

GRM2121 Field Studies II

Naturalistic aspects of the lagoon of Venice

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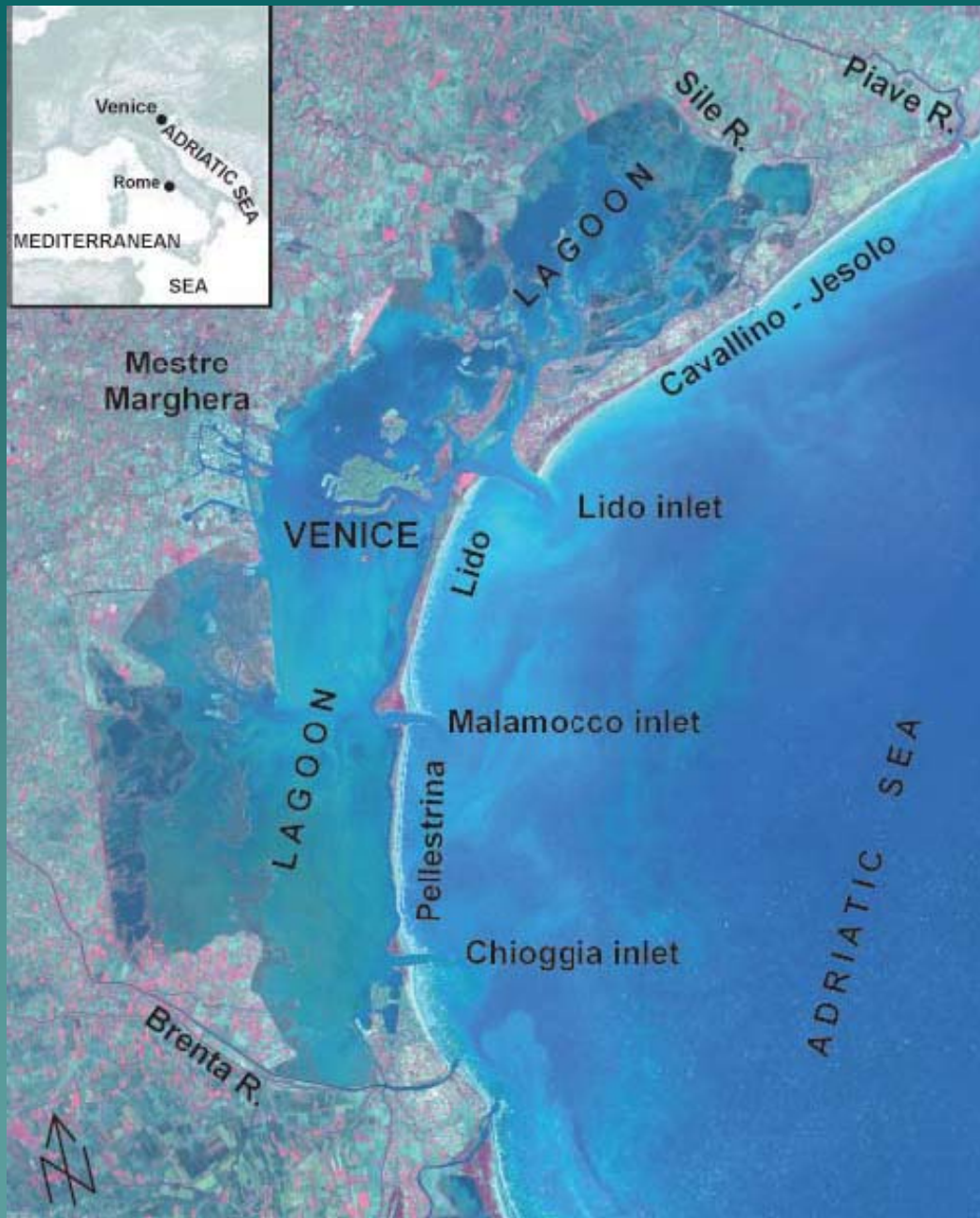
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Background of the Venetian Lagoon

- ◆ Venice is a city in northern Italy
- ◆ City of Water
- ◆ stretches across 118 small islands in the marshy Venetian Lagoon along the Adriatic Sea



Background of the Venetian Lagoon

- ◆ Lagoon of Venice is a typical ecotone and is an open, complex, ordered and dynamic system
 - ◆ low average depth
 - ◆ subject to variation
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- A decorative graphic at the bottom right of the slide, consisting of a silhouette of a mountain range in various shades of teal and blue.

◆ **Video: Venice Under Siege - Italy**
(1996)

<http://www.youtube.com/watch?v=XrOoW38JWsw>

Morphology evolution

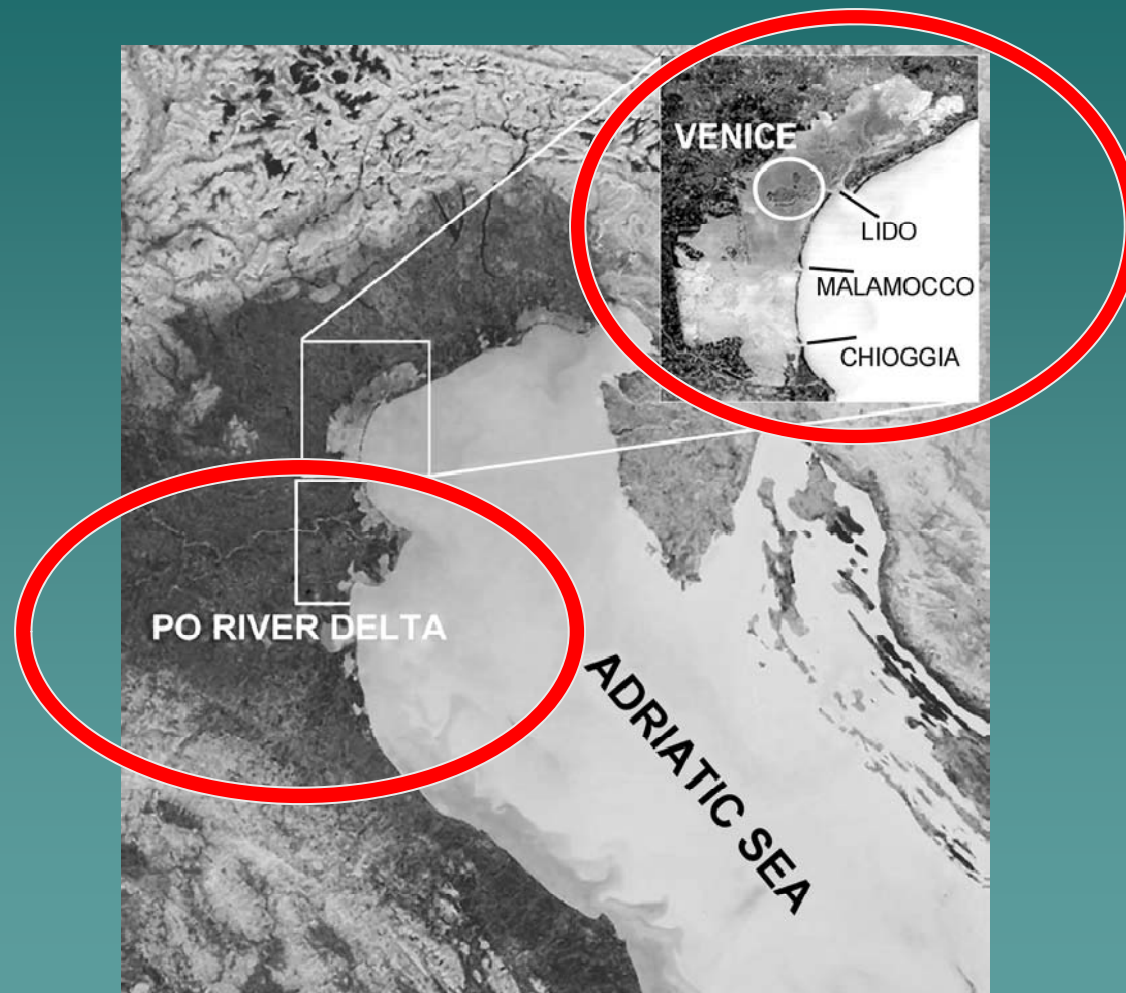


Morphology

- ◆ situated along the low-lying coast in the east of the Po Plain
- ◆ the largest lagoon on the margins of the Adriatic Sea

Venice Lagoon morphology	
Total Areas	550 km ²
Depth	1 m
Length	50 km
Width	8-15 km

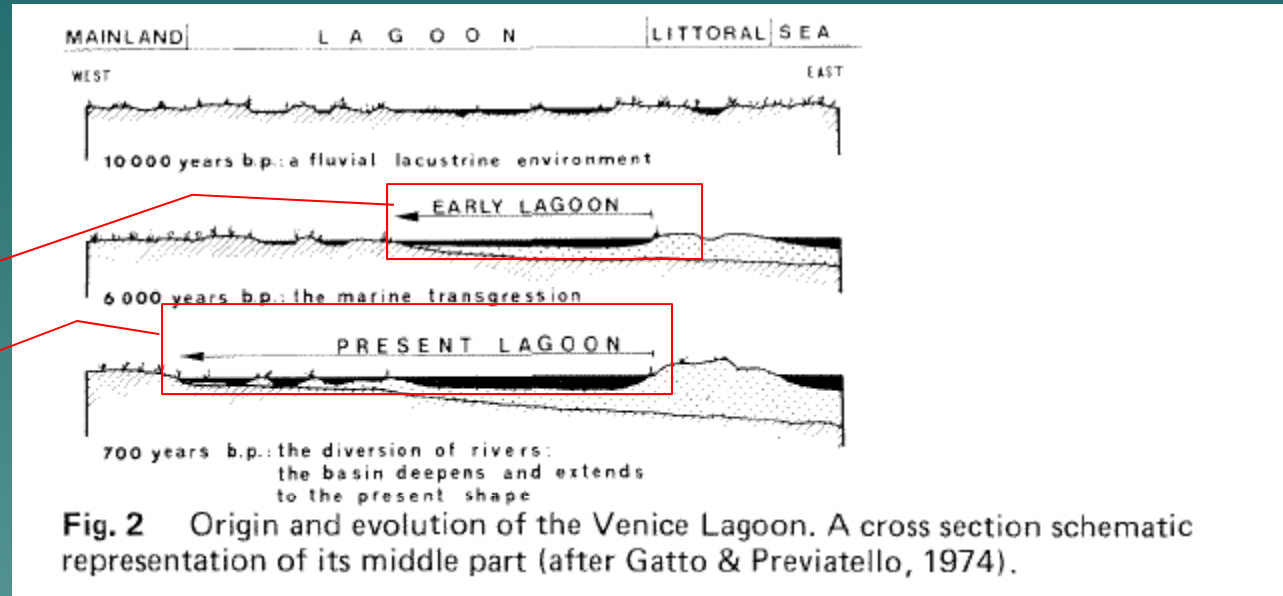
2.2. Formation of lagoon



- ◆ Lagoons are areas of shallow water near a coastal environment and have access to the sea but it is separated from the open sea by a barrier such as sandbars.
- ◆ There are two kinds of lagoons, coastal lagoons and coral lagoons.
- ◆ The Venice lagoon : coastal Lagoon
- ◆ is elongated or irregular stretches of water that lie between the coastal barrier islands and the shore line.

The formation of the Venice Lagoon is as follows. When river water in Po River reaches its mouth, the velocity is reduced to the minimum. Fine sediment becomes sticky and heavy when it meets salty water. It is laid down layers upon layer at the mouth. The sediments are deposited at the river bed as a gently sloping platform of sediment. When the surface of the platform rises above the sea level, the Po Delta is formed. As the delta grows, sediments block the river channel. The river may then overflow and split into numerous smaller channels called distributaries. This speeds up the deposition process and extends the delta. The Venice Lagoon is formed among the deposit.

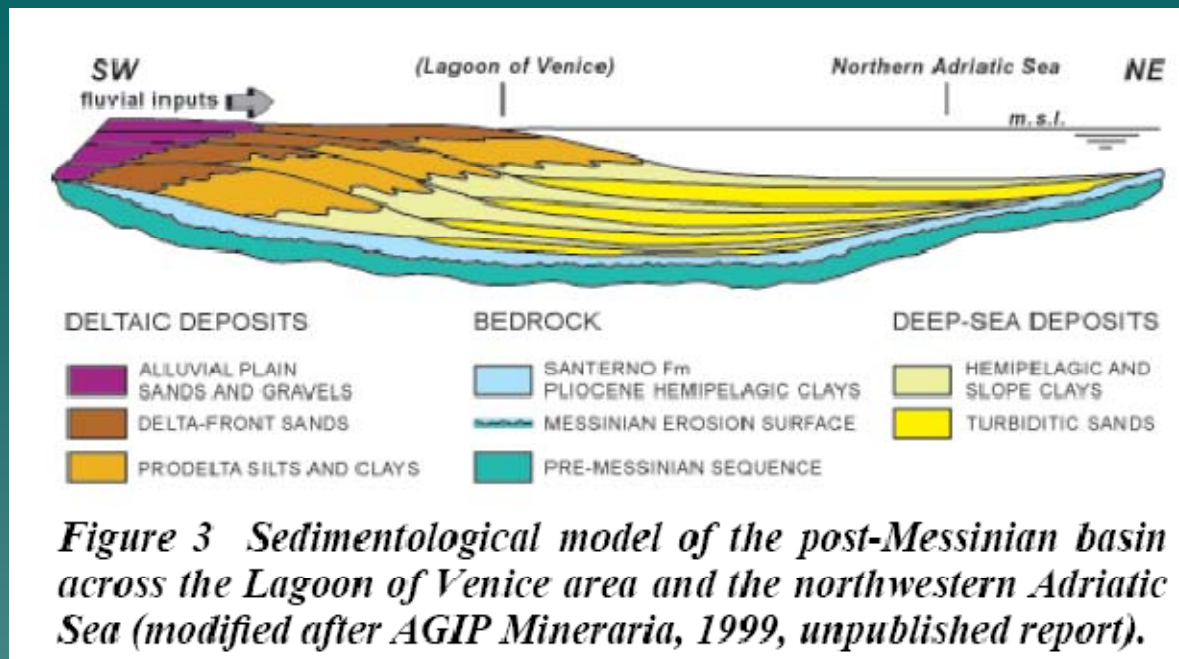
2.3 Evolution of lagoon



Smaller size of lagoon

Larger size of lagoon

- ✓The early lagoon was much smaller than the present one.
- ✓The first one is the continuous supply of sediment from Adigie, Bacchiglione, Brenta, Sile and Piave rivers.
- ✓As sediment filling is larger than natural subsidence, deposition occurs.



✓ Another factor is the there are sediment supply from the Po River when the river water flowing southward.

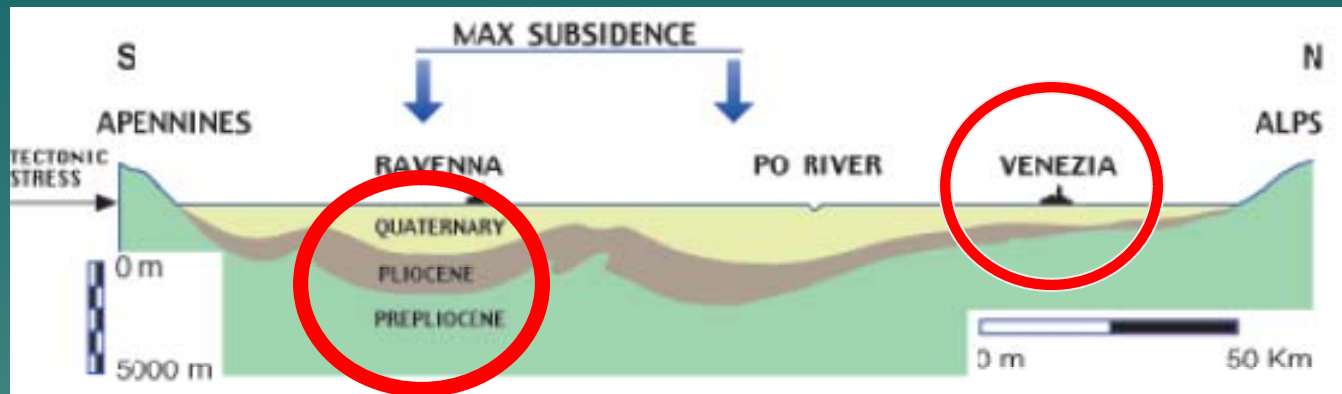


Figure 2 Schematic geological section across the eastern Po Plain (modified after AGIP Mineraria, 1969).

✓ the geological setting in Venetian Plain includes Prepliocene, Pliocene and Quaternary deposit.

✓ At the south most of this cross section, it is fold mountain Alps which is characterized overfolds and fault. As the Quaternary deposit is quite thin in Venice, there is little tectonic disturbance in the Lagoon of Venice.

- ◆ maintain a long term equilibrium by infilling with sediments in the absence of intervention.
- ◆ a natural evolution process.
- ◆ historical and economical interests in the lagoon
→undergone various anthropometric interventions since the 15th century.

Evolution of Venice lagoon

15 th – 17 th centuries	Diversion of river water from Brenta and Piave rivers around the lagoon
1791	Building of embankment of the entire lagoon margin and sea walls along the coast
18 th – 19 th centuries	The construction of jetties at the three outlets.
1900- 1093	Fish ponds are created from the lagoon for fish farming.
1920 1950	Large reclaimed lands are created at the expense of shoals and marshes
1925, and 1963-1965	Two large navigation canals are built.

2.4.Characteristics of Lagoon

- ◆ consists of the following parts, inlets, coastal strips, mud flats, salt marshes, island, fish farms, reclaimed areas and islands.



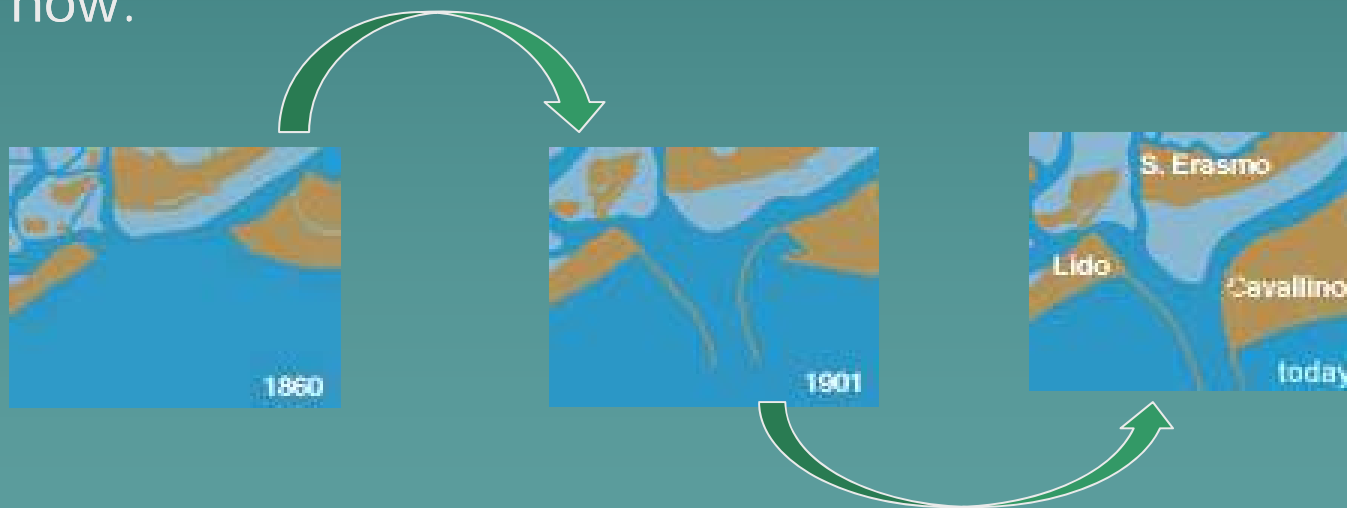
Satellite image of the Venice Lagoon.

2.4.1 Inlets

- ◆ The Venice Lagoon is connected to the northern Adriatic Sea through three wide and deep inlets, they are the north inlets, Lido; the central inlet, Malamocco and the south inlet, Chioggia.

2.4.2 Coastline

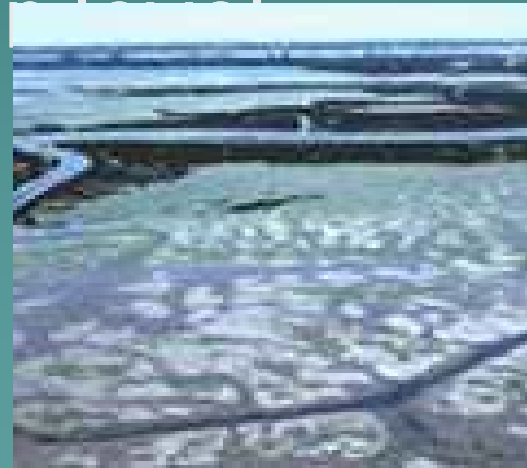
- ◆ Coast line : long elongated coastal barrier stretches
- ◆ about 60 km
- ◆ includes the coastal strips of Jesolo, Cavallino, Lido, Pellestrina, Sottomarina and Isola Verde.
- ◆ not stable as they are subject to erosive action by wave.
- ◆ For example, we can trace the evolutionary processes of coastlines in Lido, S.Erasmo and Cavallino from 1860 up till now.



Lido, S.Erasmo and Cavallino

2.4.3 Mudflat

- ◆ soft land area and usually not cover with any vegetation.
- ◆ found underwater except during low tide that they emerge to the surface due to the low water level.



Mudflat emerges during low tide

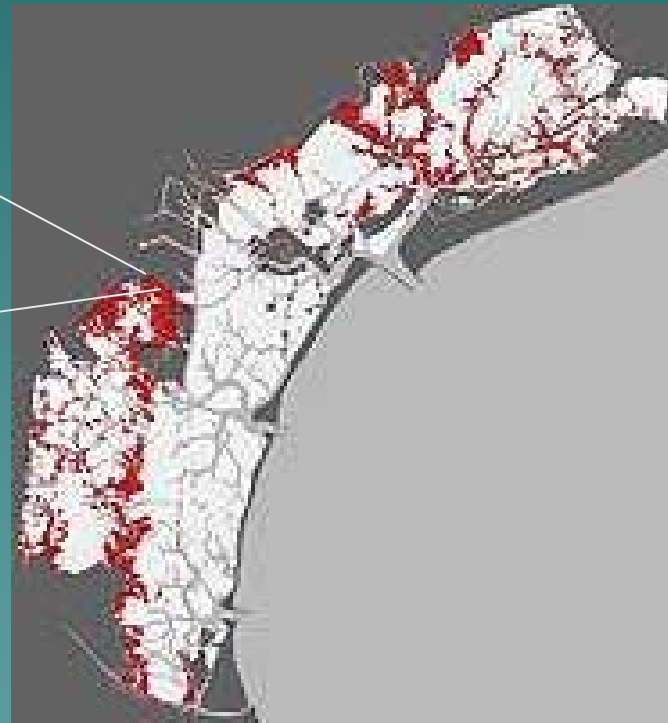
2.4.4 Salt marsh

- ◆ consist of ground areas which are usually found above the sea surface but only occasionally submerged.
- ◆ provided valuable habitats for a wide variety of wild animals especially water birds.
- ◆ perform other ecological functions like regulating the hydrodynamics of the lagoon by encouraging water exchange and reducing wave action.

The red color shows the location of salt marshes.



Salt marshes are always found above the sea surface



2.4.5 Channels

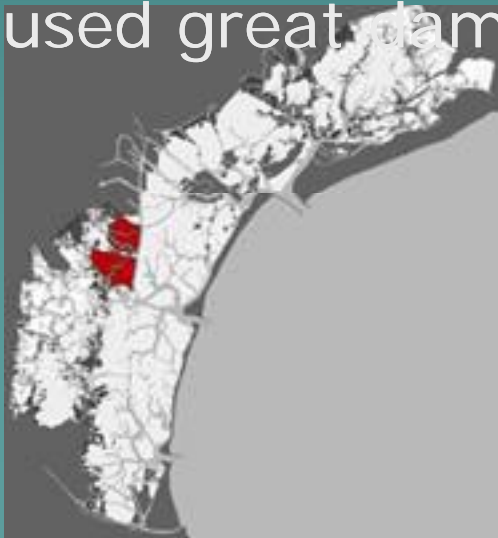
- ◆ total surface area of 67.3 km².
- ◆ link the lagoon and open sea, ensuring the exchange of water between them through the three inlets.



The green color shows the channels in the lagoon

2.4.6 Reclaimed area

- ◆ areas with 11.36 km²
- ◆ located at the south of Venice Lagoon which is an industrial area in Venice.
- ◆ Reclamation is taken place on lands that are previously salt marshes in order to cope with the expansion of industrial zone.
- ◆ artificial small channels called tidal creeks are built cross the salt marshes and link the main channel with the sea.
- ◆ caused great damage to ecological balance



The red color shows the reclaimed area.



Salt marsh before reclamation



Salt marsh after reclamation

2.4.7 Islands

- ◆ found further inward from the water shore.
- ◆ found in the central basin of the Lagoon.
- ◆ built by various processes such as sedimentation of solid materials and accumulation of transported materials.
- ◆ account for 8% of the total surface area
- ◆ the main land for dwellers with some of the islands are artificial one.



The islands are where people live.

2.5. Water levels

- ◆ Naturally, there is a higher water level in the Southern lagoon and lower levels in the northern lagoon when comparing with the open sea because surface wind stress from the northeasterly bora creates a north-south surface slope. This strengthens the outflow at the Chioggia inlet and reinforces inflow at the Lido.

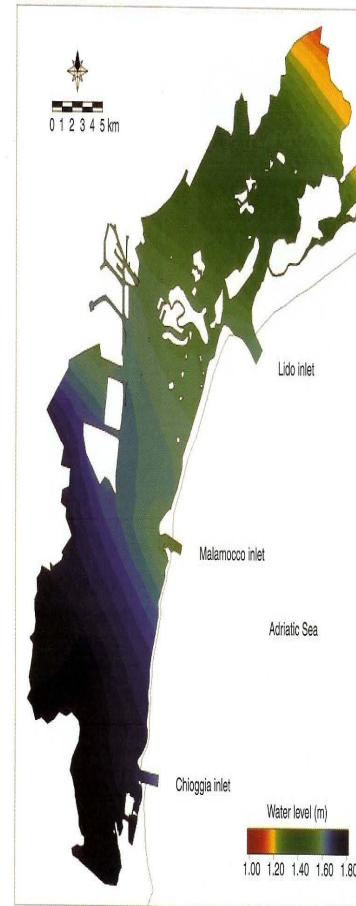


Plate 5 Spatial variability in maximum water level on 8 December 1992, showing the effect of a *bora* (NE) wind (see Ferla, chapter 12).

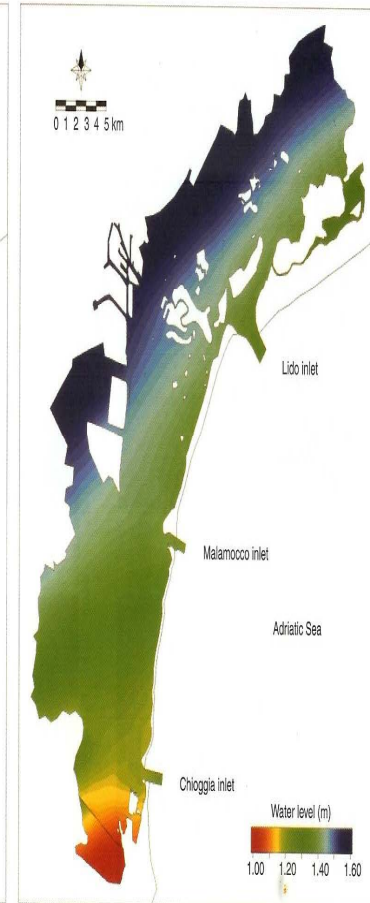


Plate 6 Spatial variability in maximum water level on 6 November 2000, showing the effect of a *sirocco* (SE) wind (see Ferla, chapter 12).

Whereas southeasterly sirocco wind causes higher water level in Northern lagoon and lower levels in the Southern lagoon. The average age residence time for south-east winds is shorter than that of north-east winds.



Ecosystem and intereaction



Animal

- ◆ In coastal area (dunes and wood)
- ◆ thermophilous

Examples:
- Kentish Plover



- European green toad



Animal

- ◆ Salt marsh
 - flooded by the tide
 - habitat for some animal species
 - excellent feeding ground for birds

- ◆ Example:
 - Avocet



- Sandwich Tern



animal

- ◆ Clay quarries (swamp, wetland meadow and woods and backwaters)

- ◆ Example:
 - Italian Agile Frog

咁



- Matrix Test



Animal

- ◆ Lagoon edge

- ◆ Example:
 - Marsh harrier



- Mallard



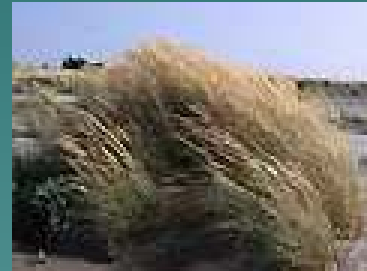
Animal in water

- ◆ Fishfarm

vegetation

- ◆ Coastline vegetation:
 - formed by coastal strip
 - acting as a 'sand holder'

- ◆ Example
 - Marram Grass



Vegetation

- ◆ Salt marshes:
 - = soil with high salt content
 - ideal for halophytic species
 - = plants which need salty soils
 - = 'salt remove mechanism' e.g. throwing leaves

- ◆ Examples:
 - Cord Grass



- ◆ Juncus Maritimus



Vegetation

in water:

- ◆ Reedbed:
 - adapted for fresh water environments
 - grow around waterways and swamps.

- 'boundary plant'
- example

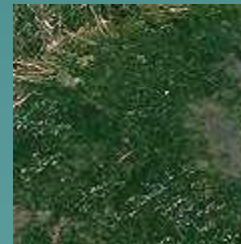
- ◆ Phragmites Australis



- ◆ Lagoon bed:
 - eelgrass protect lagoon soil



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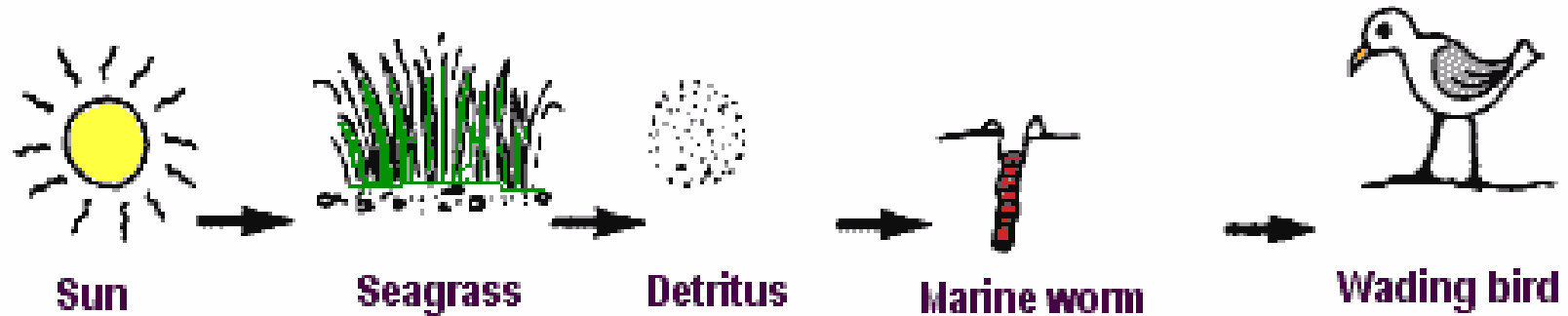
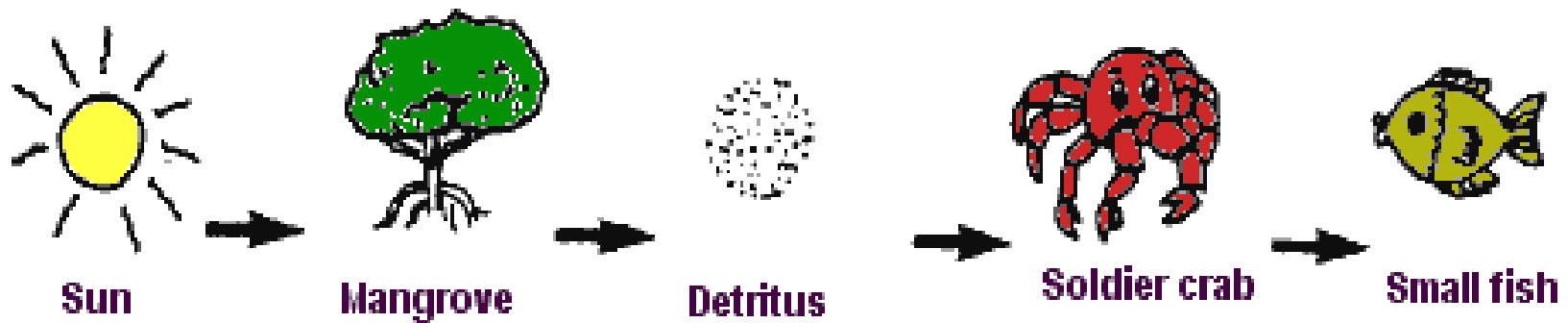


Marittima

Ecosystem--- intereaction



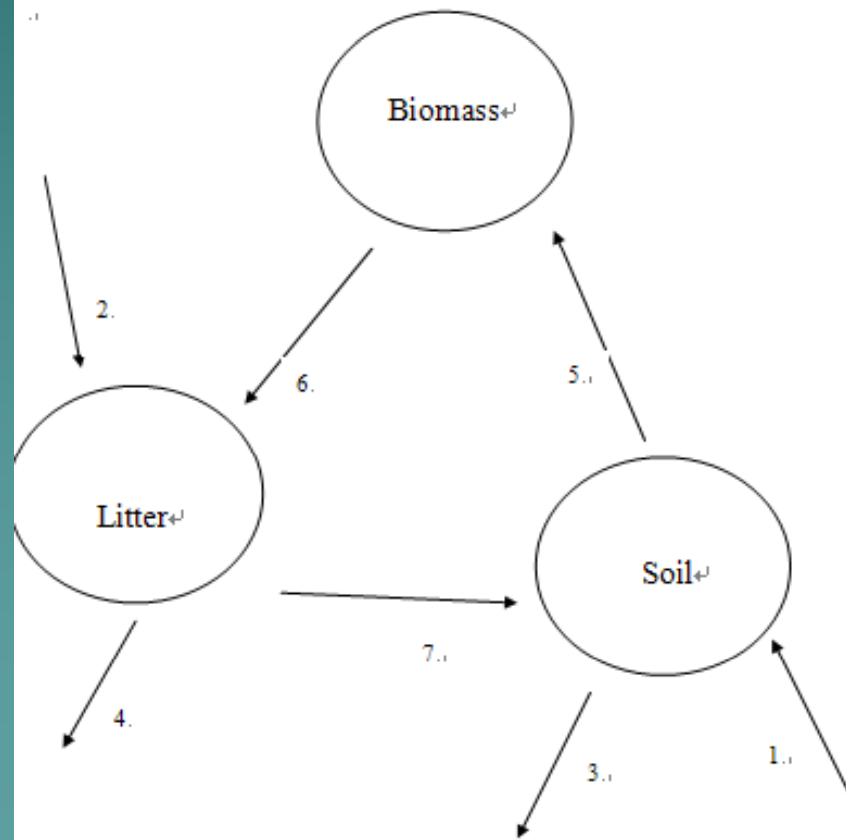
Food chain



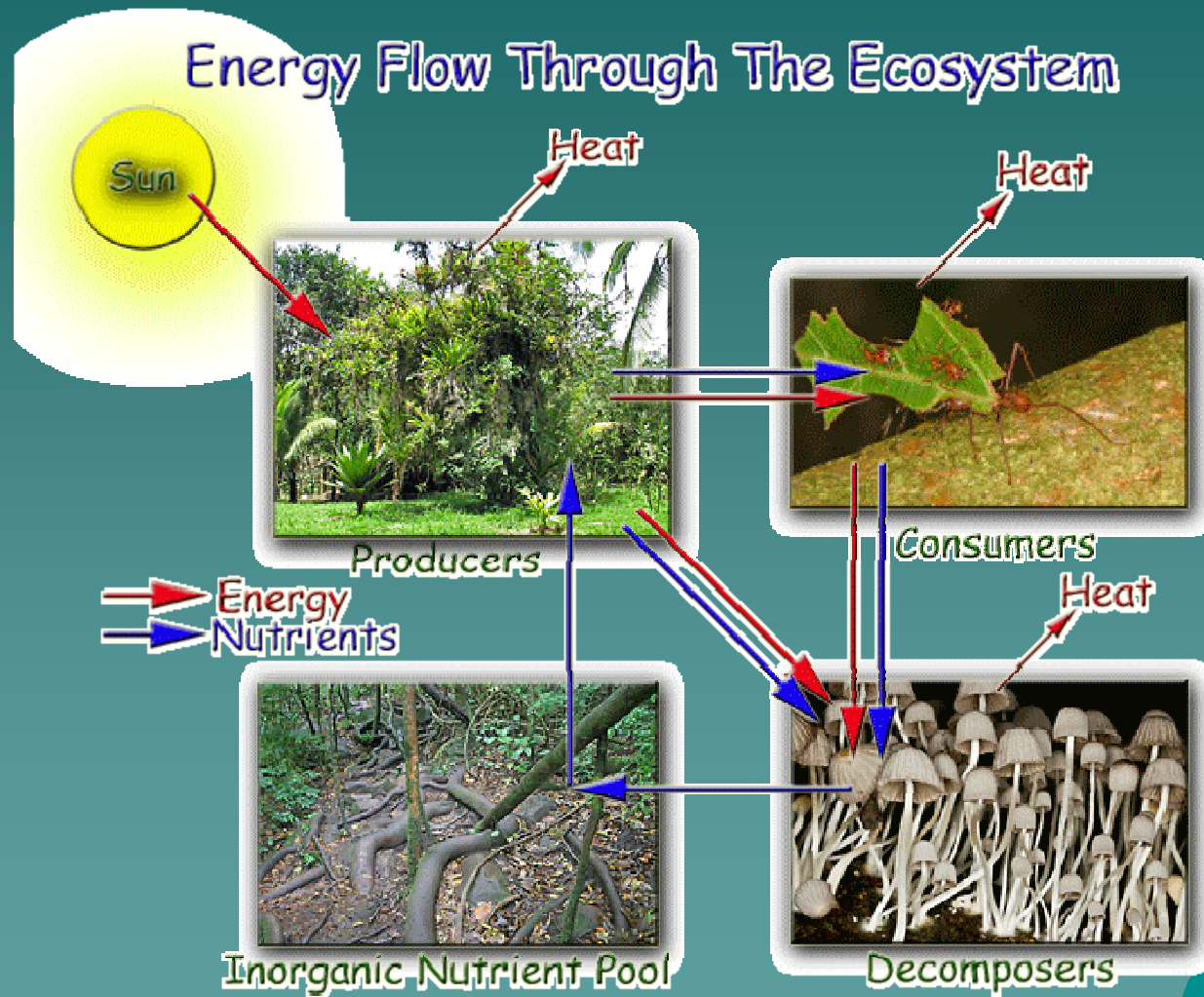
nutrient cycle

1.,	Nutrient release as litter decomposes.,
2.,	Nutrient input from weathered rock.,
3.,	Nutrient loss by leaching.,
4.,	Nutrient loss in runoff.,
5.,	Nutrient uptake by plant.,
6.,	Nutrient fallout when plant tissues die.,
7.,	Nutrient input dissolved in rainfall.,

Picture 群組左~~ 要改就要取消群組.,



Energy flow



Human interference on Venice's lagoon

The background is a solid teal color. At the bottom right corner, there is a silhouette of a mountain range or a jagged coastline, rendered in a slightly darker shade of teal.

Human activities

- ◆ Fish Farming
- ◆ Reclamation
- ◆ Transport
- ◆ Tourism
- ◆ Government Policies



Fish Farming

- ◆ major part of the culture of the Venetians
- ◆ shellfish production in the Lagoon is one of the most productive in Europe (because of the tidal influence).
- ◆ in the open Lagoon or in the fish farms ("*valli*")
- ◆ Fish farms are lagoon areas separated from the open lagoon by banks that block them off from the ebb and flow of the tide.
- ◆ Unregulated, illegal, catching of these very profitable mollusc, using drags which scrape the bottom, has exacerbated the erosion problem in the Lagoon.

Fish Farming

- ◆ Fish farms make up 1/6 of the entire area of the lagoon, and have a total surface area of 92.22 square km, this surface area can be divided as follows:
- ◆ closed lagoon (water areas): 84.76 square km;
- ◆ confining banks: 4.98 square km;
- ◆ internal banks and islands: 2.48 square km.



Types of Transport in the

- ◆ Waterbus
 - public boats
- ◆ Water Taxi
 - can hold up to 10 people
- ◆ Gondola
 - beautiful but expensive
- ◆ Traghetto
 - means "ferry" in Italian



Transport in Lagoon

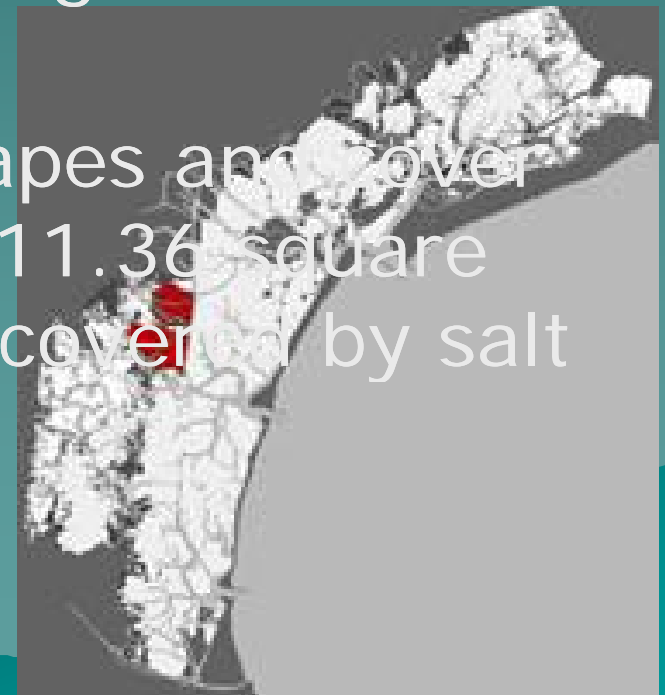
- ◆ a city built on water, as a matter of necessity, to maintain shipping channels.
- ◆ Since the industrial revolution, the size of ships and the number of motor boats have increased dramatically;
- ◆ Keeping the channels for navigation worsen the problem of erosion
- ◆ A lots of smaller motor-boats using the canals of the City and the Lagoon add to this problem.

Transport in Lagoon

- ◆ This is a fundamental problem of the survival of the City and Lagoon; if it is not solved, there is little hope for the long-term survival of Venice.
- ◆ With the lagoon being so shallow, *vaporetti* and other larger boats must travel in dredged navigation channels to avoid run-ins with mudflats and sandbanks.
- ◆ Dredging of shipping channels → Increase the speed and volume of surface flows in the lagoon

Reclamation

- ◆ The reclaimed areas, located south of the industrial port, are artificial islands constructed in the 1960's from material which came from the digging of the Oil-tanker channel
- ◆ They have geometrical shapes and cover an overall surface area of 11.36 square km, which was previously covered by salt marshes.



Reclamation

- ◆ The construction of the reclaimed areas caused a drastic reduction in the quantity and quality of the water exchanged between the lagoon and the expanses of water behind the reclaimed areas themselves.
- ◆ Greater frequency of usually high tides

Tourism

- ◆ This increase in the numbers of visitors has resulted in the generation of a vast quantity of solid and liquid waste
- ◆ puts heavy pressure on the city
- ◆ bring economic benefit to the society but also bring more pollution to the lagoon
- ◆ Tourist arrivals in Italy in 2002 → 34,087,000
(4th of the World)

Government Policy

- ◆ Aims :
 - a) to maintain a water way connecting the city with the Adriatic Sea, essential for its Mediterranean trade
 - b) to protect the city from the violence of the sea and from its enemies.
- ◆ Many artificial measures have done based on both objectives
- ◆ Lagoons lose its natural characteristic

Impacts

- ◆ Positive

 - Economic benefit → Tourism

- ◆ Negative

 - Pollution

 - chemical pollution (industry, fish farming, domestic)
 - untreated sewage
 - Oil Pollution

Chemical Pollution

- ◆ From industry, fish farming and domestic
- ◆ The development of industry and the use of fertilizers
and biocides in agriculture are the main causes of air and water pollution in the lagoon
- ◆ Operation of the industrial area around Porto Marghera has led to high levels of chemical pollution in the waters and the substrate, often with heavy metals.
- ◆ Many of the rivers coming from the Alps, which formerly provided sediments for the lagoon, now carry a heavy load of pollutants.

- ◆ Release of waste and irrigation water → eutrophication and micro-biological pollution
- ◆ Release of industrial waste water → Increase acidity

Tab. 1. Concentrations (ng g⁻¹ dry weight of tissues) of halogenated hydrocarbons in organisms collected from industrialized and non-industrialized areas of the Venice lagoon. P = pisces; C = crustacea; M = mollusca; A = algae. (from: Pavoni *et al.* 1992).

taxon	non-industrialized area			industrialized area		
	HCH	DDT	PCB	HCH	DDT	PCB
<i>Anguilla anguilla</i> (P)	18	68	383	86	170	4870
<i>Zosterisessor ophiocephalus</i> (P)	3.5	12	93	3.0	15	259
<i>Carcinus mediterraneus</i> (C)	2.0	10	72	3.6	11	451
<i>Crangon crangon</i> (C)	1.6	19	71	2.3	38	329
Amphipoda (C)	2.9	6	35	4.0	16	240
<i>Leander</i> sp. (C)	3.2	11	85	1.9	20	402
<i>Haminea navicula</i> (M)	2.7	12	62	5.9	19	179
<i>Gracilaria confervoides</i> (A)	1.8	9	17	2.2	8	24
<i>Ulva</i> sp. (A)	1.8	9	23	1.8	8	26

Untreated sewage

- ◆ Domestic sewage from mainly from food residual, rich in algal nutrients (e.g., phosphorus and nitrogen compounds), must be added to these pollutant loads.
- ◆ The untreated sewage produced by the inhabitants of Venice and its numerous tourists (about twelve million annual presences) is directly discharged into the city's 180 canals (called *rii*)
- ◆ dispersed in the lagoon by the tidal cycle


Oil Pollution

◆ Oil Pollution

The potential risk of oil pollution is increased by the use of oil-tankers of great tonnage, which increased very rapidly since the 60s.

In recent years the annual transport of oil and liquid chemical products has amounted to about 12 million tons.

Flooding in lagoon

- ◆ Land subsidence in Venice
 - ◆ sinking rate the lagoon margins are more active
 - ◆ about 5 mm a year
 - ◆ lowering of Venice has totaled 23 cm
 - ◆ erosion of the lagoon floor
 - ◆ channel silting up
 - ◆ changes in the lagoon habitat
- 
- A decorative silhouette of a mountain range in shades of teal, located at the bottom right of the slide.

Sustainable Management and development of Venice lagoon

The background is a solid teal color. At the bottom right corner, there is a silhouette of a mountain range in a darker shade of teal.

What is sustainable development?

- ◆ 'Sustainable development' was defined by the World Commission on Environment and Development

The Brundtland report provides the following content for sustainable development (Hagerhall 1988):

- ◆ People themselves have the capacity to achieve sustainable development
- ◆ A long-term perspective is necessary; there must be sufficient resources and a good environment for coming generation as well
- ◆ There must be a balance between rich and poor countries; everybody's basic needs must be provided for
- ◆ We must all, in the rich world in particular, change our attitudes and lifestyles to favor sustainable ecologically adapted development
- ◆ Development is a process that can be steered towards sustainability

Venice Lagoon

- ◆ The Lagoon of Venice is a complex and unstable system
 - ∴ sea, the watershed and the atmosphere.
- ◆ NOW, tourism = important economic resource
 - = major source of pollution
 - = ↓ quality of life of the inhabitants.

Sustainable Management and development of Venice lagoon

1. Sustainable Management Support System (SMSS) :

- a) Integrate environmental risk assessment and management;
- b) Improve stakeholder's participations in the risk assessment process;
- c) Reduce the uncertainty associated with management decisions; and
- d) Increase the communication between the stakeholders concerned with lagoon management and the risk assessors.

SMSS

- ◆ A SMSS ≠ produce solution
= identifying realistic choices
and
integrating information
- ◆ Development of SMSS : supported by TRIAD-based
- ◆ TRIAD is a procedure that integrates exposure and effects data, grouped into three disciplines: chemistry (e.g. bioavailability), toxicology and ecology (e.g. trophic index), integrity biotic index.


What is TRIAD in the SMSS?

- ◆ TRIAD is a procedure that integrates exposure and effects data, grouped into three disciplines: chemistry (e.g. bioavailability), toxicology and ecology (e.g. trophic index), integrity biotic index.

- ◆ The sustainable management support requires the definition of trophic state and ecological integrity indicators.
- ◆ This current activity in Venice aims to develop the ecological quality indices from biological, ecological, ecotoxicological and chemical indicators.

- ◆ In conclusion, the sustainable principle of establishing a symbiosis between the social-economic development of Venice and the conservation of its environment should be adopted.

Conclusion

- ◆ Ecologically and economically valuable
 - ◆ Undergo human alternations
 - ◆ Improve efficiency of sea transport
 - ◆ Enhance Venice's port and commercial capacity
 - ◆ Reduce erosion, enhance industry, reclaim land, and promote aquaculture
 - ◆ Protect natural beauty
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- A decorative graphic at the bottom right of the slide, consisting of a silhouette of a mountain range in various shades of teal and blue.

The End



Q & A

