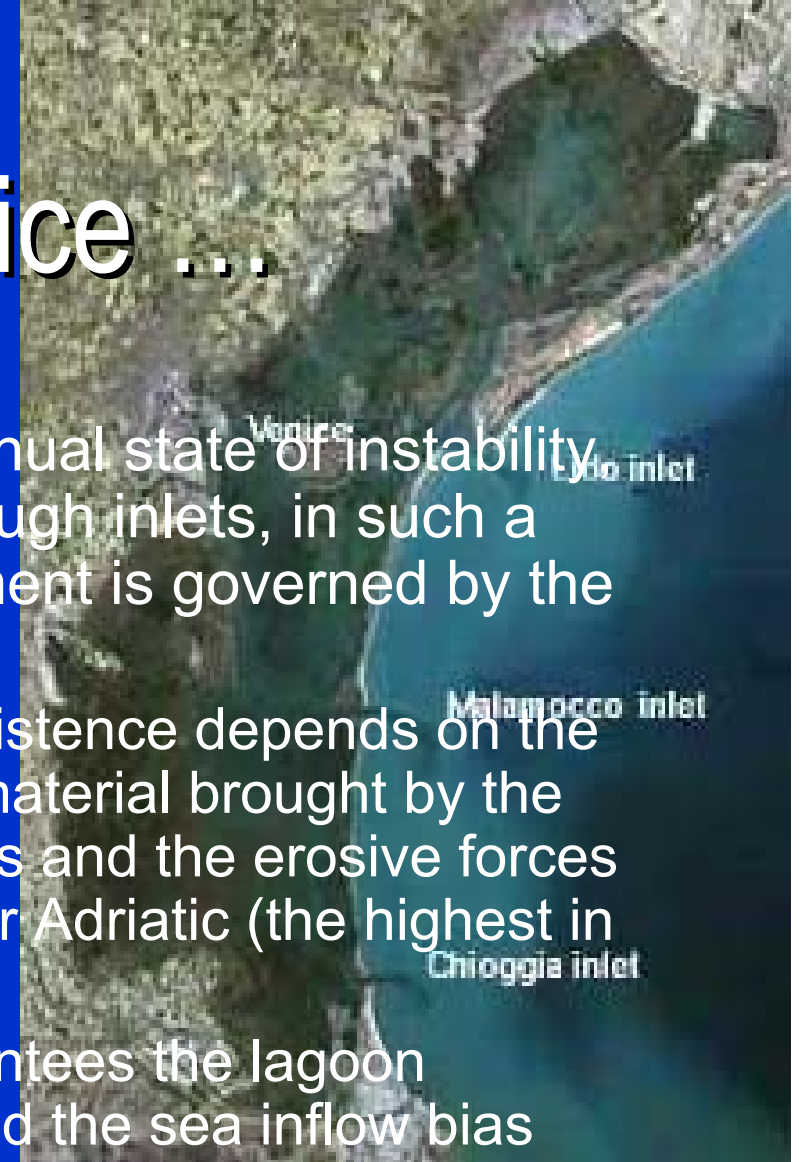
Daniel Franco

planland[®]
studio tecnico daniel franco



The Lagoon of Venice ...

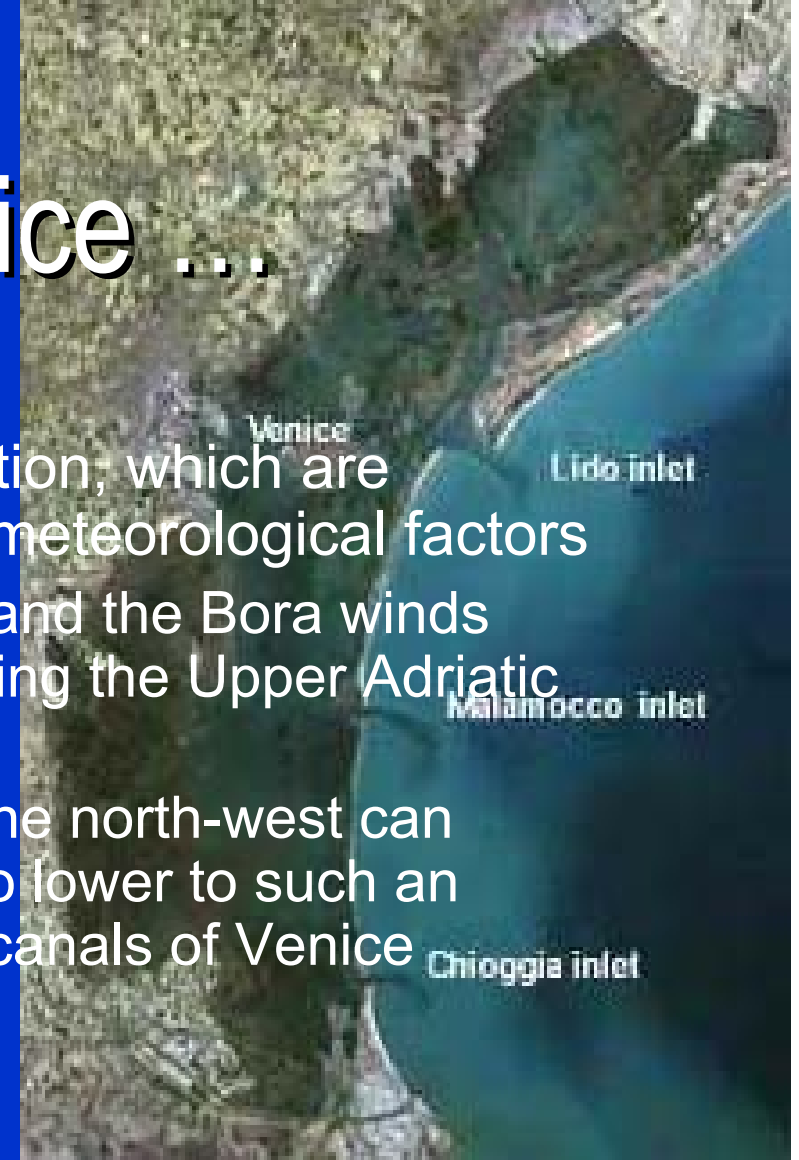
- ... is a coastal wetland in a continual state of instability, communicating with the sea through inlets, in such a way that the inside water movement is governed by the tide
 - the lagoon morphology and existence depends on the balance between the of solid material brought by the sea or the drainage basin rivers and the erosive forces of waves and tides of the upper Adriatic (the highest in all of the Mediterranean)
 - the sea – rivers balance guarantees the lagoon brackish water environment and the sea inflow bias can be considered today one of the main risk in the evolution of the lagoon basin
 - about 78% (420 km²) of the lagoon surface is covered by expanses of water cut by a dense network of channels of varying depth





The Lagoon of Venice ...

- ... presents wide tides level variation, which are determined by astronomical and meteorological factors
 - low pressure and the Scirocco and the Bora winds accentuate the high tides, causing the Upper Adriatic to swell up
 - high pressure and winds from the north-west can cause the water in the lagoon to lower to such an extent as to leave the rios and canals of Venice exposed





The Lagoon of Venice ...

- ... survives only if
 - a balance exists between sediment accumulation and erosion (through river loads, wave motion, coastal currents)
 - If the accumulation prevails, a lagoon tends to silt up, and turn to dry land
 - If the loss prevails, the erosion grows up and the lagoon tends to become a marine environment



The Lagoon of Venice ...

- and if
 - subsidence and eustasy predominate over the accumulation of solid materials
 - Subsidence (lowering of ground level) can occur because of
 - natural reasons (tectonic deformations of strata deep beneath the earth or the progressive consolidation caused by the geostatic loads of fine alluvial deposits, like silt and clay)
 - human-induced causes, the most common of which is the intense extraction of underground water supplies, or methane in the upper Adriatic
 - Eustasy (variation in sea level) can occur because of geological period
 - during the coldest periods precipitation is held back in the form of ice and (the level of the sea lowers)
 - during the hottest periods precipitation is in the form of water and (the level of the sea increases)



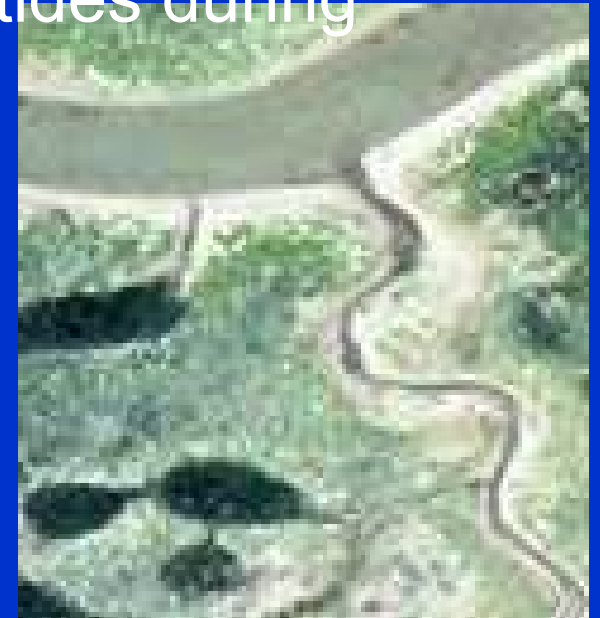
About the lagoons options...

- The unstable equilibrium persists if erosion and sedimentation compensate for each other
- The lagoon tends to silt up if the solid sediments accumulation prevails (the Po delta case)
- The lagoon is transformed into a lough if the erosive forces prevail (the current tendency)



Lagoon morphology

- Mudd flats
 - soft land areas with no vegetation which are normally underwater, emerging only during particular tidal conditions (low tides during spring tide cycles)





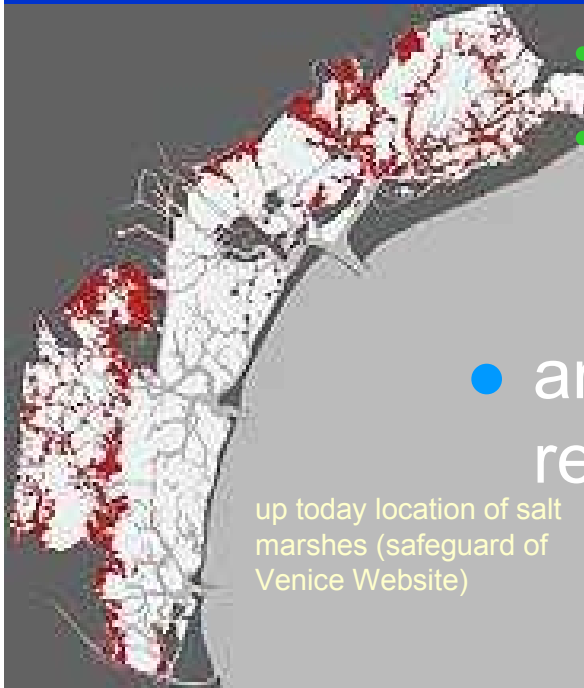
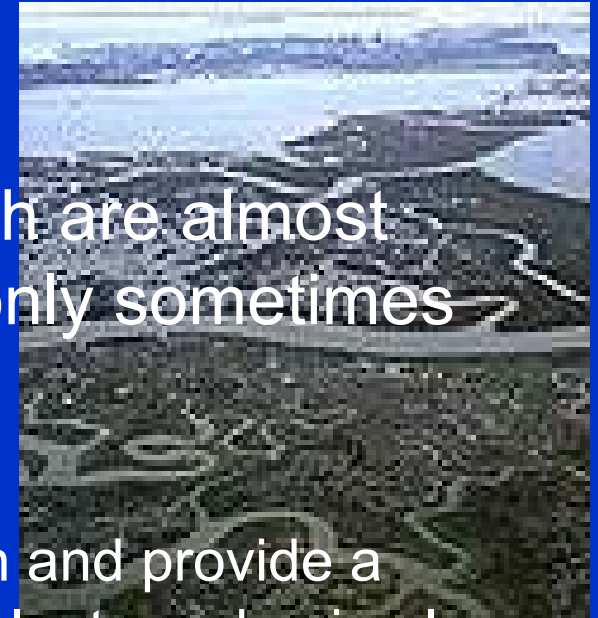
Lagoon morphology

- o Salt marshes

- consistent ground areas which are almost always above water and are only sometimes submerged

- enhance water exchange
- lessen the action of wave motion and provide a home for both a wide variety of plants and animals (brackish environment)

- are important because of their role in regulating lagoon hydrodynamics



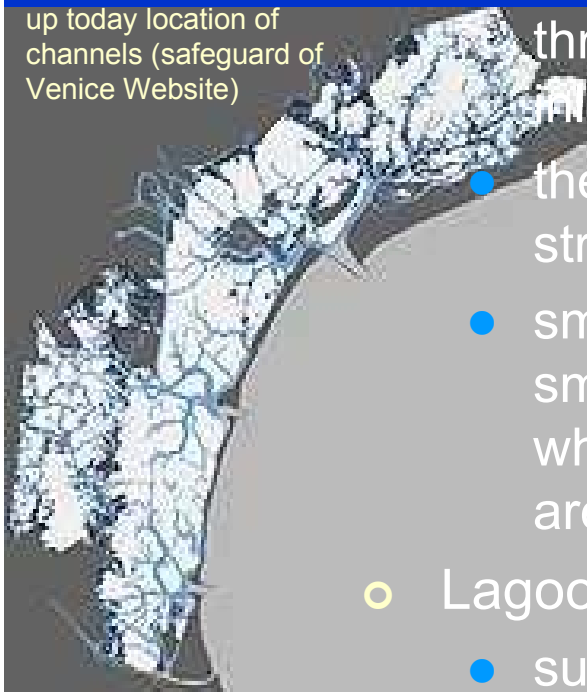
up today location of salt marshes (safeguard of Venice Website)



Lagoon morphology

- Channels (principal, secondary and tidal creeks)
 - surface area of 67.30 square km
 - depth between 15 m (Malamocco-Marghera Channel) and 1-2 m
 - the sea –lagoon water exchange occurs for the most part through the lagoon channels which branch off from the three inlets
 - the natural channels which have a winding path, the artificial straight channels have been dug over the years
 - smaller channels branch off main channels to become smaller and smaller and ever more winding: *tidal creeks* which cross salt marshes to finish in *rainwater ponds*, which are composed of brackish rainwater
- Lagoon beds (including mud flats and salt marshes)
 - surface area of 435.68 square km

up today location of
channels (safeguard of
Venice Website)





Lagoon morphology

○ Islands

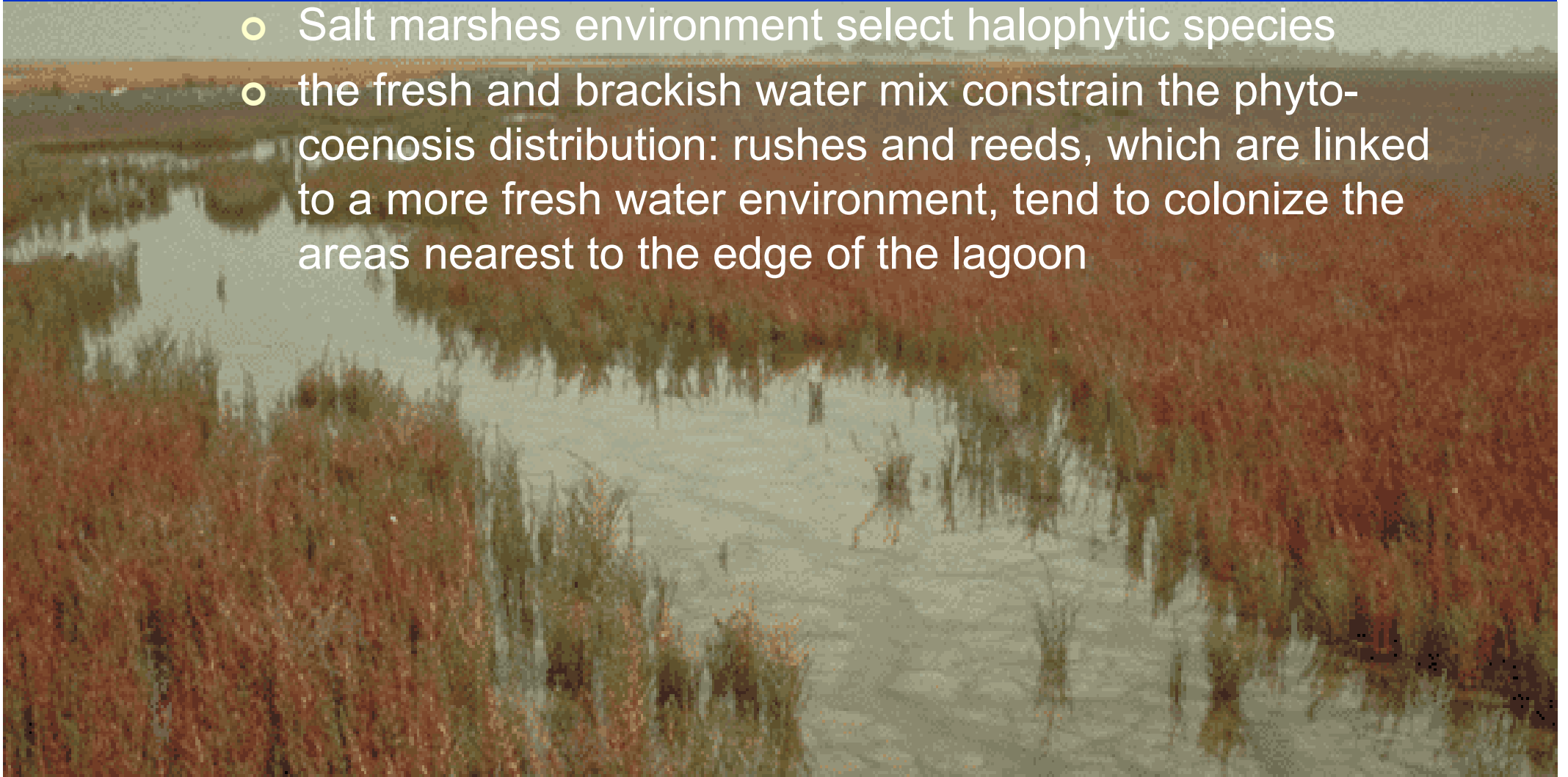
- (excluding the coastal-strip islands) cover 8% of the total surface area of the lagoon
- the inhabitants of the lagoon gave the islands precise and different functions over the centuries
 - They were used for military bases, convents and hospitals
 - Today several of them are completely abandoned
- The natural islands are either the remains of dunes, that is residual areas of old coastal strips (as in the case of Vignole or Sant'Erasmo) or areas created by the depositing and accumulating of the solid materials transported by the rivers (as in the case of Burano or Torcello)
- The artificial island was recalimed during the 19th century





Lagoon ecology

- Vegetation of salt marshes and brackish water wetlands
 - Salt marshes environment select halophytic species
 - the fresh and brackish water mix constrain the phyto-coenosis distribution: rushes and reeds, which are linked to a more fresh water environment, tend to colonize the areas nearest to the edge of the lagoon

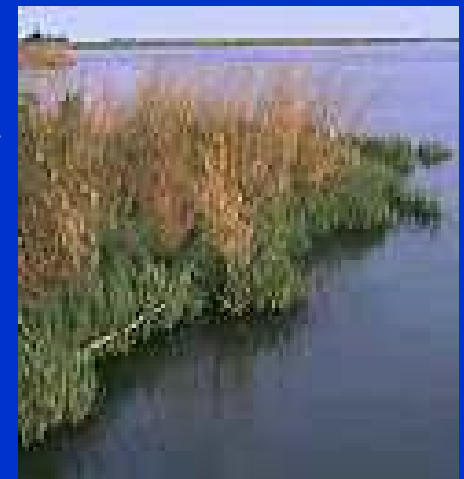




Lagoon ecology

Some peculiar species of the Lagoon of Venice

- *Salicornia veneta* colonises the lower areas of the salt marshes, and is one of the first plants to grow each year
- *Puccinella palustris* (Cord grass) is a dominant element of salt marsh environments and can withstand periodic inundation





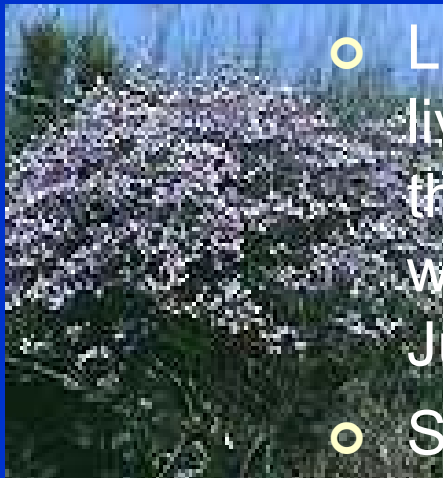
Lagoon ecology

Some peculiar species of the Lagoon of Venice

- *Limonium serotinum* is typically periodically inundated by the tide, and its flowers colour the salt marshes until the late summer



- *Limonium bellidifolium* (Sea lavender) lives along the edges of salt marshes in the most arid salty soils, and flowers with light greyish-pink colours from June to July



- *Spartina maritima* grows on the lowest edges of salt marshes and tidal creeks in heavily salty soils frequently inundated by the tides





Lagoon ecology

- o Fauna of salt marshes and brackish water wetlands



Example of the fauna of the Lagoon of Venice (safeguard of Venice Website)



Why landscape ecology?

- meaning of the landscape ecology approach in the Venice Lagoon planning and management
 - hierarchy and scale consideration
 - relationships between spatial configuration and ecological function and processes
 - ecological meaning of the “memory” in the ecosystems and in the ecosystems mosaic



The scale question

- the geo-morphology - climatic scale
 - considering this scale are the lagoon phyto-coenosis unique in the world?
 - Yes ...



The scale question

- End of last ice age (Würm), max low sea level: +- 10.000 years BC
 - today floristic heritage: alpine species



Teucrium chamaedris



Stachis recta



The scale question

- warming max and higher sea level: +- 5000 years BC
- today floristic heritage: steno-mediterranean species



Quercus ilex



Asparagus acutifolius

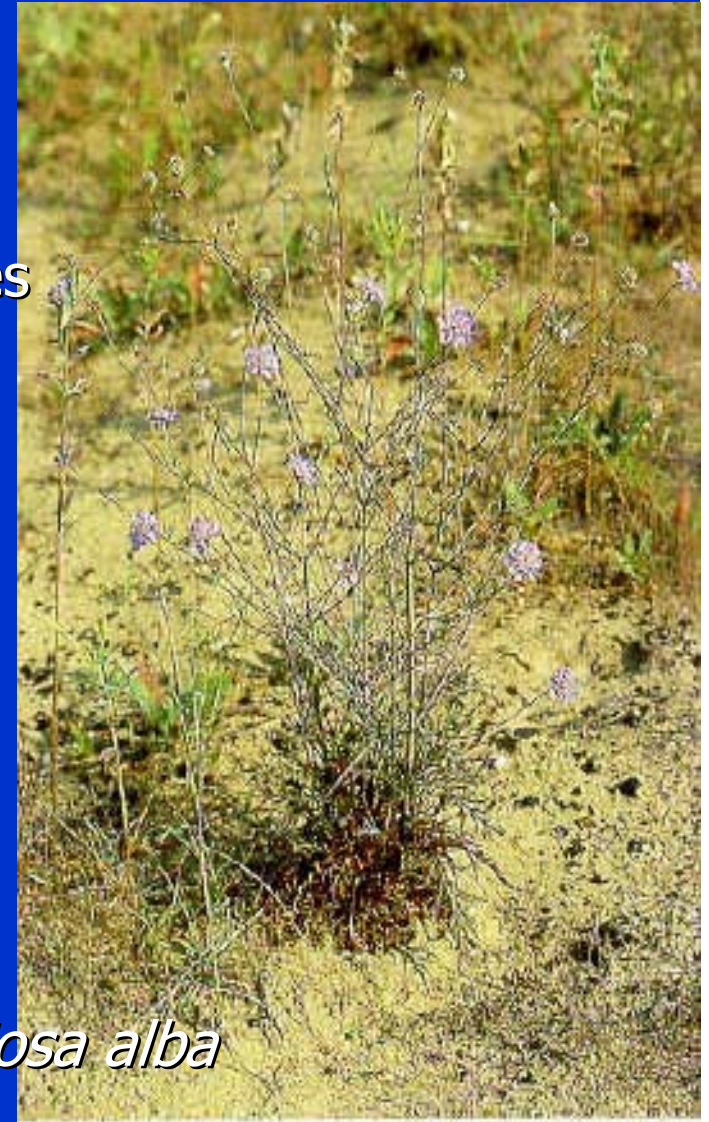


The scale question

- drought max: +- 2500 years BC
 - east immigration of steppe species



Tracomitum venetum

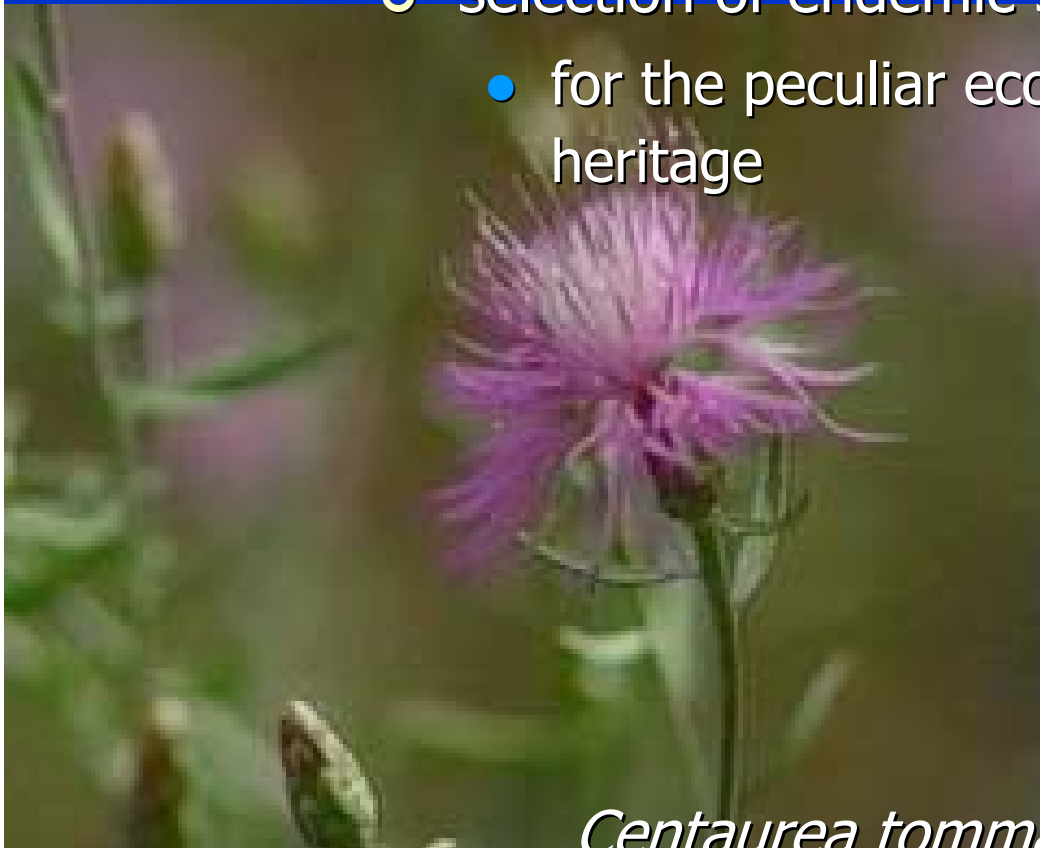


Sacabiosa alba

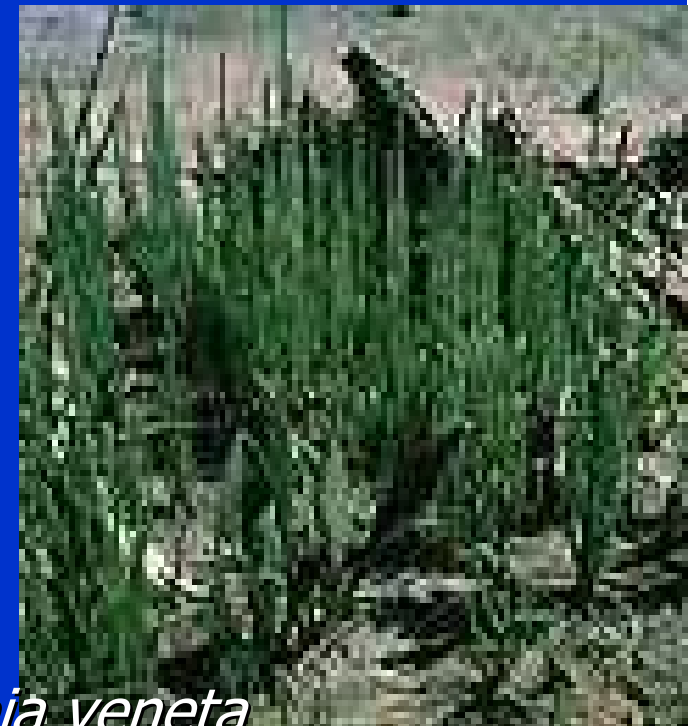


The scale question

- selection of endemic species
 - for the peculiar ecology conditions today floristic heritage



Centaurea tommasii



Salicornia veneta



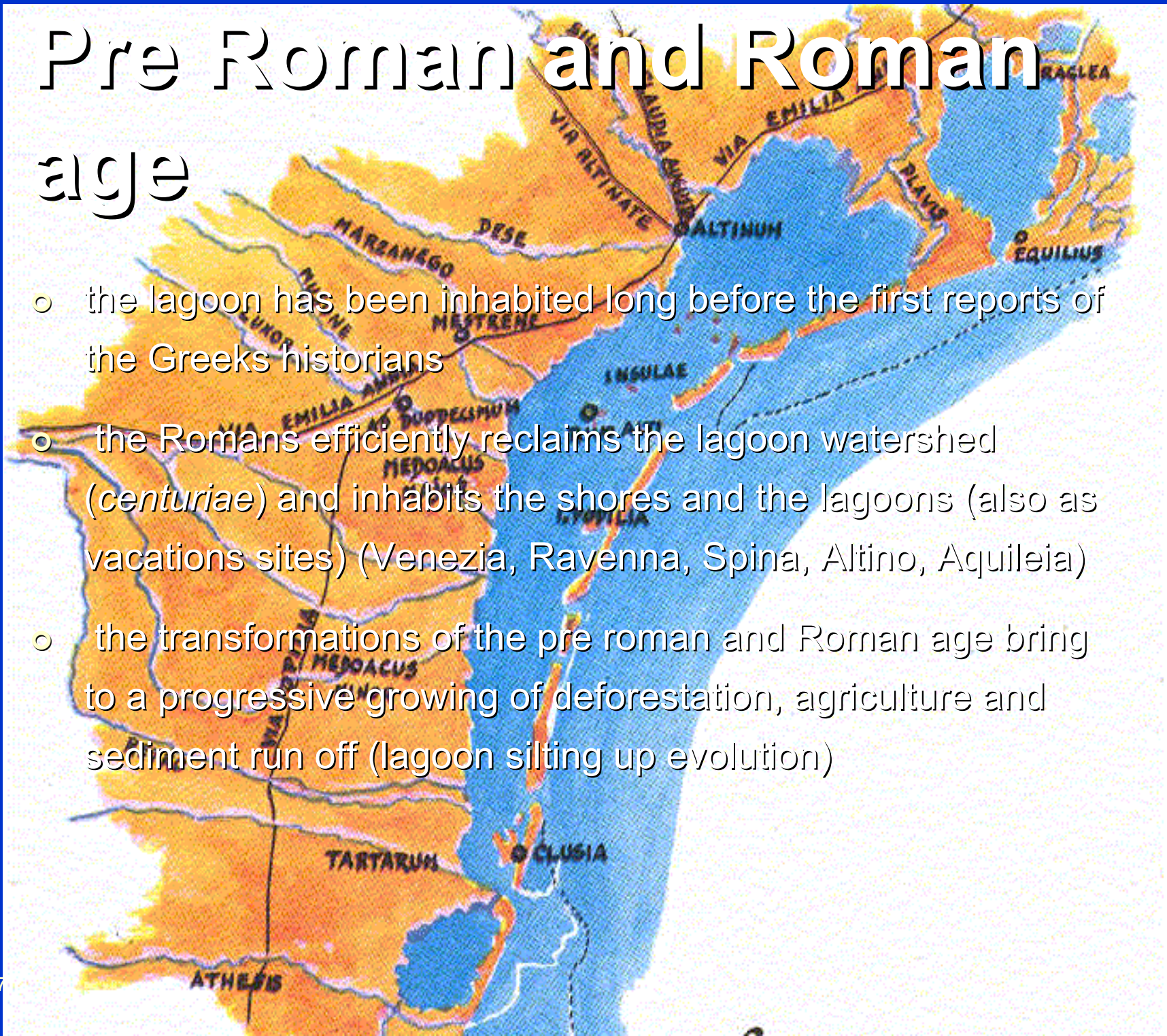
Again the scale

- the ecology of the Venice Lagoon and the humans' role in the last millennia
- the human activity have strongly influenced the geomorphic evolution of the Lagoon of Venice



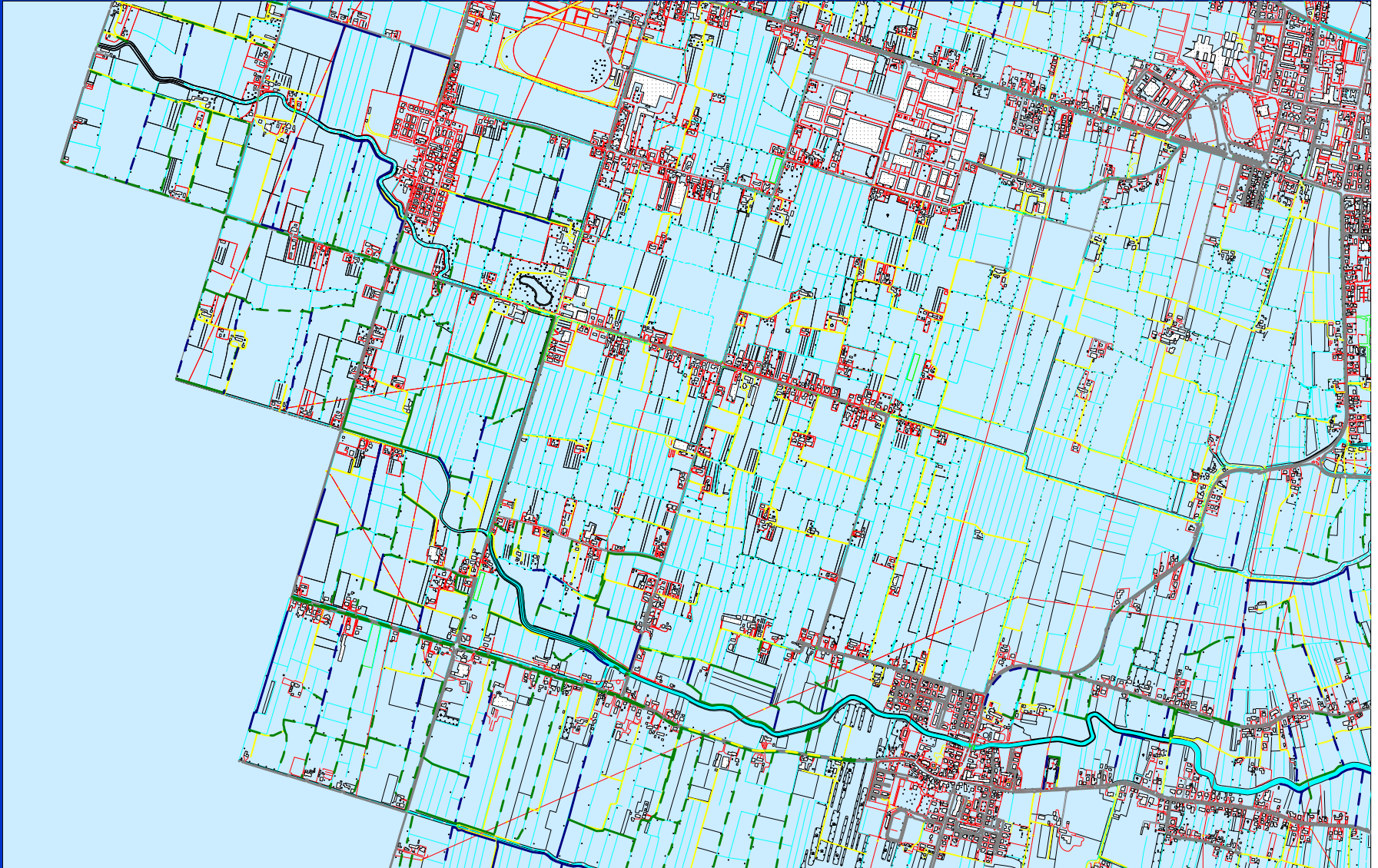
Pre Roman and Roman age

- the lagoon has been inhabited long before the first reports of the Greeks historians
- the Romans efficiently reclaims the lagoon watershed (*centuriae*) and inhabits the shores and the lagoons (also as vacations sites) (Venezia, Ravenna, Spina, Altino, Aquileia)
- the transformations of the pre roman and Roman age bring to a progressive growing of deforestation, agriculture and sediment run off (lagoon silting up evolution)





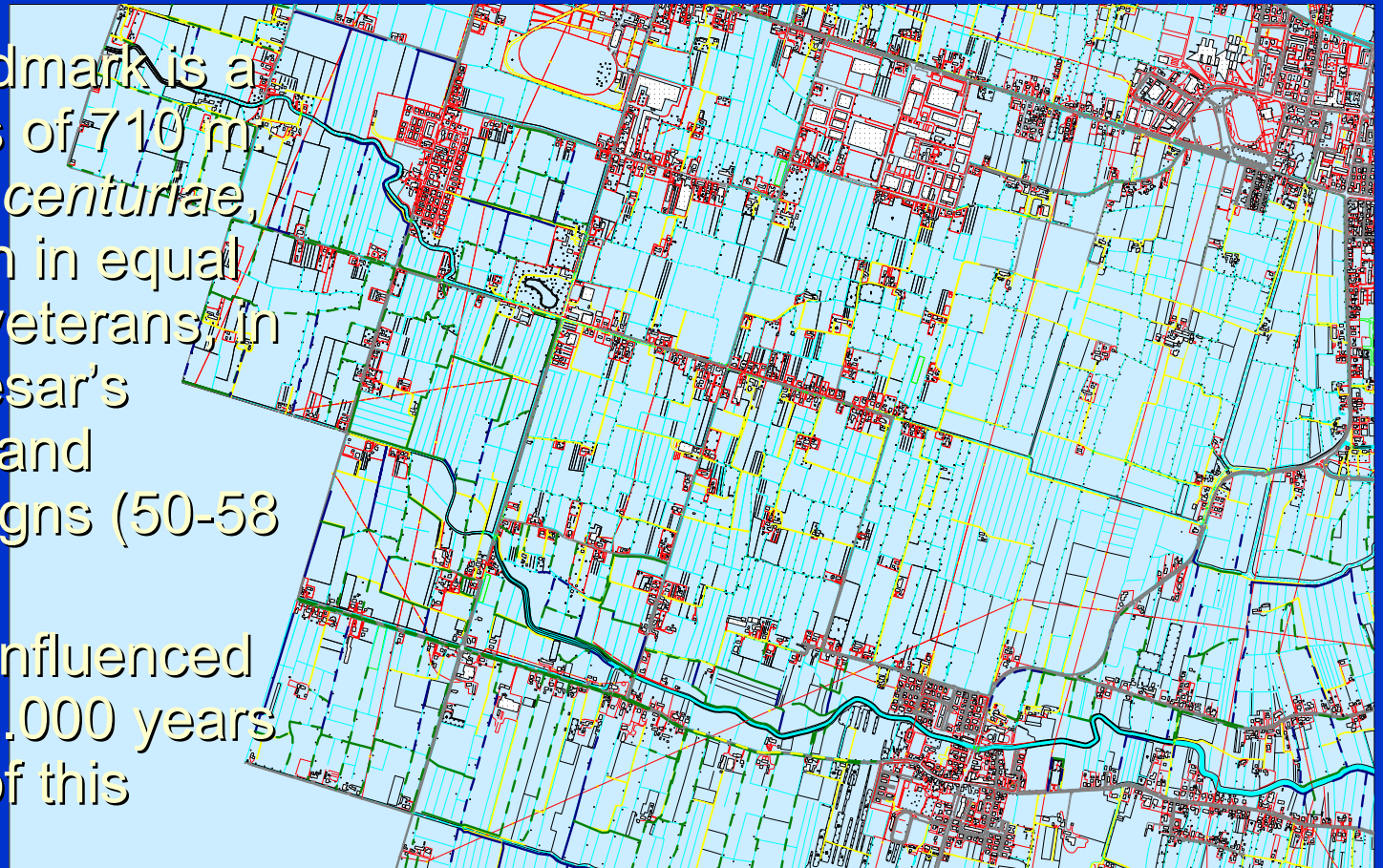
The landscape memory of transformations





The landscape memory of transformations

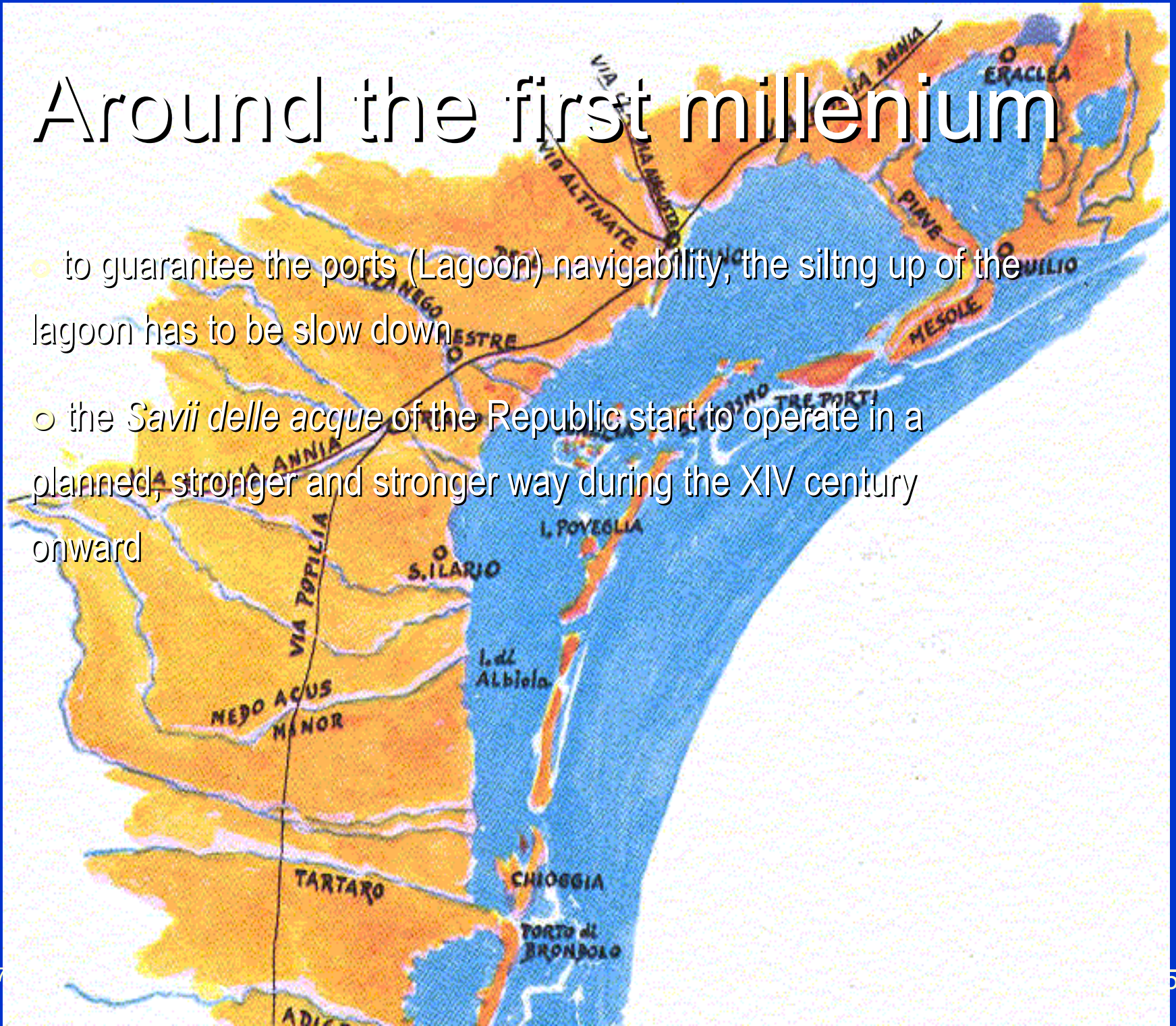
- this landscape is a few Km airline from the Venice Lagoon
- the dominant landmark is a mesh, with facets of 710 m, it is the Romans' *centuriae*, a land subdivision in equal farm lots for the veterans, in this case the Caesar's veteran of Gallia and Germany campaigns (50-58 BC)
- these structures influenced the subsequent 2.000 years transformations of this landscape





Around the first millenium

- to guarantee the ports (Lagoon) navigability, the silting up of the lagoon has to be slow down
- the *Savii delle acque* of the Republic start to operate in a planned, stronger and stronger way during the XIV century onward



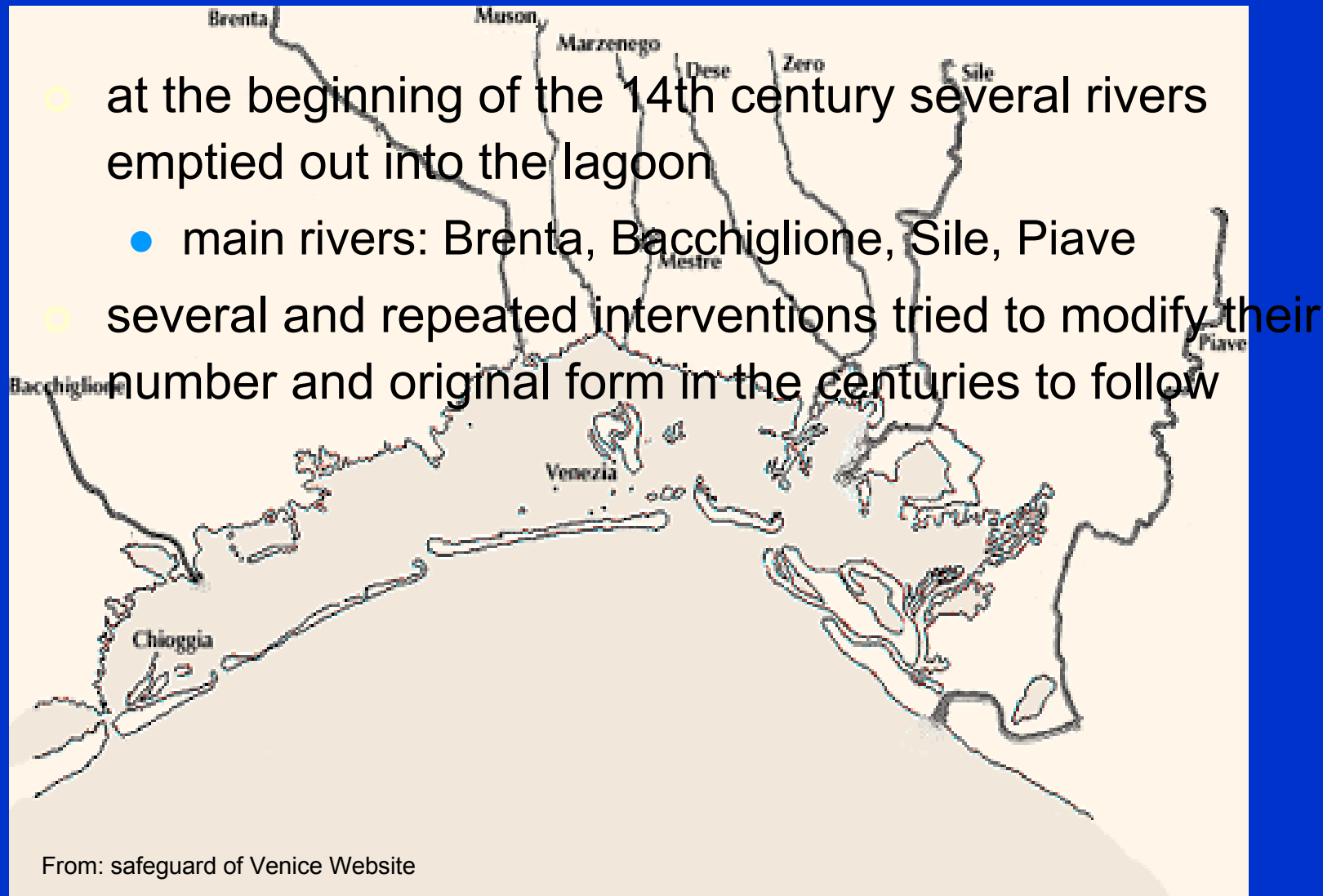


Man structural influences on lagoon evolutionary process: a time table

1324	Argine di S.Marco
1534	Taglio di Re e Cava Zucchina
1540	termina deviazione Bacchiglione e Brenta
1599	Taglio di Porto Viro
1600	Tagli Garzoni e S.Ilario
1610	Taglio Nuovissimo
1639	Diversione Piave
1683	Diversione Sile
1725	Canale S.Spirito
1727	trasformazione Porto Lido e Malamocco
1787	Murazzi
1791	Conterminazione lagunare



Let's see it: 1300 picture

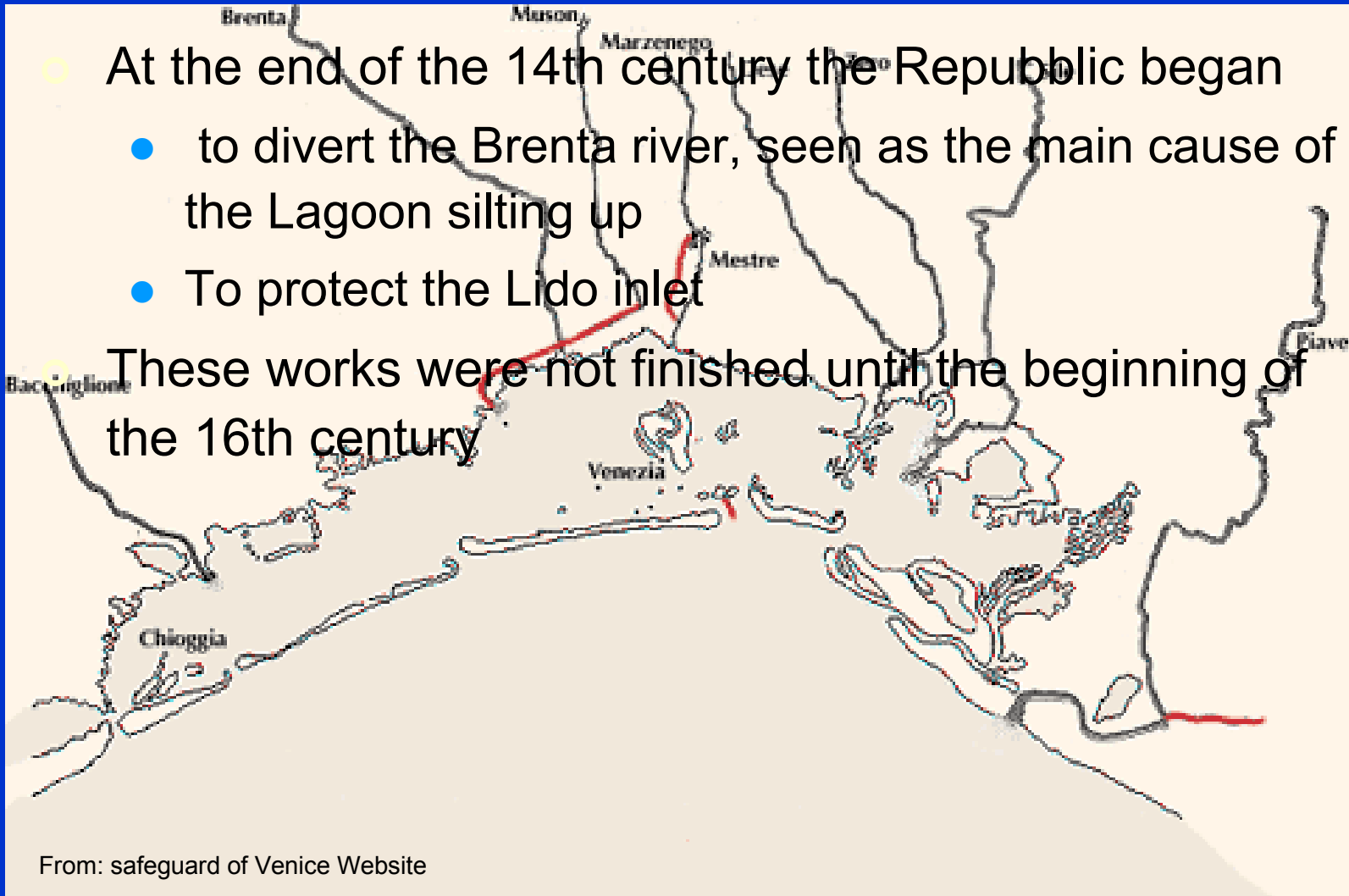




Let's see it: end of 1300 picture

- At the end of the 14th century the Republic began
 - to divert the Brenta river, seen as the main cause of the Lagoon silting up
 - To protect the Lido inlet

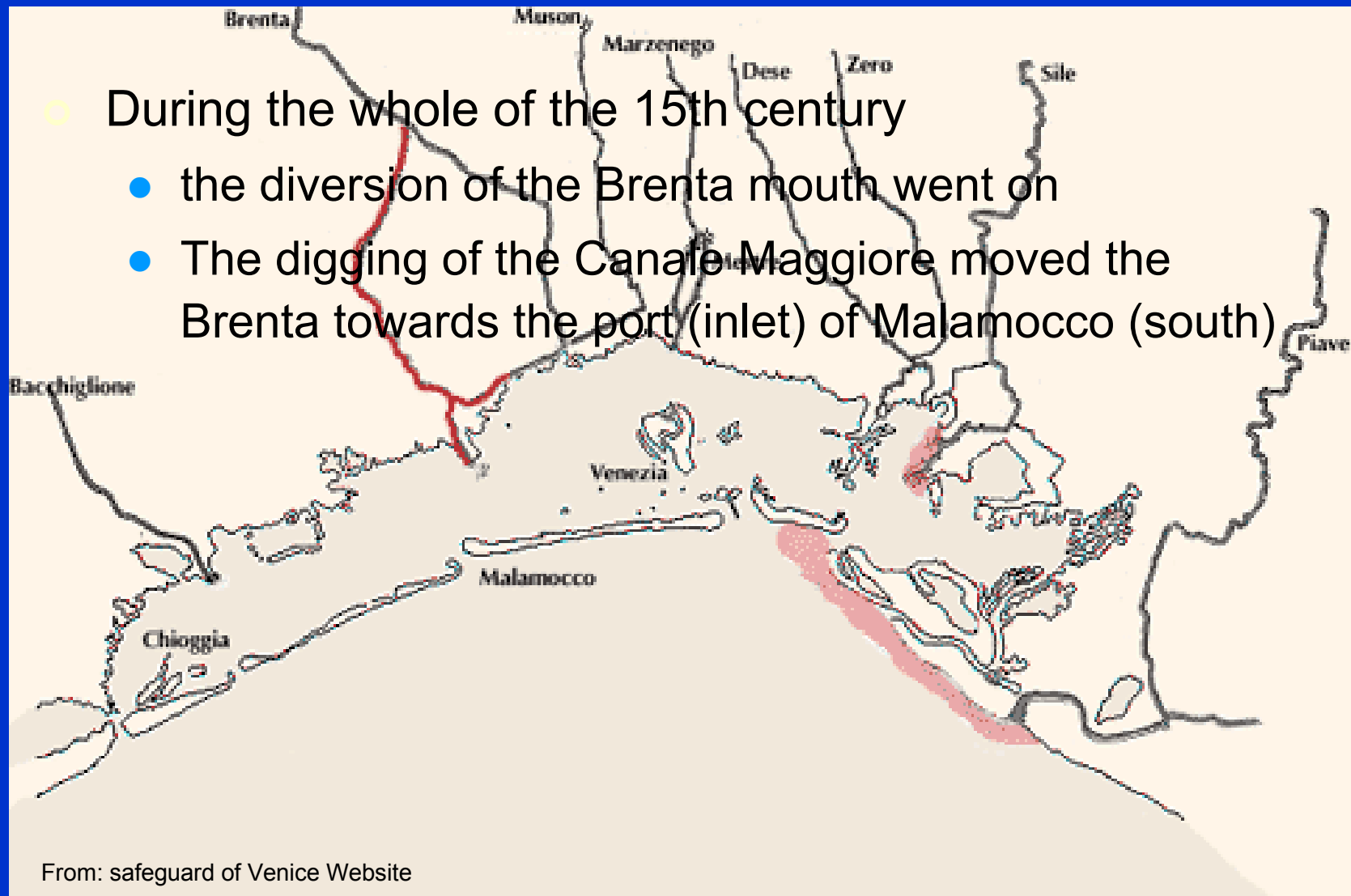
These works were not finished until the beginning of the 16th century



From: safeguard of Venice Website

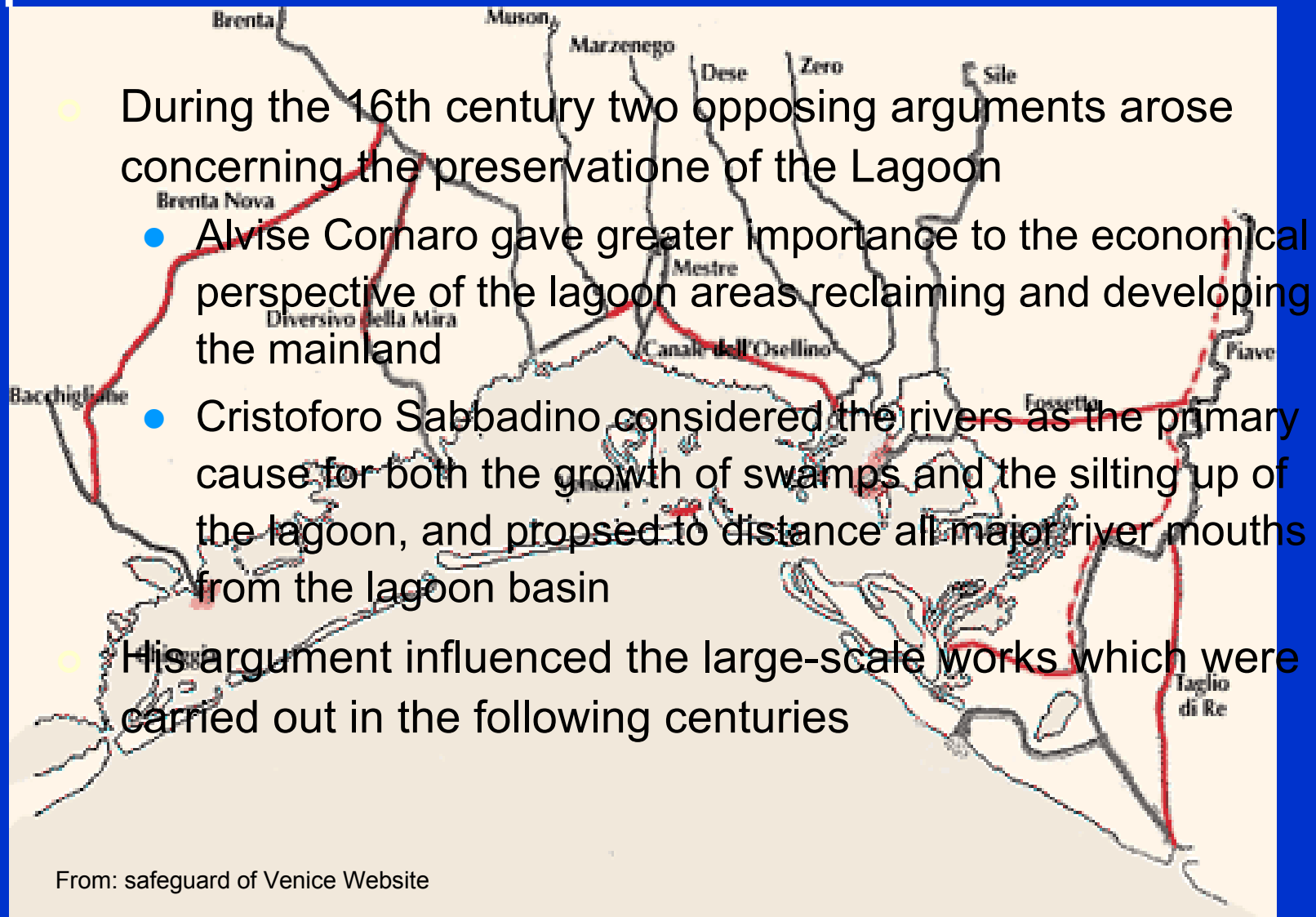


Let's see it: 1400 picture



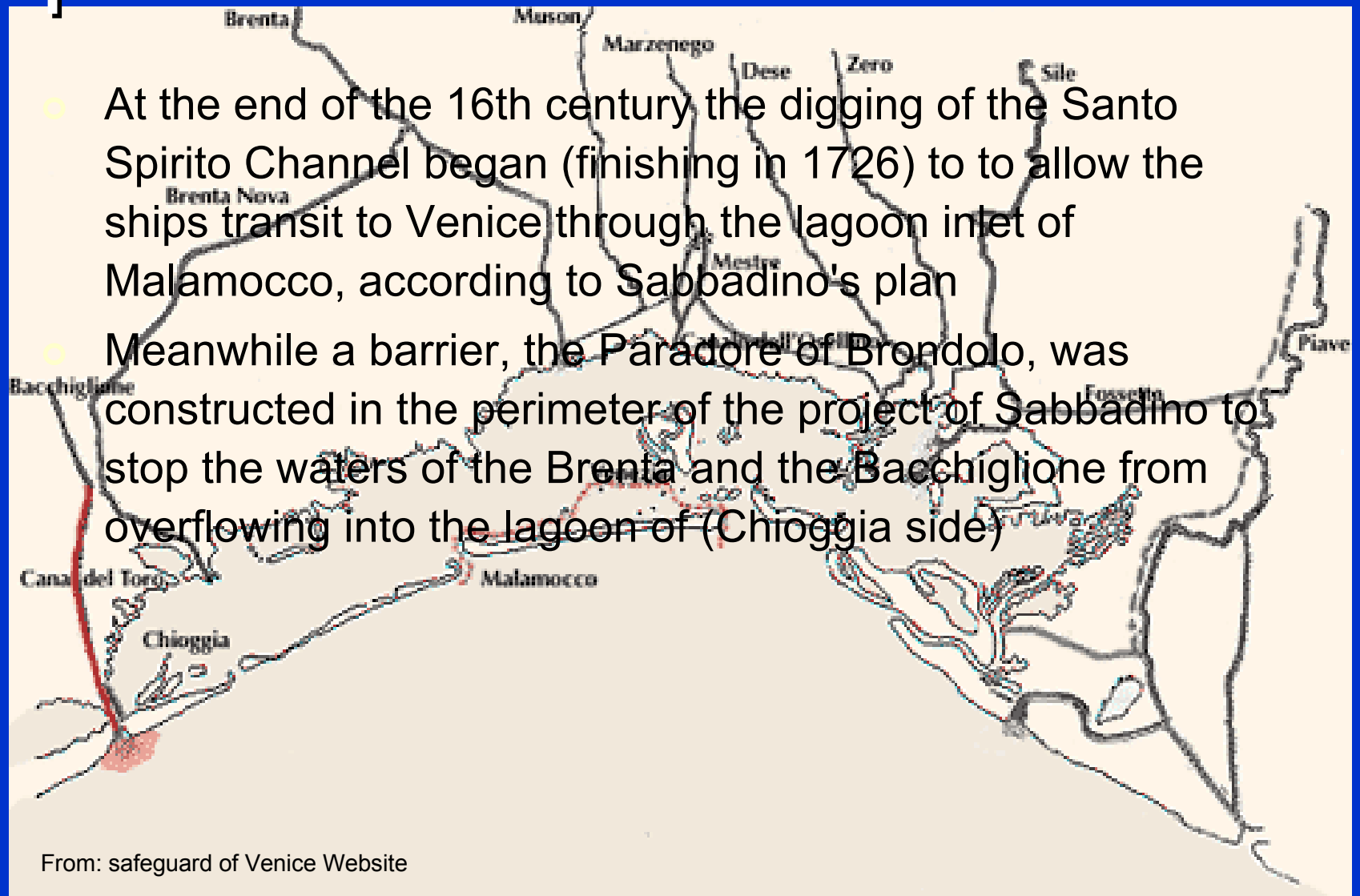


Let's see it: 1500 picture



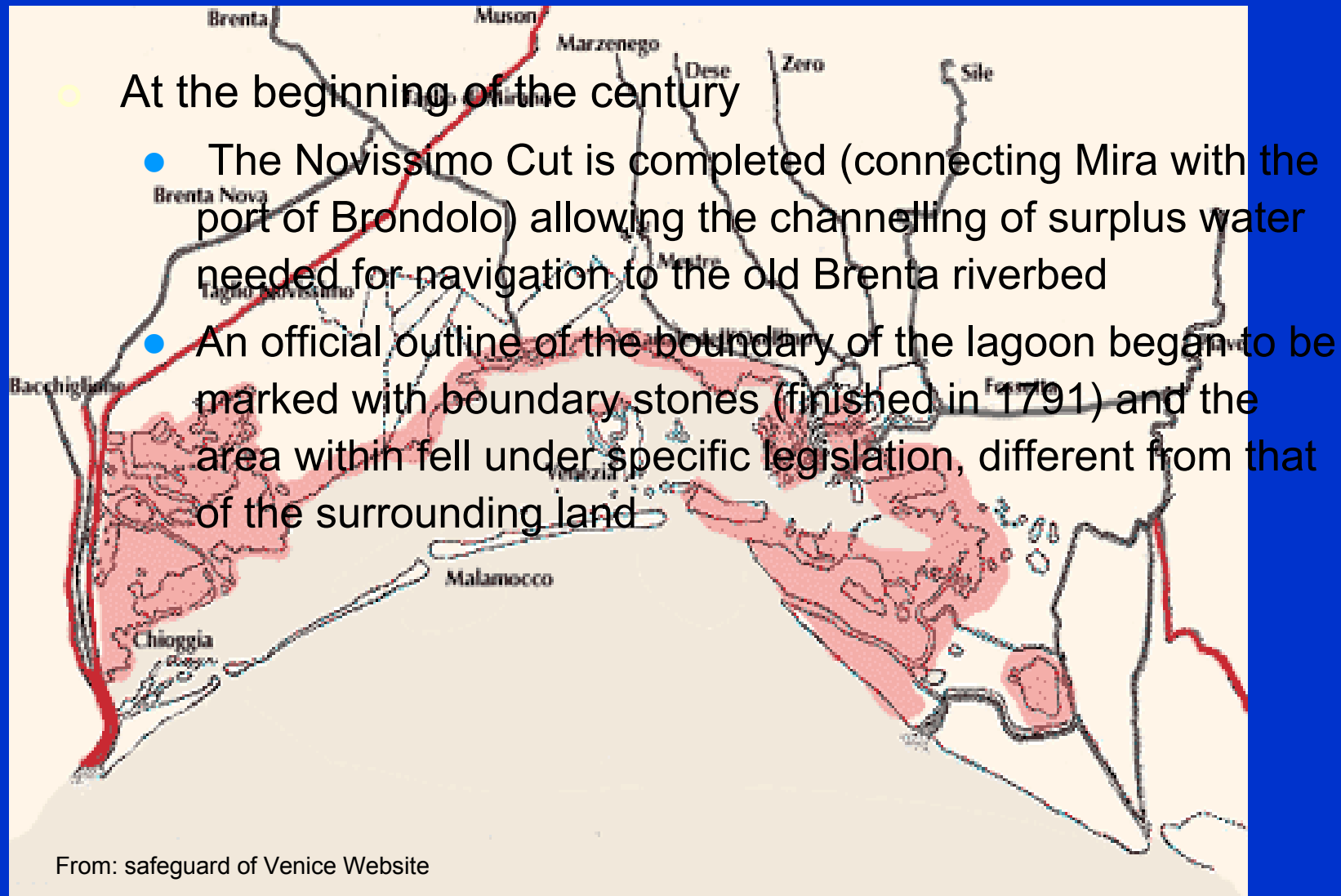


Let's see it: end of 1500 picture



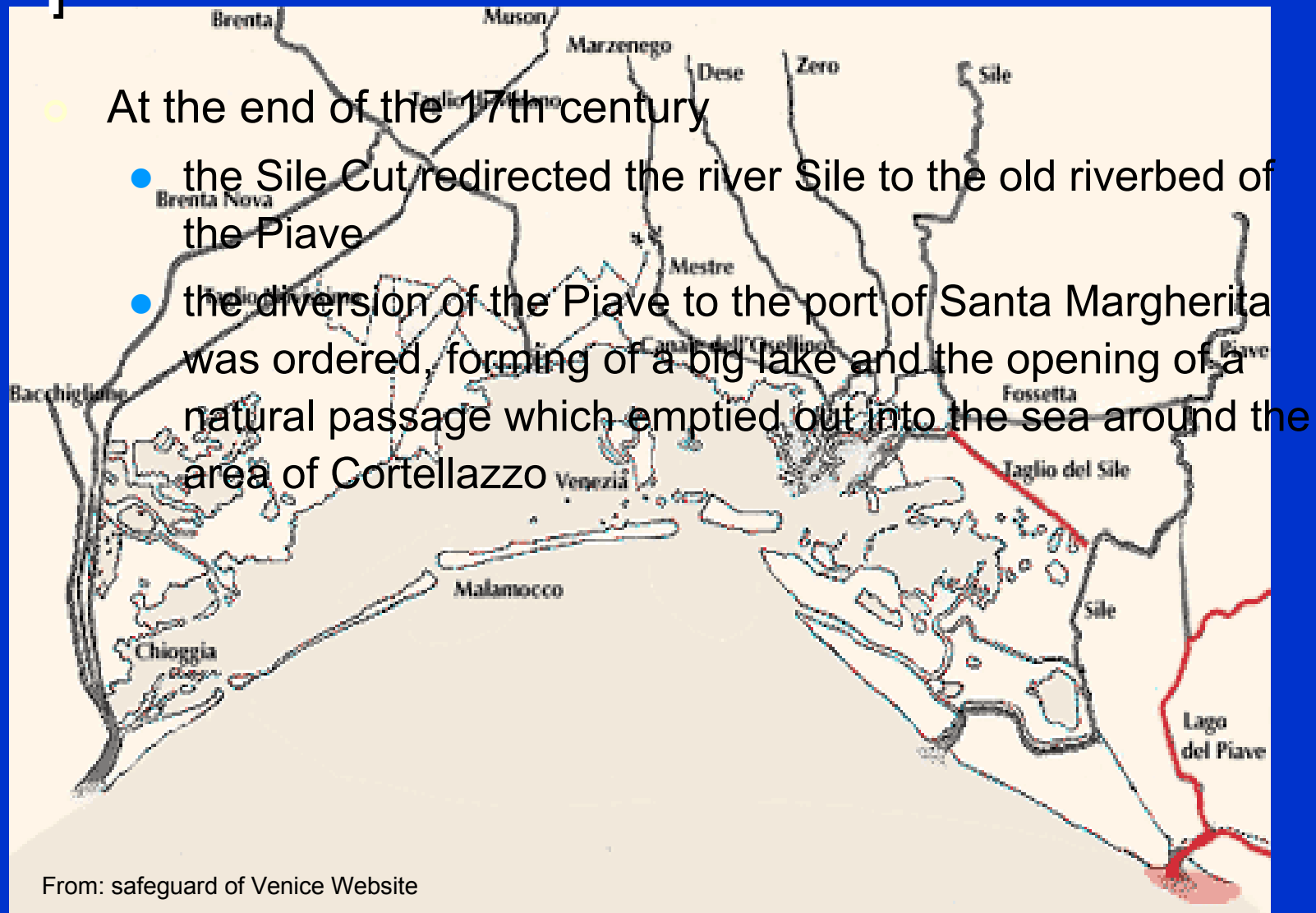


Let's see it: 1600 picture



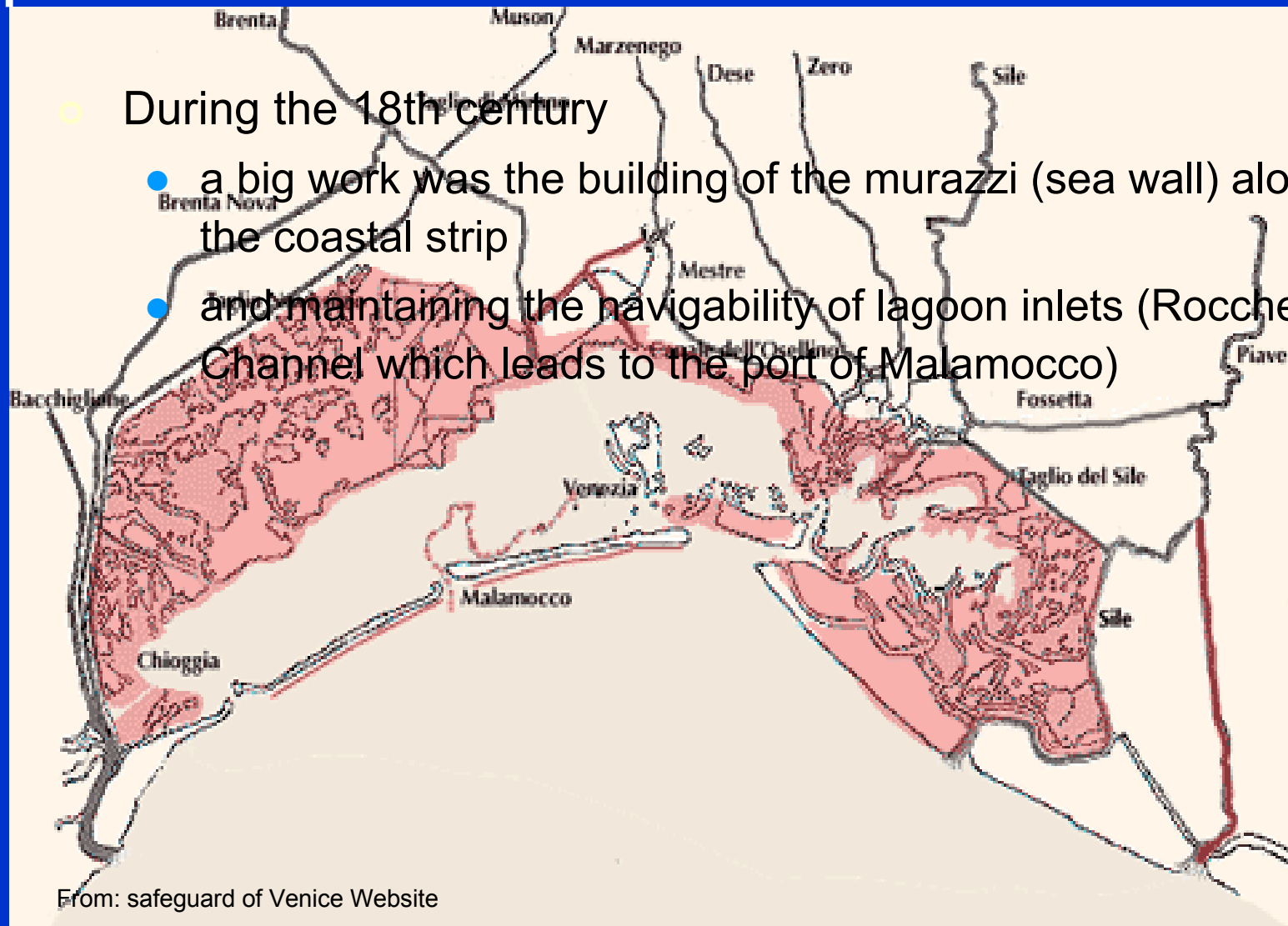


Let's see it: end of 1600 picture



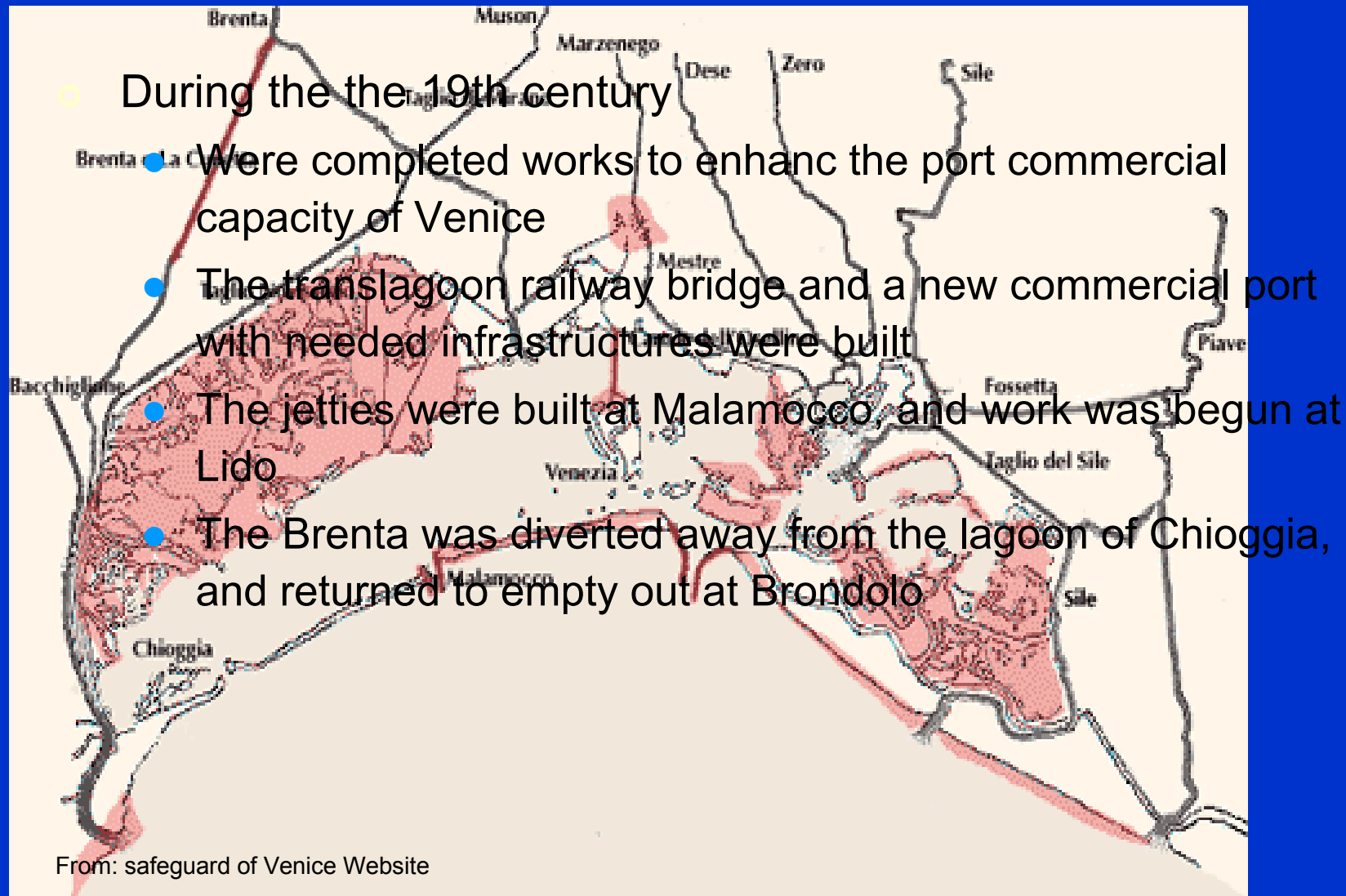


Let's see it: 1700 picture



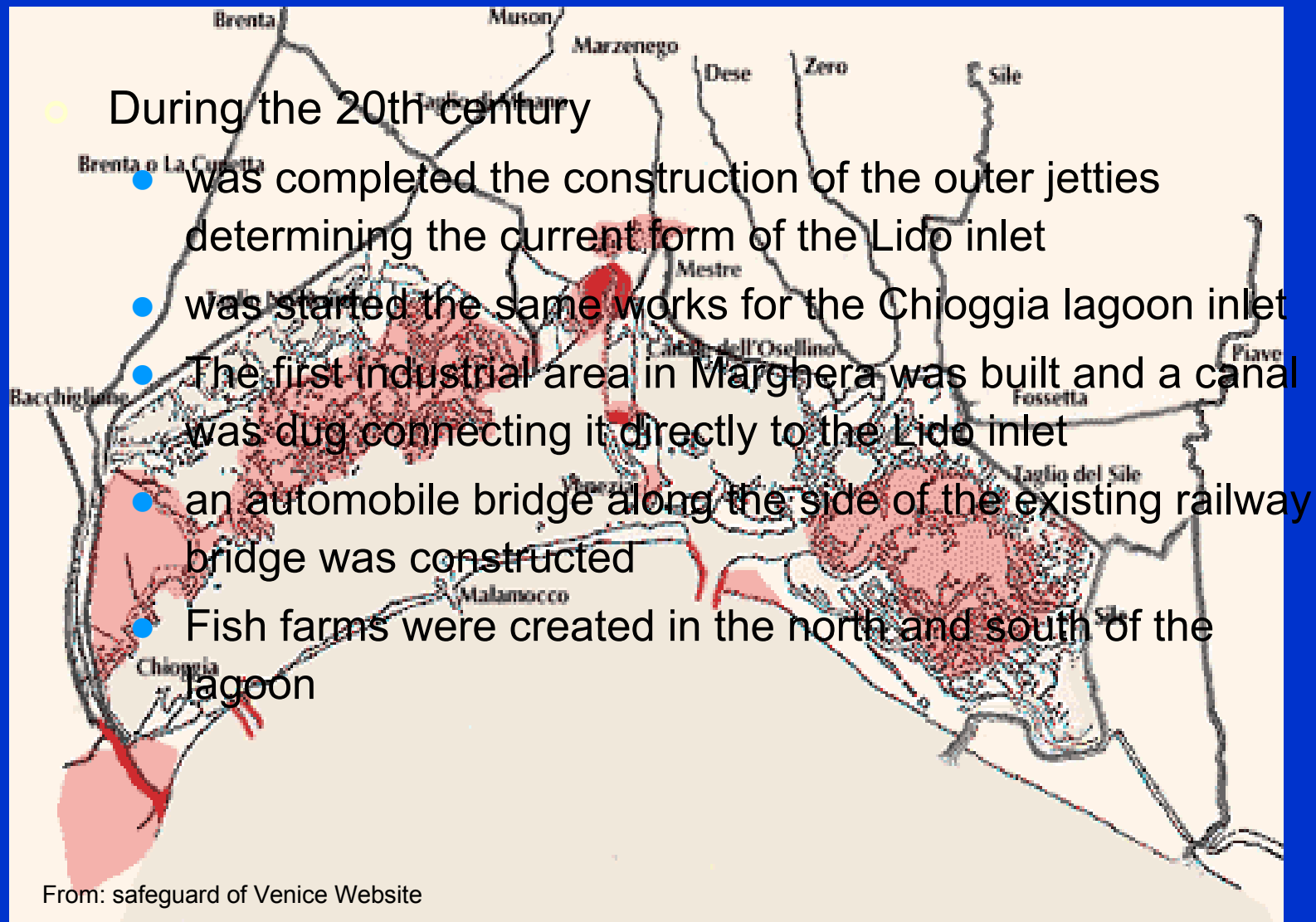


Let's see it: 1800 picture



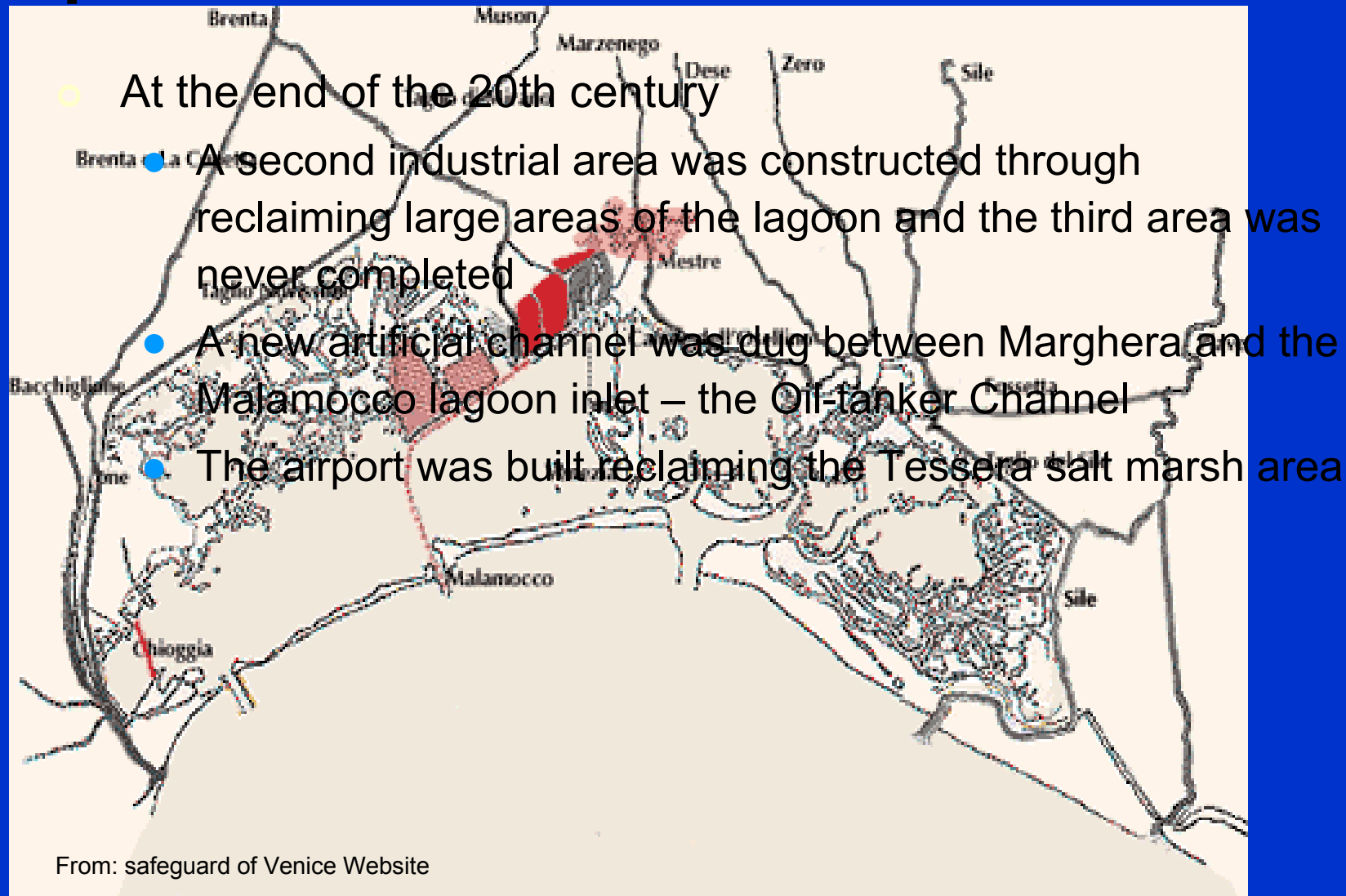


Let's see it: 1900 picture





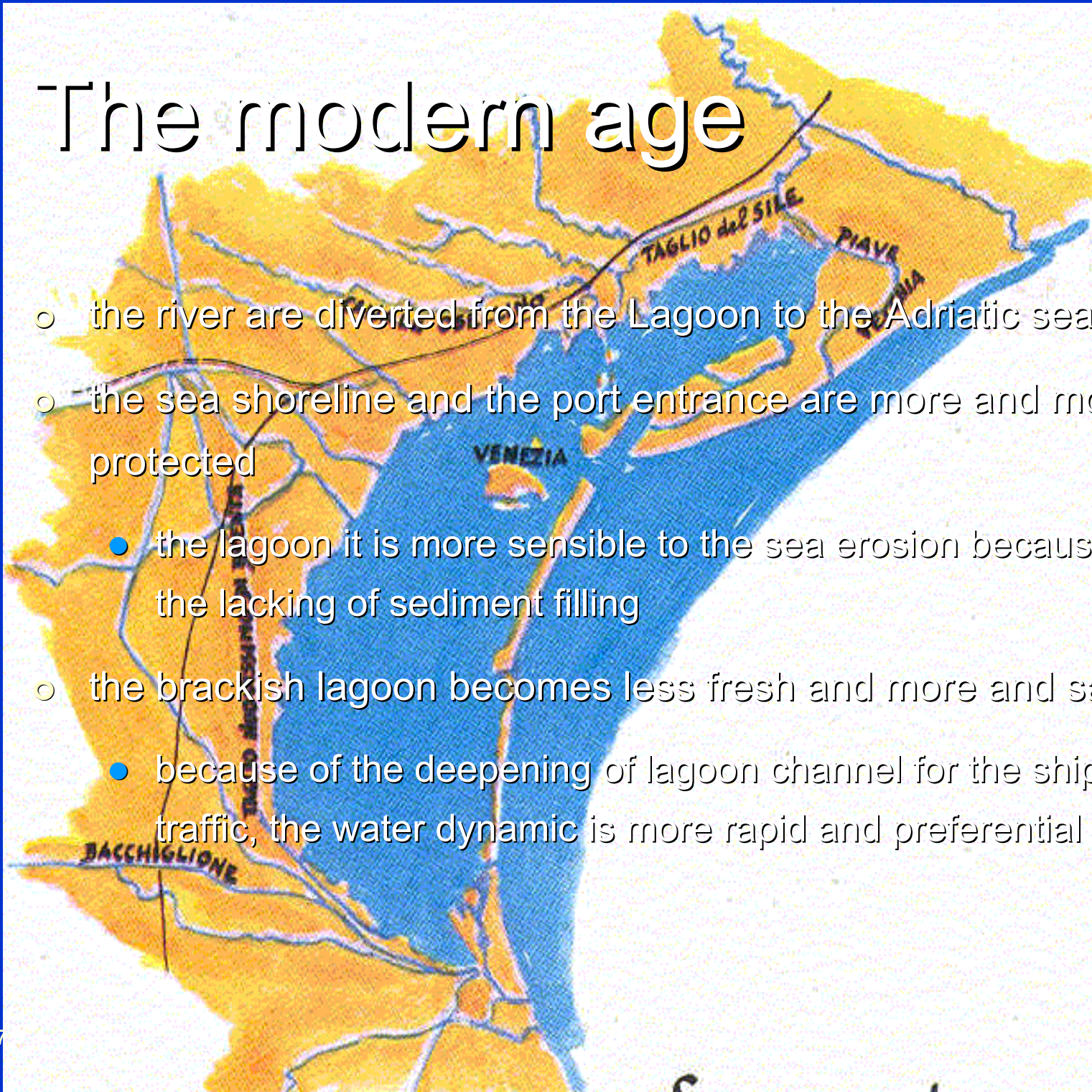
Let's see it: end of 1900 picture





The modern age

- the river are diverted from the Lagoon to the Adriatic sea
- the sea shoreline and the port entrance are more and more protected
 - the lagoon it is more sensible to the sea erosion because of the lacking of sediment filling
- the brackish lagoon becomes less fresh and more and salty
 - because of the deepening of lagoon channel for the ships traffic, the water dynamic is more rapid and preferential





First conclusion

- the human activity has strongly influenced the evolution of the Lagoon of Venice, and the lagoon would not exist today without the human activity
- the ecological/cultural legacy of the Venice lagoon landscape comes from the co-evolution of non human and human processes at different scale
- the human processes can be (in my opinion *have to be*) considered as ecological processes in a landscape ecology perspective
- why need to consider these dynamics to develop sound evaluations in a decision process for planning or design purpose

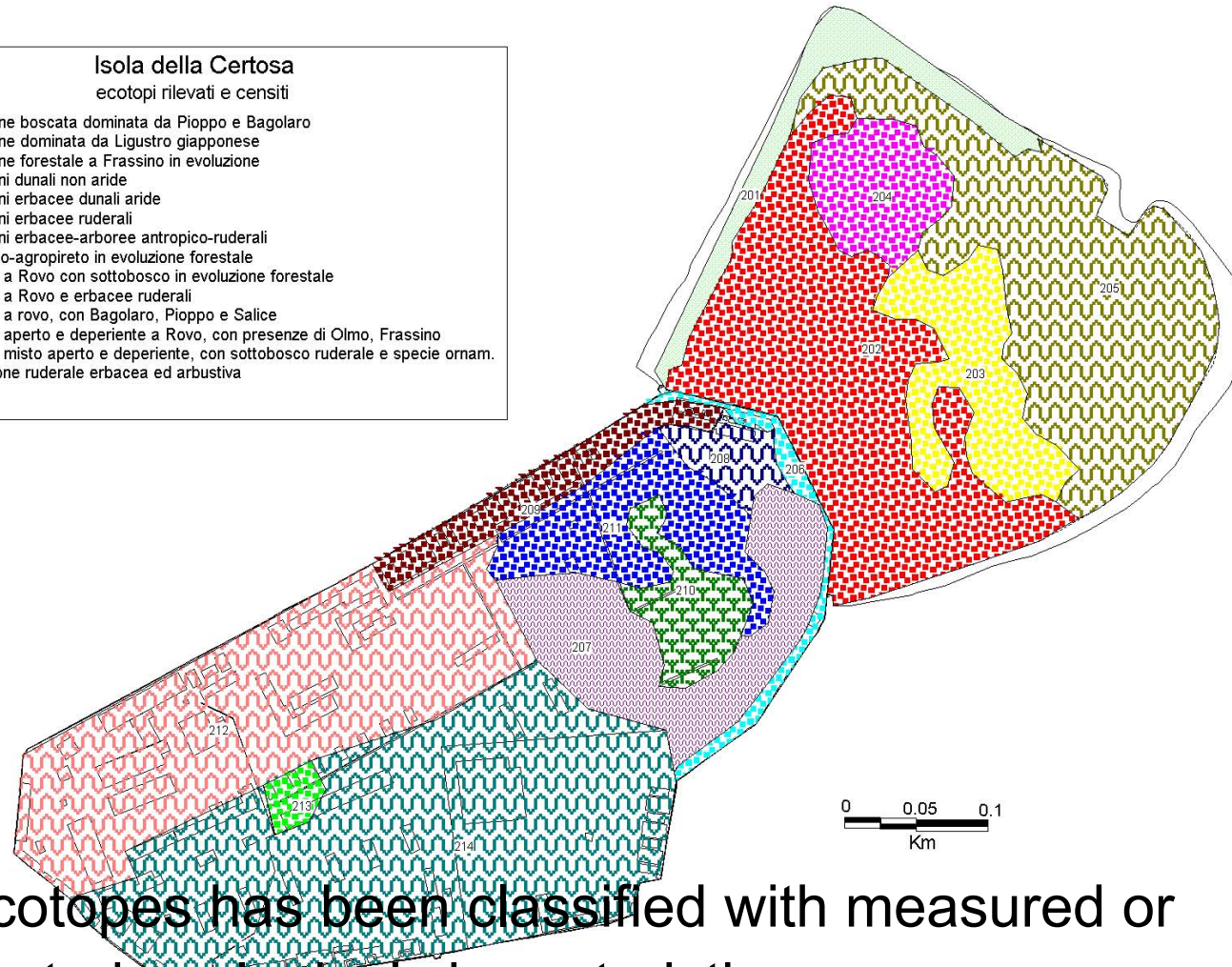


A case study

- the Certosa Island analysis and evaluation
- The approach
 - hierarchy and scale considerations



Ecotopes classification



every ecotopes has been classified with measured or estimated ecological characteristics



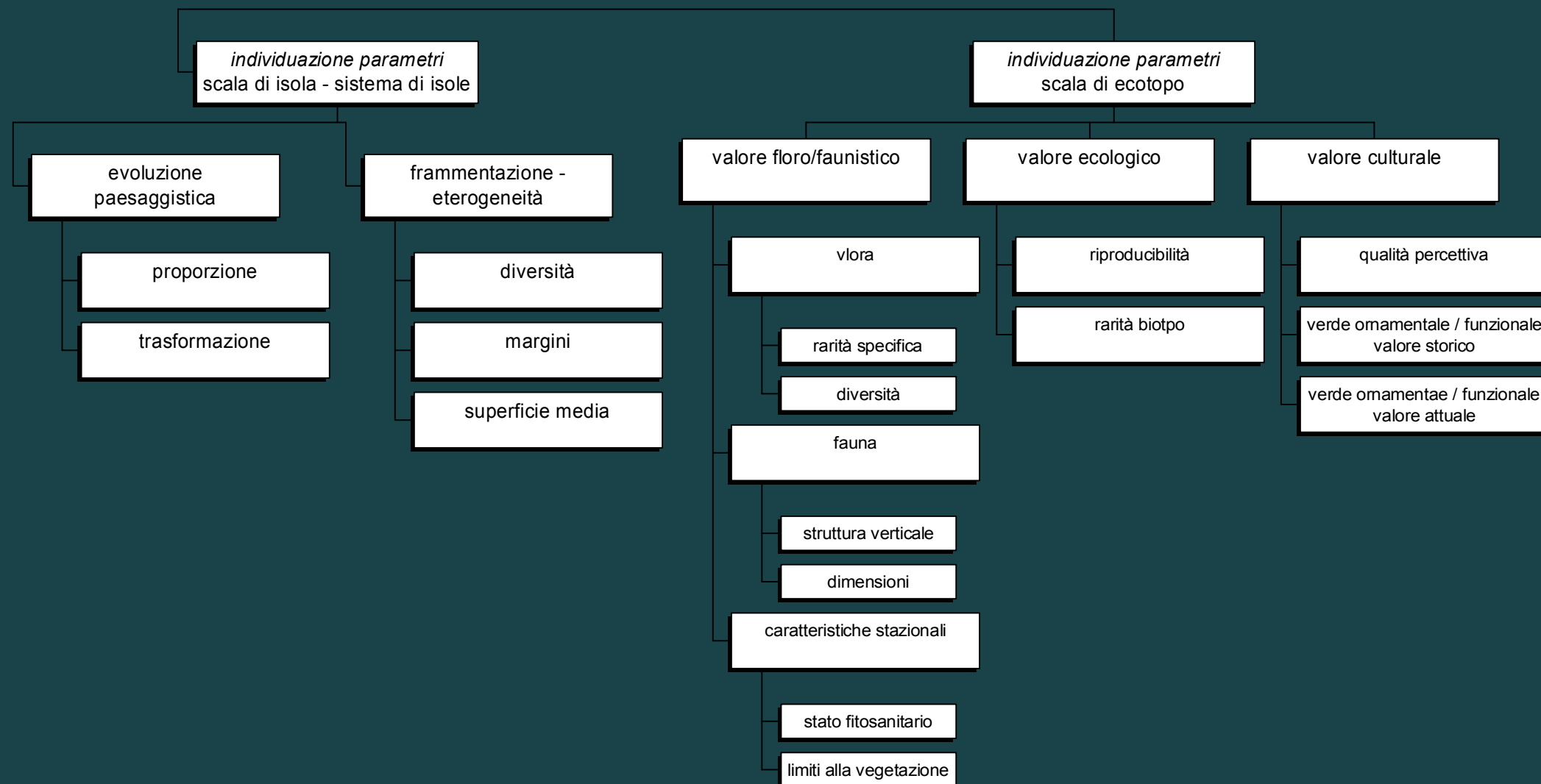
The evaluations

- an evaluation model has been built up utilizing some indexes (the less redundant and the most robust) hierarchically connected
- the model is built to give information at the single ecosystem (ecotope) level, and at the ecosystem mosaic level (the Certosa Landscape)
- the low level indexes have the same evaluation dignity (they have the same potential influence for the final judgement construction)
- the hierarchical structure it's an understanding tool of the problem and permit to rebuild the significance of the evaluation process (clearness of the value)



The evaluation model structure

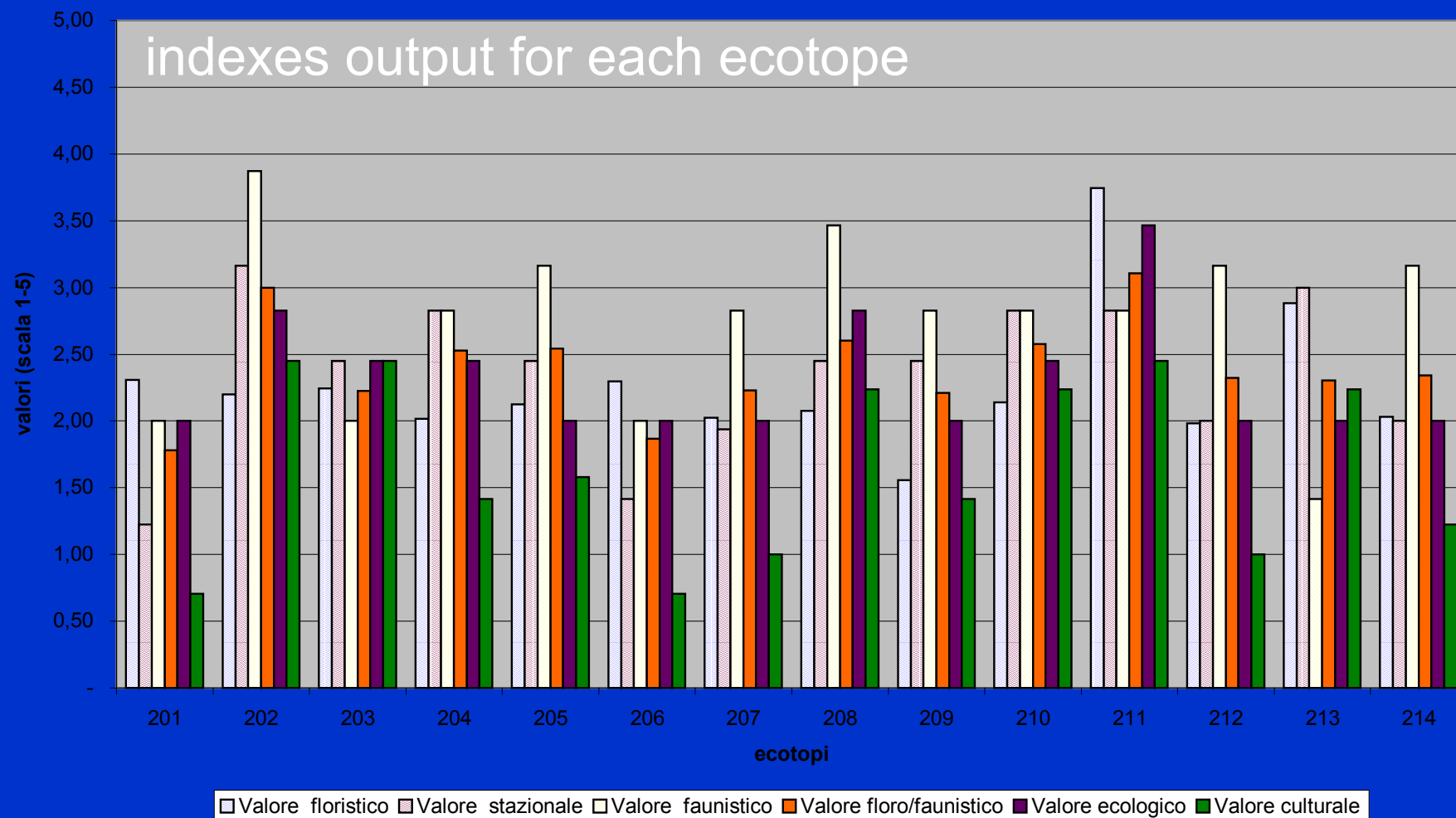
rapporti gerarchici tra criteri, sottocriteri ed indicatori individuati





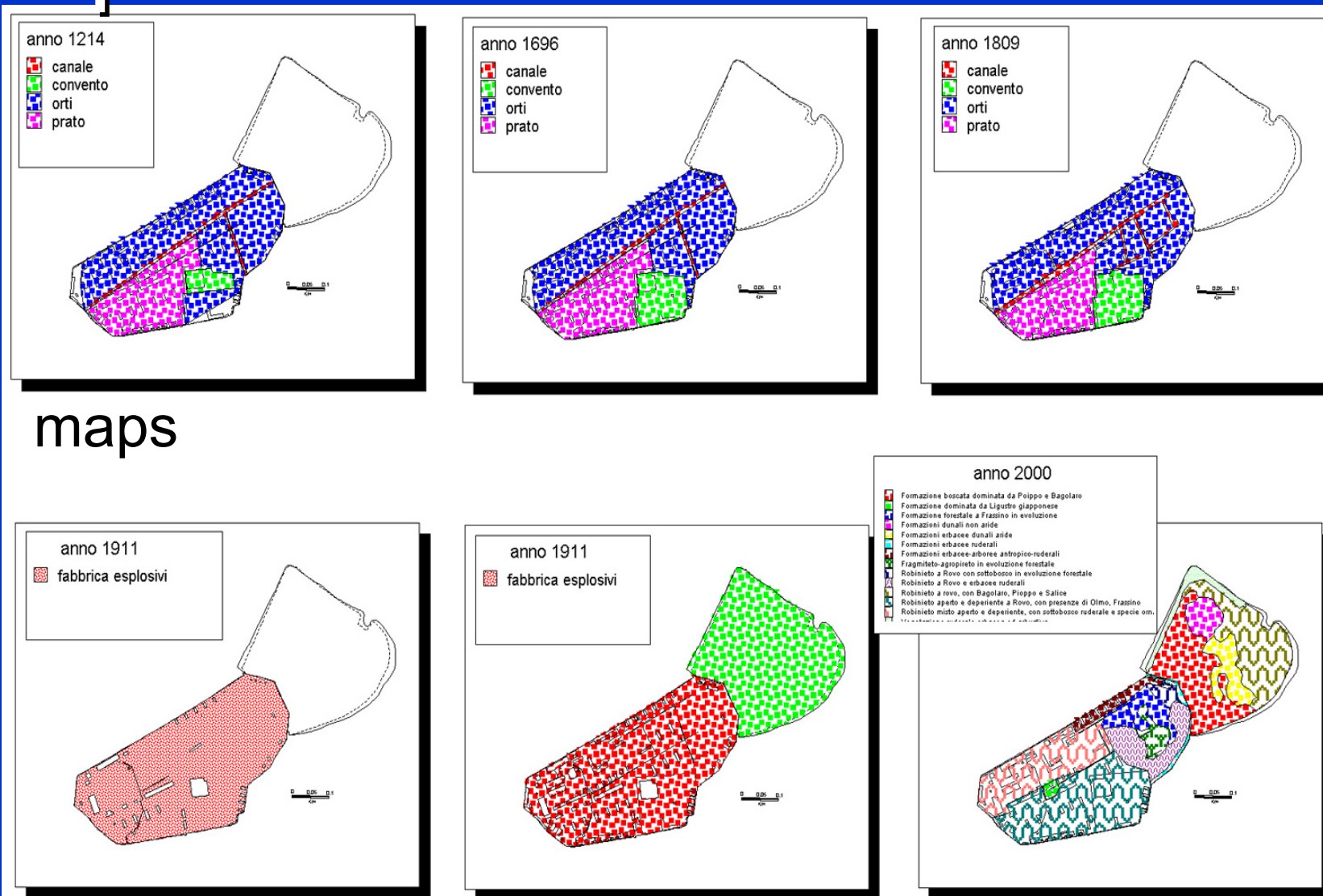
The Certosa space scale evaluation

La Certosa





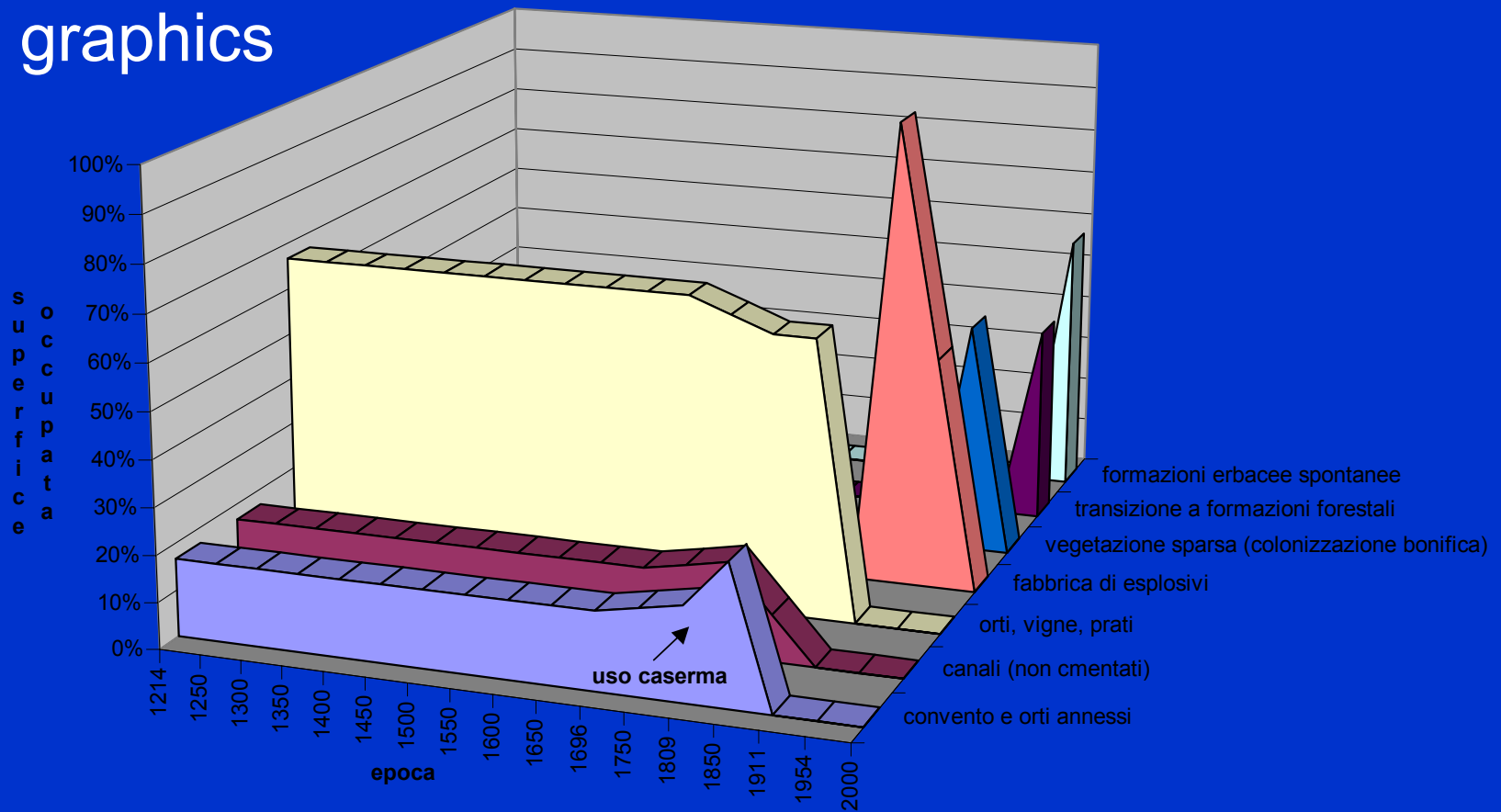
The Certosa time and space scale evaluation





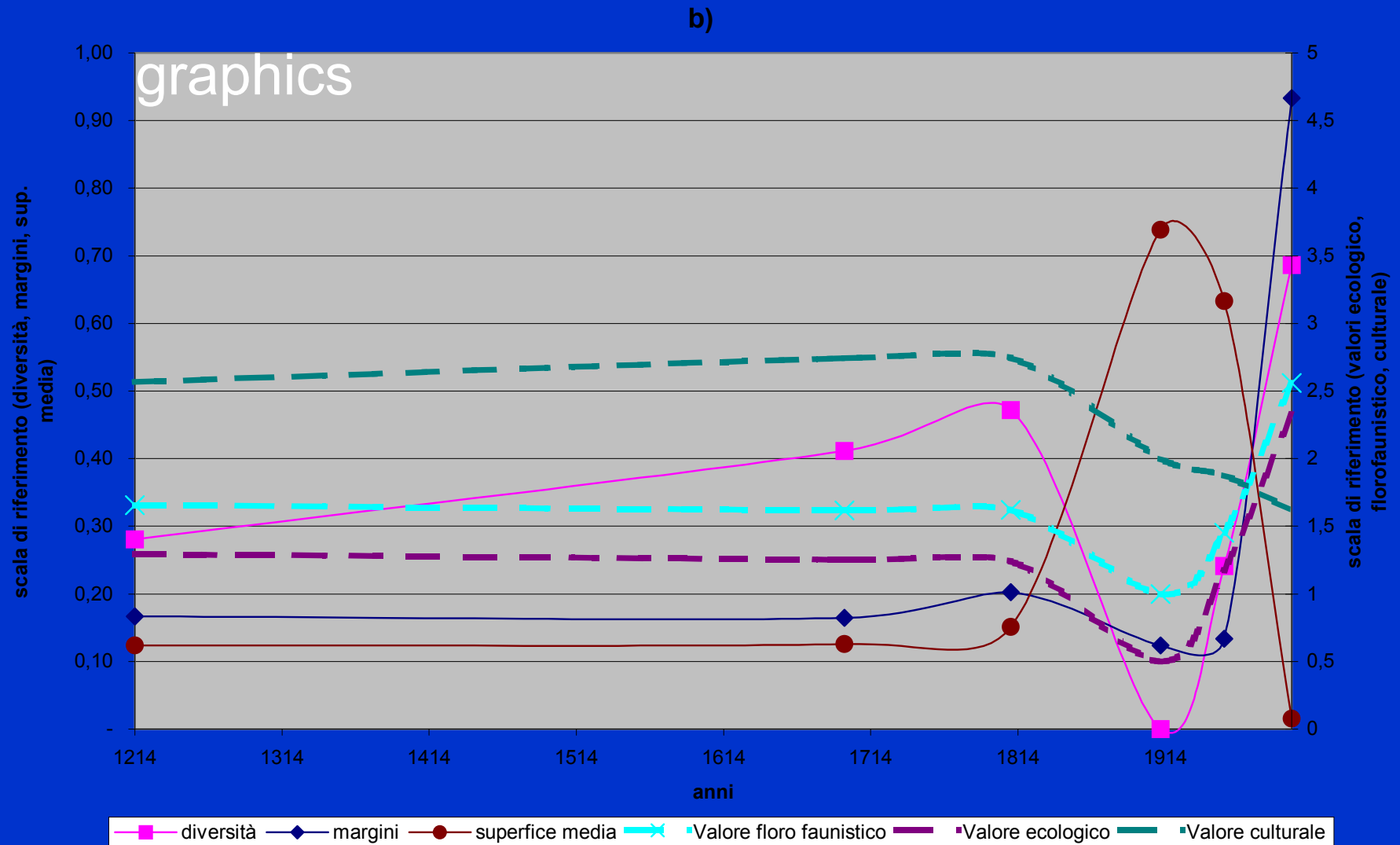
The Certosa time and space scale evaluation

graphics





The Certosa time and space scale evaluation





Conclusions

- the landscape dynamic shows that
 - the cultural weight has to be accounted for the destiny of the Certosa (as for all the Lagoon)
 - the pattern (lagoon rural configuration) remains constant for +- 7 centuries, and then changes abruptly (low diversity during the military- industrial period, high diversity after the abandonment)
 - the natural (floro-faunistic) and ecological (reproducibility, rareness) values of the single ecotopes and of the whole Island are generally not very high
 - the highest ecological interest lies on the scientific evolution analysis of some ecotopes (unknown)
 - the cultural values of the single ecotopes and of the whole Island) are generally low (real world condition) but high from the planing expectation point of view