4th Mediterranean Shipping Conference
On the way to a Mediterranean Emission Control Area
20th November 2019, Athens

Ship Pollution and Cultural Heritage

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Cultural Heritage at Risk: Venice November 2019

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Alleanza da capire e ricostruire

MA È D'ACQUA OGNI CITTÀ

PIETRO LAUREANO

MALTEMPO Un fiume di fango tra i Sassi per la pioggia. Record in Laguna, a San Marco mezzo metro di marea

Acqua alta a Matera. Come a Venezia

FRANCESCO DAL MAS e ITO SALVARO

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I nostri temi

L'INDAGINE

Giovani e politica il bene comune è al «centro»

ALESSANDRO ROSINA

A pagina 3

GANG GIOVANILI

Orfani figli

NEONAZISTI Siena

Preparavano attentato alla moschea 12 indagati

Volevano far esplodere la moschea di Colle Val d'Elsa (Siena), facendo saltare la condotta del gas. Gli agenti della Digos hanno arrestato due persone appartenenti agli ambienti dell'estremismo di destra e indagato altre 10 per «detenzione abusiva di armi correlata alla costituzione di un'associazione con finalità eversiva» dell'ordine democratico.

Italia a pagina 11

MANOVRA Ex Ilva: 5 stelle di traverso, soluzione lontana. Manovra: è scontro s

Repulisti a scu

A rischio 5mila addetti alla pulizia delle aule che non verranno

PAOLO FERRARIO

Dal 1° gennaio si cambia, ma la novità rischia di avere pesanti ripercussioni su lavoratori e imprese, che potrebbero anche essere costrette a pagare 80 milioni di euro di indennità di disoccupazione. «Questa situazione è destabilizzante», denuncia Massimo Stronati, presidente di Confcooperative Lavoro e Servizi. «Il governo trovi una soluzione per tutti i lavoratori», sottolinea la segretaria della Cisl Scuola, Maddalena Gissi. Per l'ex Ilva soluzione ancora lontana. Conte non convince i parlamentari M5s sullo scudo penale. La sua unica certezza è che «lo stabilimento non può chiudere». Forse un vertice politico in giornata. Intanto il ministro Gualtieri annuncia che il nuovo bonus per i nidi scatterà già da gennaio e consentirà di azzerare le rette per la maggioranza delle famiglie. Ma il Forum accusa il governo di mancanza di coraggio e giudica le risorse stanziate senza peso nella vita quotidiana delle famiglie.

Primopiano alle pagine 5, 6 e 7

RAID MIRATO E REAZIONE

Jihadista ucciso a Gaza Su Israele 200 razzi

Martegani a pagina 13

DA VITTIMA A TESTIMONE

«Così in carcere converto i camorristi»

Mira a pagina 11

Di questo mondo

Marina Terragni

Tra "uomini"

Dicono più quei pochi fotogrammi della videocamera di sorveglianza che un intero trattato sulla violenza maschile. Soho, Londra, febbraio 2017. Due ragazzi italiani escono dallo stanzino di una discoteca e si congratulano tra loro dandosi un cinque. Non basta a celebrare il gran momento: uno dei due allunga le braccia, l'altro gli si avvicina, si stringono dandosi amorose pacche sulle spalle.

Come due che ce l'hanno fatta, che hanno osservato il patto, che hanno portato fino in fondo un difficile compito, che hanno condiviso e superato una dura prova e si complimentano per il rispettivo coraggio.

La difficile prova è avere stuprato a turno una ragazza che non si reggeva in piedi per quanto aveva bevuto, e che per le ferite riportate avrà bisogno delle cure di un chirurgo.

Un rito tribale, un passaggio iniziatico. Dimostrarsi l'un l'altro di non avere paura, e niente fa più paura di una donna e del suo corpo che è lo stesso della madre onnipotente. Segnarla, darle una lezione, metterla sotto, scambiarsi sguardi e umori tra "uomini", suggellare il contratto del potere, noi sopra e lei sotto. Finalmente, è fatta, fratello dammi un cinque. Scrive dolentemente un uomo buono e giusto su Facebook che «raramente si pensa alla violenza che questa mentalità esercita su un maschio riluttante ad accoglierla... per alcuni è una Via Crucis».

Agorà

SPIRITUALITÀ

I tesori nascosti del monachesimo nei libri dell'eremita

Giudizio a pagina 18

NOVECENTO

Gli Anni di piombo tra ferite e perdono

Giovagnoli a pagina 19

AMBIENTE

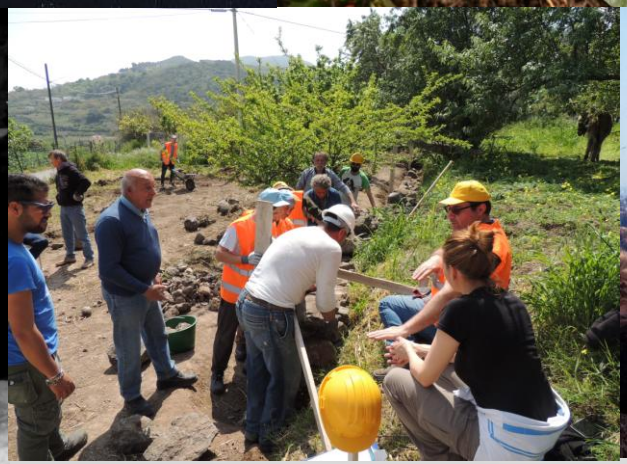
Si sciolgono i ghiacci, ritornano i virus

Bignami a pagina 20

- *Adaptation*
- *Mitigation*

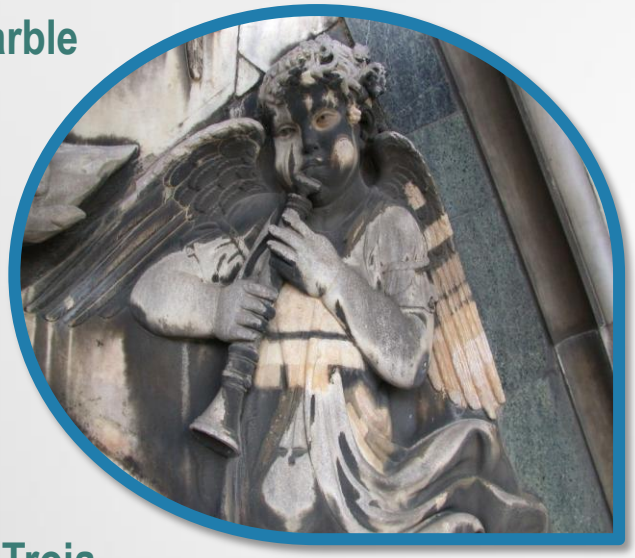
Cultural Heritage at Risk

AEOLIAN ISLANDS
WORLD HERITAGE SITE



Cultural Heritage at Risk

Black crust on Marble
Milan Cathedral



Pluvial
Flooding -
Ferrara
Cathedral

Flood – Troja,
Prague

Megalithic
Temples,
Malta

Safeguarding Cultural Heritage at Risk

2018 EUROPEAN YEAR OF CULTURAL HERITAGE #EuropeForCulture

- To encourage the **sharing and appreciation** of Europe's cultural heritage as a **shared resource;**
- To raise awareness of **common history and values;**
- To reinforce a sense of belonging to **Europe;** and
- To better **protect, safeguard, reuse, enhance, valorise** and **promote** Europe's cultural heritage.

Sendai Framework for Disasters Risk Reduction, 2015-2030

Adopted by United Nations Member States in March 2015: is the basis for a *disasters risk–informed approach* to policy-making, offering a **coherent agenda** across different EU policies to strengthen resilience to risks and shocks and supporting the EU priorities of investment, competitiveness, research and innovation.

There is **need for focused action within and across sectors** by States at local, national, regional and global levels in the following four priority areas:

Sendai Framework for Disasters Risk Reduction, 2015-2030

Priority 1. Understanding disaster risk

KNOWLEDGE (National and local levels)

Paragraph 24(d) …….**understand** ……**cultural heritage impacts,** in the context of event-specific hazard-exposure and vulnerability information.

Priority 2. Strengthening disaster risk governance

Priority 3. Investing in disaster risk reduction for resilience

PUBLIC/PRIVATE STRUCTURAL/NON MEASURES (National and local levels)

Paragraph 30 (d) To **protect or support the protection** of cultural and collecting institutions and other sites of historical, **cultural heritage** and religious interest.

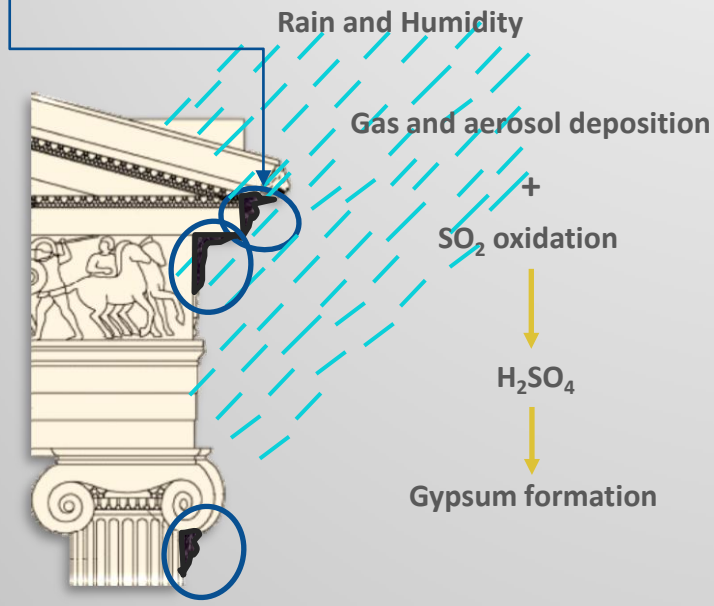
Priority 4. Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

Action Plan: Key Area 4 – Supporting the development of a holistic disasters risk management approach

Develop good practices on the integration of **cultural heritage in the national disaster risk reduction strategies** to be developed by EU Member States.

Air Pollution impact on Heritage

DAMAGE PROCESS	OUTDOOR MATERIALS MAINLY AFFECTED	CLIMATE PARAMETERS	POLLUTANTS
 SOILING, BLACK CRUST FORMATION	• Marble • Limestone • Sandstone with carbonate matrix • Air-setting and hydraulic mortar • Cement mortar and concrete • Glass	• Rain amount • Time of wetness (T, RH) • Light	• SO_2 • NO_2 • PM, PM_{10}, $PM_{2.5}$ • C fractions of PM (EC, OC) • Soluble salt fraction of PM (SO_4^{2-}, SO_3^{2-}, NO_3^-, NO_2^-, Br^-, HPO_4^{2-}, Cl^-, CHO_2^-, $C_2H_3O_2^-$ AND $C_2O_4^{2-}$) • VOC

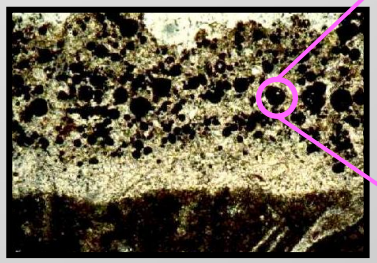


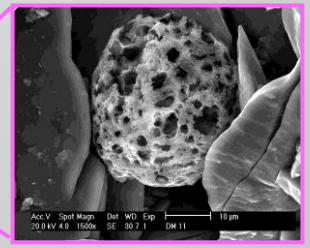
Black crust formation on surfaces partially sheltered from rain wash-out

Microscopic aspect

Black crust

Marble/limestone





carbonaceous particles

Air Pollution impact on Heritage

DAMAGE PROCESS	OUTDOOR MATERIALS MAINLY AFFECTED	CLIMATE PARAMETERS	POLLUTANTS
	• Marble • Limestone • Sandstone with carbonate matrix • Air-setting and hydraulic mortar • Cement mortar and concrete	• Rain amount • Rain pH • Time of wetness (T, RH)	• SO_2 • HNO_3 • CO_2 • PM, PM_{10}, $PM_{2.5}$
	• Marble • Limestone • Sandstone with carbonate matrix • Air-setting and hydraulic mortar • Cement mortar and concrete • Glass	• Rain amount • Time of wetness (T, RH) • Light	• SO_2 • NO_2 • PM, PM_{10}, $PM_{2.5}$ • C fractions of PM (EC, OC) • Soluble salt fraction of PM (SO_4^{2-}, SO_3^{2-}, NO_3^-, NO_2^-, Br^-, HPO_4^{2-}, Cl^-, CHO_2^-, $C_2H_3O_2^-$ AND $C_2O_4^{2-}$) • VOC
	• Carbonate and silicate stones • Air-setting and hydraulic mortar • Cement mortar and concrete • Wood	• Rain amount • T • RH • Solar radiation	• OC FRACTION OF PM • SOLUBLE SALT FRACTION OF PM (NO_3^-, $C_2H_3O_2^-$)
	• Metals: steel, zinc, copper, bronze, lead	• Rain amount • Rain pH • T • RH	• SO_2 • HNO_3 • O_3 • PM, PM_{10}, $PM_{2.5}$ • H_2S • COS • CH_3COOH, CH_2O_2 • NH_3 • Soluble salt fraction of PM (SO_4^{2-}, NO_3^-, Cl^-)
	• Glass	• Rain amount • Rain pH • T • RH	• SO_2 • HNO_3 • O_3 • PM, PM_{10}, $PM_{2.5}$ • Soluble salt fraction of PM (SO_4^{2-}, NO_3^-, Cl^-)
	• Sandstone • Limestone • Air setting and hydraulic mortar • Cement mortar and concrete • Brick	• RH cycles • Rain pH • T	• PM, PM_{10}, $PM_{2.5}$ • Soluble salt fraction of PM (SO_4^{2-}, Cl^-, NO_2^-, NO_3^-, Ca^+, Na^+, Mg^{2+}, K^+)

ISAC

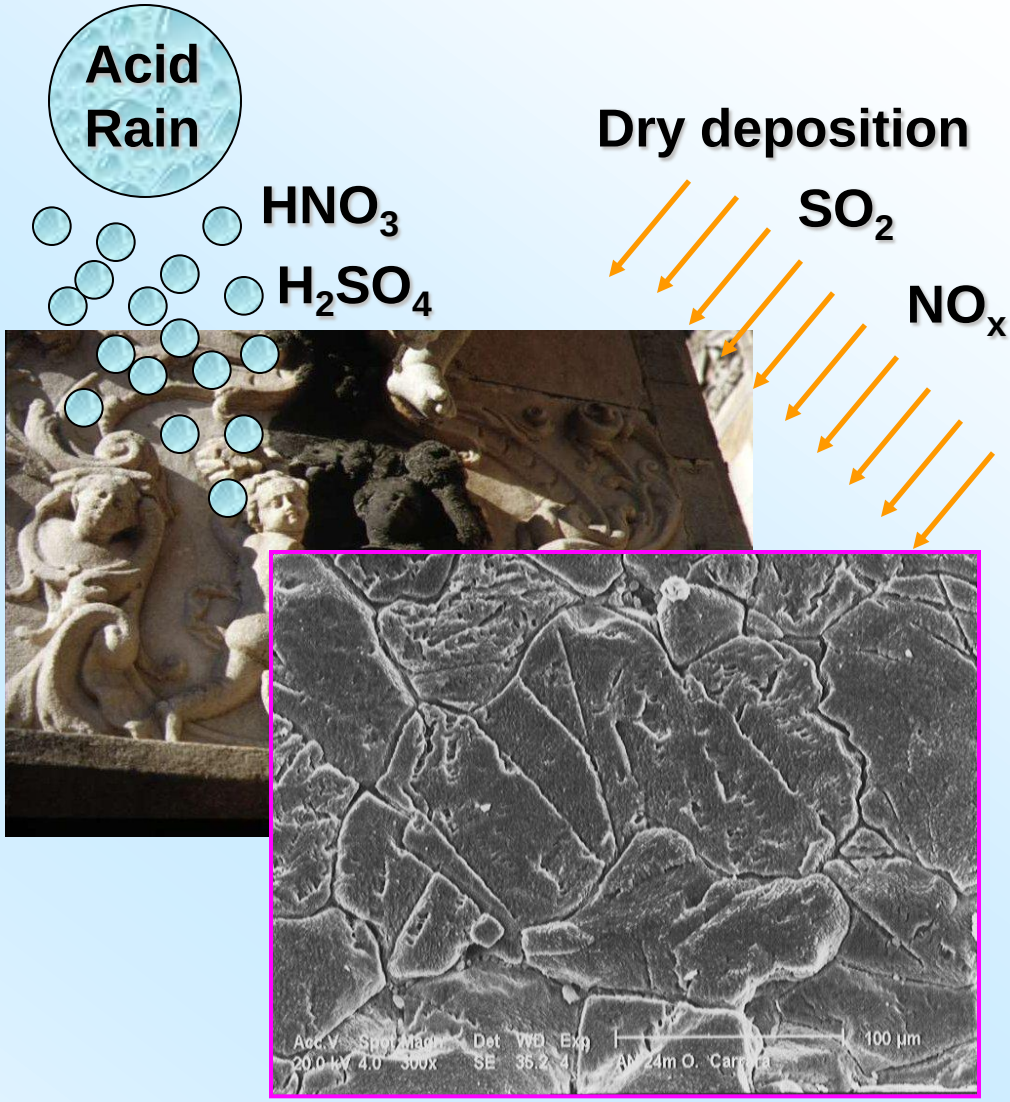
SURFACE RECESSION OF CARBONATE STONES

Material dissolution due to the chemical attack induced by:

1. **Clean rain** (rain at pH 5.6 in equilibrium with 330 ppm CO_2 – karst effect)
2. **Acid Rain** (additional acidity due to anionic components, such as SO_4^{2-}, NO_3^-……)
3. **Dry deposition** (gaseous pollutants occurring between precipitation events)

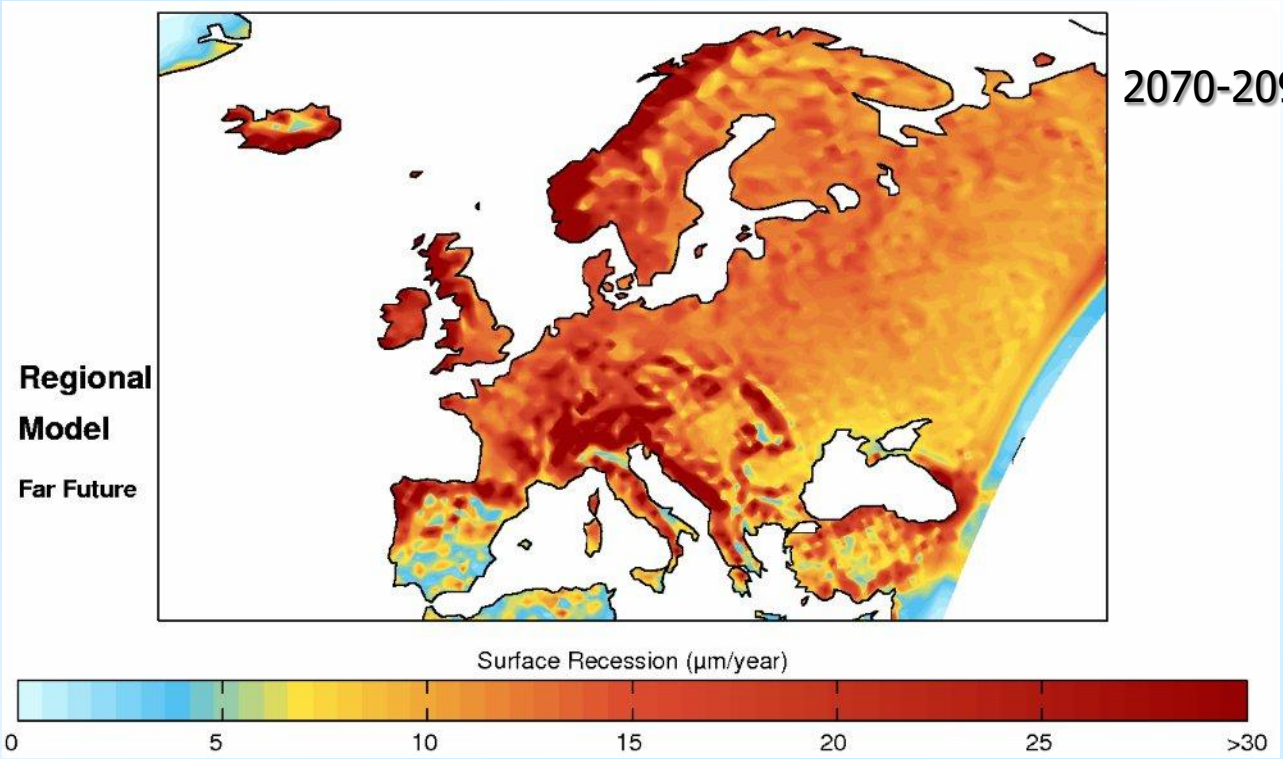
+

Material surface erosion due to the mechanical effect of rain



"Gutta cavat lapidem"

SURFACE RECESSION



Surface recession is expected to be higher in the areas that will be more affected by precipitation, that are the mountain chains (Alps, Carpathians, Pyrenees) and the westerlies exposed areas, reaching values higher than 30 µm/year

Bonazza et al. 2009. STOTEN

Coastal areas of Mediterranean Basin

Coastal areas are complex and fragile eco-cultural-systems that need specific consideration for their best preservation.

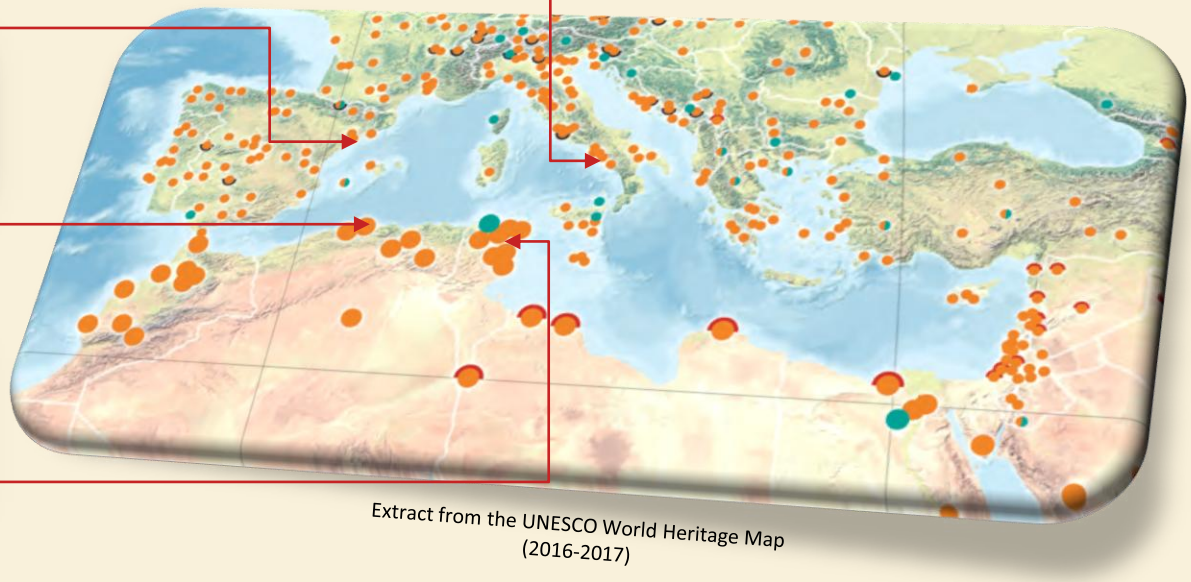
Observing the UNESCO World Heritage Map is noticeable the abundance of cultural heritage sites (in orange) that raise on the littoral zones.

Costiera Amalfitana (Italy) © OUR PLACE The World Heritage Collection

Archaeological Ensemble of Tárraco (Spain) © Instituto del Patrimonio Cultural de España.

Kasbah of Algiers (Algeria) © UNESCO

Archaeological Site of Carthage (Tunisia) © Editions Gelbart



Extract from the UNESCO World Heritage Map (2016-2017)

HOT SPOT

Heritage in Coastal areas of Mediterranean Basin

COASTAL AREAS (monuments, landscapes, etc.)

Siracusa (Italy)

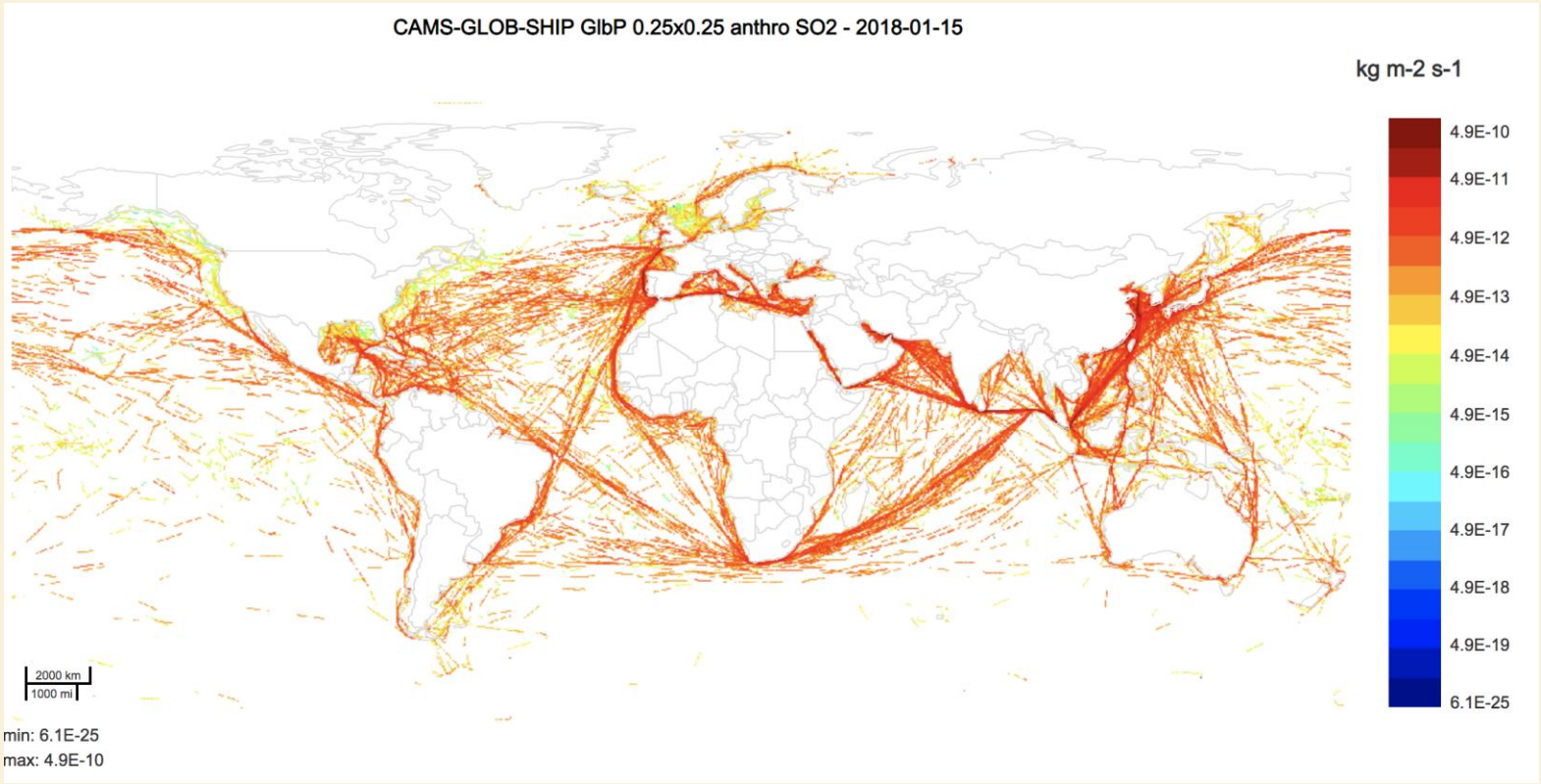
Tourism and commercial sectors

UNDERWATER HERITAGE (monuments/ecosystems)

Christ of the Abyss – San Fruttuoso (Genoa, Italy)

Baia (Naples, Italy)

Global ship emissions for various chemical species (SO_2, SO_4^{2-}, CO, NO_x, EC, CO_2, OC, NMVOCs, ash)

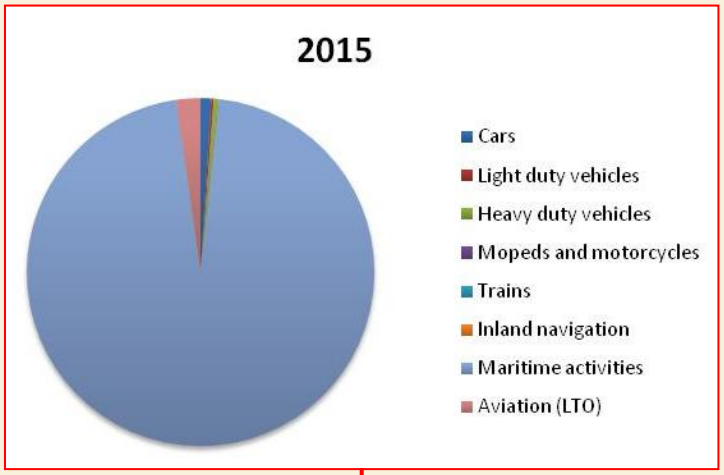


TASK FORCE COPERNICUS CULTURAL HERITAGE

SO_2 emissions of transport sector in Italy (from ISPRA report)

Modalità di trasporto	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
	t									
Cars	61.375	26.233	4.953	1.296	225	223	227	235	244	215
Light duty vehicles	16.518	11.720	2.529	450	84	89	82	70	72	53
Heavy duty vehicles & bus	50.095	32.798	4.342	611	107	113	113	104	105	99
Mopeds and motorcycles	2.404	890	163	57	9	9	10	11	10	8
Trains	846	545	69	7,3	0,9	0,7	0,8	0,6	0,3	0,3
Inland navigation	119	91	11	1,9	0,3	0,3	0,4	0,4	0,4	0,4
Maritime activities	79.018	71.121	81.592	49.746	28.380	26.538	23.915	22.498	22.403	21.070
Aviation (LTO)	243	291	448	345	524	497	478	453	490	497
TOT	**211.651**	**143.940**	**100.102**	**52.513**	**29.332**	**27.472**	**24.826**	**23.372**	**23.325**	**21.942**

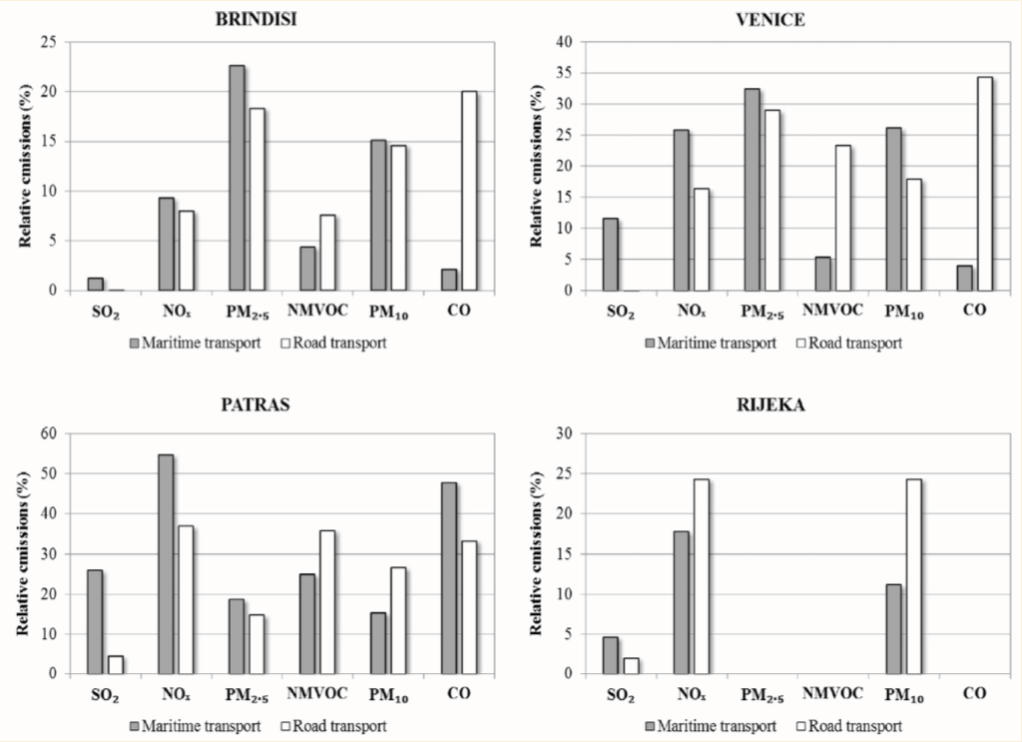
Fonte: ISPRA



[Bernetti, Contaldi and Sestili, 2017]

SO_2 emissions in port-cities

According to **POSEIDON Project**, which monitored ship emission in four port-cities, Brindisi and Venice (Italy), Patras (Greece) and Rijeka (Croatia), it was highlighted that the road traffic and maritime sector had comparable emissions especially for NO_X and $PM_{2.5}$, while **shipping** was noticed **as the transport sector mainly responsible for SO_2 emissions**.



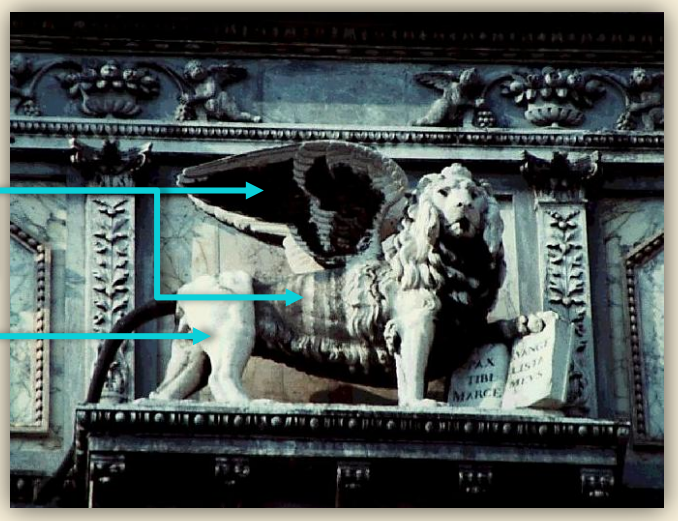
Comparison of relative emissions associated to maritime and road transport in four port cities

[E. Merico et al. 2017]

How can naval traffic affect Cultural Heritage?

Materials carbonate based:

- ✓ Limestone
- ✓ Marble
- ✓ Sandstone with carbonate matrix
- ✓ Air-setting and hydraulic mortar, etc.



- Sulfation by SO_2 → **BLACK CRUSTS FORMATION**
  - ✓ Limestone to gypsum
  - ✓ Deposition of **soot**
  - ✓ Rain partially sheltered

- **SURFACE RECESSION**
  - ✓ Rainwashed areas
  - ✓ May be white

- **SALTS CRYSTALLIZATION**

Different approaches to study the impact of pollution on Cultural Heritage in coastal areas

- **LAB SIMULATION STUDY**
- **FIELD EXPOSURE TESTS**
- **CASE STUDY**

On sandstone in Belfast (UK)

«…the mobility of gypsum may have been enhanced by the presence of NaCl…»

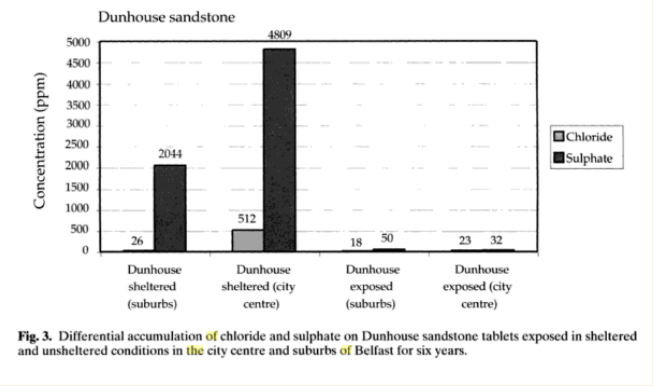


Fig. 3. Differential accumulation of chloride and sulphate on Dunhouse sandstone tablets exposed in sheltered and unsheltered conditions in the city centre and suburbs of Belfast for six years.

[Smith et al., 2002. Modelling the rapid retreat of building sandstones: a case study from a polluted maritime environment. https://doi.org/10.1144/GSL.SP.2002.205.01.25]

- **SAMPLES FROM HISTORICAL BUILDING** → e.g. Bilbao

«…Nitrate is the major soluble compound of the analysed subsamples…are supposed to come from harbour traffic (combustion of fuels) as well as from fuels used in industrial processes...»

[Martínez Arkarazo et al., 2007. An integrated analytical approach to diagnose the conservation state of building materials of a palace house in the metropolitan Bilbao (Basque Country, North of Spain). Analytica Chimica Acta 584, 350–359]

- **FIELD EXPOSURE TESTS**

e.g. ARQUEOMONITOR Project –ES → field exposure tests of metallic and stone samples underwater in Cadiz Bay

[http://arqueologianauticaysubacuatica.uca.es/arqueomonitor/; Camara et al., 2017]

FINAL REMARKS

- Need of enhancing the consciousness regarding the importance of protection of coastal natural & cultural heritage
- Ship emissions can affect the state of conservation of the materials belonging to cultural heritage, in particular buildings and outdoor monuments.
- Increase of intensity and frequency of extreme events
- Need of mitigation strategies aiming at reducing emissions (Mediterranean ECA)
- Still lack of studies regarding the naval impact on underwater heritage

Thank you for your attention

What kind of emissions can be produced by ships?

AIR EMISSIONS

- Macropolluttants:
  - ✓ SO_2, NO_x, CO, CO_2 and O_3
  - ✓ Particulate matter (PM) – ! Black Carbon (BC)
  - ✓ Non-Methane Volatile Organic Compounds (NMVOCs)
- Micropollutants:
  - ✓ Metals
  - ✓ Organic species
- Other
  - ✓ Incineration of waste
  - ✓ Noise
  - ✓ Visual pollution

DISCHARGE TO SEA

- Sewage (black water)
- Grey water
- Oil and oily mixtures
- Wash water from scrubbers
- Garbage
- Ballast water

[Norwegian Maritime Authority. 2017. Pollution from ships in fjord areas with heavy cruise traffic – Report;
F. Liguori, S. Pillon, S. Patti. Progetto MED-CAIMANS. L'esposizione della popolazione agli inquinanti atmosferici dovuti alle navi crociera a Venezia: confronto tra scenario attuale e scenari futuri di sviluppo e di mitigazione. 2016.]

Recent and Relevant EU Projects on ship emissions

Financed by the European program for territorial Cooperation MED 2007/2013:

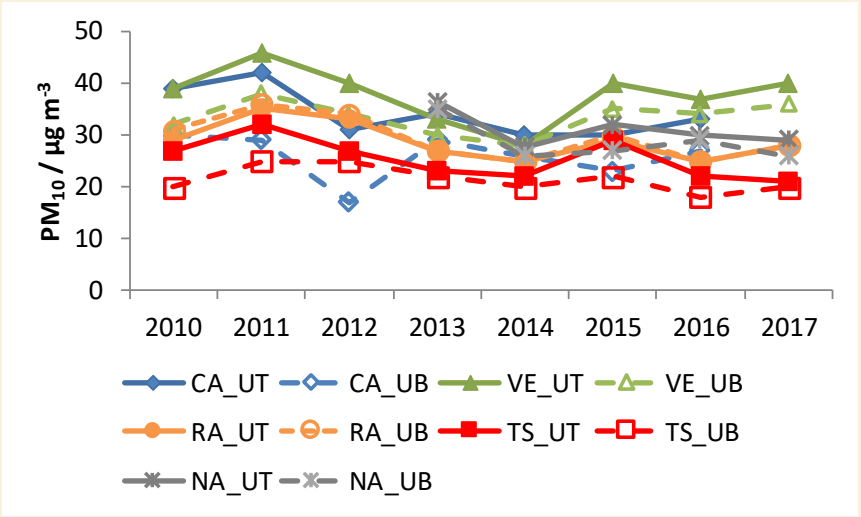
- **APICE 2010 – 2013 - Common Mediterranean strategy and local practical Actions for the mitigation of Port, Industries and Cities Emissions**
  The aim of the project was to develop a knowledge-based approach for air pollution mitigation and sustainable development of port activities, managed by spatial planning policies at local level, which included the territory around the ports.
  http://www.apice-project.eu/

- **CAIMANs 2014-2015 - Cruise and passenger ship Air quality Impact Mitigation ActioNs**
  The project studies the impact of passenger maritime traffic on air quality in five important port cities in the northen Mediterranean: Barcelona, Marseilles, Genoa, Venice and Thessaloniki.
  http://www.medmaritimeprojects.eu/section/caimans

- **POSEIDON 2014-2015 - Pollution monitoring of ship emissions: an integrated approach for harbours of the Adriatic basin**
  The POSEIDON project aimed at investigating the impact on air quality of four major harbours in the Adriatic/Ionian Seas (Brindisi, Patras, Rijeka and Venice), using a common state-of-the-art methodology based on emission inventories, numerical modelling and experimental results in order to produce comparable information useful to plan future actions and controls of emissions in the Adriatic/Ionian macroregion.
  http://www.medmaritimeprojects.eu/section/poseidon

Pollution in coastal cities

- Concentration of air pollutants monitored by the Regional Agency for Environmental Protection of Italy:



Legend:
UT = urban traffic-oriented monitoring stations
UB = urban background monitoring stations