# Sustainable conservation of built cultural heritage in a changing environment

Beatriz Menéndez
CY Cergy Paris Université

**Italian-French Bilateral Cooperation in Heritage Science: "Human-centered approach for cultural heritage in green transition: disciplines talking to each other"**
Online event
Thursday, 10th november 2022

# SCORE : Sustainable COnservation and REstoration of built cultural heritage

## Participants: intersectoral, international and multidisciplinary group

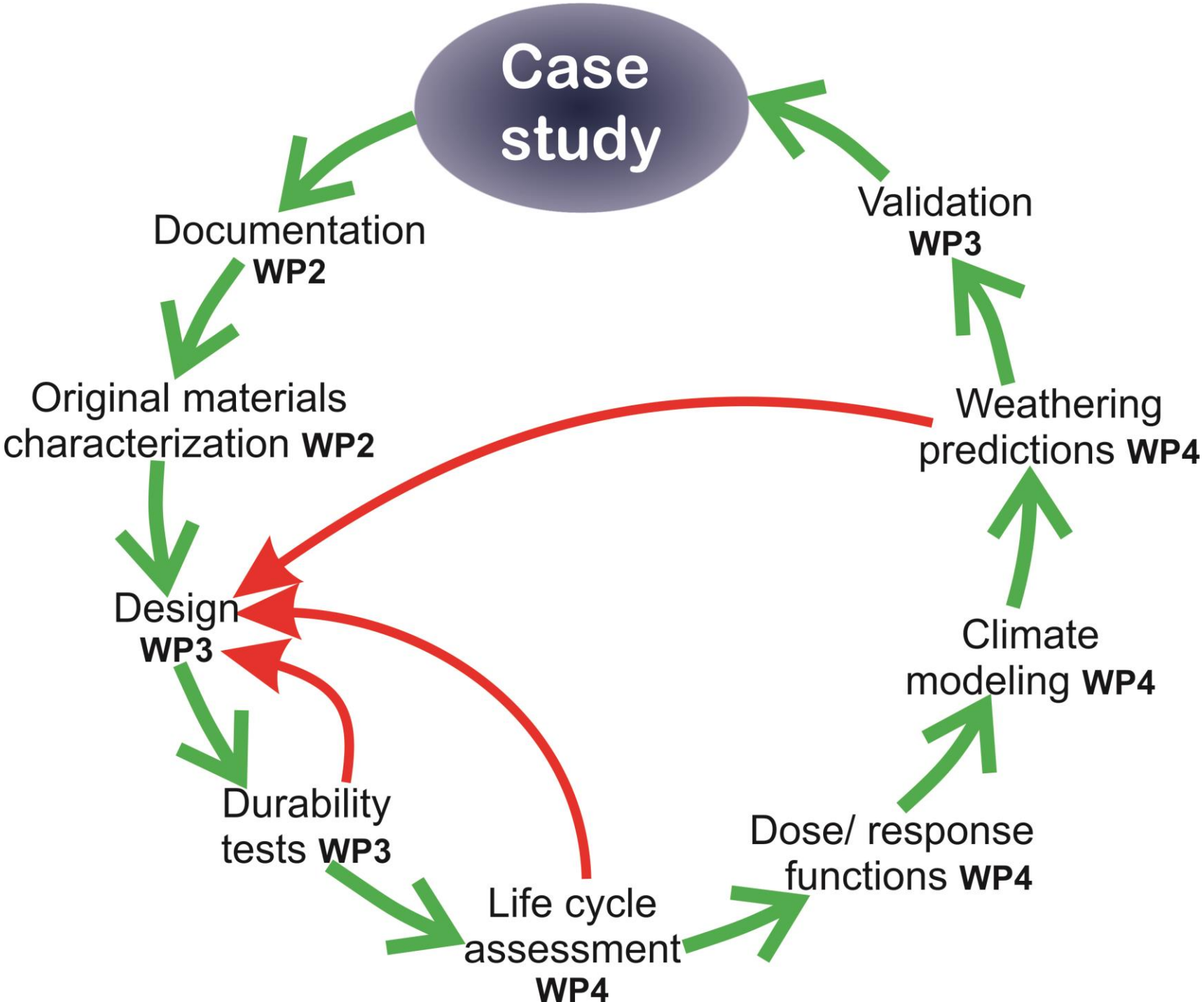
### Europe

- CY Cergy Paris (France) GEC
- CY (France) HERITAGES
- University of Modena and Reggio Emilia (Italy)
- University Pavia (Italy)
- ISAC-CNR Bologna (Italy)
- DTU Copenhagen (Denmark)
- Institute Geoscience Madrid (Spain)
- GEA Oviedo (Spain)
- REMPART (France)

### America

- University Rosario Bogota (Colombia)
- CINVESTAV Merida (Mexico)
- Univ Juarez Autonoma Tabasco (MX)
- University Autonoma Campeche (MX)
- Univ Politech Centro Tabasco (MX)
- Inst Nat Archaeology History Merida

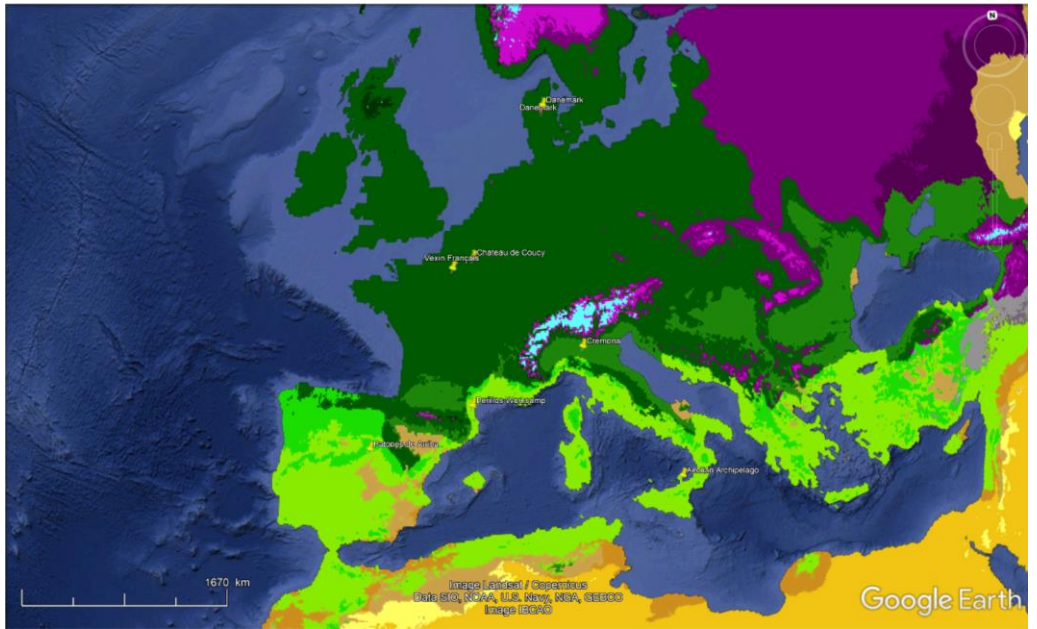
# Methodology




# Studied Built Cultural Heritage

## Vernacular BCH in Europe

- **Vexin Français** (France) Temperate oceanic climate
- **Patones de Arriva** - Madrid area (Spain) Hot-summer and Warm-summer Mediterranean climate and Cold semi-arid (steppe) climate
- **Cremona** (Italy) Humid subtropical climate
- **Aeolian Archipelago** (Italy) Hot-summer Mediterranean climate
- **Chateau de Coucy** (France) Temperate oceanic climate
- **Périllos Workcamp** (France) Hot-summer Mediterranean climate
- The use of bricks in **Danish** Built Cultural Heritage Temperate oceanic climate

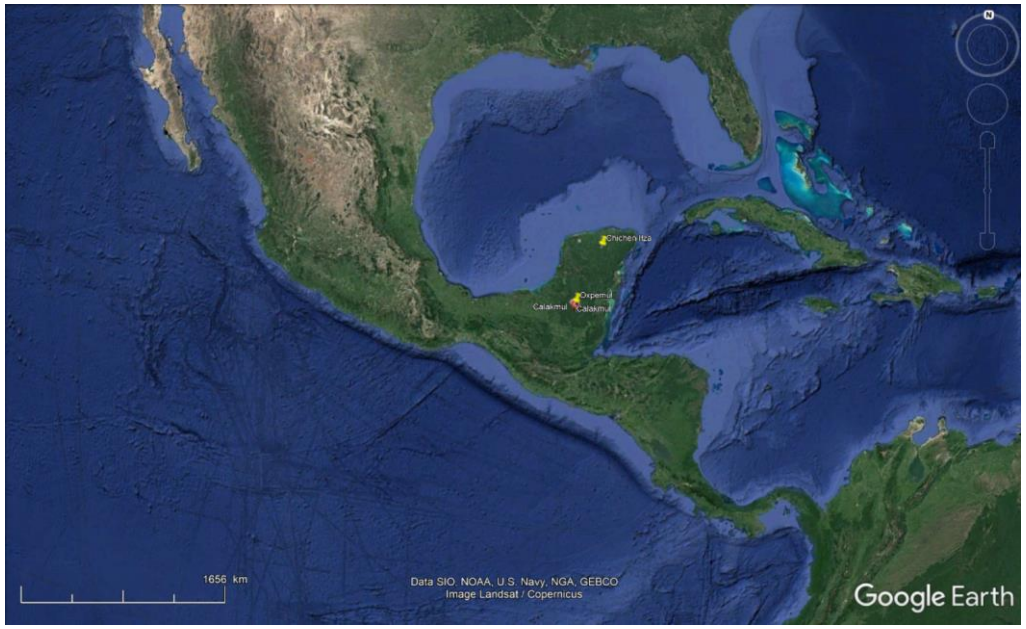



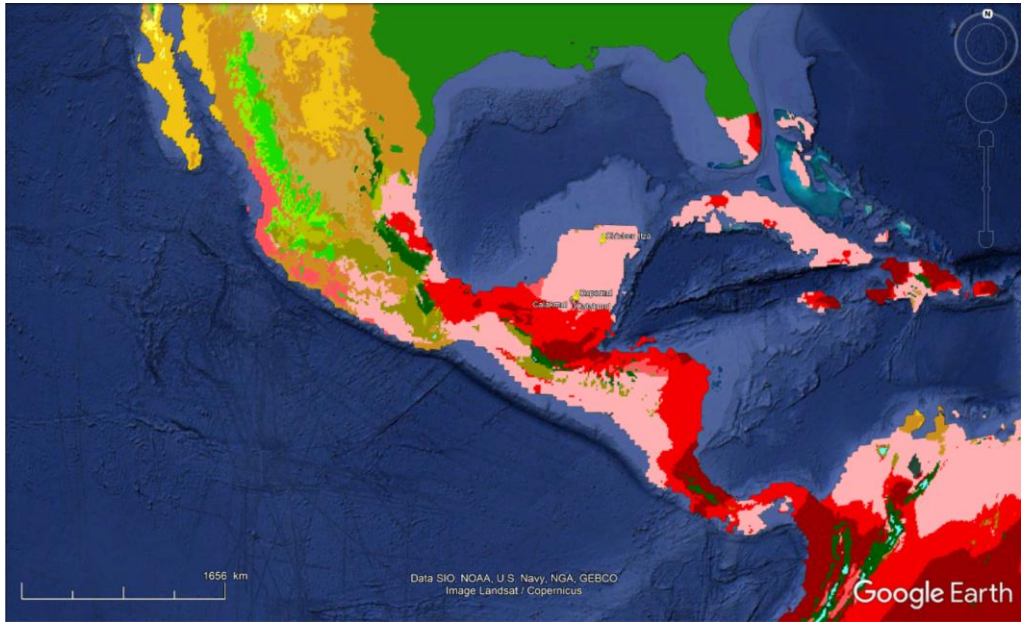
# Studied Built Cultural Heritage

Archaeological cultural heritage in Mexico

**Chichén Itza** (Mexico) Tropical dry savanna climate

**Oxpemul** (Mexico) Tropical dry savanna climate



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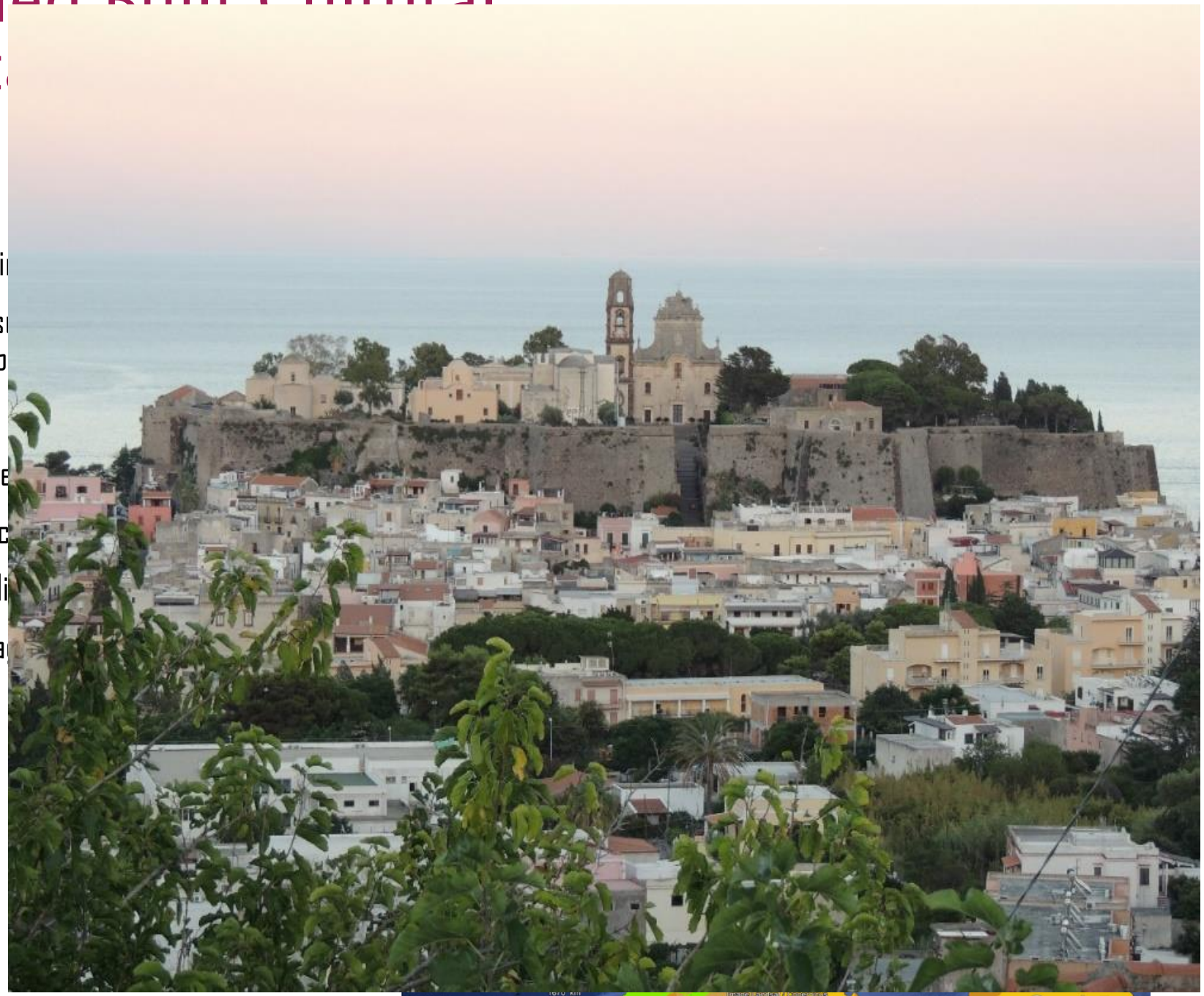

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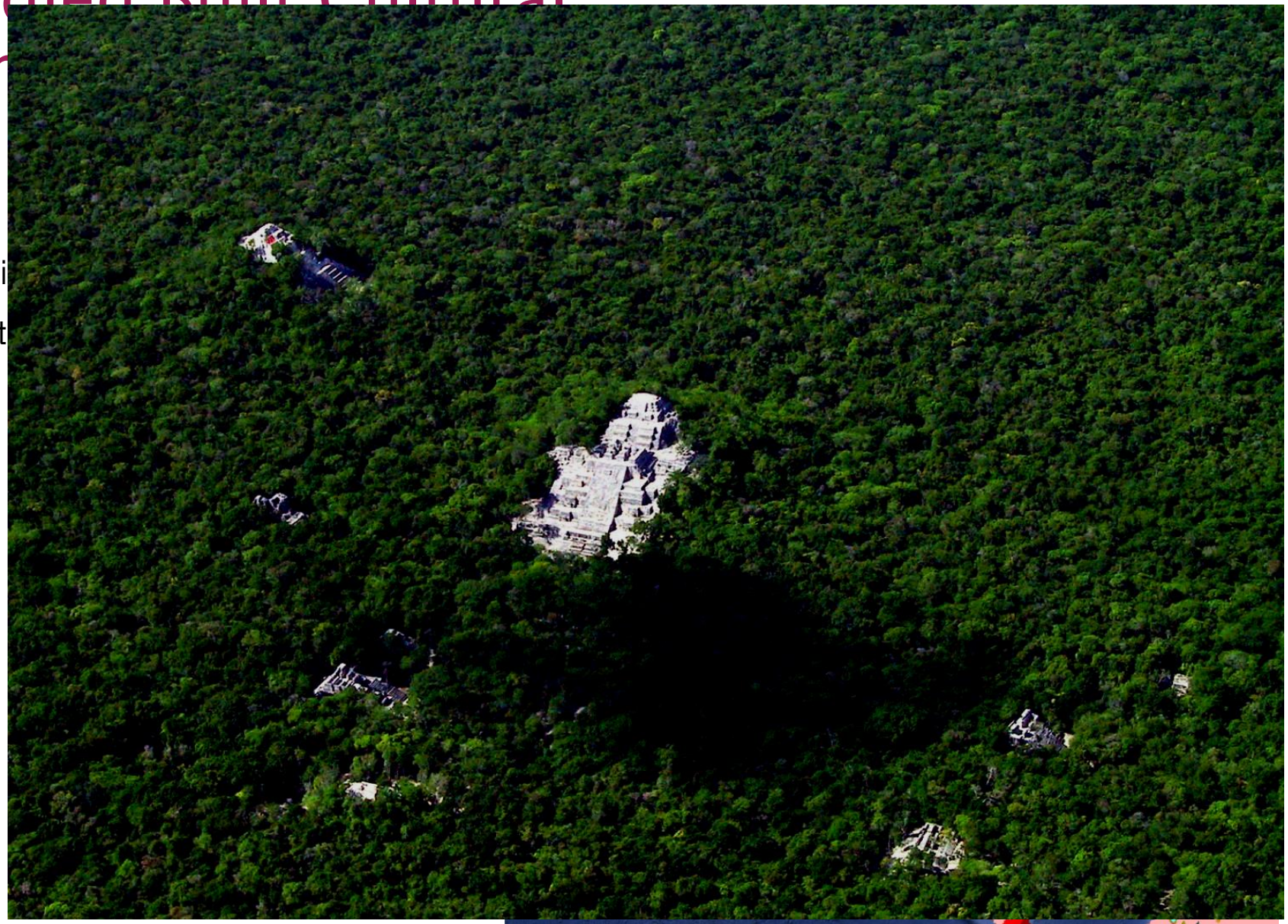
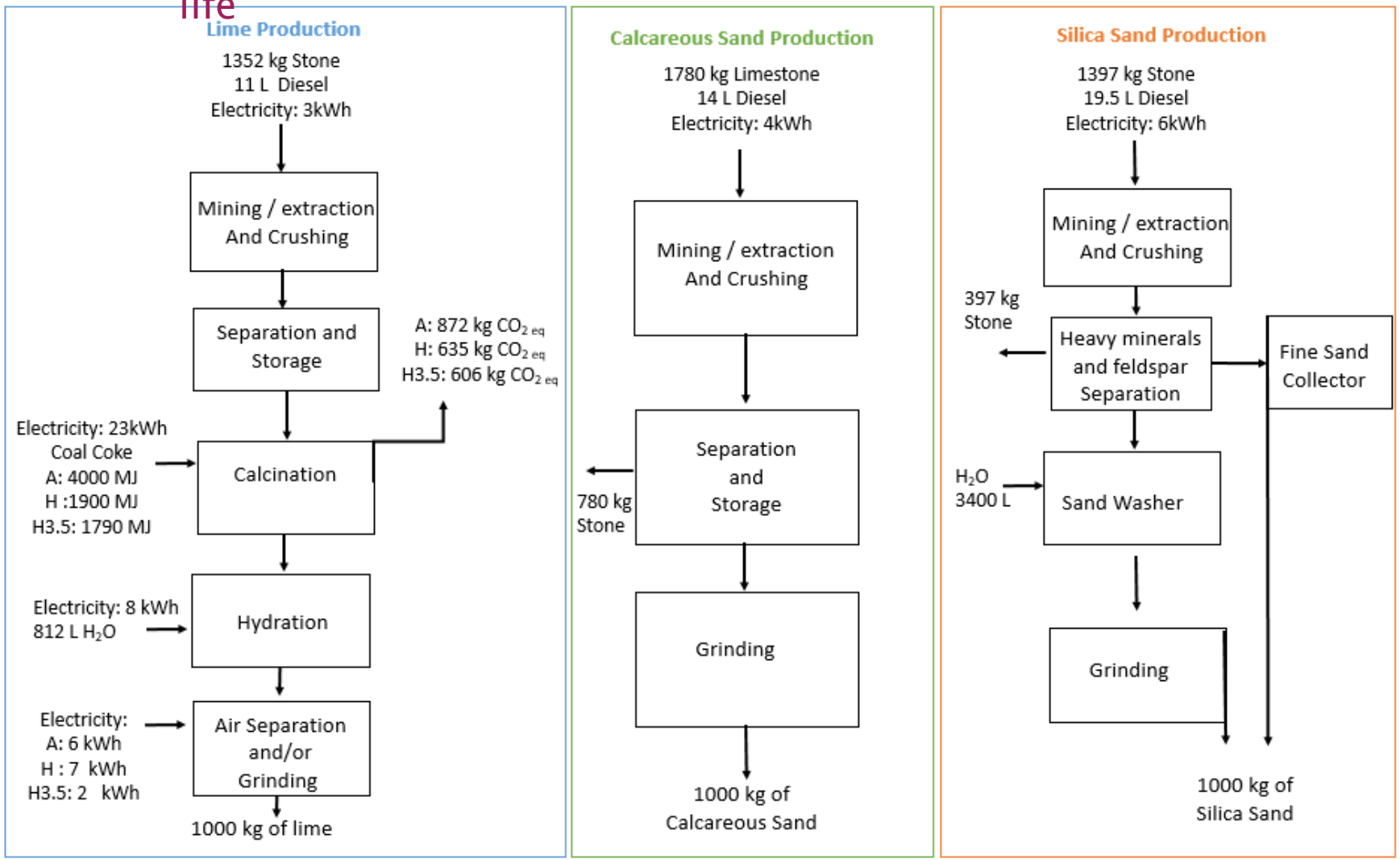
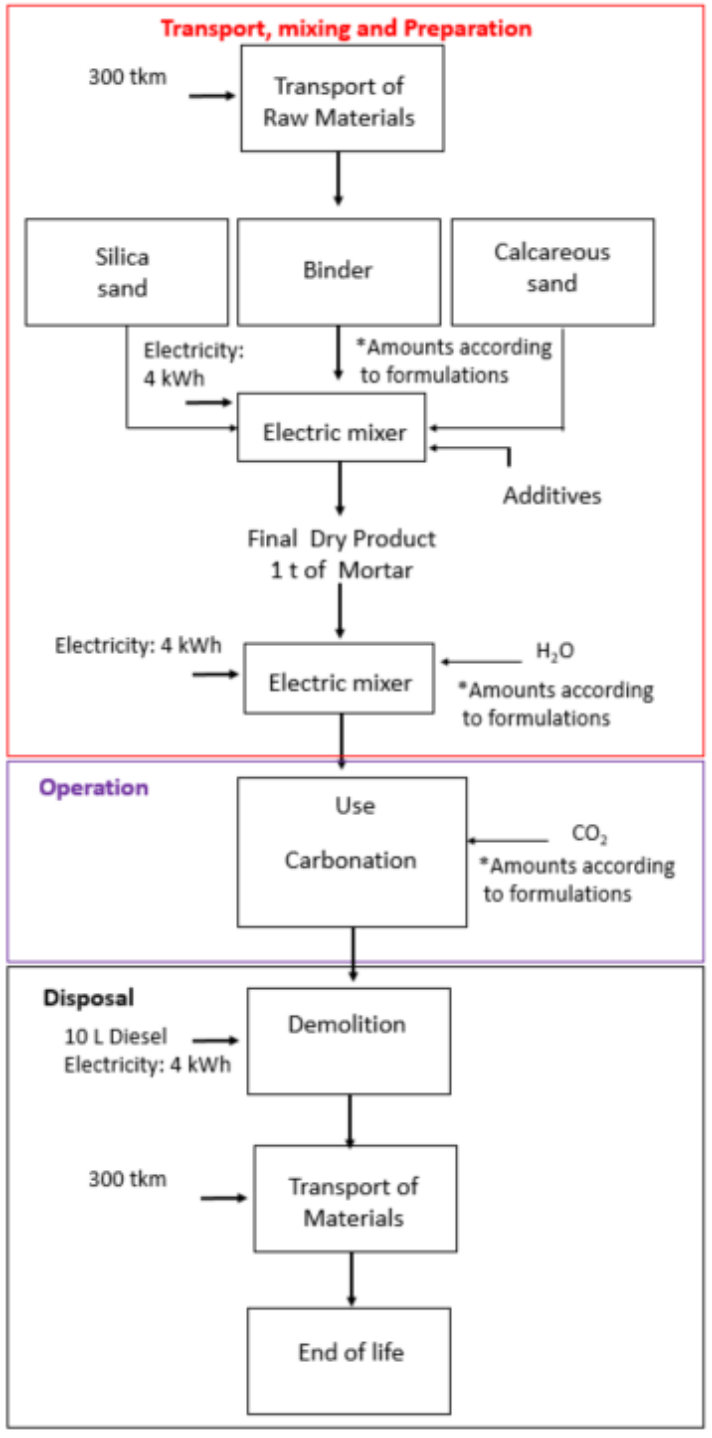


# Sustainable mortars for stone restoration

José Diaz Basteris PhD (MOPGA + Inititive d'Excellence C

## Life cycle assessment of a mortar from fabrication to end of life



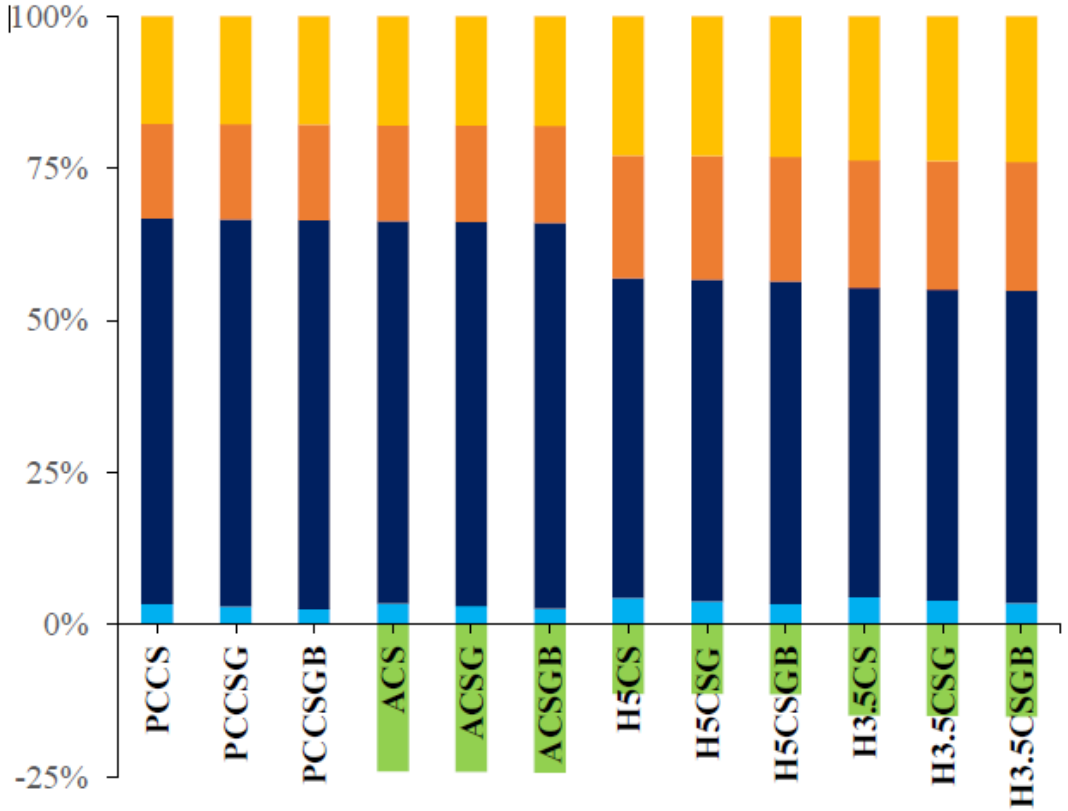
# Formulated mortars

| # | Mortar | NHl5 | NHl3.5 | CL90 | Sand D | Sand F | Sand S | Sand C | G | P | R | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **HFD** | 20 | | | 60 | 20 | | | | | | |
| 2 | **HSD** | 20 | | | | 15 | 65 | | | | | |
| 3 | **HS** | 20 | | | | | 80 | | | | | |
| 4 | **HB** | 20 | | | | | | | | | | 80 |
| 5 | **HCSR** | 30 | | | | | 45 | 25 | | | * | |
| 6 | **HCS** | 30 | | | | | 45 | 25 | | | | |
| 7 | **HSG** | 30 | | | | | 60 | | 10 | | | |
| 8 | **HSP** | 30 | | | | | 68 | | | 2 | | |
| 9 | **HC** | 30 | | | | | | 70 | | | | |
| 10 | **HCSGB** | 30 | | | | | 25 | 25 | 10 | | | 10 |
| 11 | **AS** | | | 20 | | | 80 | | | | | |
| 12 | **AHCS** | 15 | | 15 | | | 35 | 35 | | | | |
| 13 | **ACSGB** | | | 30 | | | 25 | 25 | 10 | | | 10 |
| 14 | **OAC *** | | | 40 | | | | 60 | | | | |
| 15 | **AC** | | | 40 | | | | 60 | | | | |
| 16 | **AS2** | | | 40 | | | 60 | | | | | |
| 17 | **H3.5CS** | | 30 | | | | 7 | 63 | | | | |
| 18 | **H3.5CS2** | | 30 | | | | 21 | 49 | | | | |
| 19 | **H3.5CS3** | | 30 | | | | 35 | 35 | | | | |
| 20 | **H3.5CS4** | | 30 | | | | 49 | 21 | | | | |
| 21 | **H3.5CS5** | | 30 | | | | 63 | 7 | | | | |
| 22 | **H3.5CSG** | | 30 | | | | 30 | 30 | 10 | | | |
| 23 | **H3.5CSB** | | 30 | | | | 30 | 30 | | | | 10 |
| 24 | **H3.5CSGB** | | 30 | | | | 25 | 25 | 10 | | | 10 |

**H** Hydraulic lime
**A** Aerial lime
**C** Calcareous sand
**S** Siliceous sad
**F** calcareous sand
**D** Fine siliceous sand
**O** Lime paste (90 days)

**G** Grinded glass
**B** **C**hamotte
**P** Cones
**R** Resin from cones

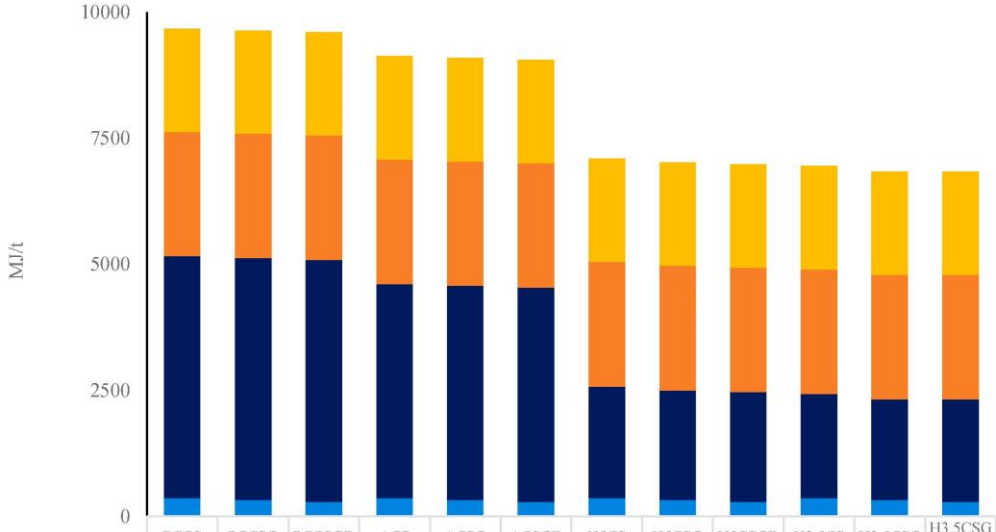
## GWP: Global Warming Potential




Operation
Disposal
Transport, Mixing and Preparation
Binder Production
Sand Production

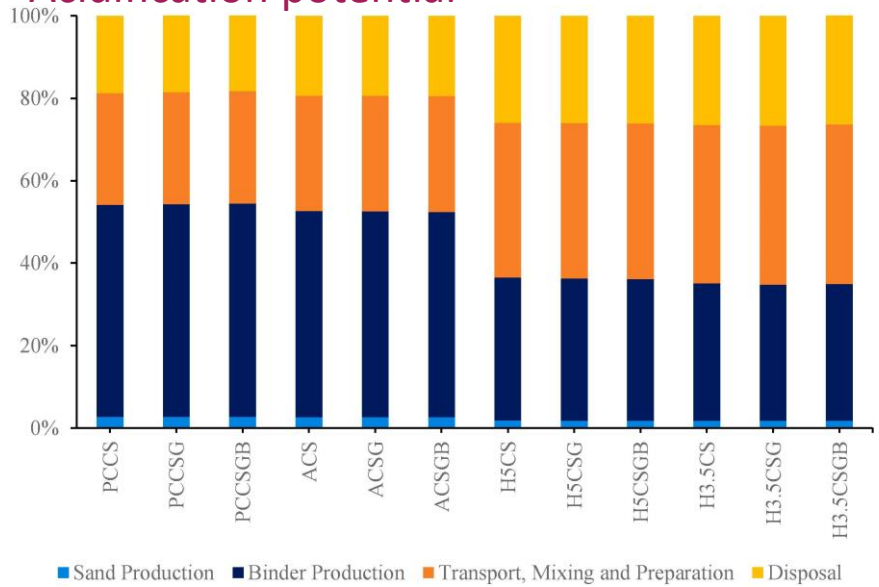
≈ 60 %

## Natural and fossil resources depletion




| | PCCS | PCCSG | PCCSGB | ACS | ACSG | ACSGB | H5CS | H5CSG | H5CSGB | H3.5CS | H3.5CSG | H3.5CSGB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 9676 | 9640 | 9604 | 9128 | 9092 | 9056 | 7094 | 7020 | 6984 | 6948 | 6838 | 6838 |
| Disposal | 2050 | 2050 | 2050 | 2050 | 2050 | 2050 | 2050 | 2050 | 2050 | 2050 | 2050 | 2050 |
| Transport, Mixing and Preparation | 2470 | 2470 | 2470 | 2470 | 2470 | 2470 | 2470 | 2470 | 2470 | 2470 | 2470 | 2470 |
| Binder Production | 4796 | 4796 | 4796 | 4248 | 4248 | 4248 | 2214 | 2176 | 2176 | 2068 | 1994 | 2030 |
| Sand Production | 360 | 324 | 288 | 360 | 324 | 288 | 360 | 324 | 288 | 360 | 324 | 288 |

## Acidification potential



# Conclusions

- Energy consumption and polluting emissions through the life cycle of mortars have been determined
- The sustainability of the formulated mortars has been estimated considering physicochemical properties, durability, environment impact and economy
- The properties and durability of mortars can be improved using recycled materials, admixtures or additives
- A selection method that can be applied anywhere and to any construction material by modifying the selected properties has been set up.

## and perspectives

- New research group is under construction to propose ressources-efficient sollutions for traditional buildings renovation

# Thanks for your attention!

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