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Measuring sustainability of building aggregates by means of LCA tools

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1 Sustainable Development and building aggregates

Building aggregates, **basic materials for the construction industry, must be produced according to *Sustainable Development* principles**

However, there are several interpretations of *Sustainable Development* although almost everybody agree upon the following approach:

> ***Sustainable Development*** **is made of three equally important components which encompasses the following aspects :**
>
> - ***Economic***
> - ***Social***
> - ***Environmental***

…therefore, if *Sustainable Development* is not fairly comprehensive and fails in one of the three aspects, an overall failure is expected

1 Sustainable Development and building aggregates

- EU is highly dependent on resources coming from outside Europe and the environmental impact of resource use by the EU and other major economies is felt globally

EU Thematic Strategy on the sustainable use of natural resources (COM 670, 21-12-2005)

- …raw materials extraction in Europe has decreased while imports have increased, resulting in a shift of environmental pressures to other regions

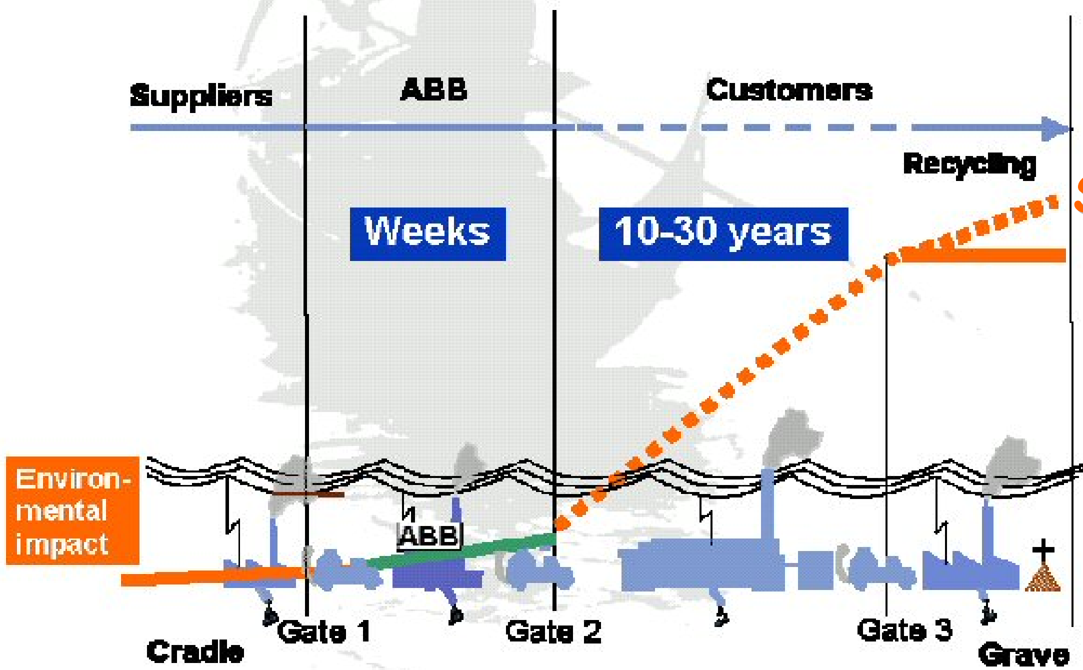
(… without achieving the expected environmental benefits!)

Sustainable Mining → is therefore more than

"eco-friendly" mining production…

1 Sustainable Development and building aggregates

- …mineral professionals should stop looking for solutions which are *limited to single processes* → *eco-compatible mining*
- …they should extend their field of interest beyond the physical boundaries of mines and start thinking about the repercussions of mineral products in their subsequent *life-cycles*



Sustainable Mining must be:

Sustainable production

and *use*

of *mineral products*

1 Sustainable Development and building aggregates

- In fact, to assess sustainability of building aggregates, we cannot limit the analysis to the quarry phase only
- We must observe that this phase is inseparabely connected with the downstream activities of the construction process, of which it represents the input
- It is the need for, and the subsequent use of mineral commodities, the very reason why mining activities exist

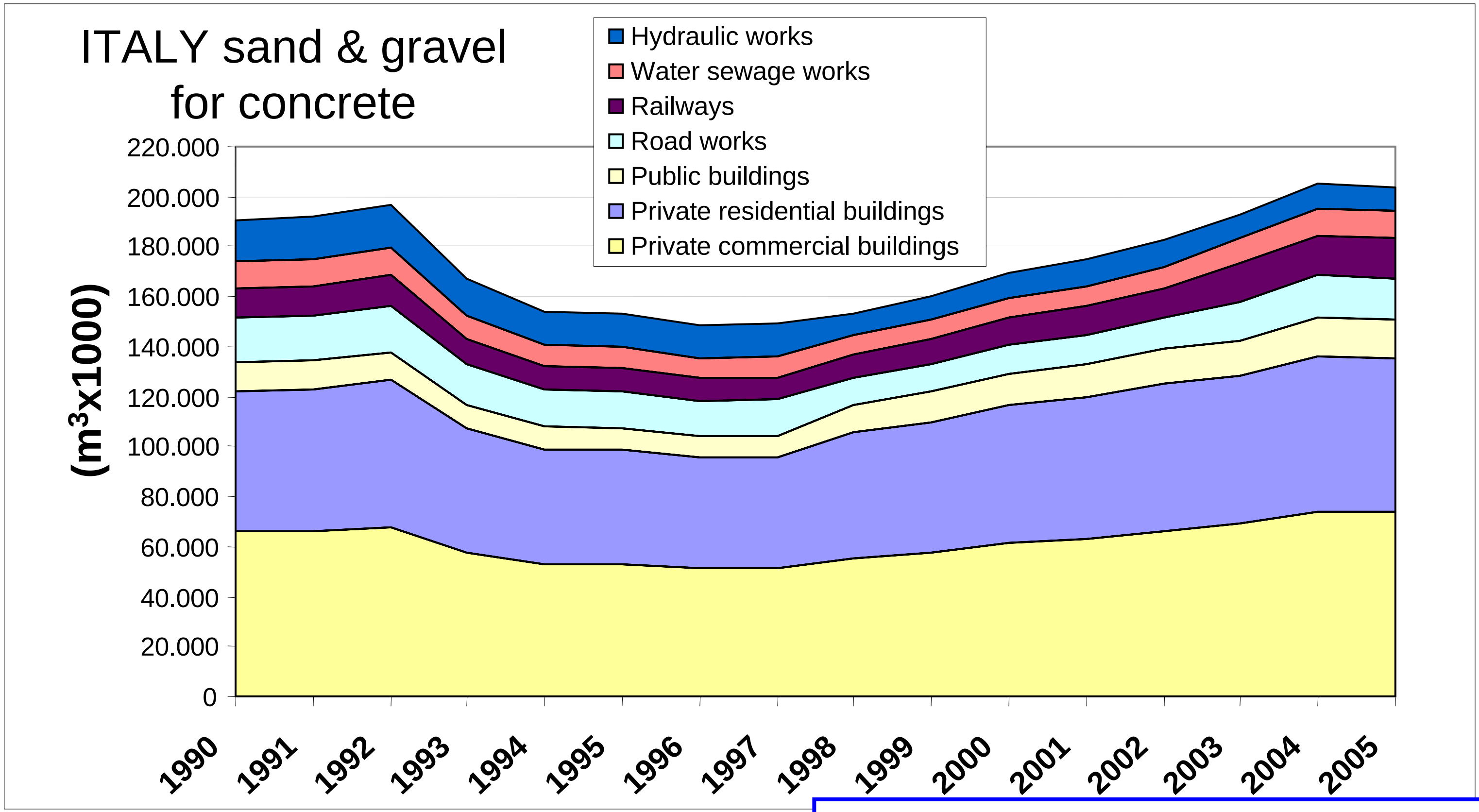
2 1st and 2nd aspect of sustainable building aggregates

In order to allow economic and social development, building aggregates must be made available in quantity and quality corresponding as well as possible to the market demand

What is the correct quantity that should be quarried?

(underestimations and overestimations should be avoided)

2 1st and 2nd aspect of sustainable building aggregates



Per capita supply 1990-2005:

(all kind of building aggregates)

6.5 t/y

Italian construction sector (2004)

5.2% GDP

8% National employement

14 job position for 0.5 M€

3 Environmental sustainability of building aggregates

During the last years the extractive activities have been claimed to be responsible of several environmental impacts

ENVIRONMENTAL EFFECT	SCALE OF INFLUENCE
Non renewable resources depletion	Global
Global warming	Global
Stratospheric ozone layer depletion	Global
Acidification	Regional
Eutrophication	Regional/local
Photochemical smog creation	Regional
Human toxicity	Regional/local
Eco-toxicity	Regional/local
Waste generation	Regional/local
Visual impact	Local
Surface water pollution	Local
Land use	Local
Water resources use	Local
Dust emissions	Local
Noise / vibrations	Local
Traffic	Local

Objective assessment tools: **LCA**

(ISO 14040)

Perceived as **very important** by the **general opinion** and by the **public administrations**

...but the **most difficult to quantify**

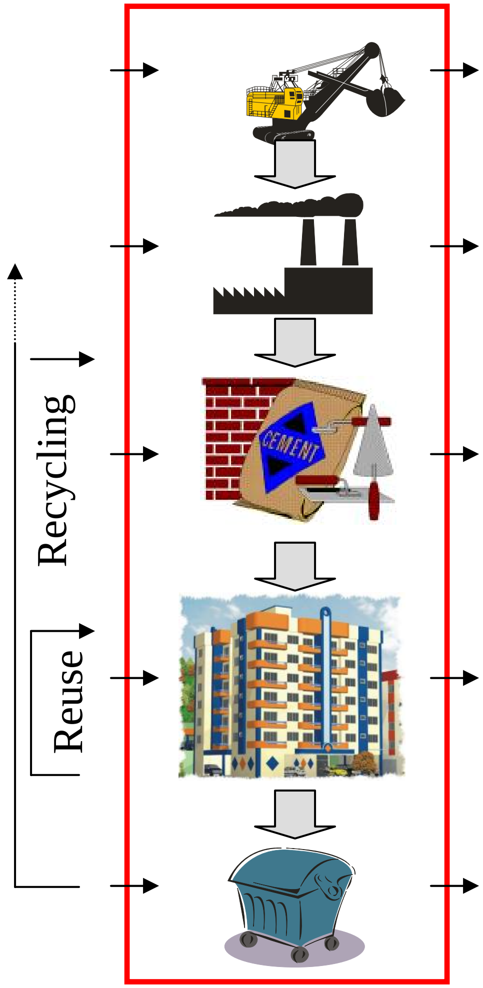
Analysis of the **relationship** between **extractive industry** and its **environmental effects**

→ ENVIRONMENTAL PROFILES of BUILDING AGGREGATES

4 Life Cycle Assessment of building aggregates

LCA (Life Cycle Assessment) according to ISO 14040 STANDARD

- **Raw Material Extraction**
- **Material Processing**
- **Production (building)**
- **Use and Maintenance**
- **Disposal**



LCA identifies and quantifies energy and materials used as well as releases to the environment and their potential impacts throughout the whole life cycle

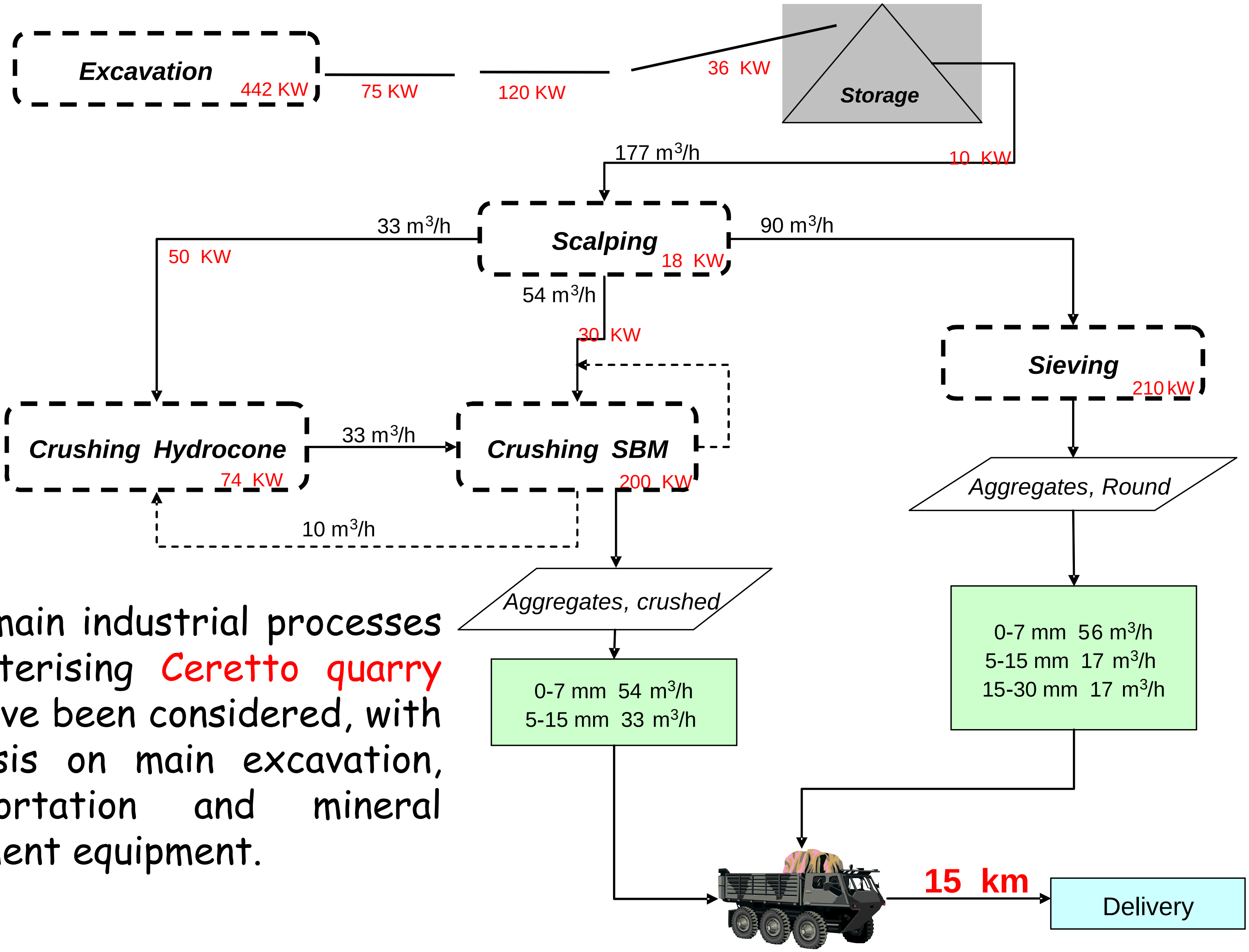
Study boundary

4 Life Cycle Assessment of building aggregates

»The production worksite under analysis is a quarry where building aggregates are excavated from an alluvial deposit, under the water table, by means of a grab dredge (Ridinger) equipment.

»Ceretto quarry is located in the southern surroundings of Torino, along the left side of the Po river.

»Production of gravel and sand accounted for 500000 t in the year 2003.

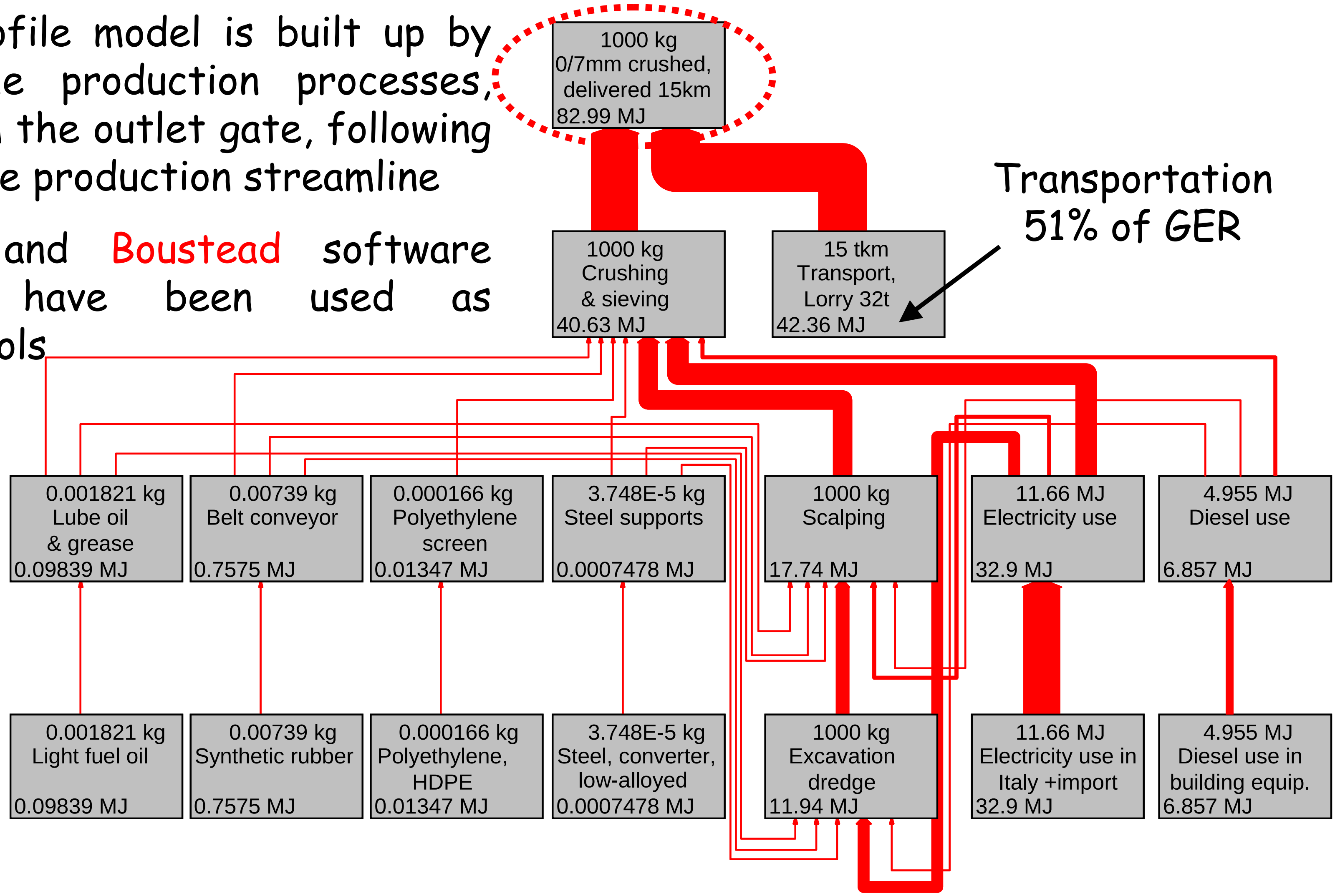


»The main industrial processes characterising Ceretto quarry unit have been considered, with emphasis on main excavation, transportation and mineral treatment equipment.

4 Eco-profiles of natural aggregates

»The eco-profile model is built up by exploding the production processes, starting from the outlet gate, following backwards the production streamline

»Sima Pro and Boustead software applications have been used as supporting tools



4 Eco-profiles of natural aggregates

»For comparison, from-cradle-to-gate LCA models, carried out in compliance with ISO 14040, relevant to building aggregates, can be found in different databases:

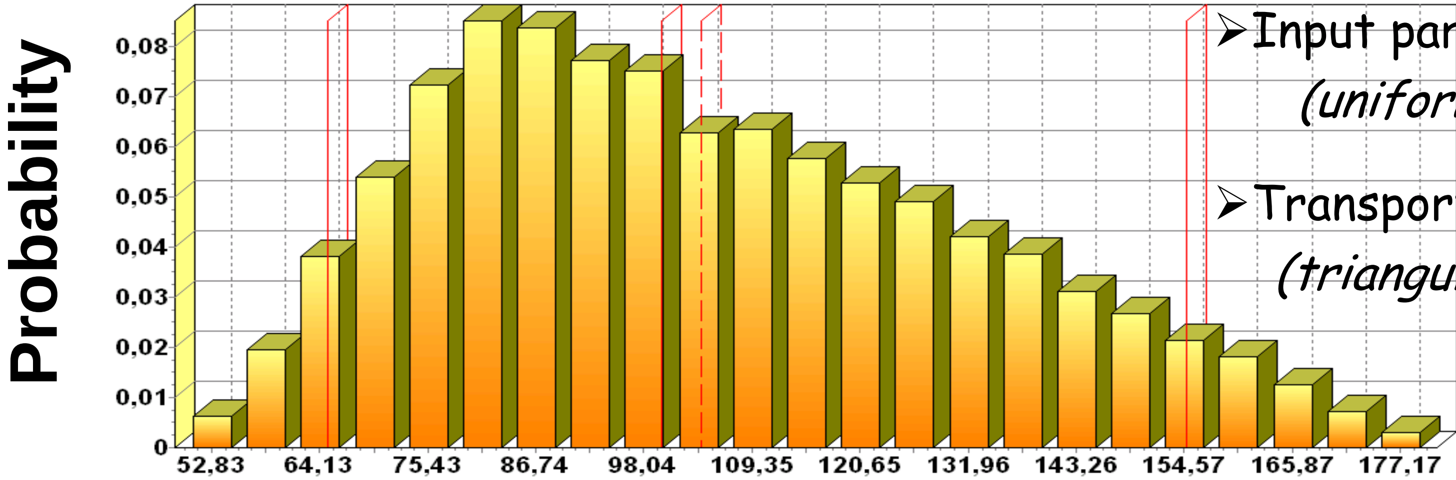
Table 1: Impact indicators representative of natural building aggregates eco-profiles, according to different sources

		Sand & Gravel (data per 1 ton)							
		not specified		crushed	round	crushed	round	mixed	mixed
Impact Indicator	Unit	ETH-ESU	IDEMAT	Ecoinvent	Ecoinvent	Boustead	Boustead	DITAG-Buwal	DITAG-Ecoinvent
GER	MJ	162.6	114.2	135.0	57.8	107.1	75.7	67.7	80.5
GWP_{100} (CO_2 eq)	kg	10.4	8.7	4.2	2.3	6.7	5.7	4.6	5.0
AP (mol H+ eq)	mol	1.69	2.97	0.88	0.57	2.18	2.43	1.70	1.21
EP (O_2 eq)	kg	0.28	0.62	0.19	0.13	0.43	0.61	0.32	0.20
POCP (C_2H_4eq)	g	0.54	0.16	0.35	0.12	0.13	0.08	0.06	0.20
Waste generation	kg	x	0.48	x	x	x	x	0.03	0.03

»Summary of the typical environmental impact indicators (eco-indicators), as gathered after the Impact Assessment step (ISO 1997), which can be regarded as representative of natural building aggregates eco-profiles.

4 Eco-profiles of natural aggregates – Monte Carlo simulation

Probability distribution of GER indicator (MJ/t) relevant to mixed aggregates



- Input parameters +/- 20% *(uniform distribution)*
- Transportation 5-50 km *(triangular distribution)*

Table 2: LCA impact indicators relevant to mixed aggregates quarried at Ceretto after Monte Carlo simulation

Impact Indicator	Unit	deterministic model	Mean value	Median	Standard deviation	5%	95%
GER	MJ	80.5	104.0	99.9	27.6	65.0	154.9
GWP_{100} (CO_2 eq)	kg	5.0	6.4	6.1	1.6	4.1	9.3
AP (mol H+ eq)	mol	1.21	1.52	1.46	0.36	1.00	2.19
EP (O_2 eq)	kg	0.20	0.28	0.26	0.09	0.15	0.44
POCP (C_2H_4eq)	g	0.20	0.27	0.26	0.07	0.16	0.40

5 CONCLUSIONS

- Eco-profiles of building aggregates can be regarded as part of the scientific background for quantifying sustainability of construction activities
- More in general, eco-profiles tell us what are the cumulative energetic and environmental performances of building materials, allowing therefore to carry out from-cradle-to-grave LCA of buildings
- However, because of the incertitude of input data and the heavy influence of parameters such as the transport distance, a risk analysis is recommended in order to supply eco-indicators as a probability distribution or a range associated to a level of confidence

Thank you for attending

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