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TECHNOLOGIES FOR THE DIAGNOSIS OF THE POLLUTION IMPACT ON HISTORIC BUILDINGS SURFACES: THE TEACH PROJECT



ADRIANA BERNARDI

National Research Council (CNR) of Italy

Institute of Atmospheric Sciences and Climate (ISAC)

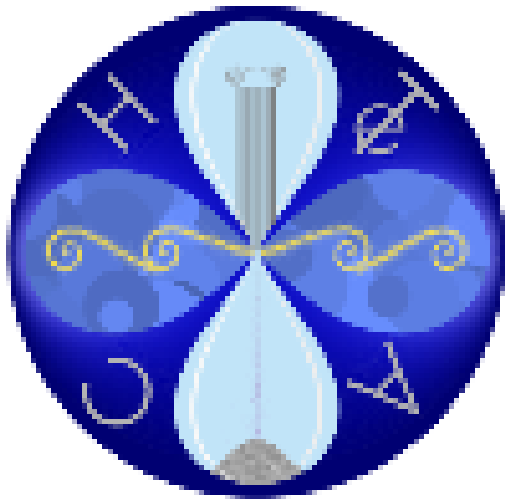
a.bernardi@isac.cnr.it



cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



TeACH Project























Technologies and tools to prioritize
Assessment and diagnosis of air
pollution impact on immovable and
movable **C**ultural **H**eritage



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Project partners

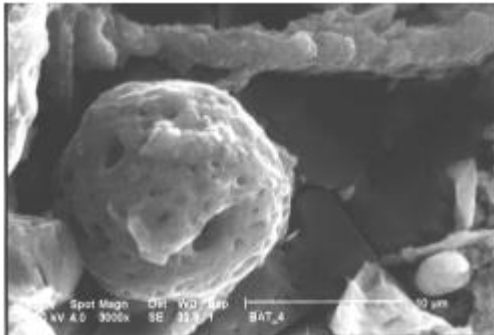


SHORT NAME	PARTNERS	COUNTRY
CNR-ISAC (coordinator)	 Institute of Atmospheric Sciences and Climate	Italy 
ICIE	 Cooperative Institute for Innovation	Italy 
TECNO PENTA	 TECNO PENTA s.a.s.	Italy 
LABEIN	 TECNALIA	Spain 
ACCIONA	 ACCIONA	Spain 
UA	 Department of Chemistry, University of Antwerp	Belgium 
NILU	 Norwegian Institute for Air Research	Norway 
UCL	 Centre for Sustainable Heritage, University College of London	United Kingdom 
HDK	 Dombauverwaltung Köln	Germany 
MNK	 Krakow National Museum	Poland 



State of Art: climate and pollutants are changing

- ✓ Role of **S** and **C** atmospheric compounds of **anthropogenic origin** in **surface soiling** and **black crust** formation
 - **aesthetic damage**
- ✓ **Atmospheric pollution is changing** due to legislation policies, different combustion sources and fuels
 - **type of soiling** on built heritage **is changing**



- ✓ **Fine carbonaceous particles** rich in organic compounds

→ **change in the color** of architectural surfaces:

OC



yellowing-brownish

EC



blackening

This change needs to be monitored and its effects controlled with new and appropriate devices and tools

Monitoring of SURFACE COLOR CHANGE may be of greater concern to evaluate the CHANGING IMPACT OF ATMOSPHERIC POLLUTANTS on architectural surfaces

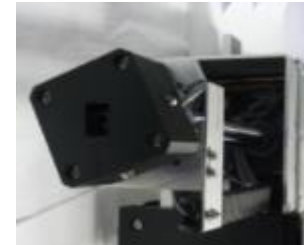


Project objectives

- To **identify multi-pollutants and prioritize** the most important ones causing damage
- To built an **innovative and cheap kit**, including new and existing sensors, for **environmental control and monitoring** dedicated to the **detection of the outdoor weathering of stone surfaces** in terms of **colour changes (blackening & yellowing)**
- To **improve the EWO dosimeter (EU MASTER Project)** towards degradation effects on inorganic materials and construct a **new compact soiling and dust dosimeter** for indoor measurements
- To investigate the **behaviour of selected protective coatings and consolidants** applied on **inorganic material (stone) outdoors** and of **organic material (paper) indoors/outdoors**.
- To **deliver guidelines for air pollution monitoring** to support policy makers & end users in **preventive conservation actions**

The new kit - Components

- ✓ **Colorimeter TAOS with 2 white LED's**



- ✓ **Electronic interface up to the gateway of the kit**



- ✓ **Mechanical arm with housing**

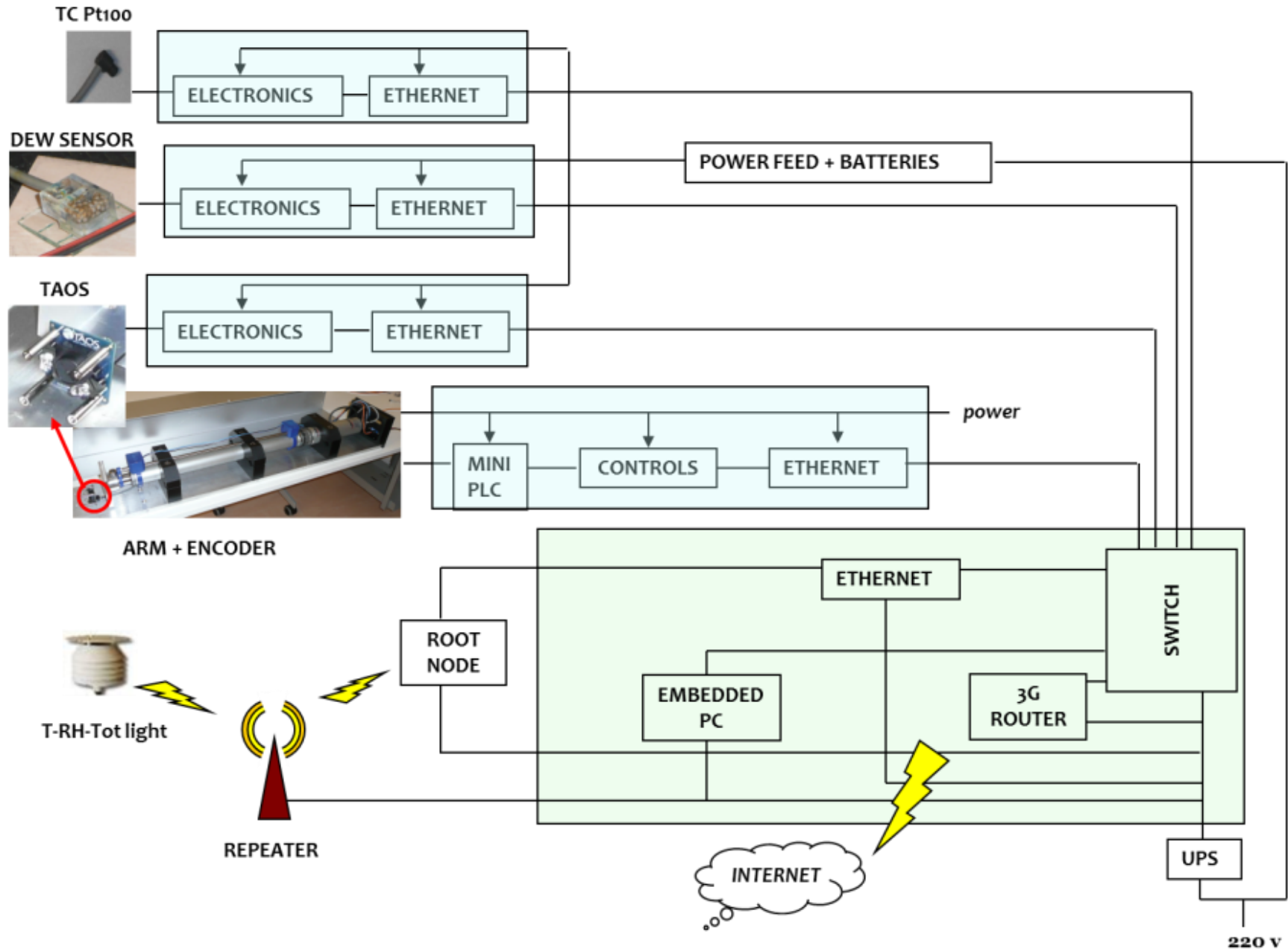


- ✓ **Slide gate and white calibration patch**





The new kit - Connections





The new kit - Parameters measured

SURFACE

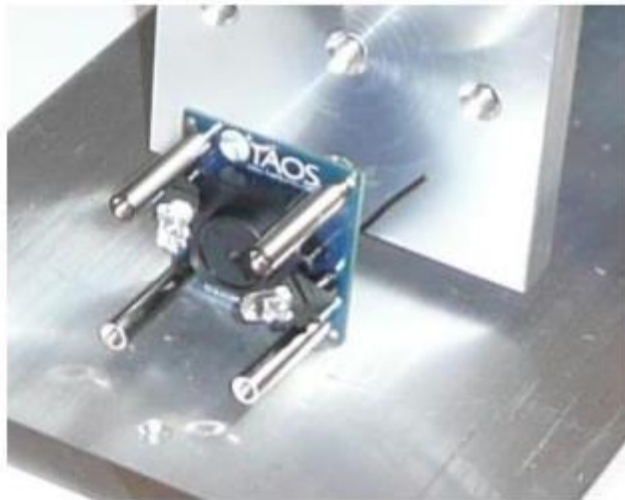
Color	→	Colorimeter
Temperature	→	PT 100
Condensation	→	Dew sensor

ENVIRONMENT

Temperature	→	Thermistor
Relative humidity	→	Capacitive
Total visible light	→	Photodiode

The new kit - Color measurement

Packaged colorimeter



COMPOSITION		
Light source	2 white leds	
Sensor	Diode array	
	8 x 8 silicone photodiodes	
Filters	IR filter	All
	Red	16
	Green	16
	Blue	16
	None	16
Results	4 values: clear, red, green, blue	



The new kit – Tests in lab & field



Museo dell'Opera
del Duomo
Florence (Italy)

sheltered



Carrara marble

- ✓ Laboratory **calibration and testing**
- ✓ Testing for **1 year in 3 European sites**
 - ✓ **Results compared with spectrophotometric measurements on damaged layers**

partially sheltered (run off, no wash out)



Cologne Cathedral
(Germany)



limestone



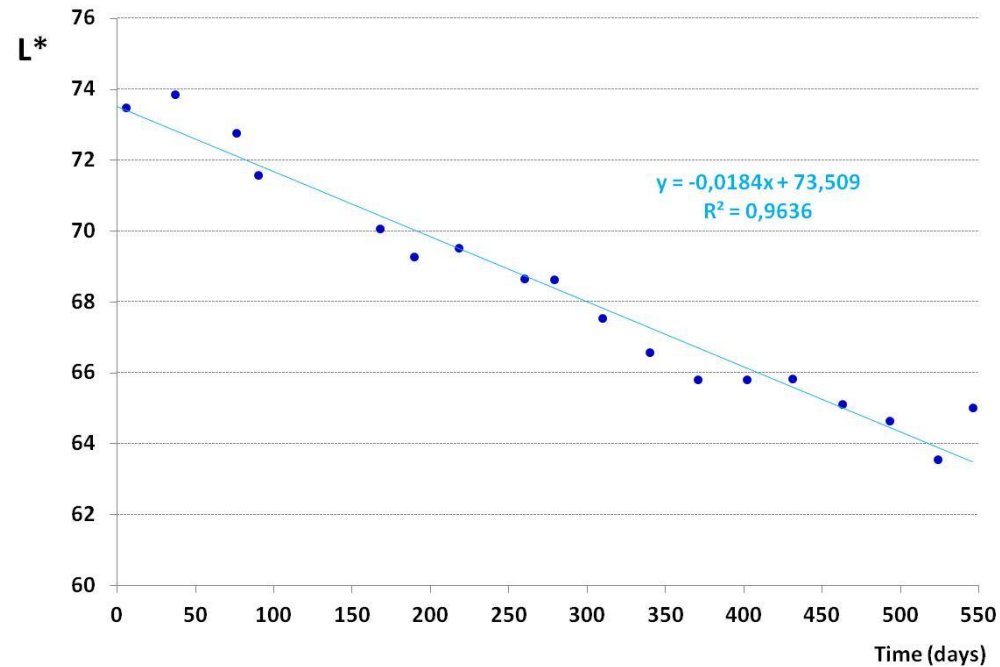
Arriaga Theatre
Bilbao (Spain)

limestone

Results in field

BILBAO

Colorimetric measurements limestone: L*



blackening

Decrease in L*





Results in field

⊗ The **new kit reliable and useful in monitoring color changes** of architectural surfaces:

⇒ in the **3 sites** detected color change of different extent (stone characteristics, location, exposure):

- **blackening higher in Cologne and Bilbao** on limestones due to the partially sheltered position
- **yellowing in Florence** on Carrara marble

⊗ In view of **changes in atmospheric pollutants composition** in the framework of **preventive conservation strategies**:

⇒ development of **technologies to monitor effect on architectural surfaces**

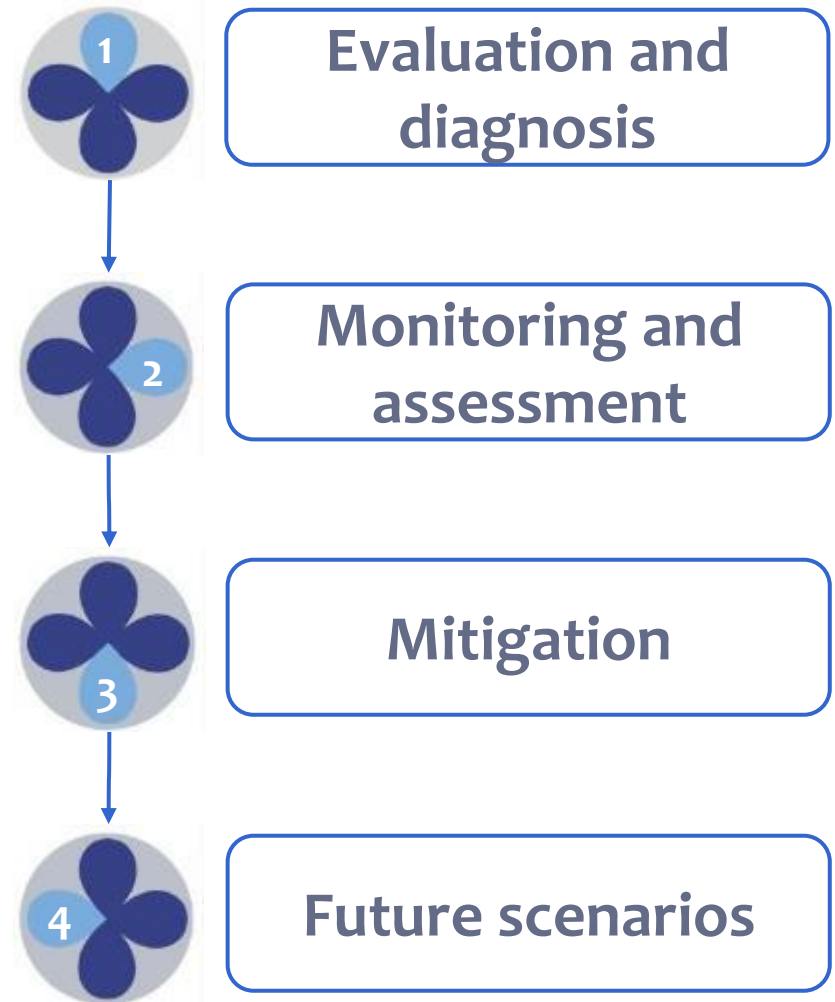
⇒ **integration in one monitoring tool surface and environmental measurements**

Guidelines



Guidelines for **future prioritization of air pollution monitoring** for **sustainable protection** of moveable and immoveable cultural heritage to **support policy makers and end users** in **preventive conservation**

Guide the user through a set of decision steps, leading to a **strategy for evaluation, monitoring and mitigation** of pollution-related damage to heritage



Guidelines - Evaluation and diagnosis



Evaluation and diagnosis

- evaluate **climate** of the heritage site
- evaluate the **macro-location**
- evaluate **external pollution** sources
- evaluate **internal pollution** sources and sinks
- evaluate **external/internal exchange**
- evaluate cultural heritage **susceptibility** to pollution

This section outlines how to **evaluate the macro and micro-environment** of a heritage site, building, or collection.

Instructions are provided to **evaluate whether pollution represents a threat** and if so, **how the magnitude of its effect can be evaluated** by taking into account available data even before a monitoring programme is put in place

Guidelines - Monitoring and assessment



Monitoring and assessment

- use publicly available data
- monitor using dosimeters
- monitor using pollutant-specific equipment

Once the possible impact of pollutants on heritage has been assessed, it is important to **establish the scale and the nature of the impact**. Both the **heritage asset and its environment can be monitored** and there are a **number of available options**, depending on the complexity of the problem, and on the **available resources**.



Guidelines - Mitigation



Mitigation

- implement **policy tools**
- adopt **passive** measures
- adopt **active** measures

If the results of monitoring indicate that the impact of pollution on heritage is significant, **mitigation strategies** need to be investigated that would **prevent future damage** to heritage. There are again a number of options available, **from intervention to policy-based solutions**.



Guidelines – Future scenarios



Future scenarios

- consider **future pollution trends**

The last section of the Guidelines deals with **future pollution trends**, to inform timely **design of prevention strategies**. Due to the beneficial environmental protection legislation in the EU, the level of environmental pollution has decreased in the past two decades and is likely to continue decreasing in the near future.

However, this may not be the case globally yet.



***Thank you
for your kind attention***



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e-mail: a.bernardi@isac.cnr.it

