

Early Warning Dosimeter for Environmental Conditions inside Showcases – Results from Monitoring Campaigns in Europe

**COST D 42 workshop: “Showcases inside out”
25 - 27 May 2009**

Elin Dahlin, Terje Grøntoft and Susana Lopez-Aparicio

Norwegian Institute for Air Research



Content

- ❖ Background
- ❖ Awareness of the environmental conditions
- ❖ EWO-dosimeter
- ❖ Results from monitoring campaigns
- ❖ Conclusion

Background

- ❖ Unsuitable environmental conditions inside showcases and microclimate frames may pose adverse effects on the displayed objects
- ❖ An **early warning** of the environmental conditions are of importance



Swartzwälder Trachtenmuseum, Haslach, DE

MASTER and PROPAINT



The National Museum in Krakow

Preventive Conservation Strategies for Protection of Organic Objects in Museums, Historic Buildings and Archives (2003- 06)



Princes Czartoryski Foundation

Improved Protection of Paintings during Exhibition, Storage and Transit (2007-10)

MASTER and PROPAINT

MASTER : Development of an Early Warning dosimeter for Organic materials (EWO) in museums

PROPAINT: Use of several dosimeters for the evaluation of the protective effect of microclimate frames.



**EWO-
dosimeter**

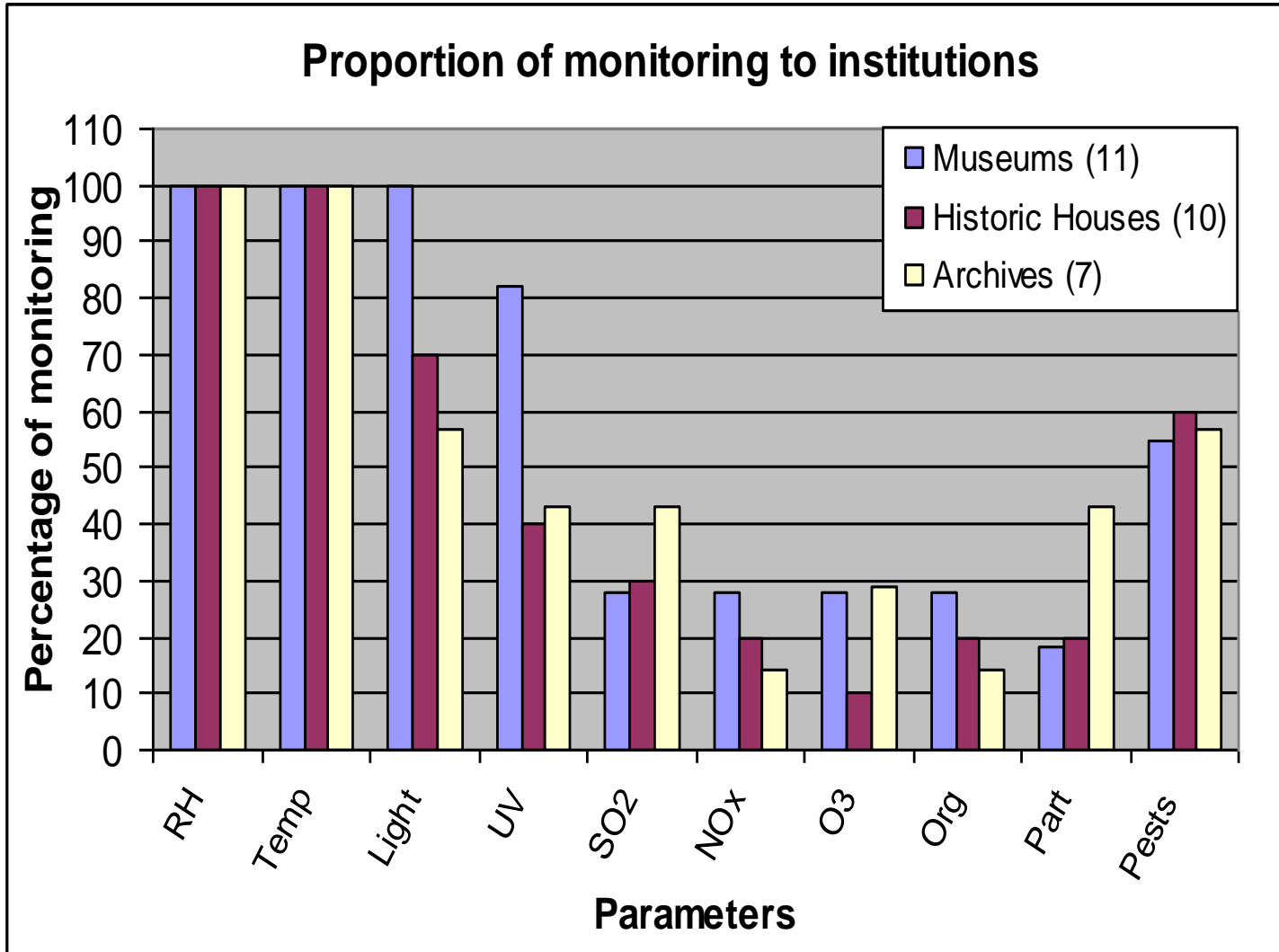
**Piezo electric
quartz crystal
dosimeters**

**Glass slide
dosimeter**

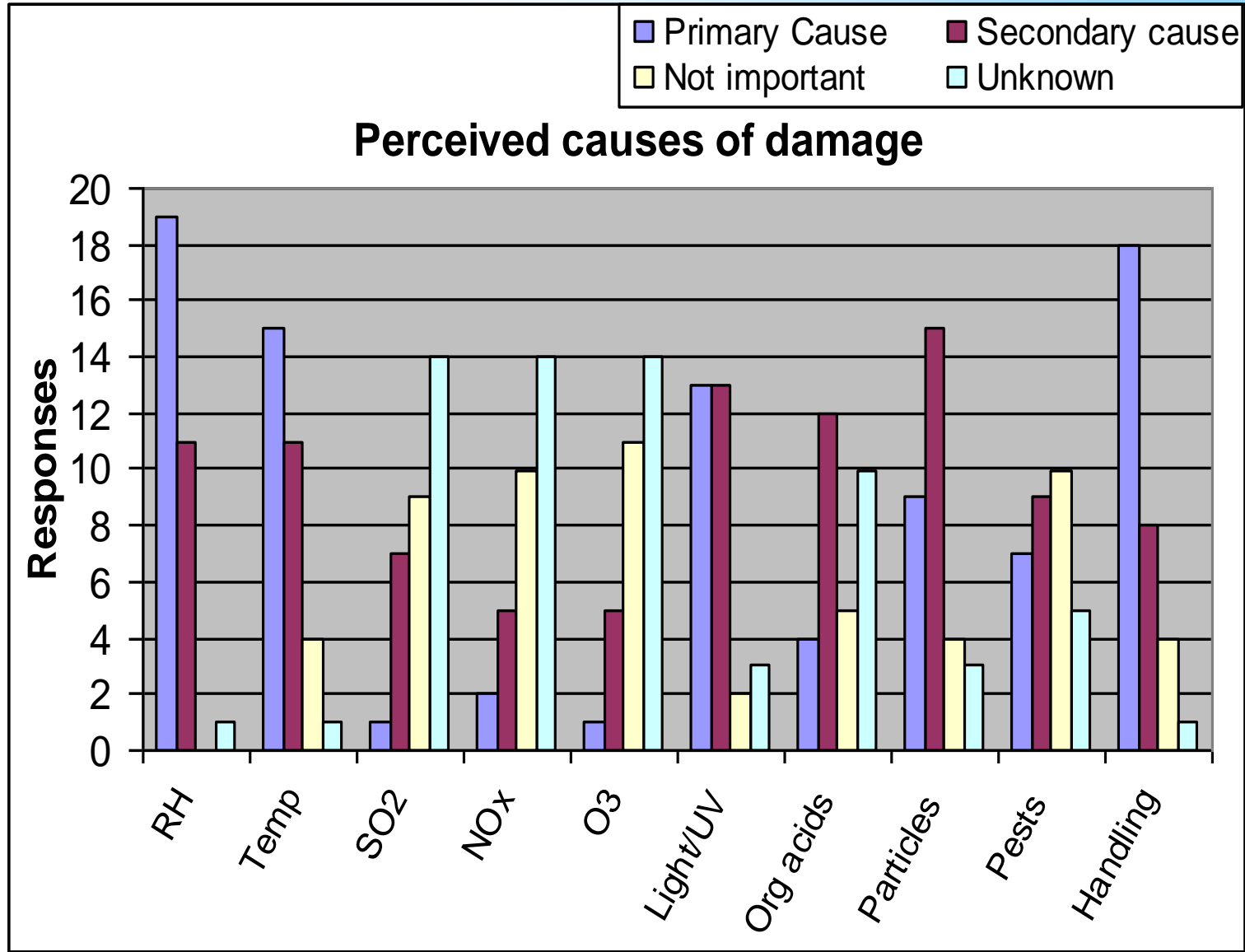
**Micro climate
frame**



The awareness of threats to museum collections



Source: Informal questionnaire, UCL Centre for Sustainable Heritage



Source: Informal questionnaire, UCL Centre for Sustainable Heritage

Environmental Conditions in showcases/microclimate frames depends on:

- ❖ Building material
- ❖ Construction
- ❖ Painting/lacquer/glue and/or different materials
- ❖ Displayed objects
- ❖ Air exchange rate/ventilation
- ❖ Composition of air outside/inside; pollution/particles/dust
- ❖ Temperature - RH and Light/UV
- ❖ Cleaning routines

The Early Warning System

- ❖ Assessment of environmental factors is not enough in order to understand the real effects on art objects
- ❖ The knowledge of the actual reaction between the art object and the contaminant is crucial
- ❖ Dosimeters which emulate the reaction between art objects and the contaminants and which give a measurable effect response is a useful Early Warning System

Early Warning Dosimeter (EWO)

- ❖ Synthetic polymer spin coated on small glass chips.
- ❖ The polymer film reacts with air pollutants and becomes less transparent
- ❖ Detection limit: **1-2 ppb**
- ❖ Responses: **Photo-oxidising**
(MASTER, PROPAIN):
NO₂, O₃, UV-light, T

Exposure at location for 3 months

EWO holder



Photospectrometer

EWO dosimeter response related to a classification system

- ❖ Change in absorption is converted to EWO-response level from 1 to 5
- ❖ Threshold based on available measures for environmental parameters and standards (Tetrault/ASHREA guidelines)
- ❖ Response level calibrated to match 5 typical museum environments
- ❖ Calibration based on field measurements.



The National Museum in Krakow, Poland

Dosimeter response level

Kind of building	EWO response level				
	1	2	3	4	5
Archive	Expected environment (acceptable)	Environment could be better	Environment is poor	Something is wrong with control	Serious problem with building/control
Purpose built museum	Environment is very good	Expected environment (acceptable)	Environment could be better	Environment is poor	Something is wrong with control
Historic house museum	Excellent environment	Environment is very good	Expected environment (acceptable)	Environment could be better	Environment is poor
Open structure	Dosimeter is not responding	Excellent environment	Environment is very good	Expected environment (acceptable)	Environment could be better
External store with no control	Dosimeter is not responding	Dosimeter is not responding	Excellent environment	Environment is very good	Expected environment (acceptable)

Developed by Centre for Sustainable Heritage, UCL, London

Showcases: One calibration point lower than the room

Pollution data from passive gas samplers

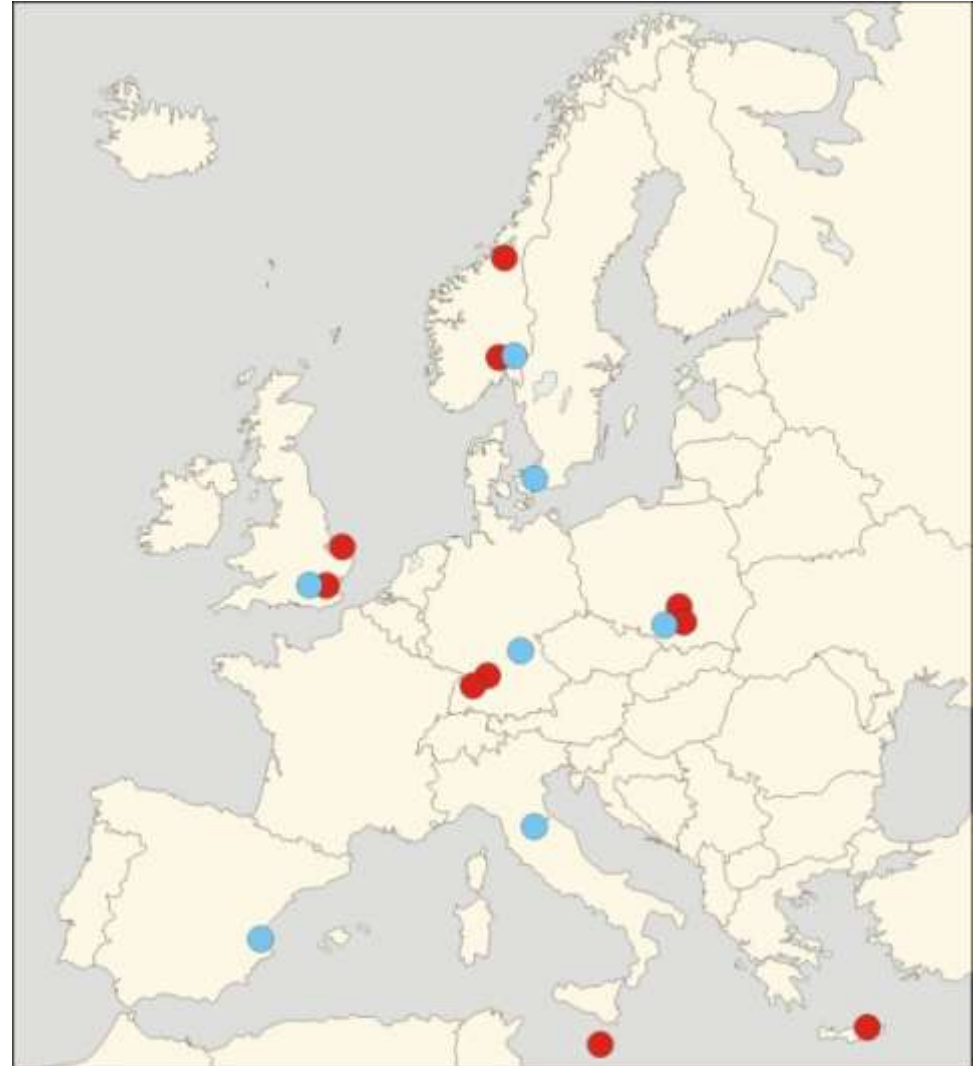
EWO dosimeters calibrated towards pollution and environmental data



Analysis methods:
SO₂ (IC of SO₄²⁻)
NO₂ (Fotometric, NO₂⁻)
O₃ (IC of NO₃⁻)
+ Organic acids

MASTER and PROPAINT monitoring campaigns

- ❖ Sulphure dioxide
- ❖ Ozone
- ❖ Nitrogen dioxide
- ❖ Organic acids
- ❖ VOC
- ❖ Temperature
- ❖ RH
- ❖ Light/UV



In addition: National Museum of Art, Mexico City

From historic houses to modern museums



Swartzwälder Trachtenmuseum, Haslach, DE



Haus der Geschichte Baden – Württemberg,
Stuttgart, DE

Monitoring in microclimate-frames (MC-frame)



Modern MC-frame built by the SIT Company, Madrid

MC- frame adapted to a classic frame, Apsley House, London

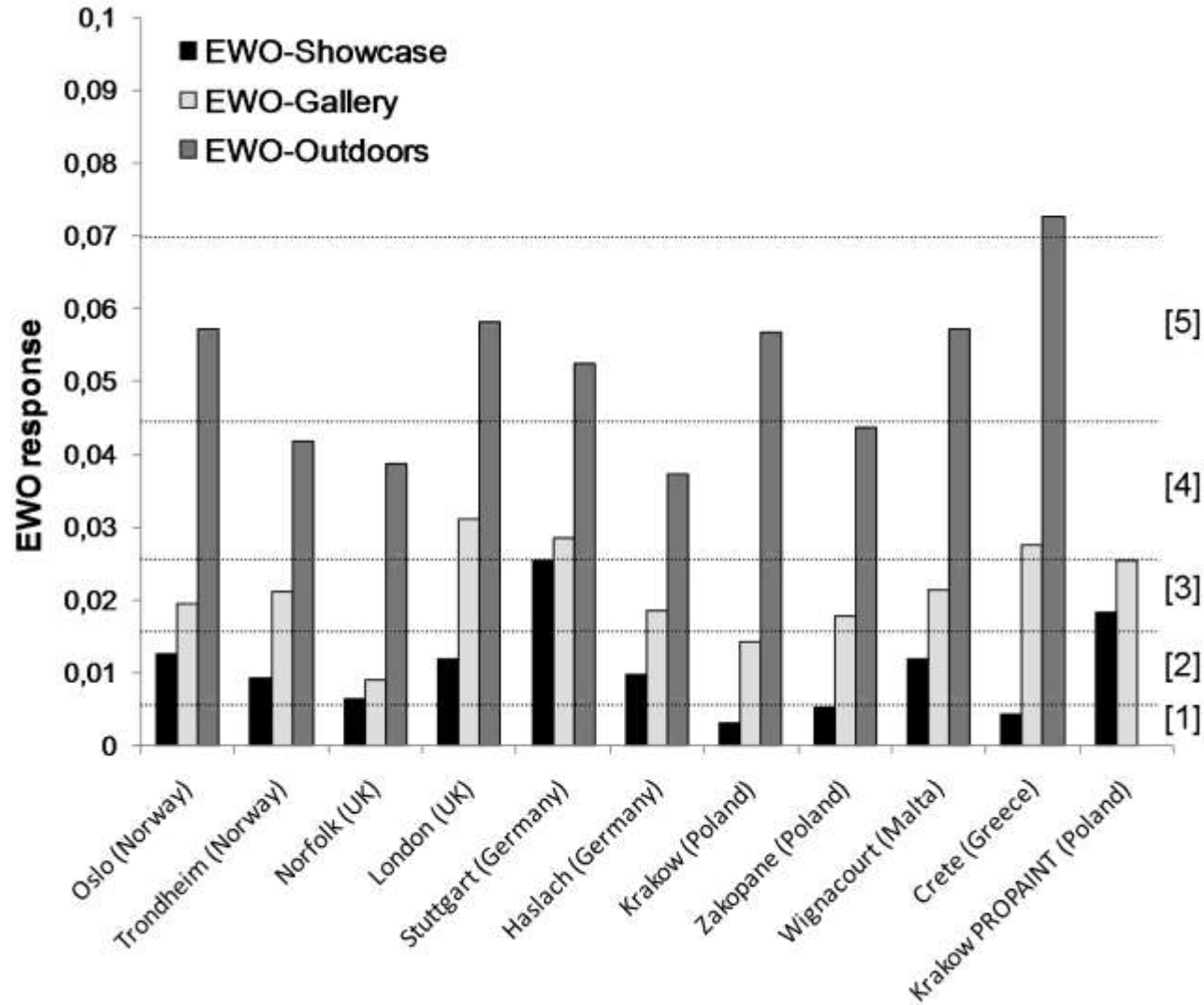


PQC dosimeters

Glass dosimeters

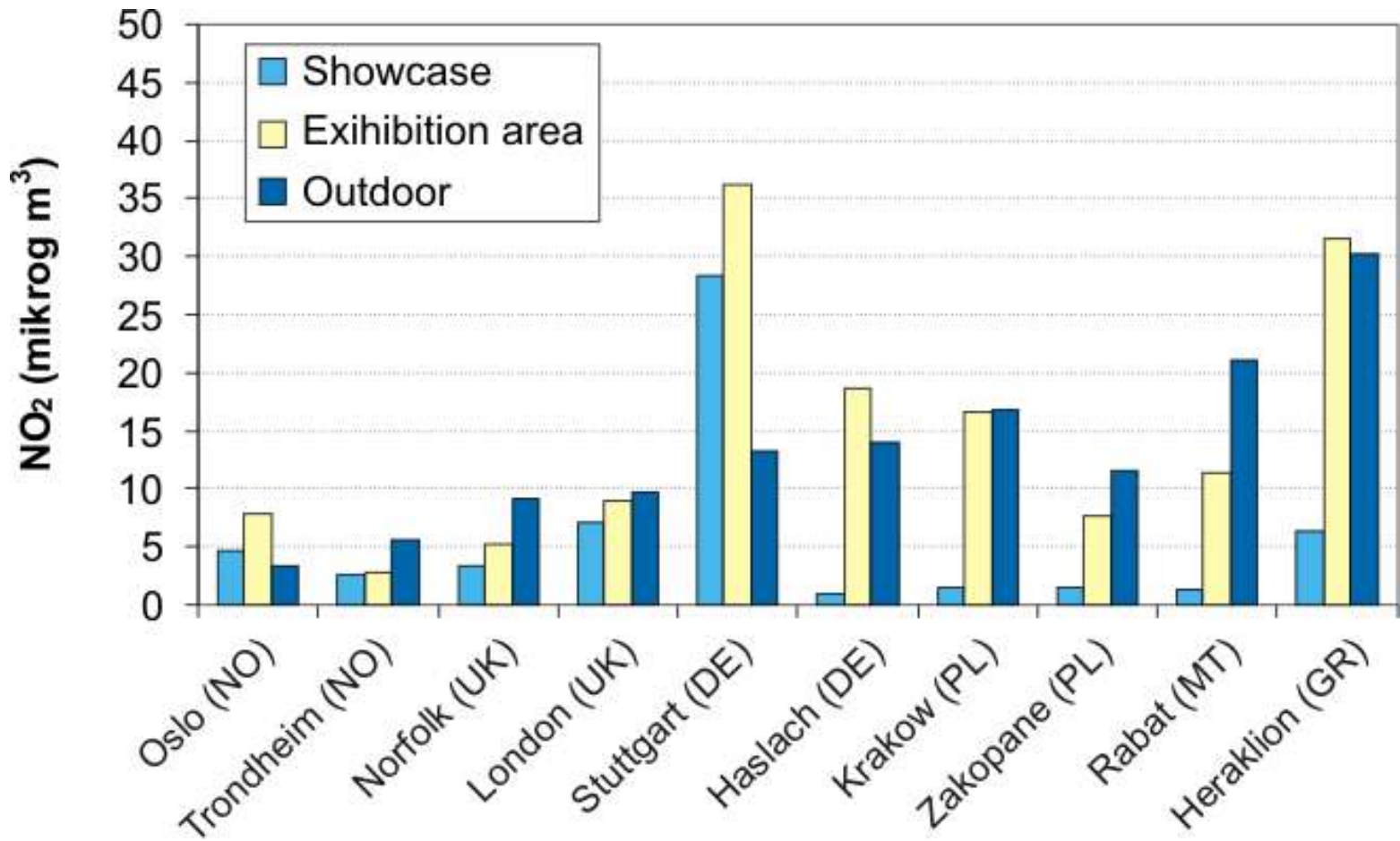
EWO dosimeter

EWO - dosimeter response MASTER and PROPAINT

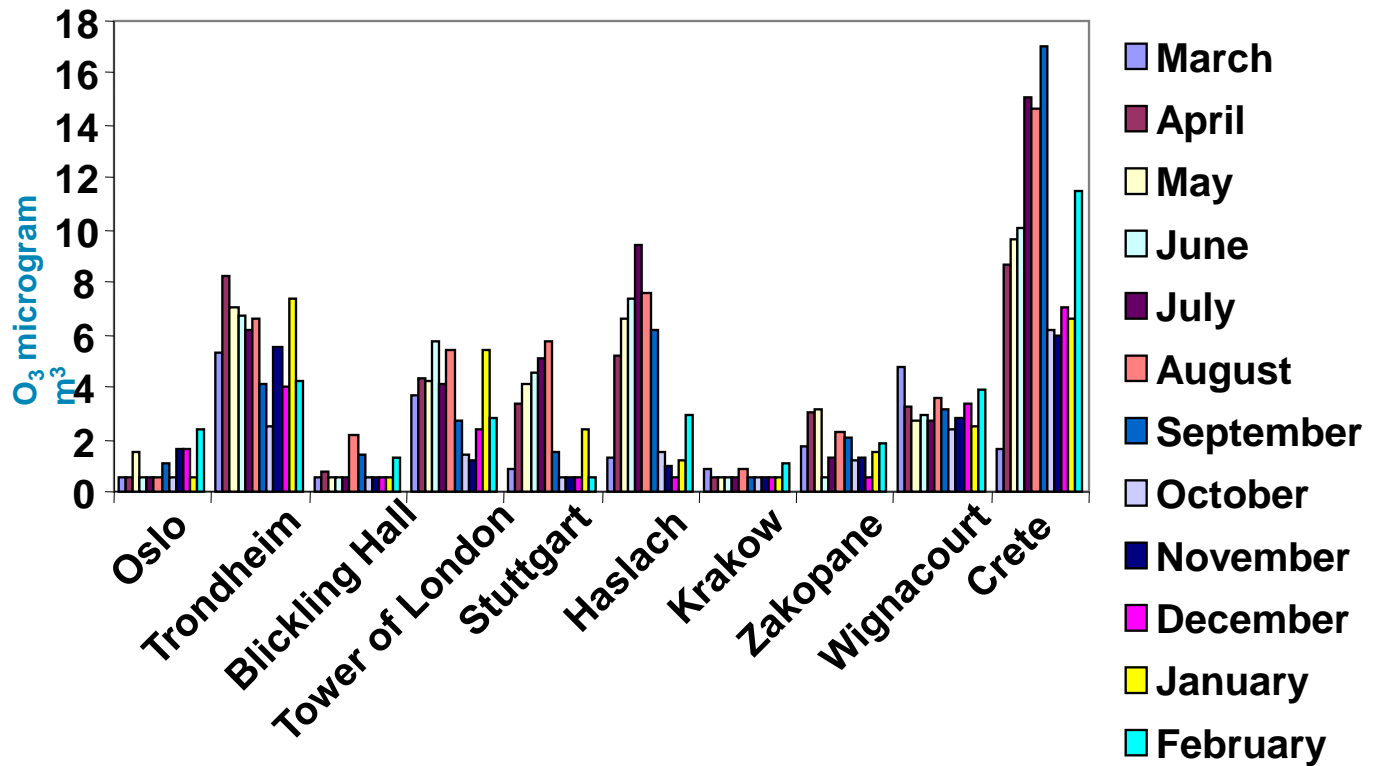


NO₂ in showcases, May 2004

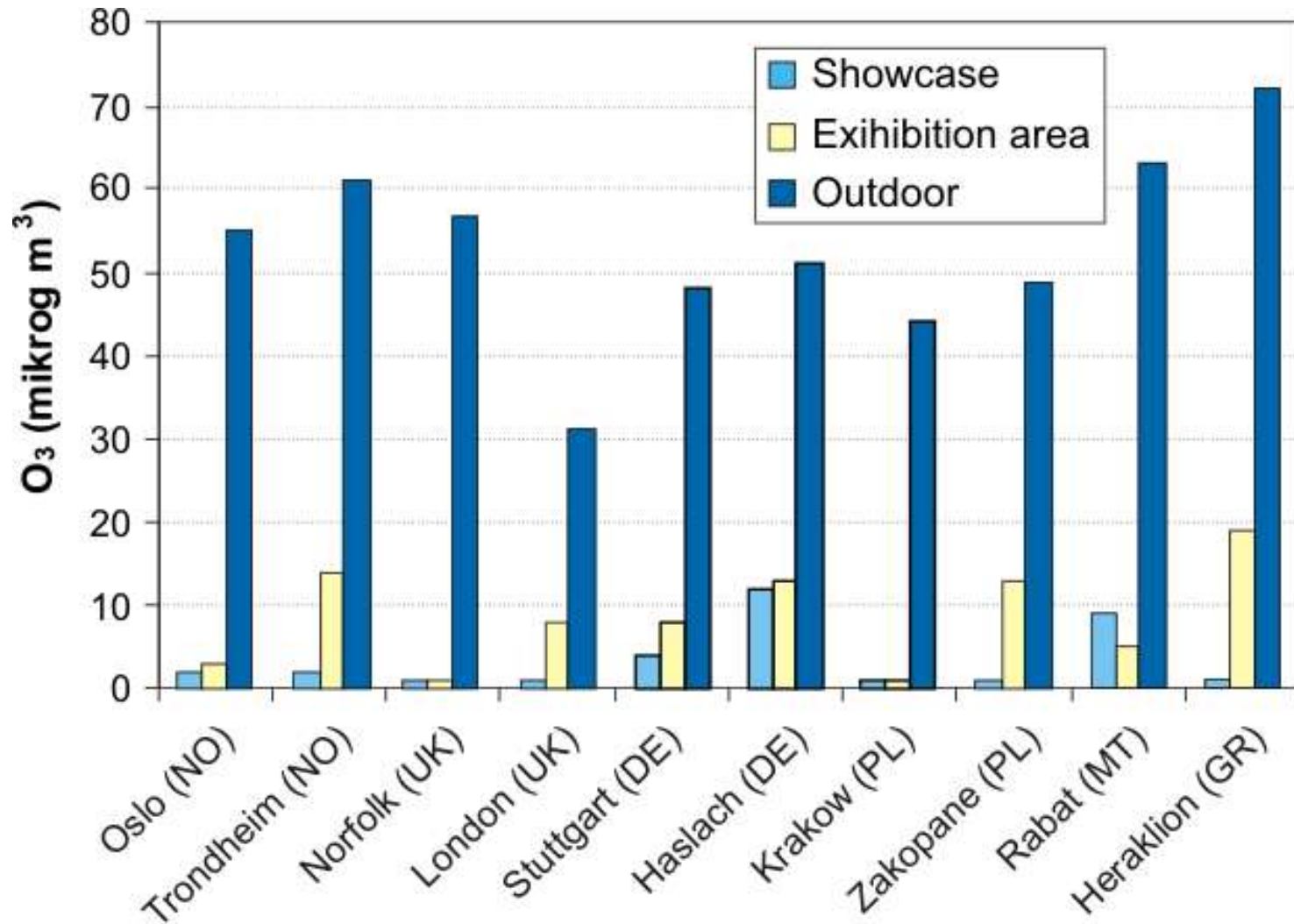
MASTER



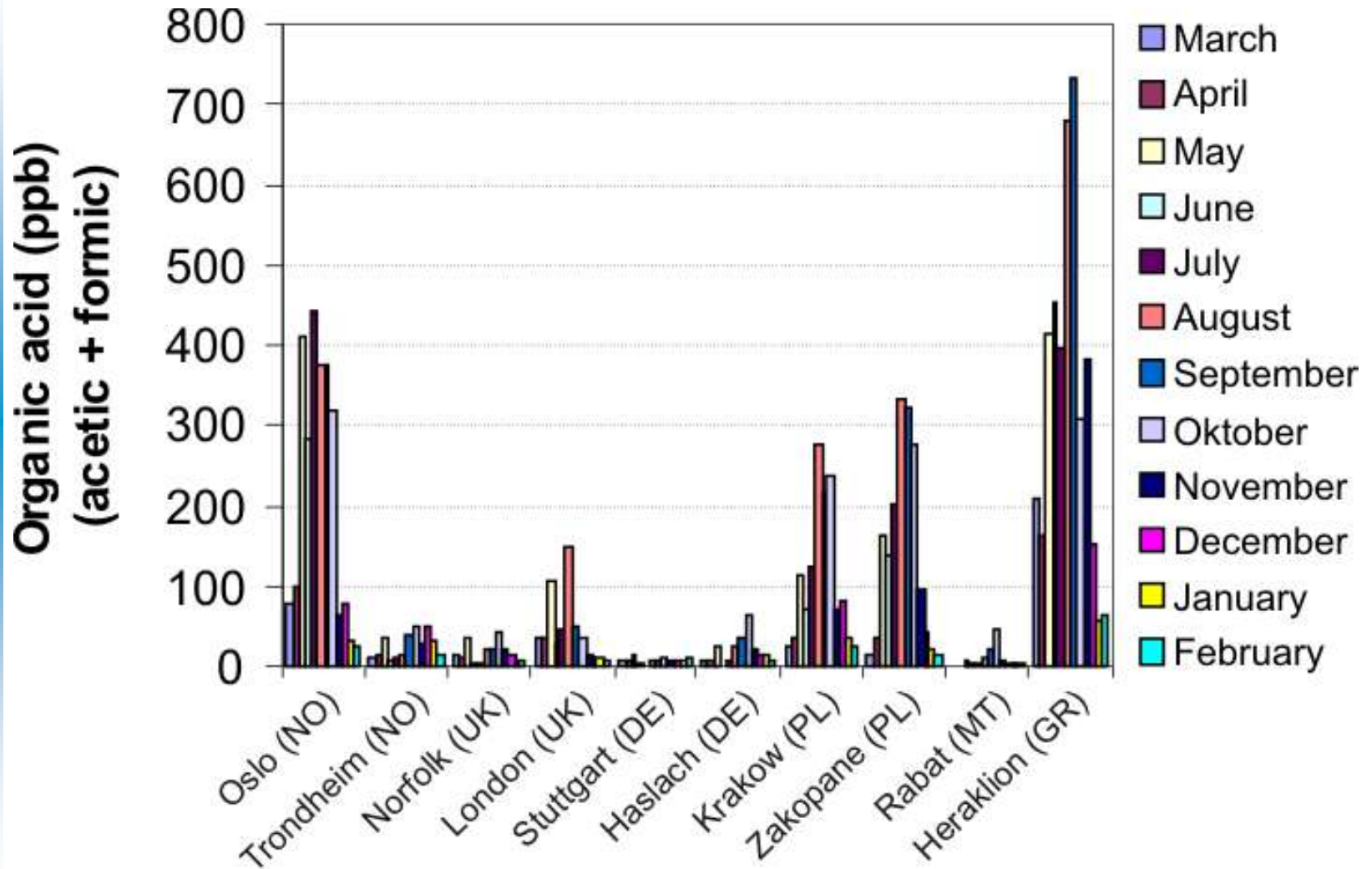
O₃ concentrations for all test sites: exhibition room - MASTER



Ozone in showcases, May 2004 – MASTER



Organic acids in showcases - MASTER



Results from monitoring inside and outside 15 MC-frames - PROPAINT

- ❖ Concentration of NO_2 and O_3 is lower inside than outside the MC-frames
- ❖ Higher concentration of organic acids and VOC inside than outside the frames
- ❖ The air exchange rate within the frames vary from almost airtight (0.15 day^{-1}) to highly ventilated (15 day^{-1})

Conclusion

- ❖ The EWO-dosimeter indicates to what extent showcases and MC-frames protect objects against outer environmental pollution
- ❖ For pollutants generated inside showcases and MC-frames, like organic acids and VOC, there is no reaction from the EWO. Passive gas samplers or other dosimeters have to be used.
- ❖ A database containing environmental data from all monitoring sites has been established.

Further research needed

- ❖ There is still little knowledge about the effect of organic acids and VOC on different materials
- ❖ The effect of absorption materials used as a sink for pollutants in showcases, needs to be investigated further
- ❖ Research related to non destructive investigation for the understanding of environmental degradation of movable objects.

Acknowledgement

- ❖ Financial support for the MASTER and PROPAINT project:
The European Commission, and
The Norwegian Archive, Library and Museum Authority
- ❖ Thanks to all the partners in both the MASTER and PROPAINT project for their work

Welcome to the PROPAINT Final Seminar and Workshop 20 - 21 November in Krakow

For more information;
<http://propaint.nilu.no>



Thank you for your attention.



Wignacourt Collegiate Museum, Malta