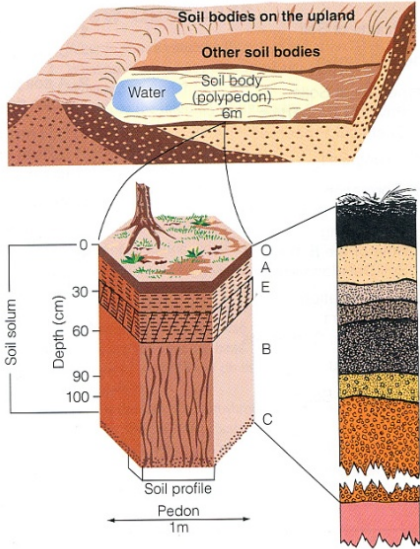


Land take impact on soil functions

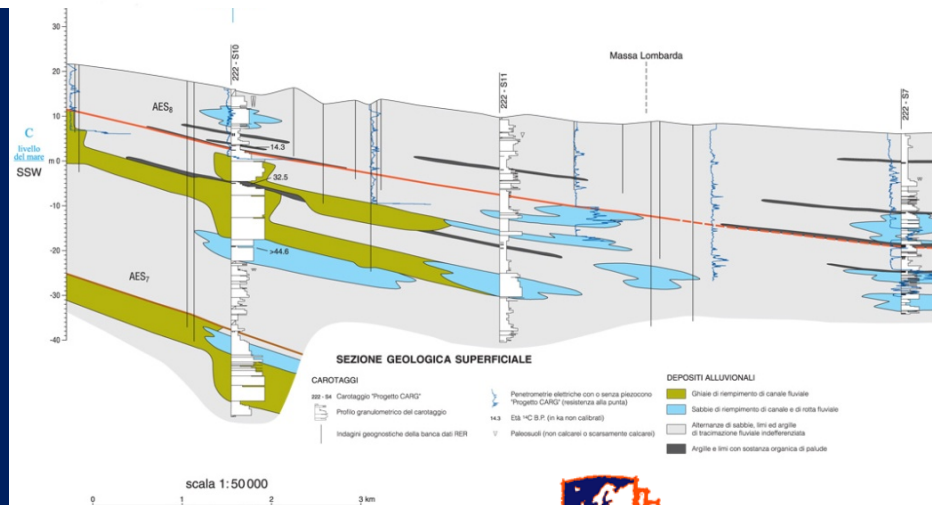
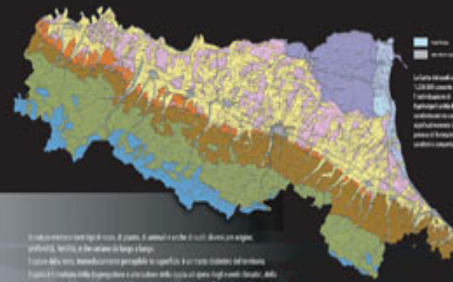
Working group 'Soil and Spatial Planning' - Regione Emilia-Romagna

(F. Malucelli, N. Filippi, F. Sacchetti, R. Bedosti, C. Calzolari, R. Scalenghe, N. Laruccia, A. Pistocchi, A.R. Rizzati, C. Gardi, M. Nardino, T. Georgiadis)

Soil is a multi dimensional body



Terre dell'Emilia-Romagna

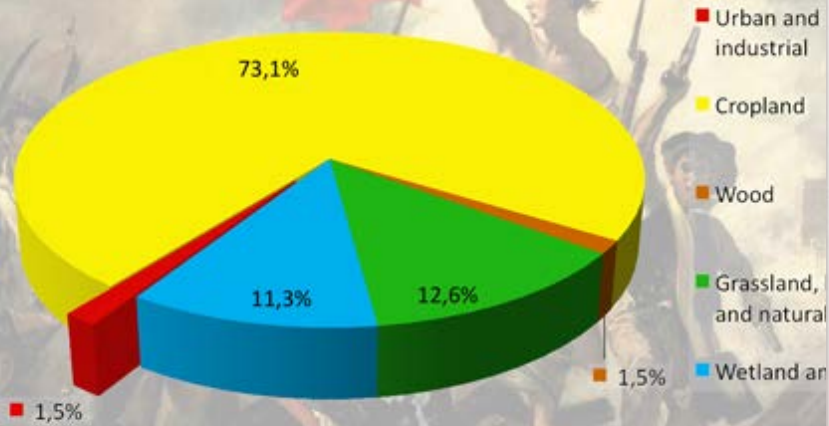


Every soil function has a peculiar thickness

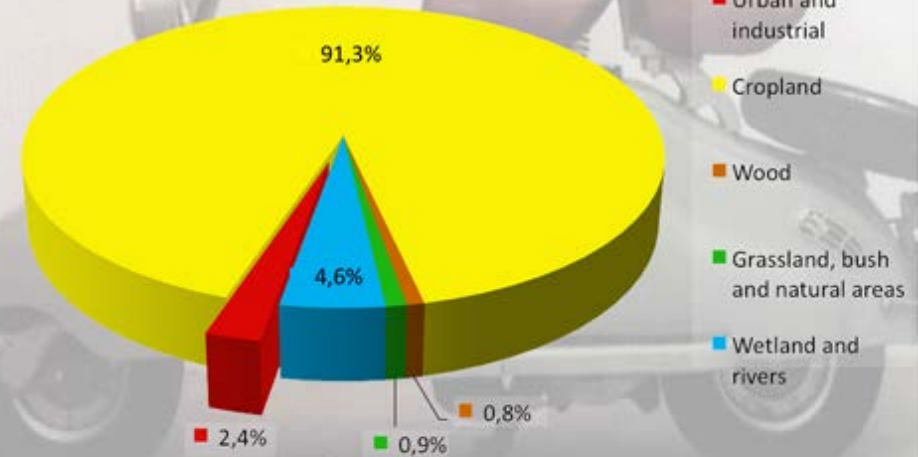
in the pie charts instead of commas read dots

Land take in E-R plain

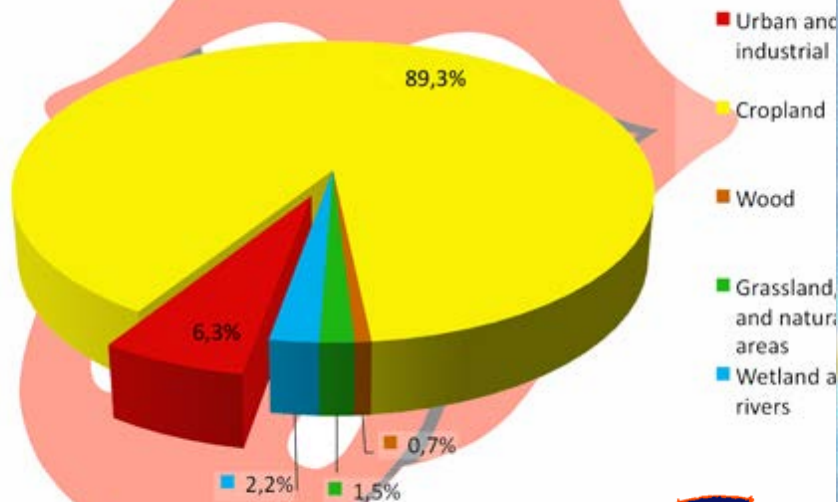
1861



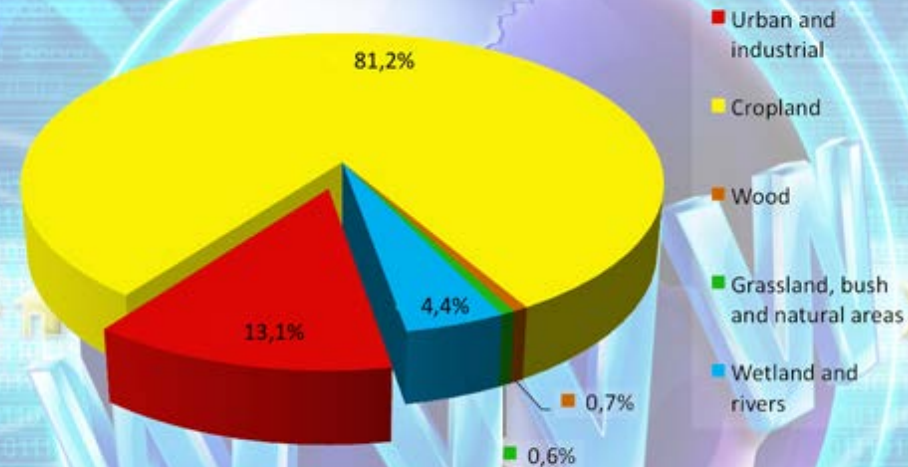
1954



1976



2003





Food security impacts

Emilia-Romagna Plain

Land Use	2003	2008	2008-2003
	hectares		
Urban and Industrial Areas	160 953	174 278	13 325
Wood, Grassland and Natural Areas	19 195	20 261	1 066
Cropland	949 754	934 047	-15 707
Wetlands and Rivers	72 615	73 912	1 297

Daily calories need per person: 2.400 Kcal
Wheat calories: 3170 Kcal kg⁻¹

Population of the plain (2011): 3 023 483
Wheat production (2010): 7.3 t ha⁻¹

Cropland lost (from 2003 to 2008): 15 700 ha

Wheat equivalent in lost cropland: 114 771 t

People potentially fed in one year: 415 325 (13.4% of the inhabitants)

Carbon sink impacts



red circle is about 1 hectare

C content above soil

Trees: 1.75 t
 Urban (concrete): 0.18 t
 Roads (asphalt): 0.32 t
 Industrial (concrete) ~0

C content Soil

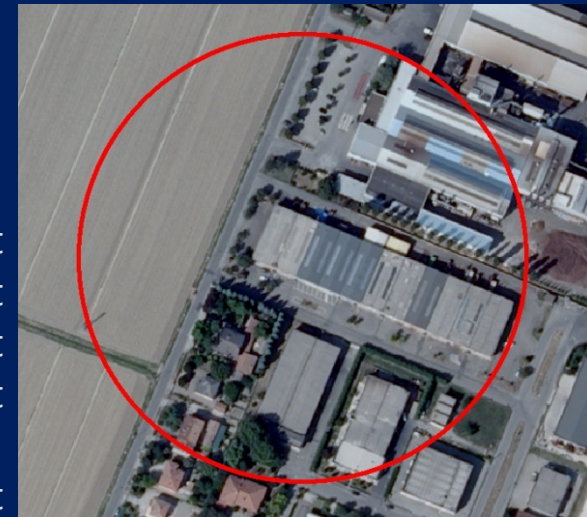
Organic carbon (TOC): 52.15 t

C content above soil

Trees: 0.5 t
 Urban (concrete): 0.16 t
 Roads (asphalt): 0.62 t
 Industrial (concrete): 0.72 t

C content Soil

Organic carbon (TOC): 5.5 t



red circle is about 1 hectare

	1861	1954	1976	2003
E-R Plain Soil Organic Carbon (TOC) [Million of t]	71.0	70.5	70.5	67.6
<i>per capita carbon</i>				
concrete + asphalt [t]	<1	1	3	3
soil + trees [t]	110	64	56	50

Every tons of C means 3.67 tons of CO₂

(*Environ Sci Technol* 45, 5112–5117)

Hydrologic impacts

Soil sealing increases runoff coefficients

Emilia-Romagna: provisions for “hydraulic invariance” (*Ing Amb 30 407-413*)

Soil sealing reduces soil water storage and infiltration

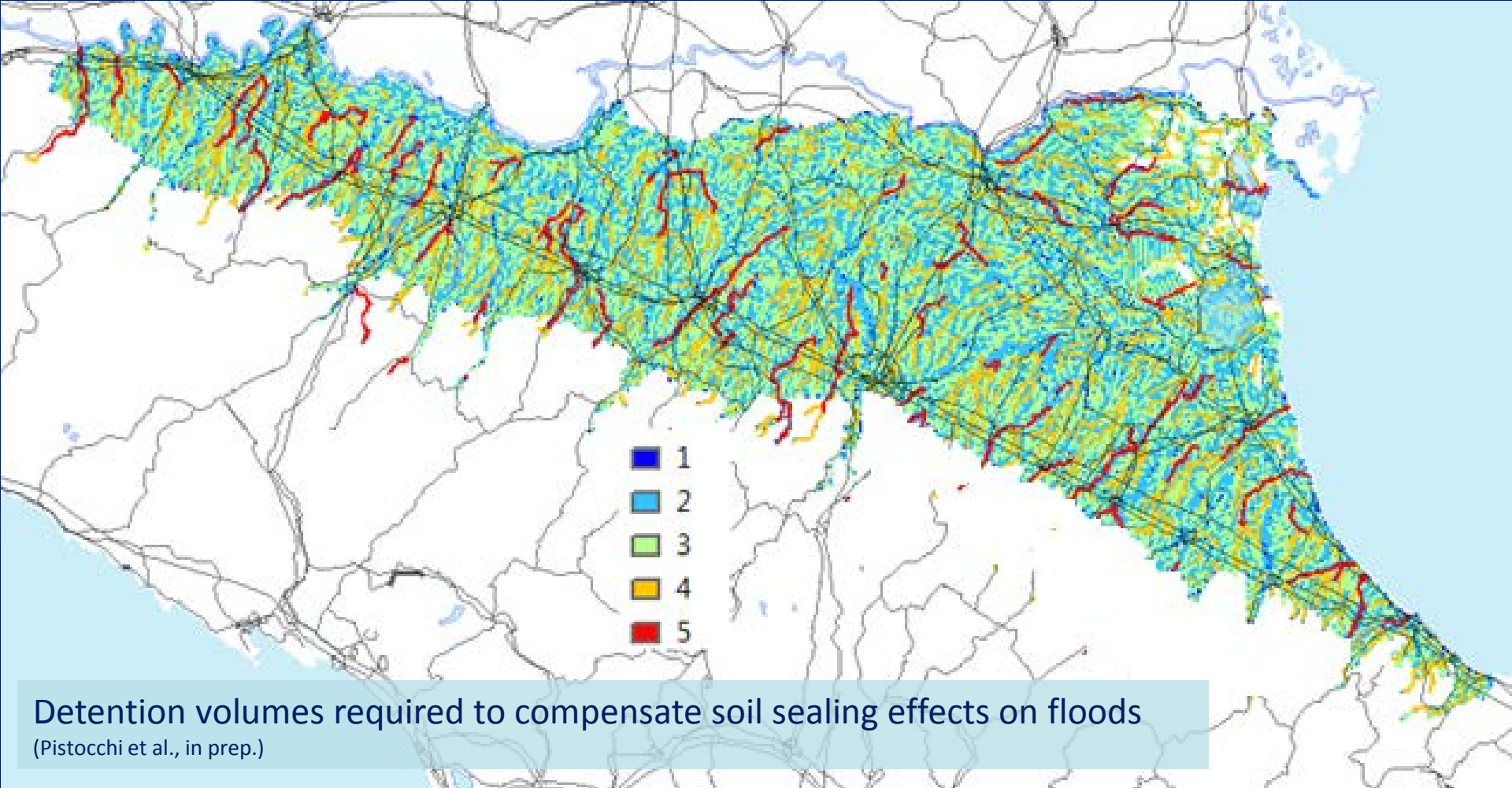
Faster response of catchments to rainfall
Long-term effects on water availability

Increase of impervious surface → increase of % rainfall going to direct runoff ϕ

e.g. $\phi = 20\%$ in natural soils → $\phi = 90\%$ in sealed soils



Peupliers au bord de l'Epte, C. Monet



Detention volumes required to compensate soil sealing effects on floods

(Pistocchi et al., in prep.)

Volume required for hydraulic invariance at catchment level. (1=below 100 m³; 2=between 100 and 1 000 m³; 3= 1000 to 10 000 m³; 4= 10 000 to 100 000 m³; 5=100 000 to 1 000 000 m³).

To adequate the water distribution/collection network in the E/R plain with flood storage areas and pumping station the need is some billion of €

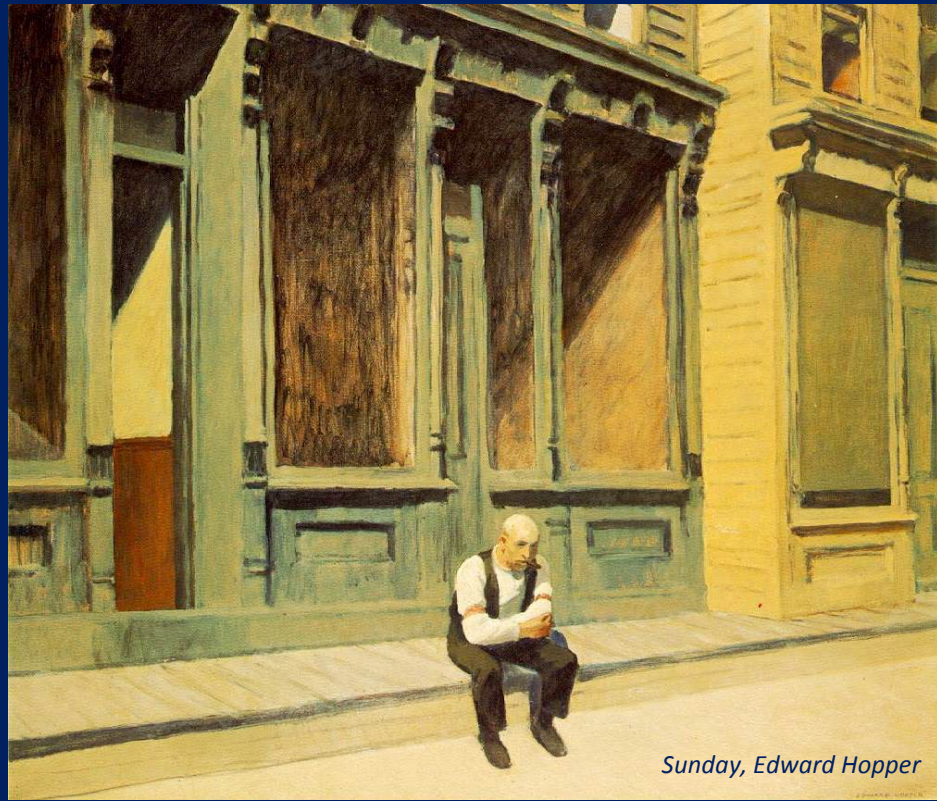
Urban Heat Island

Increase of yearly mean temperature about 3°C (strongest effect mainly in summer $\sim 5^{\circ}\text{C}$)

Increase of pollution

Bioclimatic discomfort

Overload of energy network during the heat waves and need of structural adequation



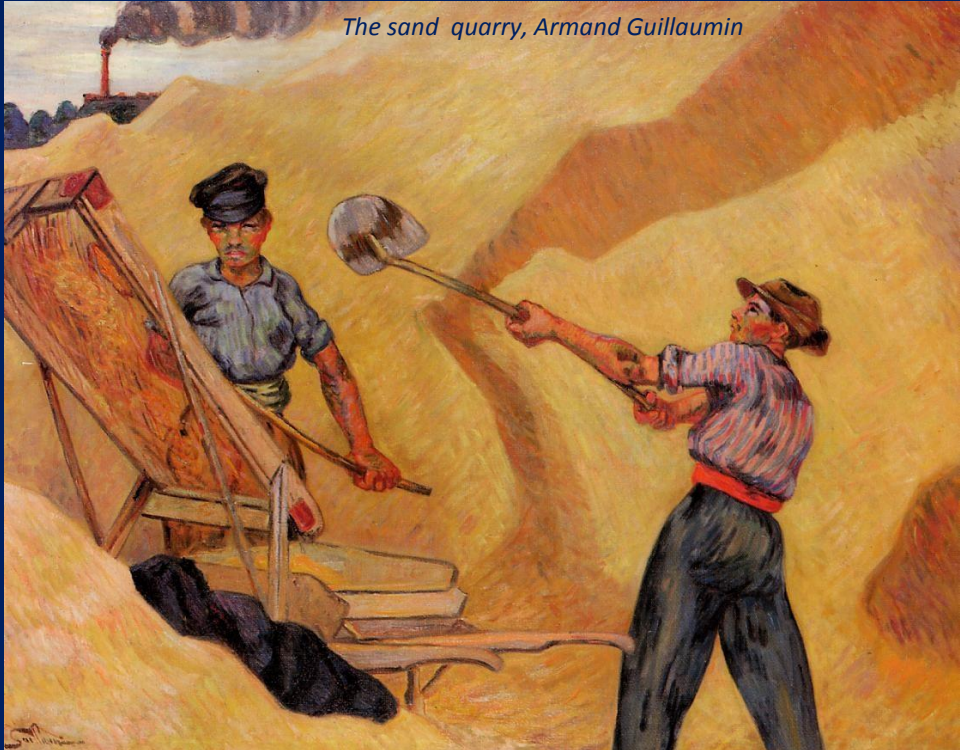
Sunday, Edward Hopper

We estimate that the effect of Urban Heat-Islands leads to a more extended use of air-conditioners in urban areas. The greater energy requirement is quantifiable in about 8 KWh per day and per apartment

On E-R plain from 1974 to 2001= $\sim 236\,000$ new apartment

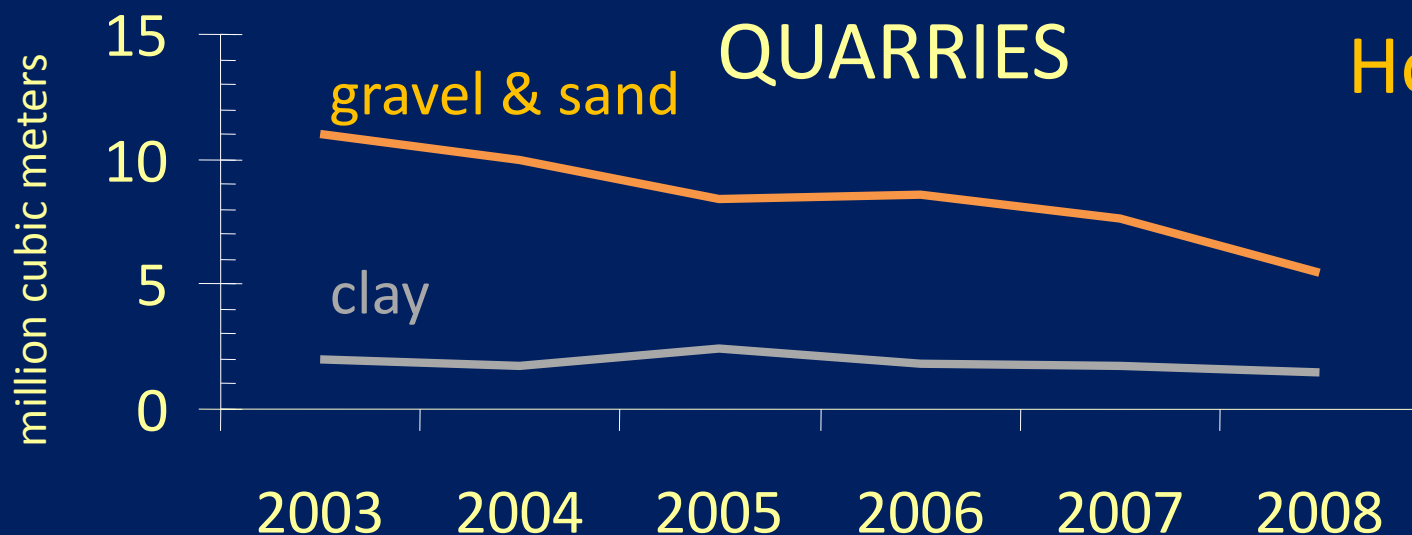
So, assuming that only 50% of new apartments are air-conditioned, in a hot summer day we need an additional energy requirement of about 1 GW h^{-1} (e.g. the Piacenza power plant produce $0,85\text{ GW h}^{-1}$)

The sand quarry, Armand Guillaumin



Source of raw material

Raw material extracted from 2003 to 2008
64 million m³



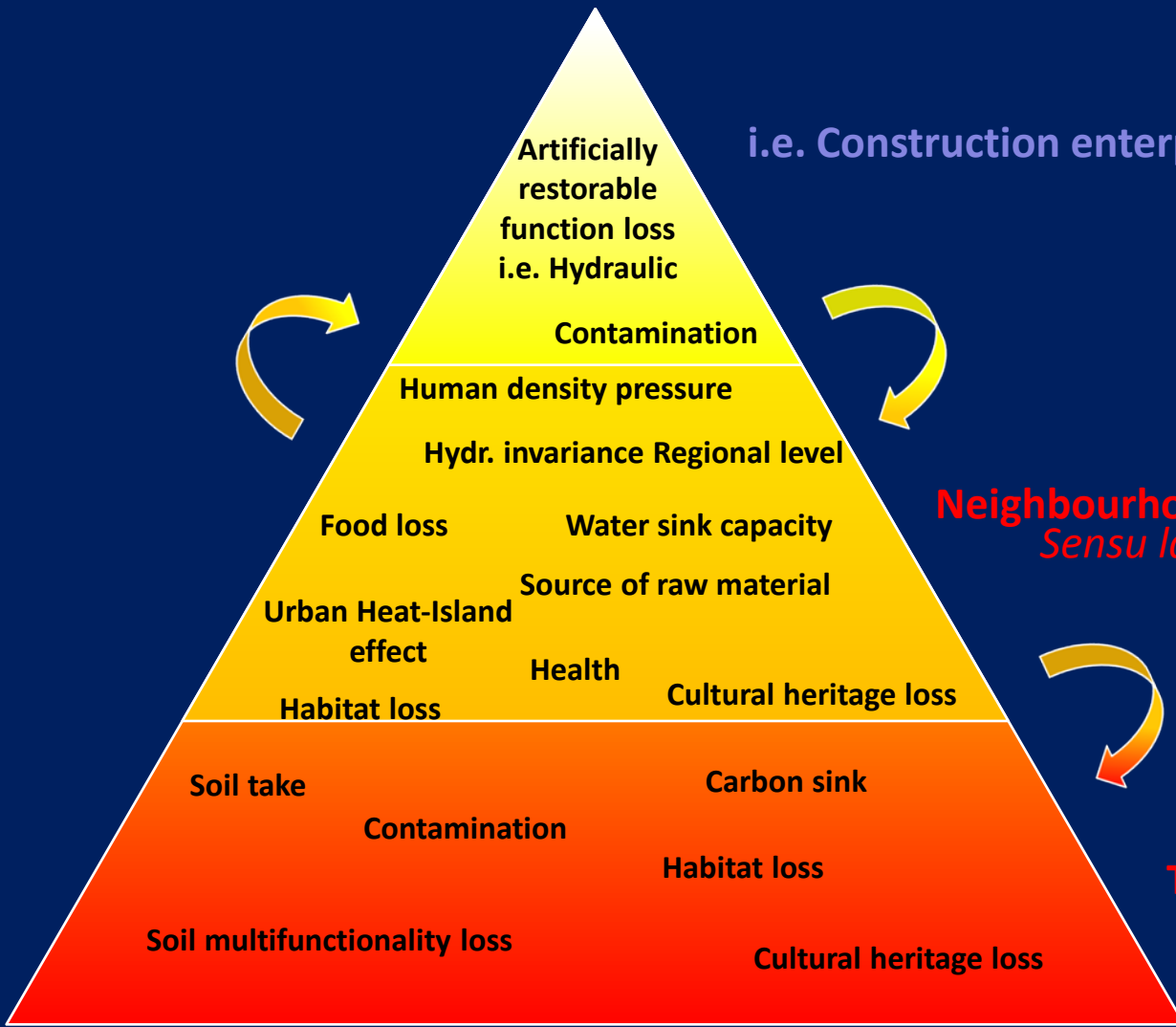
How many m³ of soil each m³ of raw material extracted?

Quantifying costs

Responsible / affected



Sealed area



i.e. Construction enterprise

Neighbourhood *Sensu latu*

The Planet & Humankind

Economic value / price

Private

Public

Sealed area

Hydraulic invariance (local scale)
few % building cost

i.e. Construction enterprise

Micro level

Private

Hydr. invariance Regional level
SOME BILLIONS of €

Neighbourhood
Sensu latu

Macro level

Public

Food loss (2003-2008)
> 415 000 PEOPLE yr⁻¹

Raw material
64 MILLION m³

Urban Heat-Island effect
NEED of 1000's MW h⁻¹

The Planet & Humankind

Carbon sink (1861-2003)
12.5 MILLION t of CO₂

>> BIOCLIMATIC DISCOMFORT
> HEALTH DISEASES

Thank you