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Misfit agriculture and urban decontaminations.
Agricoltura fuori campo, decontaminazioni urbane.

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ABSTRACT

Agricoltura fuori campo, decontaminazioni urbane.
Agricoltura fuori campo come stadio intermedio, rurale, di aree un tempo urbanizzate ora divenute naturalizzate.
Decontaminazioni urbane per un territorio compromesso, eredità di un passato meccanico, ora inglobato nel tessuto urbano.
Paesaggio come processo ed infrastruttura nella città.

Il tema consumo di suolo si muove tra le sfere dell'urbanizzato, del rurale e del naturale. Le attuali strategie di densificazione, perseguite per fronteggiare le spinte verso l'urban sprawl, evidenziano come sia fondamentale la riconversione di aree dismesse ed ex industriali per la salvaguardia di aree vergini e rurali. Le aree dimesse vengono troppo spesso considerate sinonimo di degrado e sottoposte a nuova urbanizzazione. Lunghi anni di abbandono hanno invece contribuito a fare di questi luoghi aree di paesaggio spontaneo e di nuovi equilibri. Residuati della dismissione di infrastrutture ormai obsolete o della riconversione industriale questi luoghi, prima periferici, si ritrovano ora inglobati nel tessuto cittadino: un grande potenziale da strutturare. Perché riversare la densificazione in vasti "campi urbani" anziché considerare azioni di demolizione/ricostruzione, densificazione dei margini dei vuoti urbani e della città ed, ancora, perchè non occupare i numerosi edifici inutilizzati nell'urbe?
Nel lavoro di tesi si sono indagate le condizioni del progetto, in particolare: la dismissione, con i suoi tempi e luoghi, la contaminazione e la sua geografia ed i metodi biologici di bonifica. Diversi casi studio sono stati scelti come esempi significativi di trasformazioni virtuose di ex-cave, ex-impianti industriali, ex-basi militari trasformatisi in parco e/o rigenerati con strategie agricole.
Il progetto che ne è scaturito sfrutta il potenziale di aree in disuso tuttora presenti a milano, in particolare gli ex-scali merci. I lunghi tempi post-dismissione rendono lecite strategie lente ed autoequilibranti. L'idea è quella di una macchina agricola di decontaminazione, pensata per lo scalo di Porta Romana, interpretata nel suo significato di paesaggio, capace di rendere evidente un processo e divenire un catalizzatore per il rigenerarsi dell'intorno urbano.

Misfit agriculture and urban decontaminations.
Misfit agriculture as a rural intermediary phase for formerly urbanized areas that have become naturalized.
Urban decontaminations for spoiled lands, the legacy of a mechanical past, areas that have now become embeddied in the urban tissue.
Landscape as a process and infrastructure within the city.

The issue of land consumption concerns the spheres of the urbanized, the rural and the natural. The most recent strategies of densification, aiming at the containment of urban sprawl, put an emphasis on the requalification of former industrial areas and brownfields as a fundamental premise for the safeguard of greenfields and rural areas. Abandoned industrial areas are often seen as degraded landscape and subjected to a new process of urbanization. The fact is, however, that the long years of neglect have transform these areas in interesting places where spontaneous landscape and new equilibriums can be observed. Remnants of past industrial activities and obsolescent infrastructures, these places, once located in the periphery, have now become embedded in the city, and represent a great potential waiting to be structured. Why concentrating densification in "urban fields" instead of demolishing/rebuilding and densifying urban vacuums and city edges and, furthermore, why not occupying the unused buildings around the city?
The analysis aims at investigating the project's conditions: the shutdown of industrial activities, its times and places, the contamination and its geography and biological methods of remediation. Several case studies have been chosen as relevant examples of transformation of former quarries, former industrial plants, former nuclear plants, former military bases, former mines transformed in parks and/or regenerated with the help of agrarian strategies.
The project aims at the exploitation of the potential represented by disused areas that are still present in Milan, in particular the railyards. The long period of abandonment followed by the shutting down of productive activities justify slow selfequlibrant strategies. An agrarian machine of decontamination is designed to make processes visible and to catalyse urban regeneration processes.

INTRODUCTION

La tesi trae spunto da una riflessione circa il fenomeno del consumo di suolo. Analizza le sue dimensioni in Lombardia ed in particolare nella provincia e nella città di Milano. Milano risulta essere un territorio fortemente urbanizzato, con una superficie consumata pari al 78% del territorio cittadino. Viene analizzato il rapporto tra città e campagna e la sua declinazione nelle aree periurbane caratterizzate da infrastrutture, ferrovie, elettrodotti cave e discariche.
L'analisi si sofferma sulle attuali strategie di urbanizzazione che mirano al contenimento del fenomeno dell'urban sprawl tramite azioni di densificazione. Le attuali proposte elaborate dal piano di Governo del Territorio (PGT) del comune di Milano comportano la densificazione dei vuoti urbani (a fronte della preservazione di aree agricole e naturali.)
La tesi critica in parte questo modello poiché esso non considera l'enorme potenzialità costituita dalle aree dismesse e dagli scali merci abbandonati in termini di possibile paesaggio come infrastruttura alla scala urbana. La maggior parte di queste aree non sono state intaccate dall'urbanizzazione per la presenza della contaminazione o per i lunghi processi di cambiamento di destinazione d'uso. Molte fra queste aree sono state colonizzate e naturalizzate dal paesaggio spontaneo costituendo ora dei vasti campi inglobati nel tessuto cittadino.
Si propone l'occupazione temporanea di queste aree per quei lunghi tempi in cui esse risultano essere inutilizzate.
Il modello proposto presuppone in alternativa alla densificazione dei vuoti urbani azioni di demolizione/ricostruzione dell'esistente con incremento volumetrico in altezza e l'occupazione con riuso dei numerosi edifici inutilizzati nella città.

La tesi indaga il fenomeno della dismissione con l'obiettivo di evidenziare come l'evoluzione dell'economia industriale abbia alterato il paesaggio della città. Aree dimesse, ex-scali ferroviari, ex-industrie, ex-cave. Un timido tentativo tassonomico rivela tratti comuni. Chilometri di muro, recinti, filo spinato rendono questi luoghi inaccessibili ai più, rifugio per un pulviscolo di diversità. Isole inglobate nella città di dimensione vasta, apprezzabile da una vista zenitale. Vuoti urbani colmi di terzo paesaggio, di memoria storica ed occupazioni informali. Il processo di deindustrializzazione, iniziato sul finire degli anni '80, ha reso disponibili vaste aree divenute strategiche per i nuovi assetti urbani. Un'analisi approfondita è stata svolta circa i tempi post dismissione, che intercorrono tra vecchie e nuove destinazioni d'uso. Si tratta di lunghi periodi (nell'ordine del decennio) in cui le aree risultano essere totalmente inutilizzate. Molte lo sono tuttora, principalmente per problematiche legate alla contaminazione. Il potenziale che sembra essere di maggior rilievo consiste in 7 scali merci in via di dismissione, 1300 ettari disposti ad anello, aree un tempo alle porte cittadine ora divenute inglobate.

Un'approfondita analisi ha riguardato il fenomeno della contaminazione. Le dimensioni, le principali cause e conseguenze sono indagate dalla scala europea fino a quella della città di Milano. Nella regione Lombardia sono situati 7 siti contaminati di Interesse nazionale, nella provincia di Milano è collocato più del 50 % dei siti contaminati dell'intera regione. Milano mostra tuttora i segni del suo passato industriale con 1050 ettari di suolo compromesso. Un'analisi accurata circa le cause della contaminazione e della sua distribuzione rivela la presenza di piccole e distribuite aree contaminate diffuse nella città (dovute a depositi di carburanti, officine, logistica) ed aree estese in posizioni periferiche dovute ad industrie e scali merci (che risultano essere "potenzialmente" contaminati). Tre casi studio sono stati presi a riferimento per comprendere l'entità del fenomeno in termini di concentrazioni e profondità dei contaminanti: uno scalo merci (porta Vittoria), un'area ex-industriale (Bovisa) ed una cava (Cava Chiasserini). I valori più alti riguardano le aree industriali (Bovisa è tuttora inutilizzata per problematiche legate ai costi di bonifica, problema analogo all'area Falck di Sesto San Giovanni). Gli scali merci presentano invece livelli di contaminazione bassa e diffusa, poco profonda (1 – 4 m) che possono essere affrontati con metodo biologici di bonifica.

Notevoli suggestioni pervengono da metodi di bonifica in situ, interpretati nel loro significato di paesaggio. Bioremediation: la crescita di batteri e di popolazioni autoctone, in grado di digerire i contaminanti, permettono il ristabilirsi di nuovi equilibri e successioni ecologiche. Phytoremediation: Zea Mais, Sorghum Vulgaris, Helianthus Annus vengono utilizzati per l'estrazione di Pb, Zn, Cd ed idrocarburi a discapito del loro commestibilità. seminar zizzania, graminacee e malerbe divengono in questo contesto azioni di progetto. Ci si rivolge ad elementi primari, al suolo. si rendono visibili processi naturali prima nascosti, si evidenziano i pattern della vegetazione disturbata, ci si trova a trattare con la natura e la topografia distrutta di luoghi dimessi. L'interesse verso questa sfera è legato al suo significato in termini di paesaggio.

I casi studio analizzati riguardano la trasformazione di aree ex- industriali ex- infrastrutture ex-cave trasformate in parco con strategie di tipo agricolo.
Alcuni casi sono di rilievo per quanto riguarda la tecnica della Phytoremediation (Chernobyl, New Gretna, Arcola) altri riguardano significativi rapporti tra urbanizzato e scelte di paesaggio (Unimetal park e Downsview park) infine vi sono esempi importanti di scelte paesaggistiche e di vegetazione(IBA Emscher park, High Line, Fresh Kills landfill).

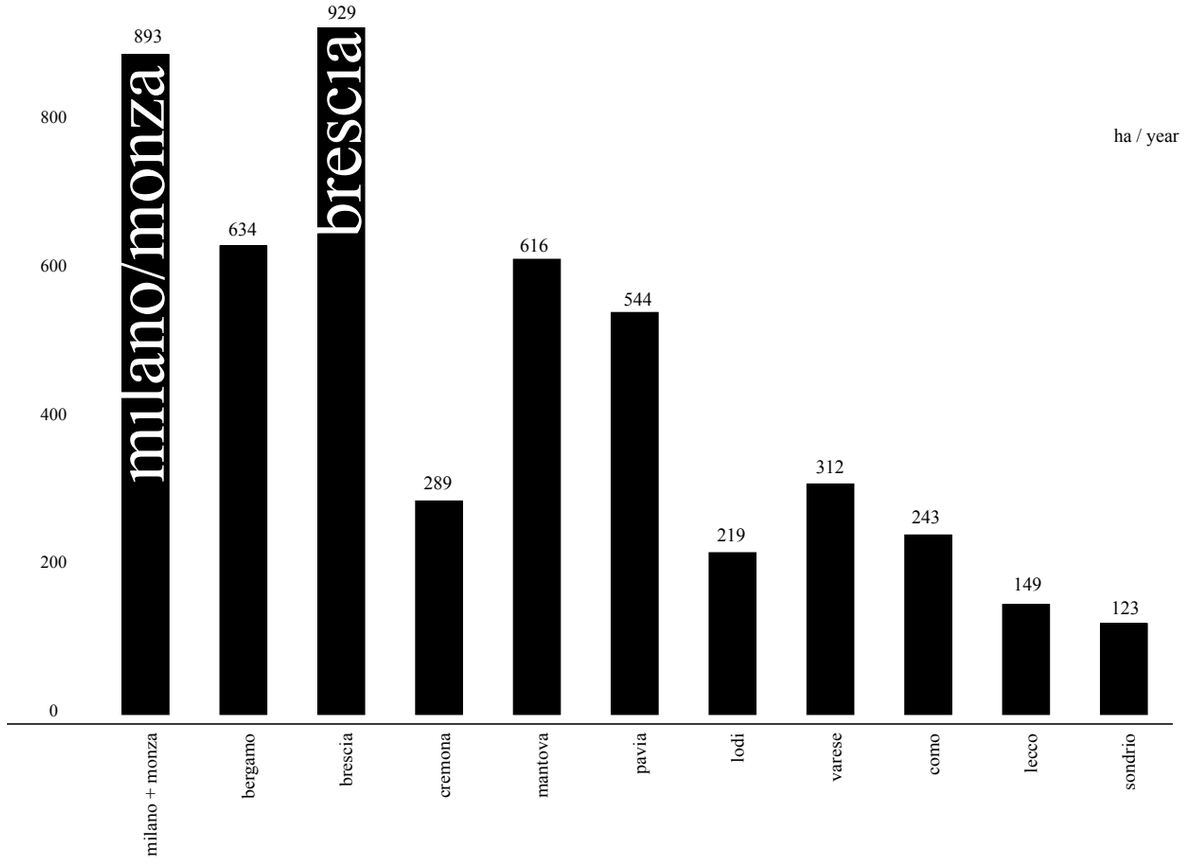
La macchina delineata per Porta Romana è un luogo inaccessibile ma osservabile. Isole salvifiche contaminate rimarranno inaccessibili ad oltranza, diventeranno i luoghi per un nuovo terzo paesaggio. Le aree, trasformatesi da urbane a naturali, saranno interessate da uno stadio rurale che lascerà le proprie tracce per un parco post bonifica. Si tratta di ipotizzare i dispositivi di un processo per la composizione di un paesaggio tecnologico, agricolo ed urbano in cui giustapporre "campiture" estensive ed intensive.

1. A REFLECTION ABOUT LAND CONSUMPTION

Landscape conceptual scope[..] to theorize sites, territories, ecosystems, networks and infrastructures and to organize large urban fields.
J. Corner cit. in Waldheim, 2006, p.23.

1.1 landsat satellite, image IRFC, milan,, 1991

4950 ha/year means **5,5sqm / person**



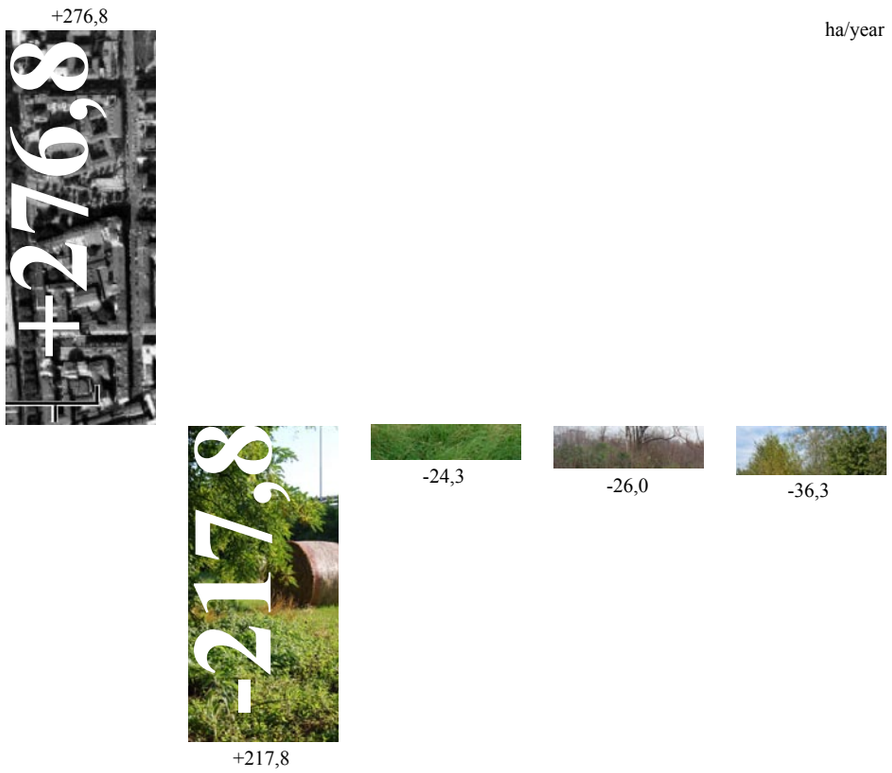
1.2 Annual soil consumption in Lombardy.
Source: Centro Studi Pim and Provincia di Milano (2009), p.57. Graph based on Istat (2001) and Arpa Lombardia data (1999-2004)

1.1 size.

in lombardy 5000 ha of soil disappear every year[1].

An EEA research[2] classifies Italy as the IV consumer of soil in Europe, surpassed only by Germany, Spain and France.
The province of Milan is one of the highest density territories in Europe, 7% of the Italian population lives here. The growth of the population in the province in the course of the 70s was responsible for the suburban development of the city. In the 80s the shut down of industrial activities was accompanied by a reduction of the "industrial population" and a diffuse unemployment that didn't correspond, anyway, to a reduction of soil consumption. In these years, the province's urbanized land reached in these years the 37% compared to 8,4% in 1936 and continued to grow in during the 80s - 90s. Today the process of development is connected to the transformation of already urbanized land rather than the occupation of not urbanized spaces, a phenomenon that should contribute to an increase in city density.
According to Centro Studi PIM[3] **in the province of milan the land consumption today is equal to 35%**. The value grows to 42% if urban previsions are taken into consideration.

1 Centro Studi Pim and Provincia di Milano (2009), p.46
2 The research take into consideration a "land take" indicator: the size of previously not urbanized land that have become urbanized. M. G. Salzano et al. (2006), p.124
3 Centro Studi Pim and Provincia di Milano (2009), p.10



	urban land	agrarian land	meadows	natural land	wood
mi	+ 60,9	- 47,8	- 4,8	- 6,0	- 12,4
bg	+ 17,5	- 13,9	- 4,0	- 1,4	+ 1,8
bs	+ 36,8	- 39,1	- 2,2	- 4,7	- 2,4
cr	+ 31,0	- 29,3	+ 0,0	- 0,6	- 1,3
mn	+ 46,0	- 43,4	- 1,1	- 3,7	- 3,0
mn	+ 12,9	- 9,0	- 1,2	- 1,7	- 1,1
pv	+ 22,9	- 16,1	- 0,3	- 0,6	- 2,7
lo	+ 15,1	- 11,4	- 0,8	+ 1,1	- 4,3
va	+ 12,8	- 2,5	- 3,0	- 2,3	- 6,7
co	+ 12,1	- 2,0	- 1,6	- 1,1	- 5,6
lc	+ 4,1	- 1,3	- 3,8	- 2,9	+ 2,9
so	+ 4,7	- 2,0	- 1,5	- 2,1	- 1,5

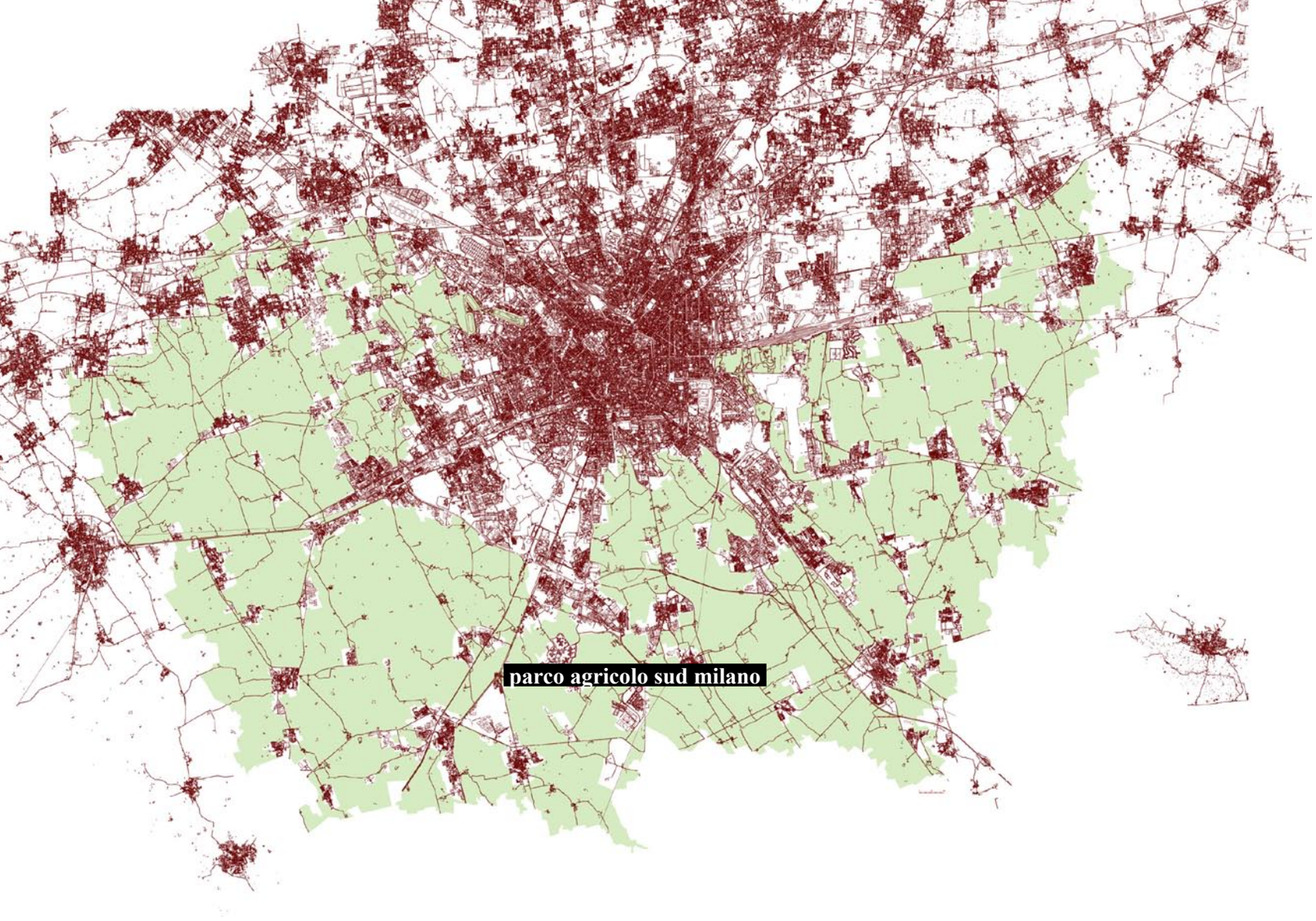
1.3 Annual land use tranformation in Lombardy

Source: Centro Studi Pim and Provincia di Milano (2009), p.58. Graph based on Istat (2001) and Arpa Lombardia data (1999-2004)

Urban plan instruments (PTCP[4]) propose to contain the urbanization within the 45%. It is well know, in scientific literature, that exceeding 55% means having a territory incapable to environmentally regenerate itself.

The system of **regional parks**, involving 39% of the province of Milan territory, **contribute to safeguard** the most important environmental systems **from urbanization**. Looking at a territory scale the most **relevant scenarios**, linked to the city of Milan, are **parco agricolo sud milano** (a huge area delimitated by the Parco Ticino at the west and the Adda river at the east) and Parco Nord (a green wedge between the line Milan-Meda and Valassina). Parco Agricolo Sud involves 1/3 of the province land (61 municipalities). The 9% of its surface is located within the municipal boundaries of Milan

4 Piano Territoriale di Coordinamento Provinciale



1.4 soil consumption: land use classification

natural
anthropical

- productive (agriculture)
- **soil consumption** (non productive)
  - several form of consumption (public gardens, sport infrastructure)
  - **build land** (building, industry, commercial, roads and railways)
    - permeable land
    - **impermeable land**

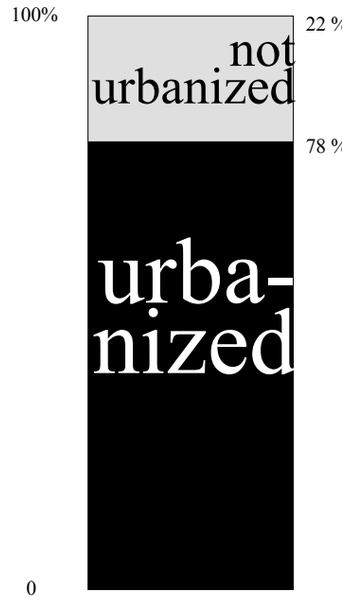
what's soil consumption?

Soil is a limited and non-renewable resource, damage to soil (such as erosion, sealing and contamination) is not easily recoverable. Soil consumption is a difficult indicator to define. Usually the issue is linked to the reduction of fertile lands, other times it is interpreted as a sign of development.

One of the main problem linked to its definition regards green areas: are urbanized land only the ones built or can private gardens, public park be considered consumed soil as well that reduce land dedicated to agriculture?[5] According to a research carried out by EEA[6] land use can be subdivided as shows in the scheme "land use classification". The classification start from a **natural level** moving trough a **rural level** arriving to a **urban level**: impermeable land. In the widest meaning of the word soil consumption is related to a certain relationship between city and countryside and different urban strategy

5 In Milan green areas have been considered urbanely occupied and therefore "consumed"

6 Murbandy/Moland: project to monitoring urban expansion. EUR 21319 EN/6 in M. G. Salzano et al. (2006), p.183



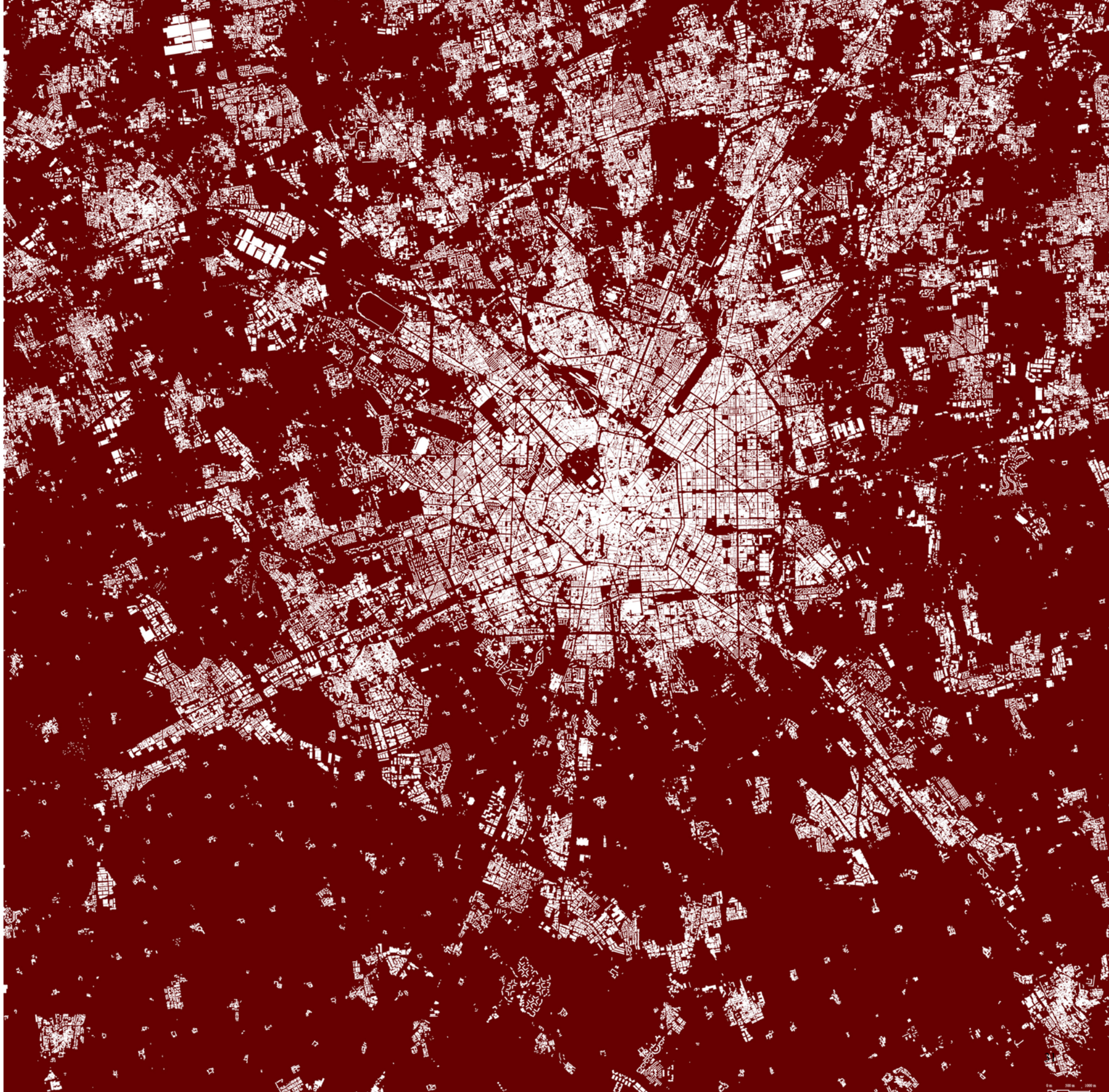
1.5 Urbanized land in Milan
Source: PGT, Rapporto Ambientale, 2009, p. 82

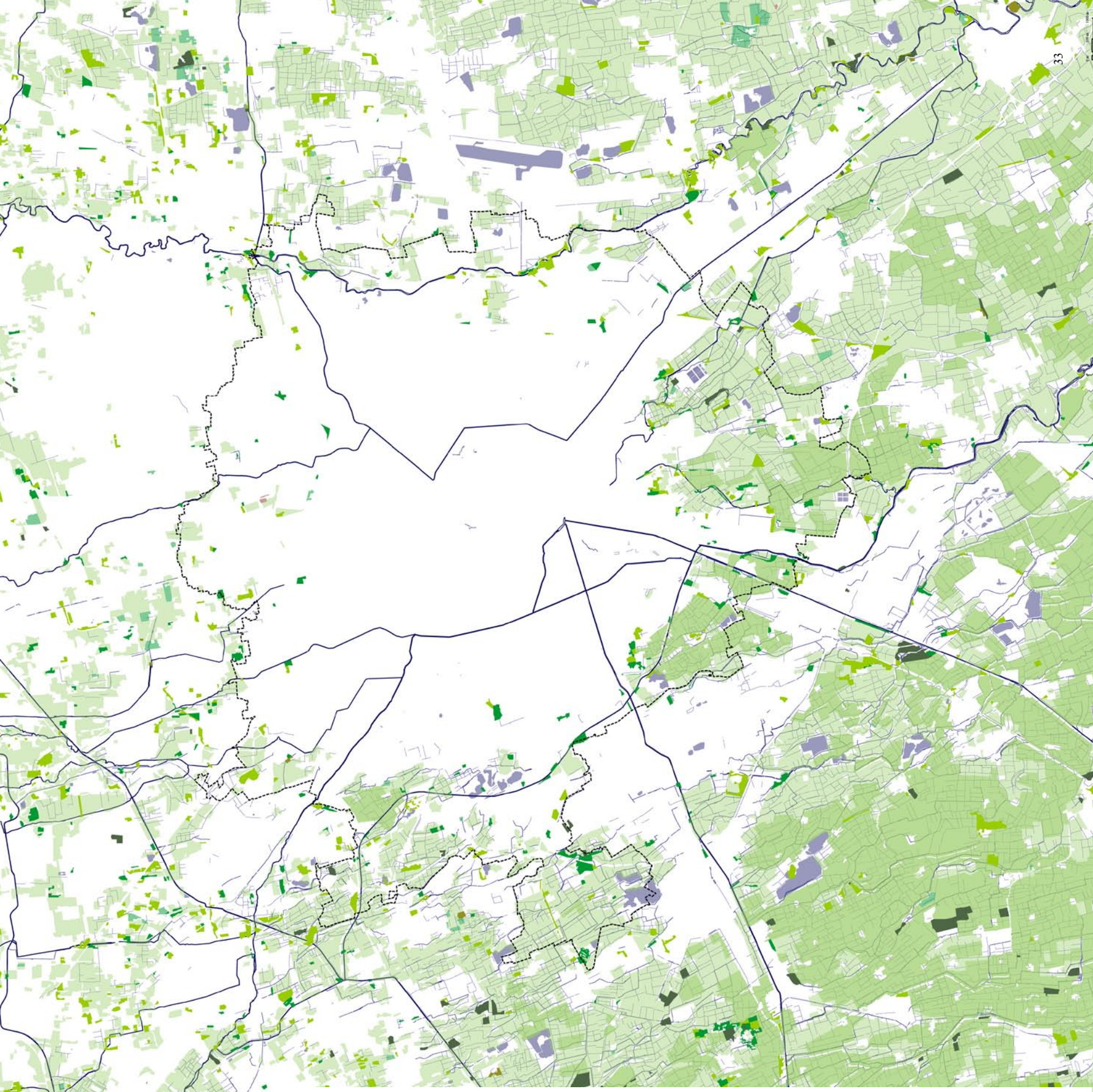
the city of milan is 18178,75 ha, most of which urbanized. according to the analysis of pgt, today the urbanized land[7] in milan is 78% (14.191 hectares), while non urbanized land[8] is 22% (3987 hectares)[9].

The resident population is around 1.294.503[10], the **urban density is 7122 people/sqkm**: the value is quite high if compared to the mean density of the territory in the municipality (1968,7 people/sqkm). According to Istat's forecast the city resident population will grow to 1415385 people in 2014 and 1787637 in 2030, an important issue if considered in terms of future land consumption. Milan's land use data reveal a continuous increase of urbanized land and a gradual reduction of the one being cultivated. In the 80s the territory was 34% urbanized, 9% dedicated to new expansions and 57% dedicated to agriculture.
Today land use data shows almost 65% of land constituted by impermeable area, 20% dedicated to agriculture, 15% dedicated to green area and water surface. The agrarian areas are present only beyond the external ring road of the city: the already mention 9% of **parco agricolo sud** that provides a green "cushion" that **avoids the welding with the nearby urbanized municipalities**.
Parks and gardens represent around 12sqm for citizen with a loss of balance in their allocation[11]. In theme of green areas the city is in a good situation in comparison to the European average cities.

7 Including: streets, railways, buildings, public and residual green
8 Including: water, agrarian land, woods, uncultivated land, public green (over municipal)
9 PGT. Procedura di VAS. Rapporto Ambientale, p.82
10 Settore Statistica, anno 2008 retrieved in PGT, Rapporto ambientale
11 In the 2nd zone there are only 5sq per inhabitant while in the 7th there are 28 sq per person)

1.6 Urbanized land





[1.7] Not urbanized land

“ a little plot of herbaceous land has a different meaning if it is surrounded by woods or highways”.
C. Socco, 2005, p. 50
[1.8] tangenziale est, milan, september 2009

1.2 city / countryside

“Cities are like organisms, sucking in resources and emitting wastes. The larger and more complex they become, the greater their dependence on surrounding areas”.
Crispin Tickell, in R. Rogers, 1997, p. VI

The ongoing process of deindustrialization of older city areas and the rapid urbanization of newer city areas (the periphery) is a regional urban landscape formation. Periurban area are the physical result of the growth of cities, a transition between the city, rural land and natural ones.

urban fringes are characterized by **infrastructural networks** (going from the city towards other cities), industrial areas, residential neighbourhood and fragmented landscape of urbanization and agrarian land.

The definition of “periurban landscape” is controversial. Some researchers of the Bartlett School of Planning in London[12] define Urban fringe as “a territory between city and countryside with specific features”. Even the definition is not precise because it’s not possible to clearly define a Urban Fringe.

This landscape, generally analysed from an ecological point of view that emphasize rivers’ corridors, rare biotopes, woods and so on, is a space between infrastructures and buildings.The Urban Fringe are in general surrounded by residential buildings, industrial sheds, shopping malls, road barriers and railways, power stations, power lines, open quarries, abusive allotment gardens, garbage dumps and deposit areas.

12 Urban Fringe – Policy, regulatory and Literature Research” in C. Socco et al. 2005, p. 82

The constructions could be subdivided in elements required to make a city work (such as airports, power stations, dumps, purification plants and so on) and elements that belong to the residual space of a city (dwelling and commercial activities).
Anything the city throw in the periphery becomes a pressure that can modify the quality of the agrarian spaces. These space are “weak”, pressured by real estate interests. Moreover agricultural activities are responsible of a reduction of biodiversity.

[1.9] tangenziale est, milan, september 2009

[1.10] aler building, milan, september 2009

residential buildings industrial sheds, road barriers and railways, power stations, power lines, open quarries, abusive allotment gardens, garbage dumps, deposit areas.

[1.11] Countryside as a carpet

[1.12] Infrastructures

[1.13] Power lines

[1.14] chiaravalle abbey and power lines

Milan’s edges

[1.15] milan/parco agricolo sud, via pismonte, september 2009

[1.16] NY / parco agricolo sud

1.3 urban sprawl / density. which strategy?

urban sprawl is a horizontal landscape phenomenon.

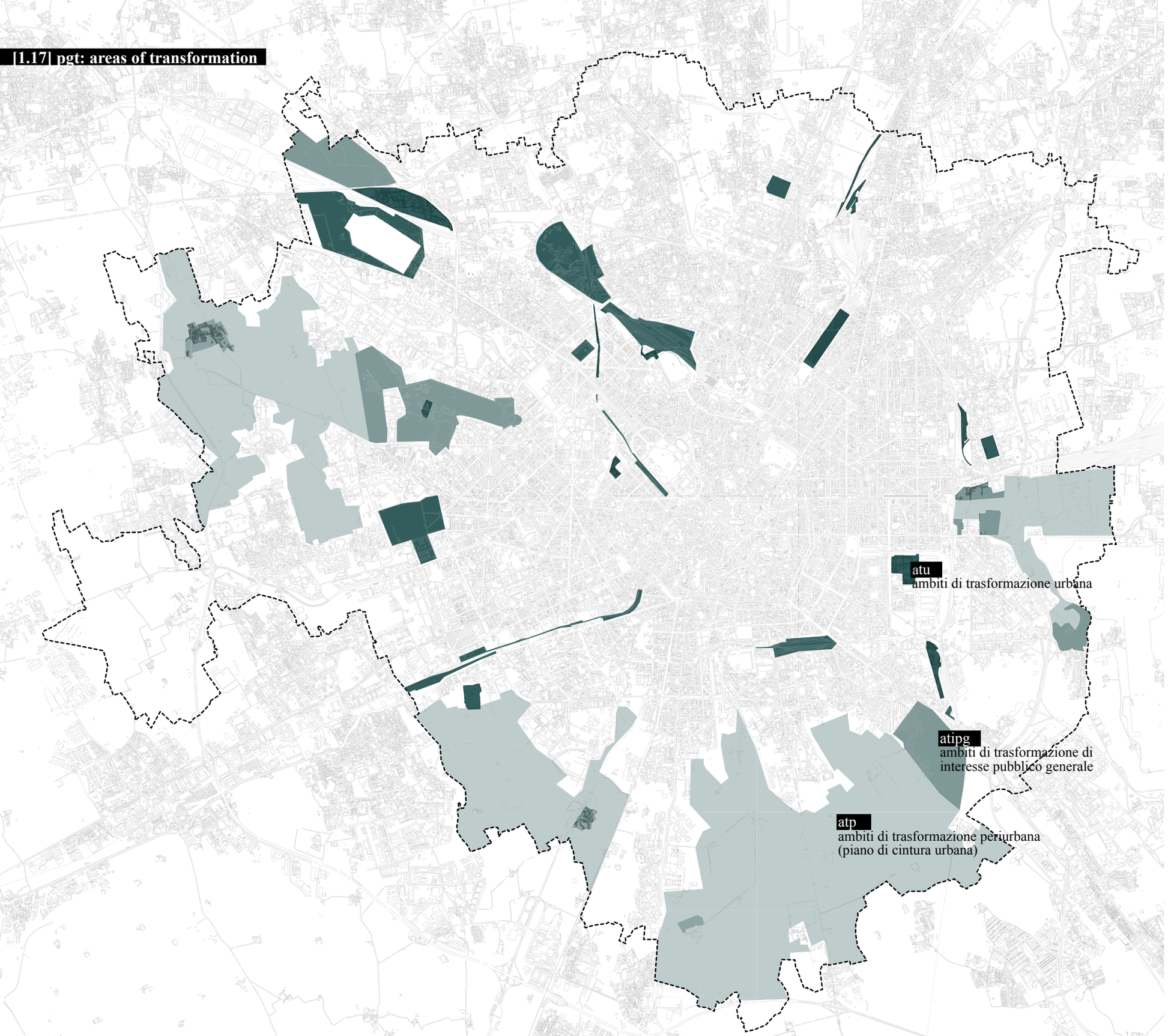
It occurs when the rate of land use conversion and consumption for urban uses exceeds the rate of population growth. Sprawl is often considered as a negative phenomenon, especially in connection with the topic of agricultural land consumption. Uncontrolled urban expansions consume land dedicated to agriculture, and agriculture, in turn, invades natural areas. The theme “density vs urban sprawl” is particularly debated today. The international trends are moving towards densification. As well most of the strategy carried out from regional level to the municipal one aim to contain soil consumption trough densification.

The lombardy regional law LR 12/05 states the goal to minimize soil consumption. The province as well, with PTCP, fixed to 45% the maximum of soil consumption. The idea is to **densify the historical tissue in order to protect greenfields**. PTCP, looks for a compact and dense land settlements and highlights as strategical to urbanize free areas embedded in urban tissue, to recover dismissed area and eventually to redefine city edges. This is one of the main principle to guide urban transformation.

The new urban plan of the municipality of Milan **pgt** (it. Piano di Governo del Territorio) not active yet, enhances densification actions and re-use programs as well. The aim is to contain land consumption within the 5% in respect to the present one.

The individuation of “areas of transformation” (it. Ambiti di trasformazione) followed the goal to realise a compact urban tissue and

[1.17] pgt: areas of transformation



to rise the density in the city.

The PGT enounces three categories of land transformation: ATU, areas of urban transformation (it. Ambiti di Trasformazione Urbana); ATIPG, areas of transformation of public interest (it. Ambiti di Trasformazione di interesse pubblico generale) and ATP, areas of periurban transformation (it. Ambiti di trasformazione periurbana). ATU are areas embedded in the city main rail yards, some industrial areas and barracks, ATIPG involve many quarry/landfill with project strategically important while ATP include periurban areas interested by belt plan. The main instrument of PGT is called "**perequazione**", a method of distribution of "right to build" to the owner of the soil. This instrument allows the Municipality of Milan to acquire the portion of Parco Agricolo Sud embedded in the municipal boundaries by giving a "building rate" (it. Indice di edificabilità) to the land owners. This building rate has to be used in another area. Most of the ATU and ATIPG are interested by a densification coefficient that means they are able to receive "square meters". By contrast ATP cannot receive square meter from city consolidated tissue.

"Irrigation of territories with potential"
R. Koolhaas cit. in Waldheim, 2006, p.31

"Creating a landscape infrastructure that will form the basis for later urbanization"
P. Viganò, cit. in Waldheim, 2006, p.158

Urban lands ready to be transformed and densified according to PGT, are basically urban voids in Milan: open areas that could constituite a landscape infrastructure within the city. Most of these lands have remained protected by urbanization because of their contamination or process of changing in destination of use. Many have become naturalized by third landscape, they are spontaneously shifting from urbanization to nature.
Why in order to densify the city aren't demolition and rebuilding of low dense areas taken into consideration? Why not densifying urban edges or fully re-using abandoned/closed office and services building rather than densifying vast open areas embedded in the city?
Dealing with these areas means dealing with uncertainty. What I propose is a temporary occupation of these places by a decontaminant agrarian landscape in the hope for their future safeguard.
A landscape that might drive urban pressure at low dense edges of these area or to the nearby edge of the city.

[1.18] Concept

2. MILAN IS DEINDUSTRIALIZING

“Manufacturing trends [..]reveals how industrial evolution alters the landscape of the city”
A. Berger, 2006, p.48

what’s left over?

[2.1] bovisa img.1, milan, january 2010

[2.2] Innse factory, Milan, August 2009

2.1 disused land and third landscape

Elevare l'improduttività fino a conferirle dignità politica.
G. Clement, 2004, p. 63

Not all deindustrialized sites are equal. Some are abandoned due to contamination, many are left unused until resources for their rehabilitation become available. "Deindustrialized sites are all transitional places. They await some form of reclamation prior to reprogramming and reuse" (A. Berger, p.51).
Deindustrialized land in Milan often means "**urban voids**": areas previously at the edge of the city that now have become embedded. When doing on site surveys and looking at these "urban voids" by satellite they reveal to be actually quite "full": of **manufact, memory, labour culture, third landscape[1] and informal uses**.
The III landscape is defined by Gilles Clement in his book Le Tiers-Paysage. It's a spontaneous landscape that can easily occupy **residual spaces** coming from land previously exploited by different activities such as agriculture, industry or urbanization and become a refuge for "**diversity**".
In a rural context the residual spaces are generally areas not compatible with agricultural machineries. In urban context they correspond to "waiting lands": waiting for their reuse, for a new destination of use or for land reclamation. Long periods of **abandonment**

1 Defined by Gilles Clement as spontaneous landscape: the third landscape like the Third Estate constitutes a great potential that aim to be "something". As the Abbé Sieyès wrote in his pamphlet during the French revolution "What is the Third State? Everything. What has it been until now in the political order? Nothing. What does it want to be? Something."

[2.3] bovisa img.2, milan, january 2010

permit the development of the III landscape.
Residual spaces take on a great interest in terms of **landscape ecology** and process of colonization.
These places evolve, in fact, naturally towards secondary landscape: a "young residual space" is first invaded by **pioneer plants** that are substituted in a quite short period of time by more **stable plants** until the instauration of an **equilibrium**.
The equilibrium partially dependent on the number of human beings acting in the area. In "unworked fields" for instance, it is easy to find the most advanced phases of ecological succession. The more isolated are the fragments the bigger will be the number of the species[2]. By contrast there are different species that doesn't appear in the III landscape such as cultivated plants, breeding animals and several living creatures whose existence depend on agricultural practice (such as plants that need ploughed land[3]).
The growth of the cities increased the number of the residual spaces but didn't correspond to a growth of the III landscape. This process rather brought to a more fragmentation[4] and to the reduction of complex natural surface and species. The communication between the fragments can be possible with the safeguard of biological corridors, an issue that is currently being addressed at a province/regional scale by city plan instruments[5].
A strategy calculated to understand the effects of fragmentation can profit from "indicators"

2 In Pangea there will be less species than in an equal surface constituted by several continent (G. Clement, 2005, p.22)

3 The Papaver Rhoeas for instance (G. Clement, 2005, p. 17)

4 A residual space fragmented is associated to a lower number of species

5 Such as PTCP (Piano Territoriale di Coordinamento Provinciale) and PTR (Piano Territoriale Regionale)

[2.4] third landscape in porta romana: identifiing species

a forest of catalpa bignonioides

catalpa bignonioides

catalpa bignonioides

catalpa bignonioides; alnus

platanus; robinia pseudoacacia

celtis; ulmus

[2.5] fraxinus

[2.6] pinus; populus

[2.7] platanus

[2.8] potentilla

[2.9] robinia pseudoacacia; populus

[2.10] sambucus

[2.11] sambucus

[2.12] Porta Romana: 2 km from Piazza Duomo, 1,5 km from Parco Agricolo Sud, 1822 wall meter long

[2.13] porta romana, milan, january 2010

such as the number of hedges or certain groups of animals suitable as biological **indicators**, especially **bird species**. Bird species can be used in fact as “indicators of ecological diversity in urban environments”[6] as well as indicators of environmental quality.

landscape is a process able to change during time[7].

The deindustrialized lands in Milan are changing from urbanized land to naturalized land.

Long periods of abandonment and the almost totally absence of human being allows organism and plants to colonize the land: hence the flourishing of III landscape in railyards and ex industrial areas.

6 G. Sanesi et al. (2009) p.80

7 The main process of transformation are three: long geomorphological process; process of colonization by organism (both long and short time) and local disturb of single ecosystem in short time. V. Ingegnoli et al. (1996) p. 91.

[2.14]bovisa img.3, milan, january 2010

[2.15] bovisa img.4, milan, january 2010

[2.16] innse factory img. 2, milan, August 2009

[2.17] porta romana

[2.18] 4’.37’’ - teorema, pier paolo pasolini, 1968

2.2 post fordism and city organization

“una tecnologia, quella elettronica, meno traumatica nei suoi rapporti con l’uomo rispetto alla vecchia meccanica”.
A. Branzi (2006), p.15

Deindustrialization is an interesting phenomenon if it’s considered in terms of production and geography.
The fordist system of mass production influenced the organization of the cities from the beginning of XX century for more than fifty years. Fordism was based on a regime of accumulation, with employees purchasing the product they produced. The fordist city stressed on automation, standardization and economy of scale supported by infrastructures. Geographically it promoted a centralized production able to assemble the product on site.

Post fordism refers to flexibility, an economy able to quickly adjust itself to changing demands. The saturation of the key market of fordism brought to a shift from mass production to small batches of specialized goods. The economies of the western countries shifted from industry to service and knowledge based economy. The industries started to relocate where the production was cheaper: to the second and third world countries. Post fordism has arisen also thanks to the globalization and a more fluid movement of capitals.
Instead of investing in mass production, the process of production and consumption needs flexible plants and labour, capable of producing customized goods and quickly responding to market changes. Post fordism was driven by

[2.19] 02. 48’.15” - rocco e i suoi fratelli, luchino visconti, 1960

information technology that geographically **no longer needs storage** and depots. Its patterns are based on extensive infrastructure networks that encourage the establishment of production facilities outside of the traditional city. Therefore new territories are growing to accommodate flexible production in the periphery of cities[8]. According to Yona Friedman the urban peripheries have becomes place where the distance is a function of time, not space.

2.3 process of deindustrialization

between 1960 and 1974[9] around 180 hectares occupied by productive plant have been identified as abandoned/ underutilized in the city of milan. in 1984 the sites grow to 320 ha, in 1988 to 440 ha until the last survey carried out in the 1995 that highlight 510 ha[10].

A precise estimation of the phenomenon in Milan is difficult because of a scarcity of homogenous and updated data. This issue is common: at a national scale, for instance, estimates for disused land vary from 2800 ha to 10200 ha. All significant data have been retrieved directly in the library of Centro Studi PIM[11] (data until mid 90s).

8 According to Allen Scott, professor of geography at UCLA, cit in A. Berger (2006), p.55

9 Analysis carried out for the Variante Generale del PRG ‘80

10 Centro Studi PIM (1998)

11 Piano intercomunale milanese

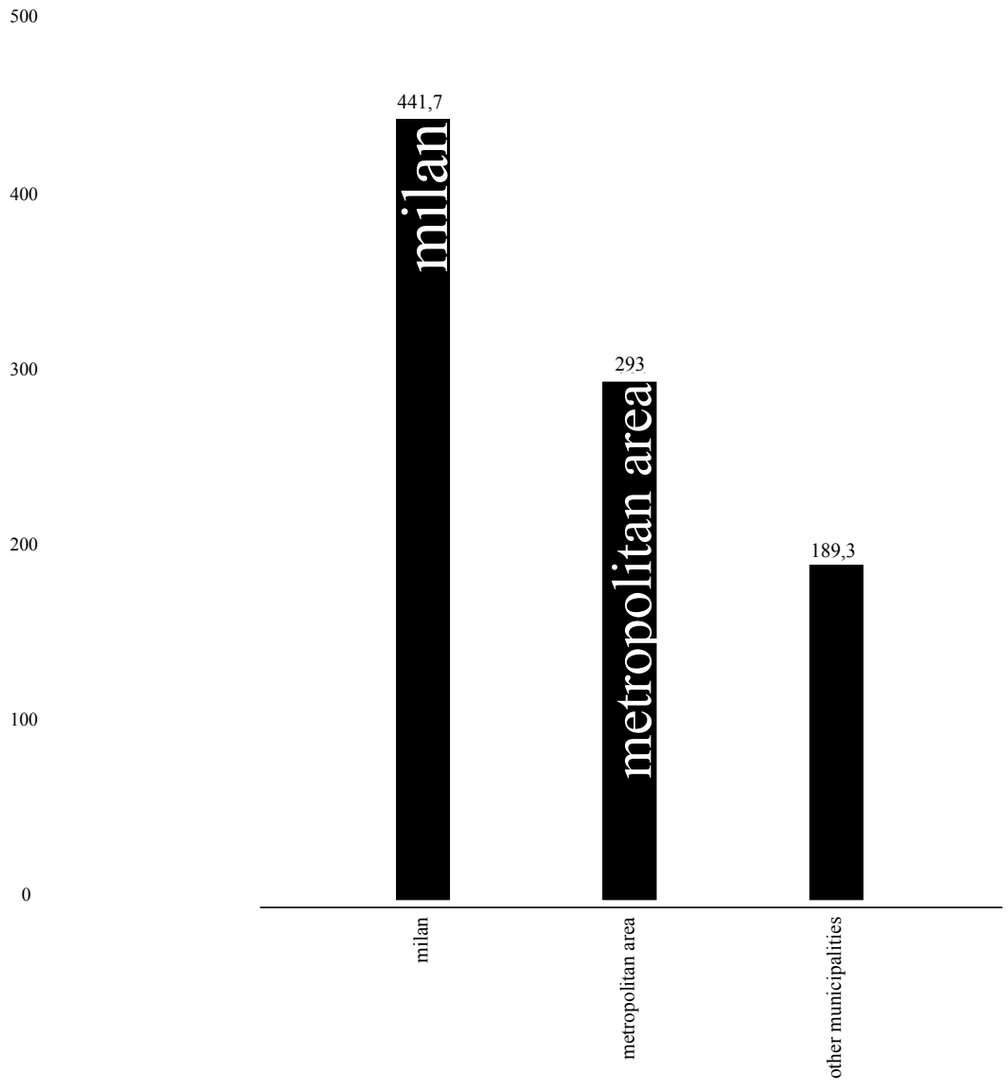
[2.20] 4’.07’’ - teorema, pier paolo pasolini, 1968

[2.21] innse factory img. 3, milan, august 2009

2.22 unused and ex industrial areas in milan, 1986

The process of shutdown of productive plant in Milan started several decades ago. The process started in the **60s** – mid 70s during the development of the city and the growing of the productive sector. The **shutdown of productive areas in the city**, in fact, **was combined with their outplacement** in the metropolitan area. Industries such as Pirelli, Alfa Romeo, Autobianchi were moved outside the city to permit their expansion. Thanks to the decentralization of the productive sector the city of Milan had the opportunity, for the first time, to carry out requalification projects in the city, according to PRG '53.

The phenomenon started to be a problem only at the end of the 70s when the economy of the industrial sector deeply changed and the urban development started to slow down without being able to absorb any transformation.
The abandonment of the productive activities involves extensively over a short period of time the historical industrial zone of the city generating: a north/west line (Bovisa towards Saronno), a nord/est line (Bicocca towards Sesto San Giovanni), a west line (with industries linked to naviglio and to rail yards) and a sud/est area (with a ring of rail yards and industrial sites connected).
To the amount of industrial areas should be added 1300 ha (1300000milion of sqm!) of railyards that are no longer used because of the modernization of the transportation plan. Huge areas contribute to maintain stable the quantitative data: areas such as ex-Alfa Romeo in Portello or Pirelli in Bicocca have been substituted by the left over of mechanical industry in the west side.



[2.23] Abandoned and unused industrial areas in the province of Milan
Source: Centro Studi Pim, 1988

Regarding the Province of Milan a survey carried out in 1988 by Centro Studi PIM individuated 924 ha of dismissed industrial sites of which 440 ha in the municipality of Milan. The disused land in the city were especially concentrated in the 7th and 9th zone (240 ha are constituted only by Pirelli, Montedison, Alfa Romeo and Bovisa).

It is well known that the PRG[12] of Milan carried out in 1980 confirmed the importance of the industrial sector for the city, reserving for productive activities more than 1400 ha. Thus the changes in the industrial scenario and the phenomenon of disuse didn't reflect any changes in P.R.G. that aimed at the safeguard of the productive sector anyway. An article of the implementation normative (it. Normativa di attuazione) came to help, it allowed the transformation of the 50% of these areas into services[13]. Therefore many transformations took place thanks to "normative automatisms", others thanks to a great amount of "variants" carried out to PRG. The "variants" of Progetto Passante, for instance, involved huge areas such as: Montedison Area, ex Redaelli, ex Alfa Romeo, Pirelli Bicocca and Bovisa.

Different attempts have been made to deal with abandoned areas and rail transportation. Documents such as "Documento direttore del Progetto Passante Ferroviario" and "Documento direttore delle aree dismesse e sottoutilizzate" contributed to initiating "land use rating" (it. indici di utilizzazione fondiaria[14]) to enhance functional mix and to constrain 50% of the areas to public green.

12 Piano Regolatore Generale (urban plan)

13 E. Dansero et al. (2001), p.92

14 0,55 mq/mq. Minimum percentage: 50% residential, 20% production of the floor gross surface (it. Superficie lorda di pavimento) and 75% to public green

[2.24] bovisa, milan, january 2010

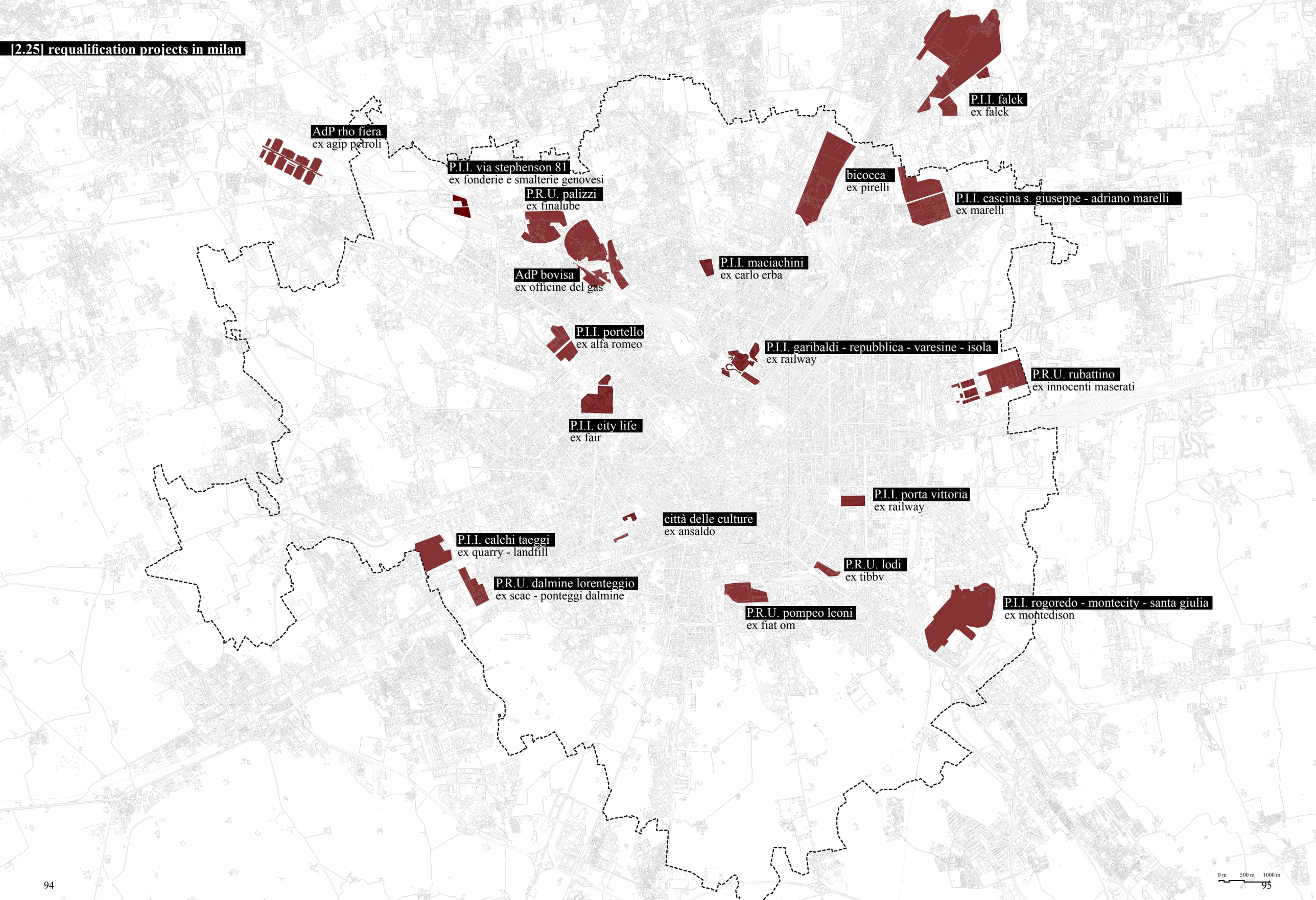
2.4 disused land and requalification project: successes and failures

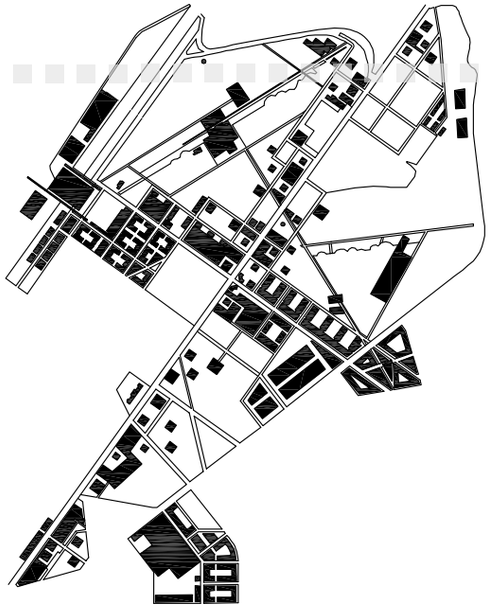
Urban voids means to deal with uncertainty, contamination and real estate.

From 1995 the administration predisposed several requalification programs for dismissed industrial sites (it. Programmi di riqualificazione urbana). A perimetration of urban areas to be requalified (it. Perimetrazione degli ambiti di riqualificazione urbana) has been carried out for great number of areas (370 ha of ex industrial areas and 930 ha of rail yards).
The projects have been developed at operative level with quick and flexible plans capable of solving to solve complex situation, called special programs such as PRU, program of urban recovering (it. programmi di recupero urbano) today PII, integrated program of intervention (it. programmi integrati di intervento). Other instruments to deal to these realities today are PRIU and PRUSST[15].
Many of the disused areas in Milan have already been requalified, some are still interested by the requalification such as PII Garibalid-Repubblica-Varesine- Isola.
Other are interested by requalification project but are blocked because of remediation cost issues (such as Bovisa and Area Falck).
The analysis of the requalification projects reveals that many sites have been stopped for long time after the shut down of their productive activities. These year of inactivity represent a great resource for the city: huge areas are available for a temporary occupation.

15 Programmi di Riqualificazione Urbana and Programmi di Riqualificazione Urbana e Sviluppo Sostenibile

[2.25] requalification projects in milan





1994-1996 — 2010

14 years of inactivity

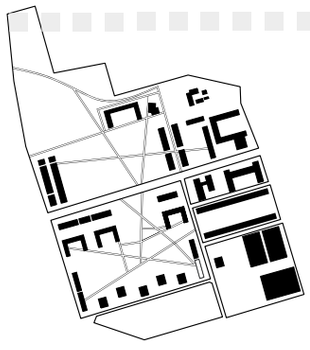
today: blocked

[2.26] P.I.I. falck

Renzo Piano Building Workshop

residendial/public/park

130 ha



1981-1983 — 2006

23 years of inactivity

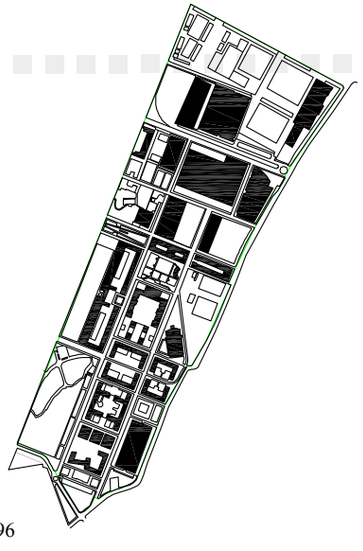
today: in progress

[2.27] P.I.I cascina s. giuseppe-adriano marelli

Paolo Caputo

housing/sport centre

47,5 ha



1985 — 1994 — 2004

9 years of inactivity

today: completed

[2.28] bicocca

Gregotti Associati International

University, housing, tertiary

37 ha

closing of the last productive activity in the area

starting the building yard

80s 2008

around 25 years of inactivity

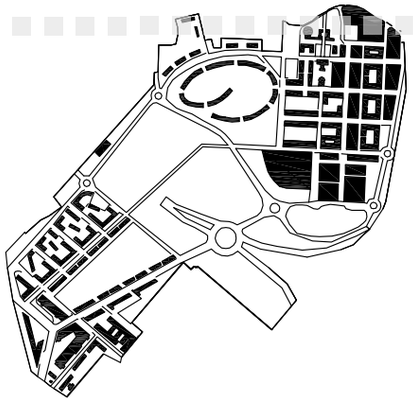
today: in progress

[2.29] P.I.I. porta vittoria

Bolles+Wilson, Nonis, Ticozzi

BEIC library, housing,

15 ha



1985 2005

15 years of inactivity

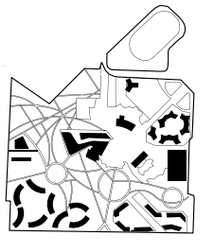
today: in progress

[2.30] P.I.I. rogoredo - montecity - santa giulia

Foster and Partners, Caputo, West8

housing, park

61,5 ha



2007 2008

0 years of inactivity

today: in progress

[2.31] P.I.I. city life

Z. Hadid, A. Isozaki, D. Libeskind,

P.P. Maggiora.

housing, tertiary, park

25,5 ha

1982 2001

19 years of inactivity

today: almost completed

[2.32] P.I.I. portello

A. Kipar and C. Jencks / G. Canali and C. Zucchi / Studio Valle Architetti Associati

park, housing, tertiary

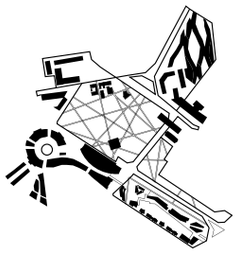
24 ha

50s

2007

around 55 years of inactivity

today: blocked



[2.33] P.I.I. garibaldi - repubblica - varsine P.I.I. isola

C. Pelli (P.I.I. Garibaldi Repubblica); KPF (Area Varesine); Boeri Studio (P.I.I. Isola)

office, commercial, park, housing

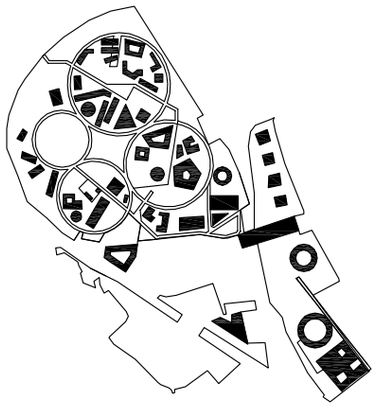
30 ha

1994

2010

16 years of inactivity

today: blocked



[2.34] AdP bovisa, area ex gasometri

O.M.A.

housing, tertiary, research

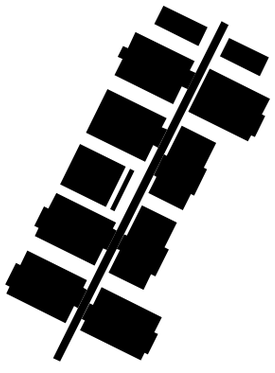
40 ha

1992

2001

9 years of inactivity

today: completed



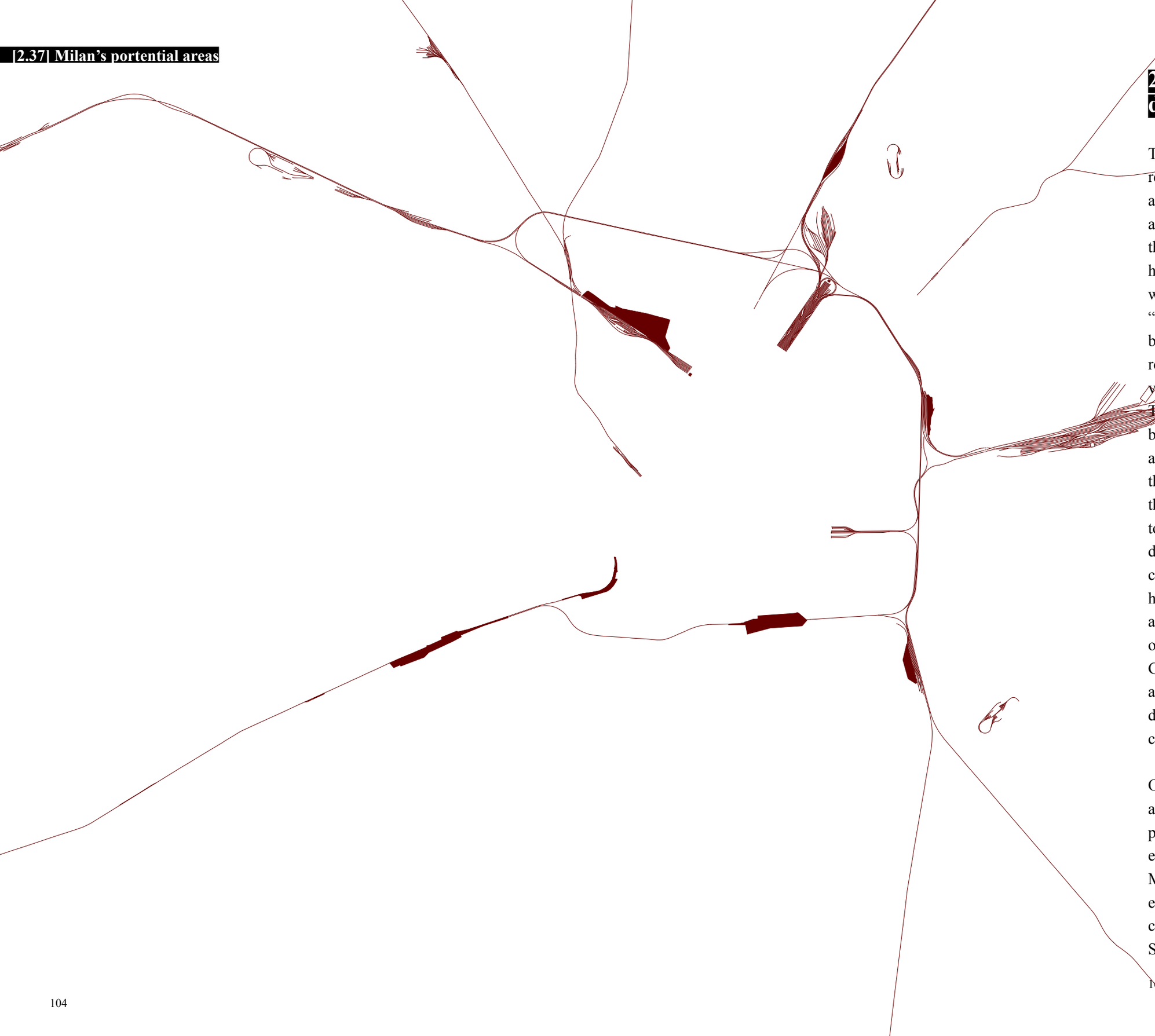
[2.35] Adp rho fiera

Massimiliano and Doriana Fuksas

new trade fair

7,7 ha

[2.36] Bovisa: 2715 m wall and barbed



[2.37] Milan's portential areas

2.5 which is the potential today?

Today the most important resource in Milan is represented by the railyards. Documents of the archive of Centro studi PIM[16] of the mid 80s already highlight as important to decentralize the rail yards to make free 1300000mq (130 ha)of urban soil. Now it could be possible to work on these areas thanks to the so- called "Accordo di Programma" (AdP) stipulated between the Municipality of Milan and Ferrovie dello Stato (State's Railways)in 2007 involving among others the region of Lombardy. The purpose of the agreement is to start a urban transformation of underutilized railway areas in order to generates funds to empower the railway system of Milan. In January 2009 the parts have started the procedure required to propose a variant to the PRG (it. proposta di variante urbanistica al PRG vigente in Accordo di Programma) involving almost 1300 ha of rail yards. The areas interested by the agreement are 7: Porta Romana, Porta Genova, San Cristoforo, Lambrate, Rogoredo, Greco-Breda and Farini. In PGT the rail yards are embedded in the category called Ambiti di Trasformazione Urbana (ATU) (crf. 1st chapter).

Other important resources are represented by almost 60 farmsteads owned by the municipality that are spread around the city and several empty office buildings (privately owned). Moreover there are still former industrial areas that are not in use because of remediation cost issues such as: Area Falck and Breda in Sesto San Giovanni, Bovisa and Stephenson

16 Centro Studi PIM (1988)

[2.38] Farini rail yard: 4200 m closed

3. DERELICT LAND

Dross is understood as a natural component of every dynamically evolving city. As such it is an indicator of healthy urban growth. *A. Berger, 2006, p. 1*

There are different reasons for a land to be contaminated. In general these lands cannot be reused because they suffer from environmental degradation and pollution related to their former land uses (such as old airports, chemical and petroleum plants, landfills, industry and military installation). They are generated from old and new urbanization, central and peripheral one.

the process of deindustrialization is one of the main "producers" of waste landscapes.

In Italy too, the process of transformation of the production system due to new international trade and a new international division of work is changing the territory. The progressive deindustrialization of the country, in fact, and the abandonment of steel, chemical and heavy mechanical industry are now **bequeathing their legacy**: vast abandoned and contaminated lands. These are common issues of most of the western countries called **brownfields**: abandoned / underused industrial and commercial facilities whose redevelopment is complicated by environmental contaminations. Not all deindustrialized sites are equal, a **"taxonomic" approach** to the problem should be carried out. Some are cordoned off due to severe contamination, many are left abandoned until market create resources for their rehabilitation. "deindustrialized sites are all transitional places. They await some form of reclamation prior to reprogramming and reuse" (Alan Berger, 2006, p.51).The necessity to carry out interventions that associate remediation to reuse is important for the issue of soil consume. These sites should become a urban planning priority for redevelopment of the city.

3.1 diffuse/local contamination

There are two kinds of soil contamination: diffuse contamination and local contamination, they are different issues and are addressed as distinct soil problems.

Diffuse contamination is related to atmospheric deposition, agricultural practices (overuse of fertilizer) as well as to the wrong treatment of waste water and incorrect recycling of wastes. The contaminants are transported over wide areas, often far from the source. It includes heavy metals, acidification, nutrient surplus.

Local contamination (contaminated sites) regards restricted areas, it depends on the presence of particular activities such as closed mines, industries and landfills. In general these site seems to be more interesting for city development because there is a direct link between the source of the contaminations and the contaminants .This distinction implies different management and different legal aspects.

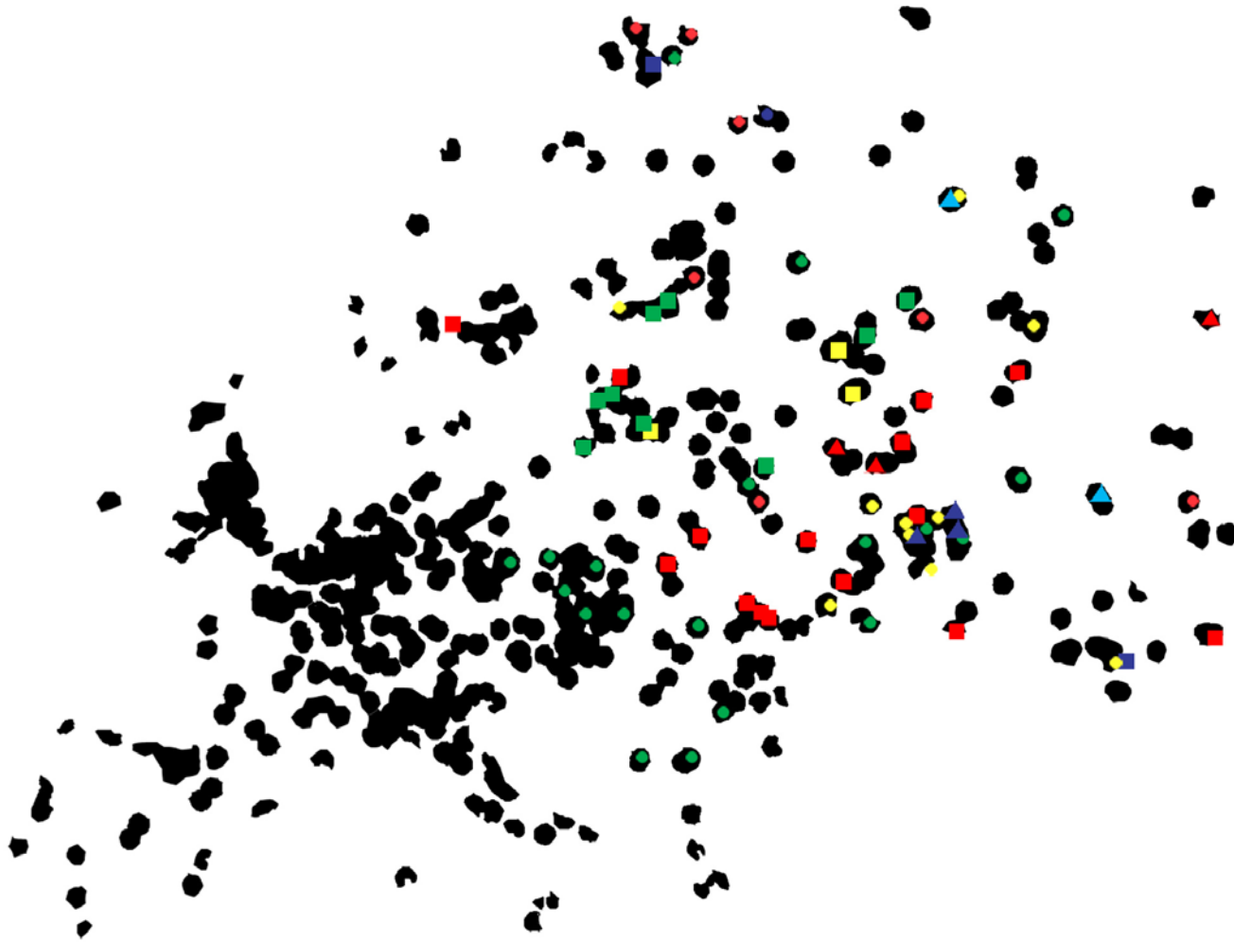
The two kind of degradation can also coexist: in highly-contaminated areas in the proximity of the city for instance, where the pollution can be caused by local (landfill) and diffuse sources (road transportation).

The sources of land disturbance and dereliction can be anthropical or natural. Natural sources can be volcanic eruptions while anthropic source are in general linked to industry (chemical, iron and steel industry, paper factory and so on), processes of combustion (road haulage, thermoelectric power stations, incinerators) and agriculture (fertilizer, livestock sewages and plant protection product). The main contaminants linked to agriculture are

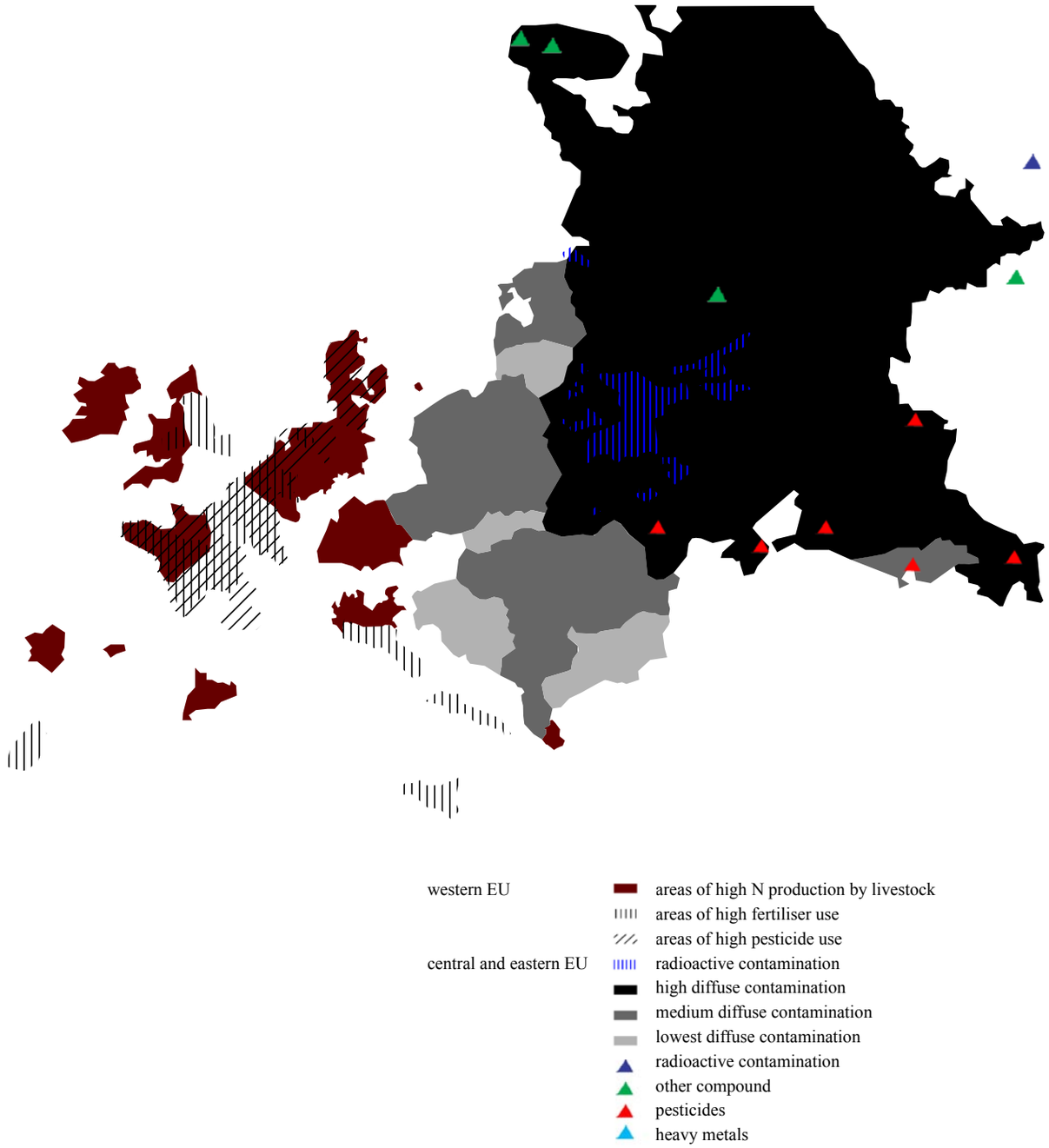
[3.1] population

[3.2] (local) contamination

- coal mines
- shale mining
- metal mines
- oil and gas extraction
- metal smelters
- chemical industry
- mixed industry
- power generator
- waste disposal
- waste (also radioactive)
- radioactive contamiantion
- heavy metals
- high probability of local contamination



[3.3] diffuse contamination



Data source: EEA (2000)

nutrients (such as Nitrate), herbicide and pesticide and heavy metals[1] . Anyway , according to EEA, the use of pesticides is decreased in most EU countries over the past decade, probably thanks to the Common Agricultural Policy. The main contaminants connected with industrial activities are hydrocarbons, heavy metals, aromatic hydrocarbons BTEX, PAHs, mineral oil, chloride hydrocarbons (CHC) and phenols.

3.2 size: from europe to milan

europe

the european environment agency estimates the number of contaminated sites at approximately 250000 sites. this number is expected to grow to nearly 3 million sites[2] . "if current investigation trends continue, the number of sites needing remediation will increase by 50% by 2025"[3]

By contrast, in the countries where data regarding remediated land were available, around 80000 sites have been remediated in the last 30 years. In general a consistent share of remediation costs (35%) is covered by the public budget because applying the "polluter-pays" concept is difficult in the case of the remediation of historical contamination.

The **difficulties** faced by EEA in analyzing the contamination trough Europe are linked to the **heterogeneous criteria** used to identify a contaminated site at international level. The enormous gap between estimates (250000 vs 3 million of sites) is connected with the "absence of a common European definition of a contaminated site" and it reflects a variety of approaches to "acceptable risk level". Moreover access to data and information is difficult since soil users are many and the data have been collected by different organizations in view of different goals. Therefore only a general assessment of the conditions European soil is possible to date.

Diffuse contamination, with the possible exception of acidification[4] , is not a great problem for the European soil. Anyway contamination is high in restricted urban areas or hot spots due to diffused and localized sources. A **diffuse contamination** can be found, generally speaking, **close to places of intensive agriculture**, places affected by atmospheric fall out, industrial regions and communication routes.

The map shows areas with an high probability of diffuse soil contamination (using data on chemical use in agriculture for diffuse contamination in agricultural areas) and area mapped as contaminated.

For central and eastern European countries a "subjective classification based on national State of Environment Reports"[5] has been used thus it's possible that all relevant hot -spots have not been identified. An intense agricul-

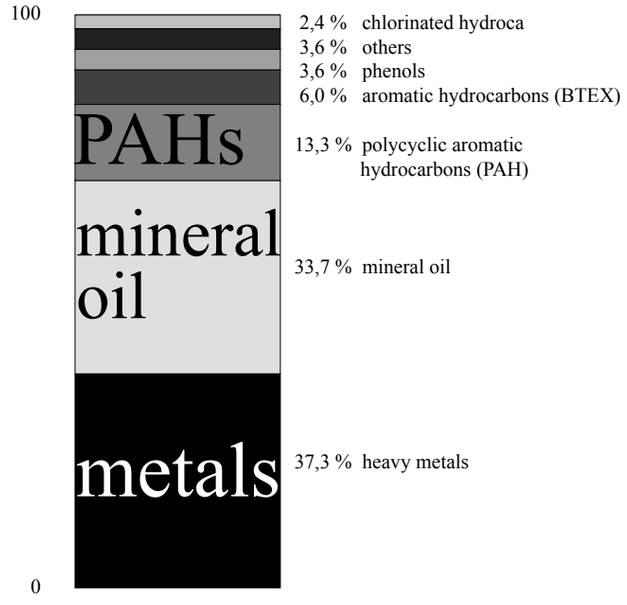
1 contained in fertilizer, livestock sewages, plant protection product and depuration mud baths

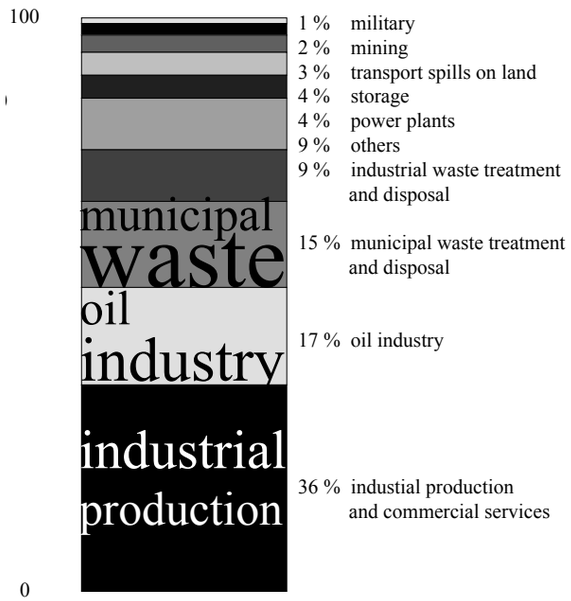
2 including the 250000 sites already mentioned

3 EEA (2007)

4 Reduction of soil PH through deposition of nitrogen emitted into the air

5 EEA (2000), Environmental issue series No 16, p.8





[3.4] Contaminants and causes of contamination in Europe
Data source: EEA (2007)

tural chemical use is present in the lowlands of western Europe: Denmark, the Netherlands, Belgium, Luxembourg and the north of France. Areas of high livestock manure production are randomly distributed but prevalent in North Western Europe. In Europe's eastern regions, the problems connected with diffuse contamination are higher in Azerbaijan, Belarus, Moldova, Russia and Ukraine.

local contamination, on the basis of the available data of the countries analyzed, is **due to industrial activities**, former waste sites or military installation.

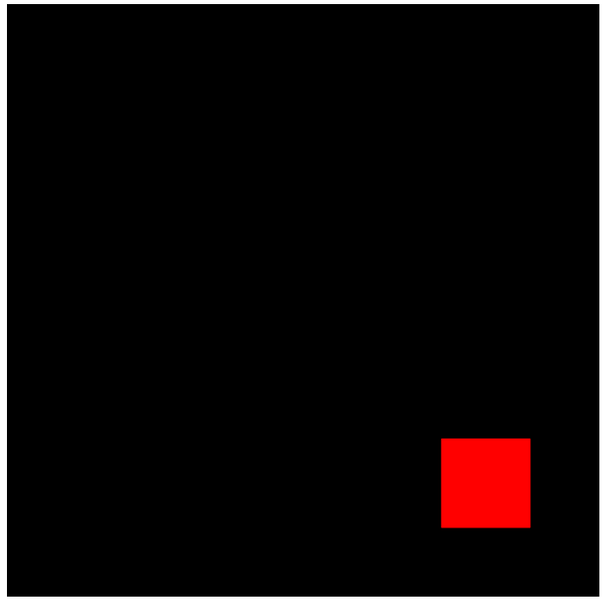
The importance of the problem is linked to its consequences on human health and ecosystems that are often underestimated, one of the major types of impact is usually a limited access to clean drinking water.

The map shows areas with a high probability of local soil contamination (created by using the map of industry activities) and areas mapped as contaminated. The map does not cover all countries because of the lack of data. The areas where the probability of local contamination is high are located in North-Western Europe, from Nord-Pas de Calais in France to the Rhein-Ruhr region in Germany, trough Belgium and the Netherlands. Moreover there are the Saar region in Germany; northern Italy; the regions located where Germany, Poland and the Czech Republic meet (the so-called Black Triangle) and the areas around all major cities[6] .

The most frequent soil contaminants indicated by the national reports of the countries investigated are heavy metals (37,3%), and mineral oil (33,7%) while the most diffuse in groundwater mineral are oil and chlorinated hydrocarbons. Other contaminants include polycyclic aromatic hydrocarbons (PAH), aromatic hydrocarbons (BTEX), phenols and chlorinated hydrocarbons (CHC).

The main activities causing local contamination in selected western European countries are: industrial and commercial activities and the treatment and disposal of waste both municipal (15%) and industrial (9%). In general the main problems derive from industrial activities, but contamination around military sites poses problems particularly in the Baltic

6 EEA (2000), Environmental issue series No 16, p.22



italy surface: 302233600 ha
contaminated land: 674835 ha

[3.5] Italy contaminated surface
Data source: Ministero dello Sviluppo Economico (2008)

States, Czech Republic and Hungary.

italy

according to agenzia per la protezione dell'ambiente e per i servizi tecnici (apat)[7] in italy there are 4400 contaminated sites, 8600 potentially contaminated sites, 1500 disused mines and 54 sites of national interest. the site of national interest represent around the 2,2% of the italian territory and 130000ha of sea water areas.

The total amount of the Sites of National Interest surface in march 2008[8] was 674835 ha that means the 2,2 % of the Italian territory (302336 km² according to APAT) equal to 37 the surface of Milan (18178,75 ha according to PGT)[9].

The Sites of National Interest (SIN)[10] are 54 distributed in all the regions, 37 of them are interested by a requalification plan and 25 of them involve also water areas (sea)

A SIN is a contaminated area with an very high health and environmental risk level, characterized by a relevant socio-economic

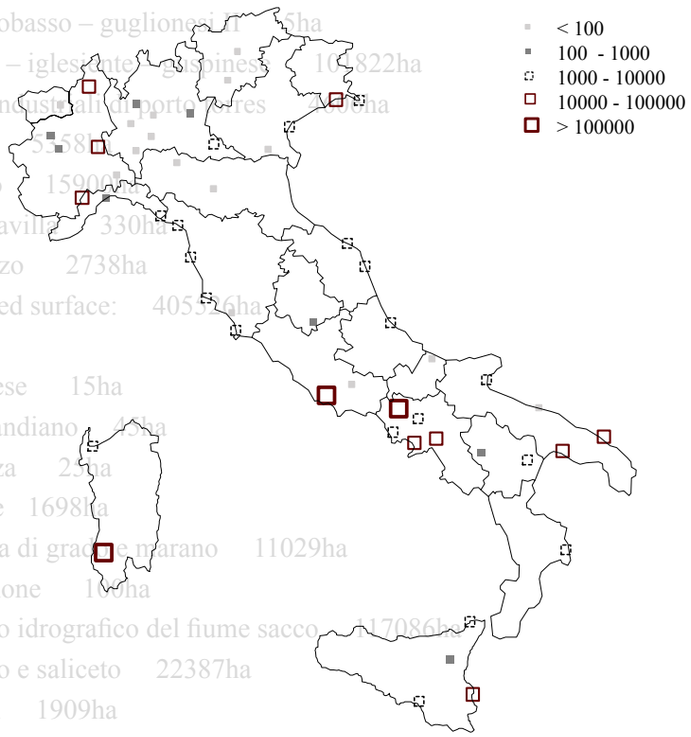
7 APAT today has been embedded in Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)

8 Ministero dello Sviluppo Economico (2008)

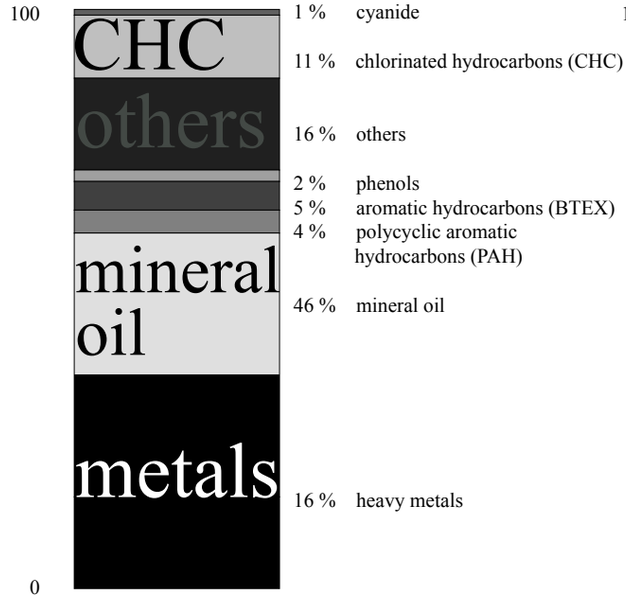
9 According to previous data (annuario 2005-2006, APAT) the sites of national interest represent almost the 3% of the Italian territory and 170000ha of sea water areas.

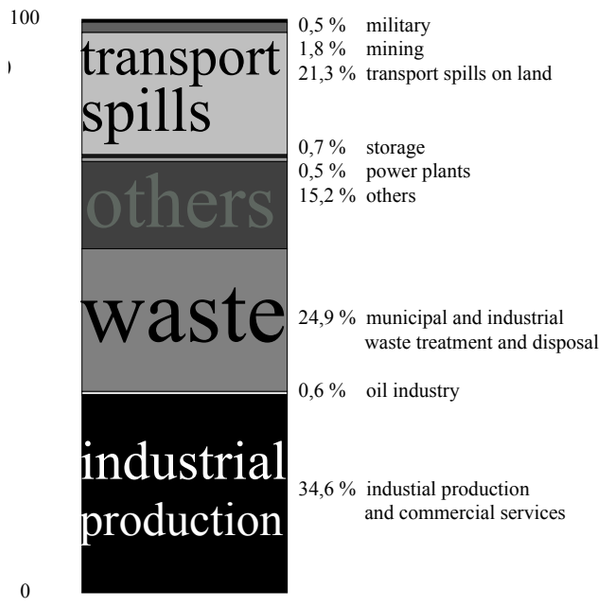
10 Individuated by a decree of Ministro dell'ambiente e della tutela del territorio e del mare in agreement with the region interested.

abruzzo	fiumi saline e alento	1915ha
apulia	manfredonia	1054ha
	brindisi	11324ha
	taranto	11374ha
	bari – fibronit	15ha
basilicata	tito	315ha
	area industriale della val basento	3330ha
calabria	crotone – cassano – cerchiara	2320ha
campania	napoli orientale	2267ha
	litorale domizio flegreo ed agro aversano	179437ha
	napoli bagnoli–coroglio	2439ha
	aree del litorale vesuviano	16313ha
	bacino idrografico del fiume sarno	42664ha
molise	campobasso – guglionesi	15ha
sardinia	sulcis – iglesiente – guspinese	10822ha
	aree industriali di porto torres	1[illegible]ha
sicily	gela	3[illegible]ha
	priolo	1590[illegible]ha
	biancavilla	330ha
	milazzo	2738ha
south of italy total contaminated surface:		405526ha
aosta valley	emarese	15ha
emilia romagna	sassuolo – scandiano	45ha
	fidenza	23ha
fruili venezia giulia	trieste	1698ha
	laguna di grado e marano	11029ha
lazio	frosinone	1[illegible]ha
	bacino idrografico del fiume sacco	17086ha
liguria	cengio e saliceto	22387ha
	pitelli	1909ha
	cogoleto – stoppani	214ha
lombardy	sesto san giovanni	256ha
	pioltello e rodano	85ha
	cerro al lambro	6ha
	milano – bovisa	43ha
	brescia – caffaro	263ha
	broni	14ha
	laghi di mantova e polo chimico	1030ha
marche	basso bacino del fiume chienti	3832ha
	falconara marittima	1272ha
piedmont	[illegible]	74825ha
	balangero	317ha
	pieve vergonte	15242ha
	basse di stura (torino)	163ha
	serravalle scrivia	74ha
trentino-alto adige	bolzano	27ha
	trento nord	24ha
tuscany	piombino	2948ha
	massa e carrara	3539ha
	livorno	2079ha
	orbetello	2706ha
	discarica le strillaie	57ha
umbria	terni – papigno	655ha
veneto	venezia (porto marghera)	5787ha
	mardimago – ceregnano	57ha
centre and north of italy total contaminated surface:		269309ha



[3.6] Site of National Interest' surface (ha)
Data source: Ministero dello Sviluppo Economico (2008)





[3.7] Contaminants and causes of contamination in Italy
Data source: EEA (2007)

impact caused by the pollution[11] . SIN can also involve particularly interesting landscape (protected environment, for instance).

in the centre and north of italy there are 34 sites (269309 ha) while in the south 20 sites (405526ha).

The unbalance between the surface is due to water contaminated areas, prevalent in the southern regions.

The pollution is **manly caused by industrial activities** in fact only 5 on 34 SIN in the north and centre of Italy[12] are not caused by industrial plants and 3 on 20 SIN in the south[13] are related to different activities, such as mines and quarries. The SIN involve both active and disused industrial plants (the data about the surfaces are not available).

Most of the SIN are **huge areas** in the proximity of big arterial roads, airports or logistic centres. Looking at the map of rail roads it possible to see that 35% of the sites are **distributed along the main routes** and railways[14].

The contamination is especially due to industries and mines, wastes disposal, oil-coal and gas refinery, chemical industry, iron and steel industry and harbour activities.

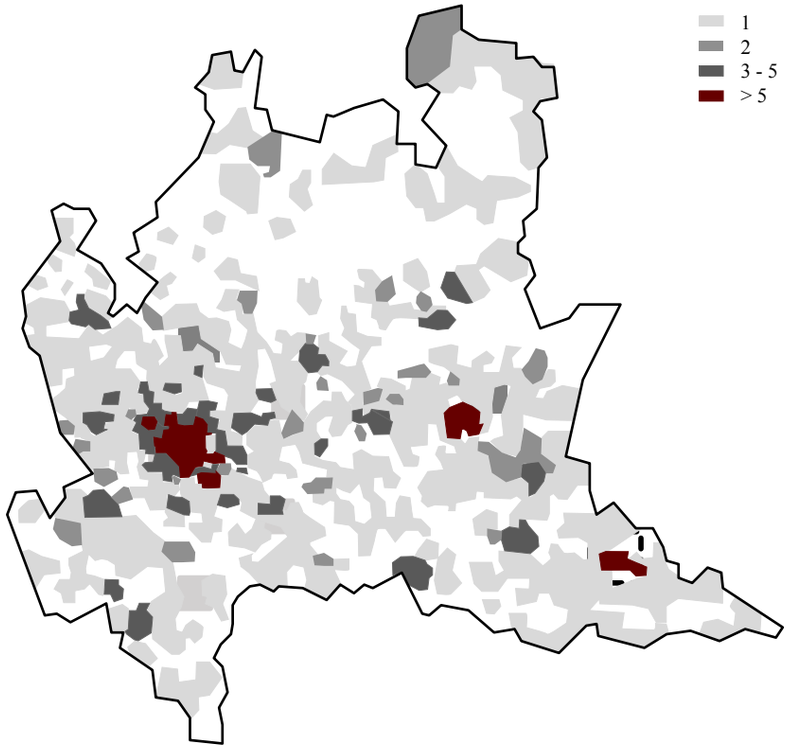
in lombardy most of the contaminated **sites are linked to previous industrial activities**, as it is clear looking at their geographical position. They are present especially in Milan and hinterland, in the proximity of cities such as Brescia and

11 Art.252cD. Lgs. 152/06

12 Balangero, Basse di Stura, Cerro al Lambro and Strillaie

13 Campobasso-Guglionesi, Biancavilla, Fiumi Saline-Alento.

14 Ministero dello Sviluppo Economico (2008)

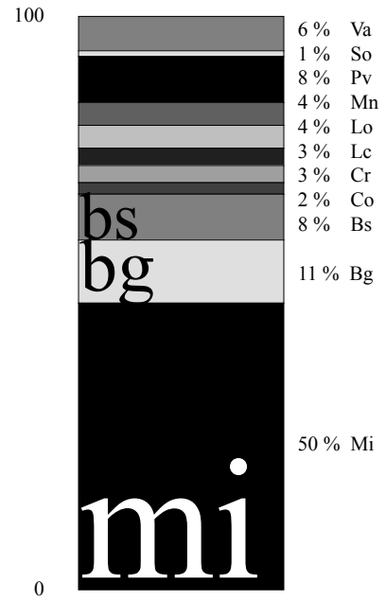


[3.8] Site of National Interest in Lombardy and number of contaminated sites for each municipality
Map data source Arpa Lombardia (2007)

Bergamo and in the Po Valley (only small dimensions smaller ones are found close to citiyes centers).
In order to understand the regional distribution of sites it is interesting to examine these data from years 2002: in Lombardy there are 1287 contaminated sites, 50% of which are located in the province of Milan, followed by Bergamo (102 sites), Pavia (78) and Brescia (74)[15] . The potentially contaminated sites, however, are 2300, of which 700 are in the Milanese territory[16] . The Province of Milan is one of the Italian realities with the greatest number of areas interested by requalification projects caused by the deindustrialization.

15 Arpa Lombardia (2002) p.2

16 Arpa Lombardia (2007) p.88



[3.9] Distribution of contaminated sites in Lombardy
Graph data source: Arpa Lombardia (2002)

[3.10] milan surface:
contaminated land*: 1048,7 ha

*including: land reclamation in progress, land to be reclaimed, partially reclaimed land, potentially contaminated
Data source: Servizio Piani di Bonifica del Comune di Milano.

milan

the “ufficio bonifiche” of the municipality of milan has located in the city 674 sites subjected to contamination for a total surface of almost 1450ha[17]. excluding the areas already reclaimed[18] the surface is equal to 1054 ha: 320,3 ha of potentially contaminated land, 236,7 ha of land to be reclaimed and 496,5 ha of land where reclamation is in progress[19]

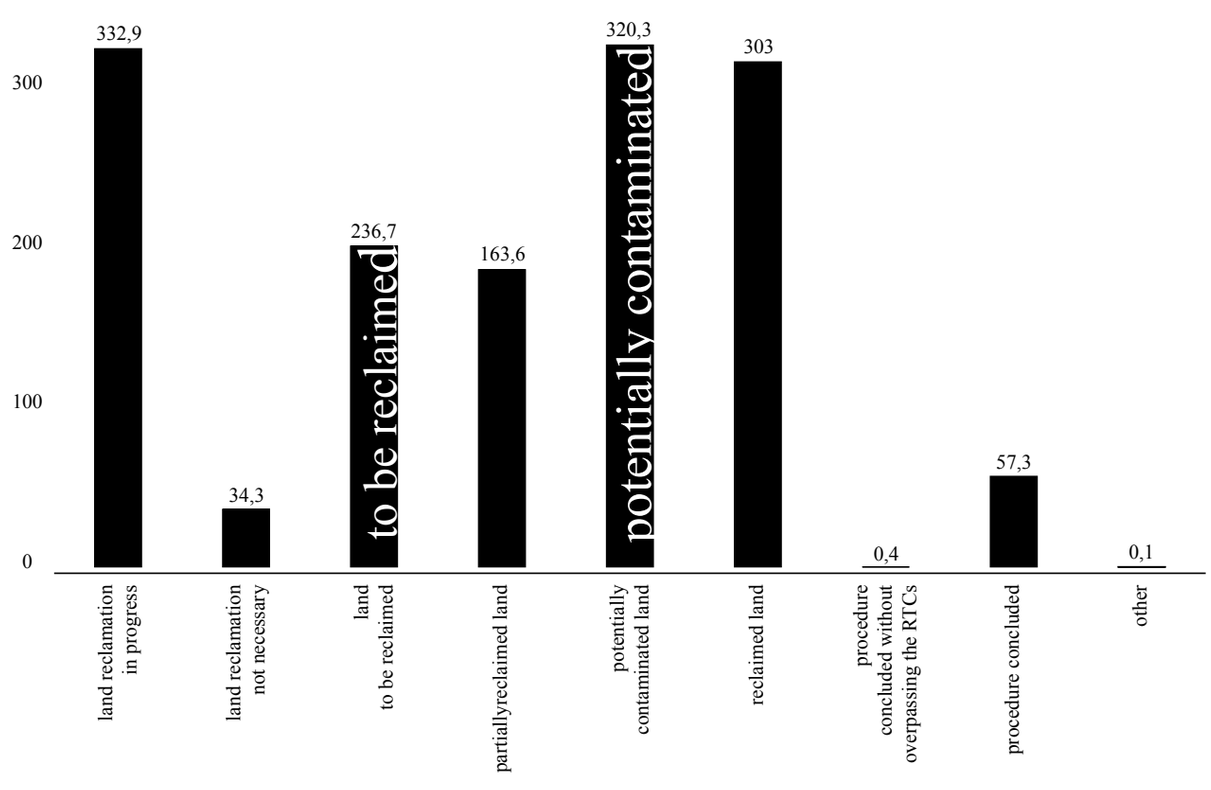
All data have been retrieved directly from the “Ufficio Bonifiche” of the municipality of Milan between December 2009 and January 2010. Available data concern only local pollution. In the city there are both little contaminated plots and extensive polluted surfaces. The **little contaminated plots** generate a spread contamination mainly **due to fuel depots, fuel stations and civil tanks** as the map cause of contamination clearly shows. **extensive polluted surface**, instead, are **due to quarry landfills**, mechanical and metallurgical **industry,** oil, coal and gas refinery (Bovisa site for instance) **and rail**

17 1448,7 ha

18 395 ha, including the categories: land reclamation not necessary, reclaimed land, procedure concluded without overpassing the RTCs and procedure concluded

19 Including the categories land reclamation in progress and partially reclaimed land

[3.11] land reclamation status



Source: Servizio Piani di Bonifica del Comune di Milano.

yards. They are mainly located in the peri-urban areas of the cities.

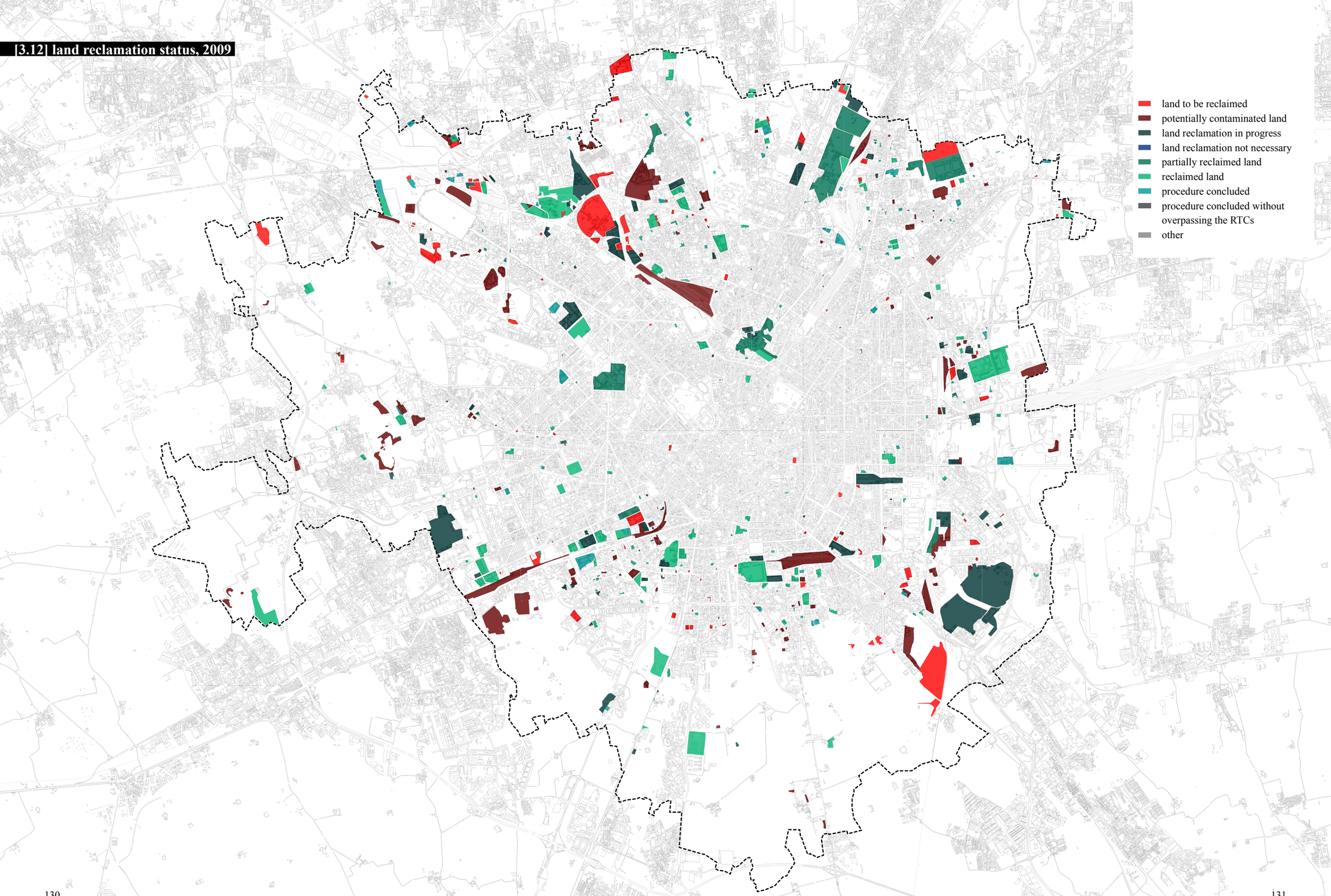
According to data from 2006[20] 50 % of these site are characterized by a green/residential use, a great occasion for the redevelopment of the cities. The main soil contaminants found in Milan are hydrocarbons, inorganic compounds and heavy metals while in water they are metals, aliphatic and aromatic compounds. It is important to notice that **most of the soil of the city of milan is filling material coming from demolitions due to the second world war**. This mean that other kind of **pollution can be found randomly in the city**.

3.3 mapping the contamination

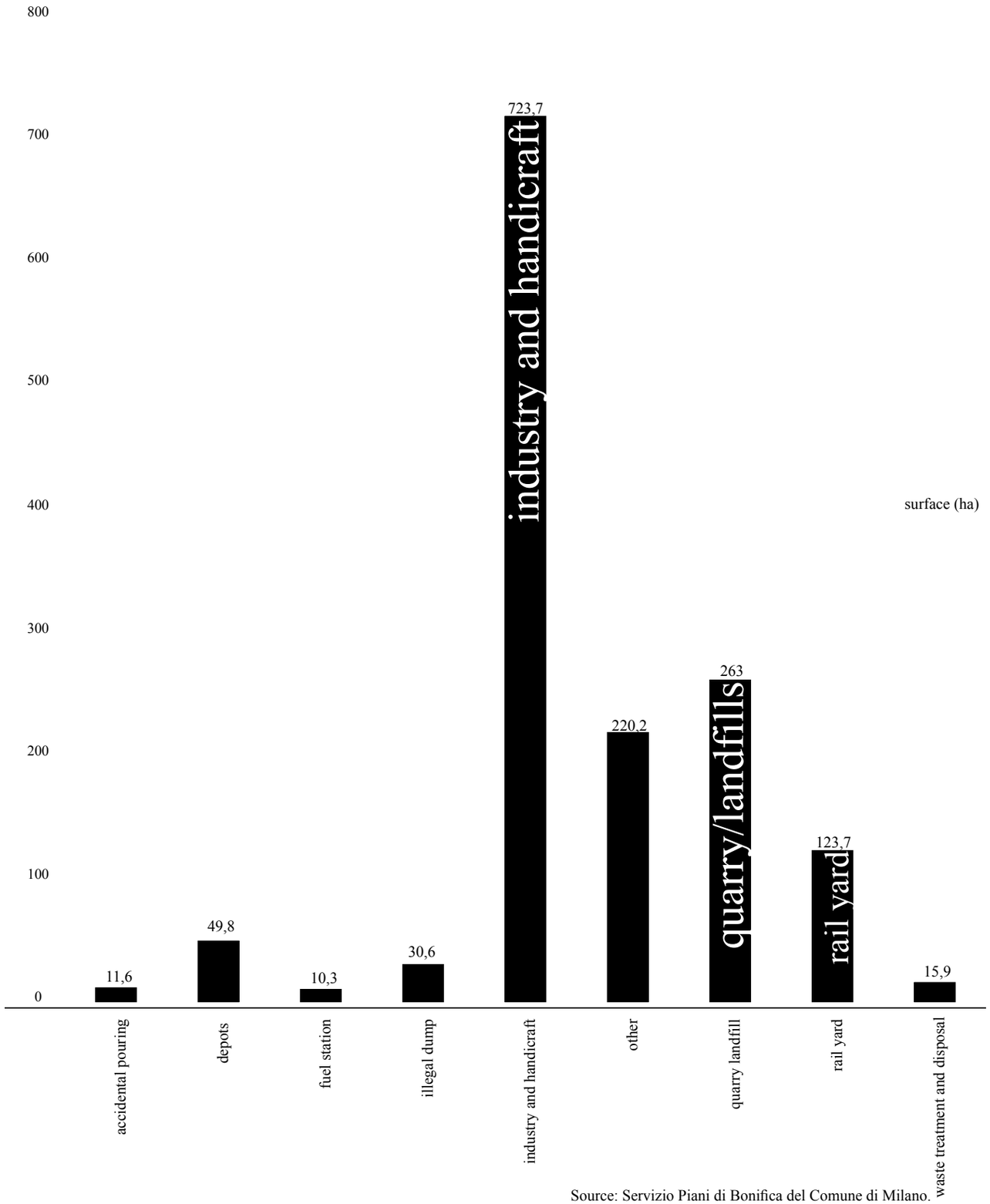
The aim of the maps drawn is to highlight the **land reclamation status** (in order to understand which are still the most problematic areas) and the **cause of contamination.** Because not all derelict land are equal this this analysis aim to develop a land classification approach to the issue. Mapping the causes of contamination, furthermore, is useful to hypothesise the presence of contaminants where no investigation has been carried out. It's possible to argue from analogy, studying for instance the contaminants of a rail yard and suppose that a similar situation can involve other rail yards, too. For this reason the analysis of three case studies has been carried out as representative of an industrial activity, a rail yard (where the pollution is caused by transport spills) and a quarry landfill. The case studies highlight the contaminants, their concentration and their depth.

20 PGT(2009), Rapporto Ambientale

[3.12] land reclamation status, 2009



[3.13] causes of contamination



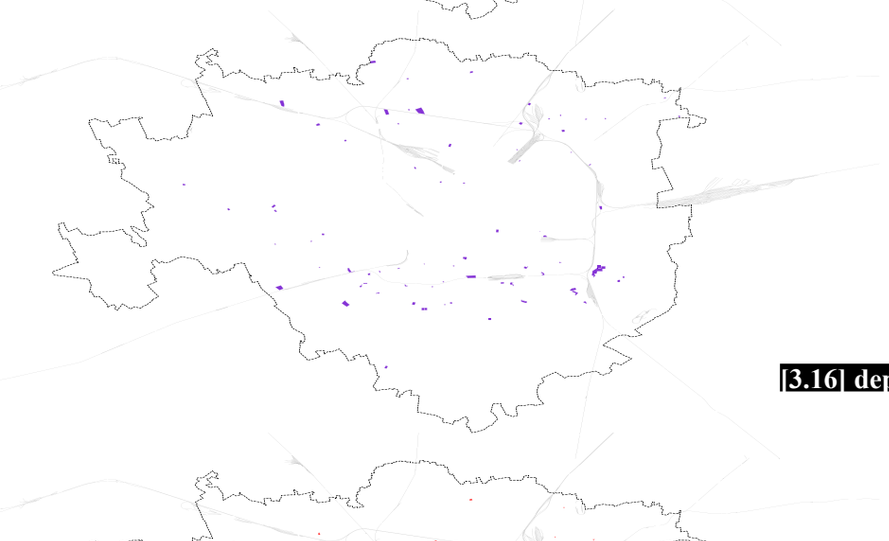
Source: Servizio Piani di Bonifica del Comune di Milano.

[3.14] cause of contamination, 2009

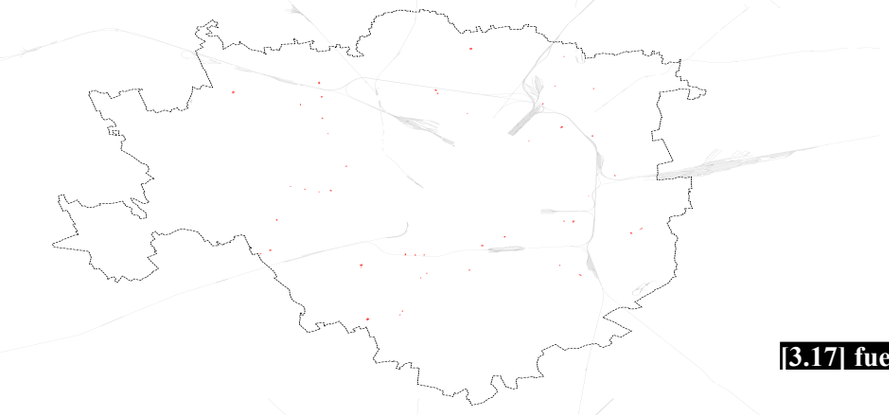
- accidental pouring
- depots
- fuel station
- illegal dump
- industries and handicraft
- other
- quarry landfill
- rail yard
- waste treatment and disposal

0 m 500 m 1000 m

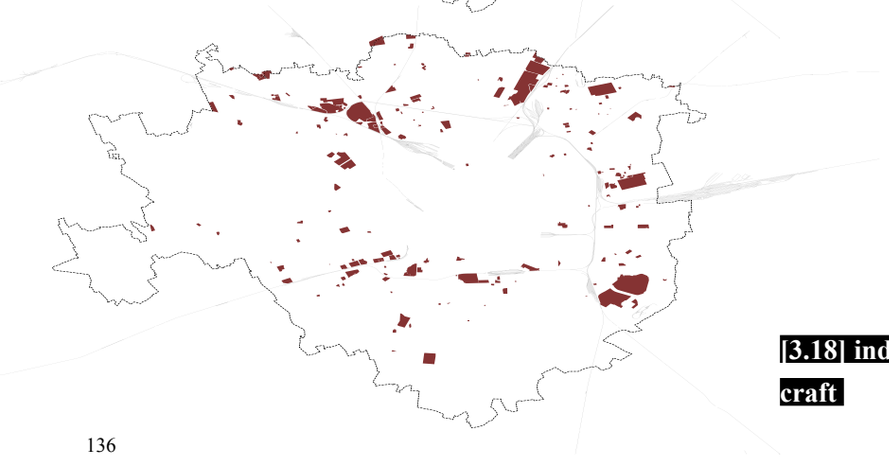
[3.15] accidental pouring



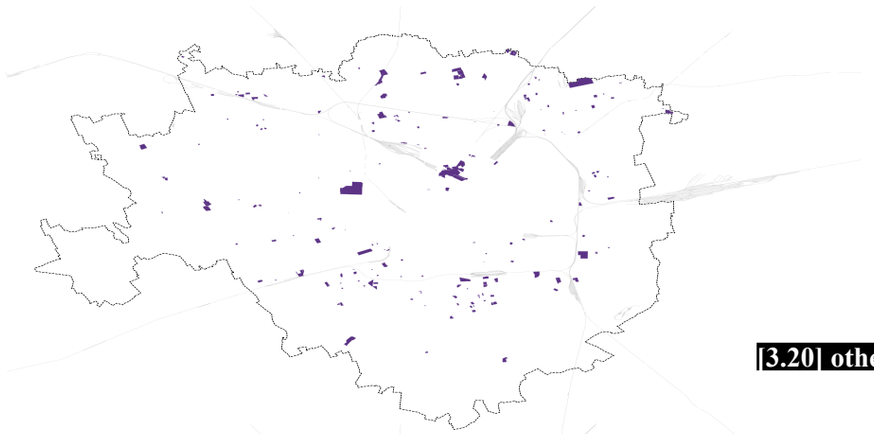
[3.16] depots



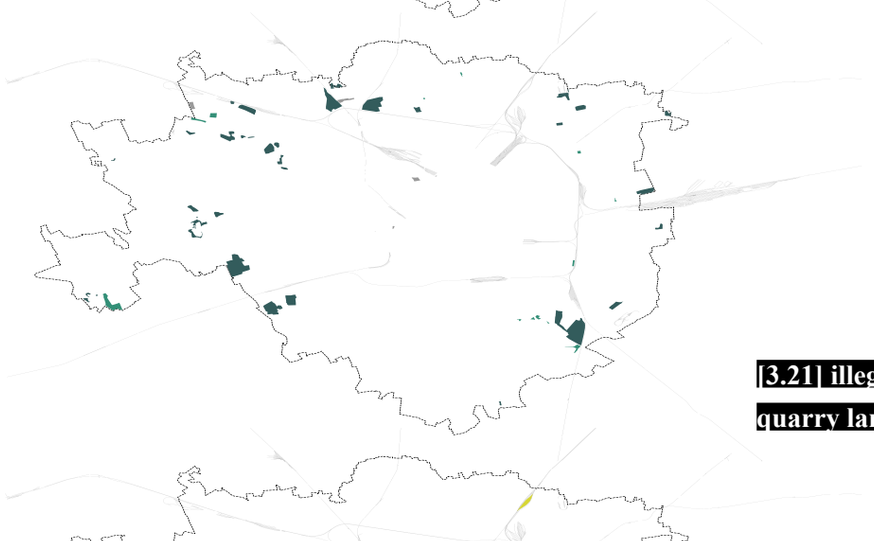
[3.17] fuel station



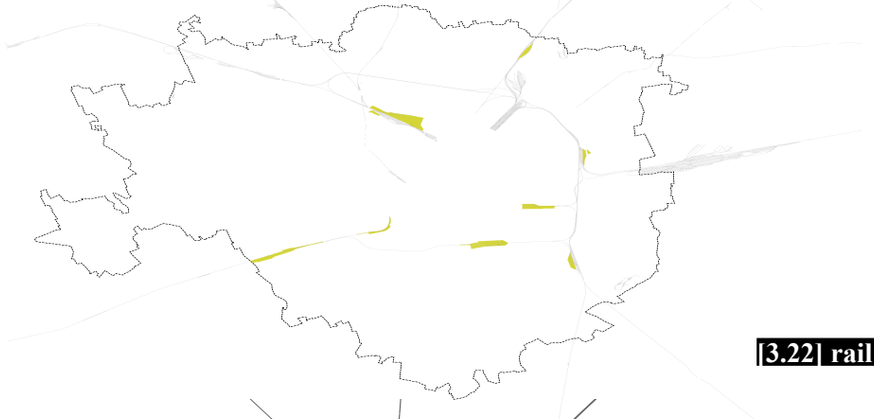
[3.18] industries and handicraft



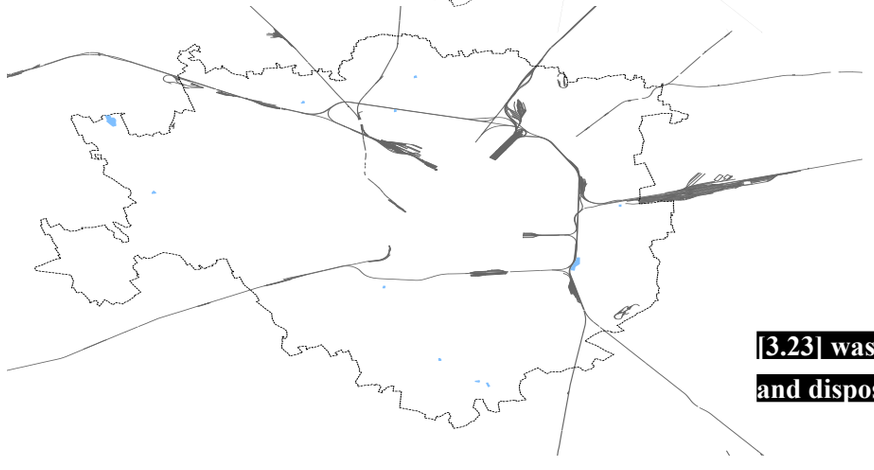
[3.20] other



[3.21] illegal dump and quarry landfill

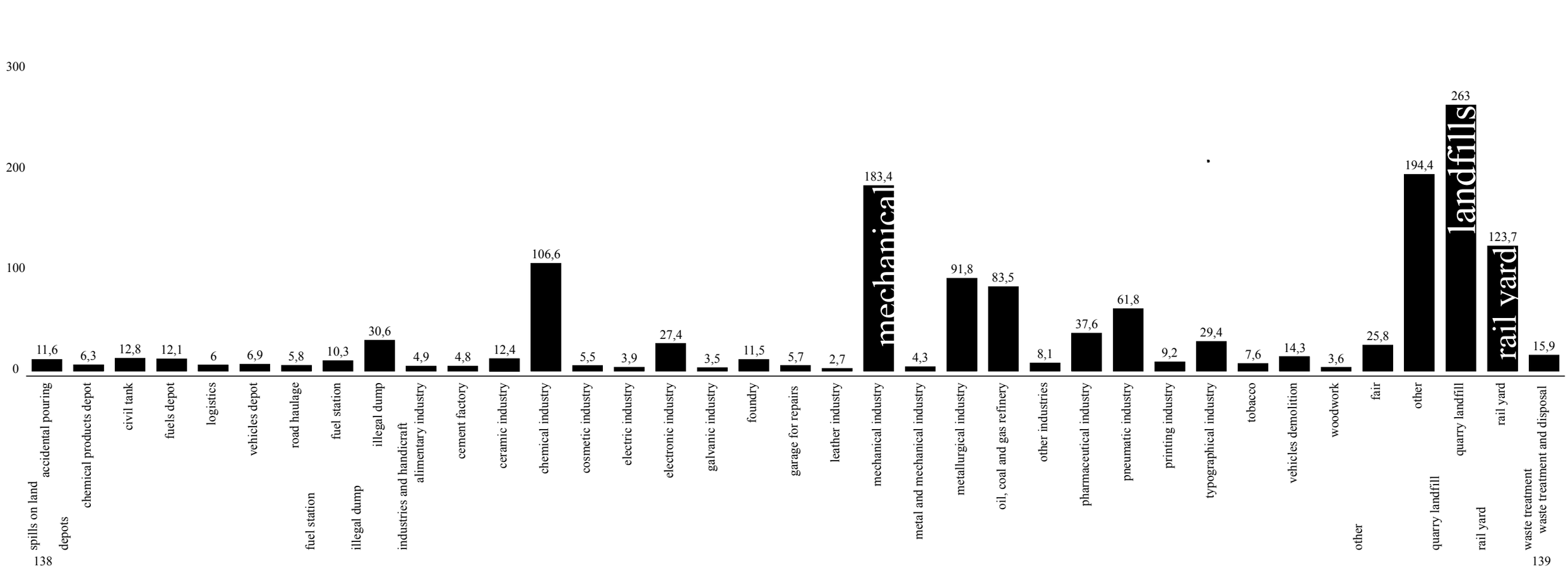


[3.22] rail yard

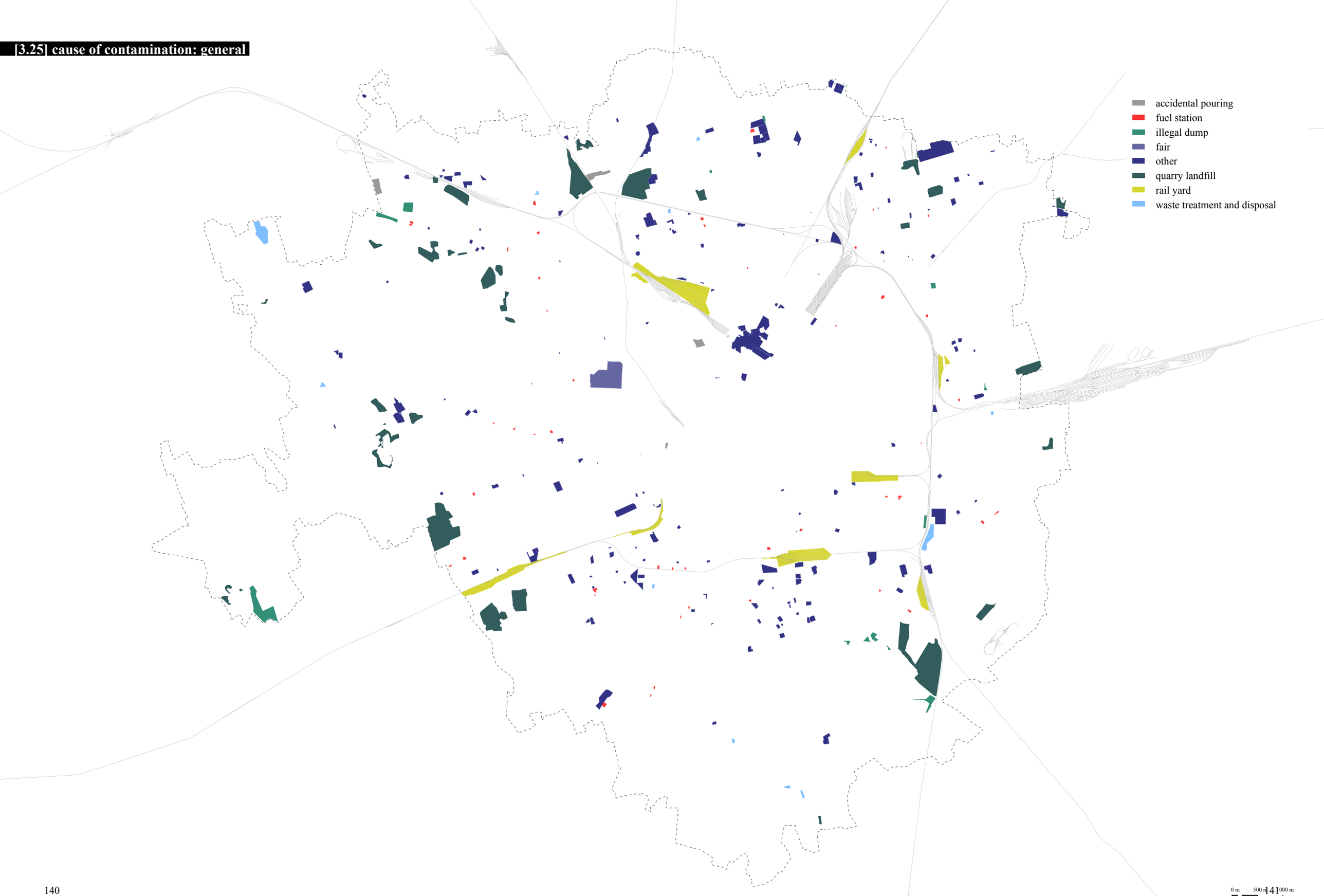


[3.23] waste treatment and disposal

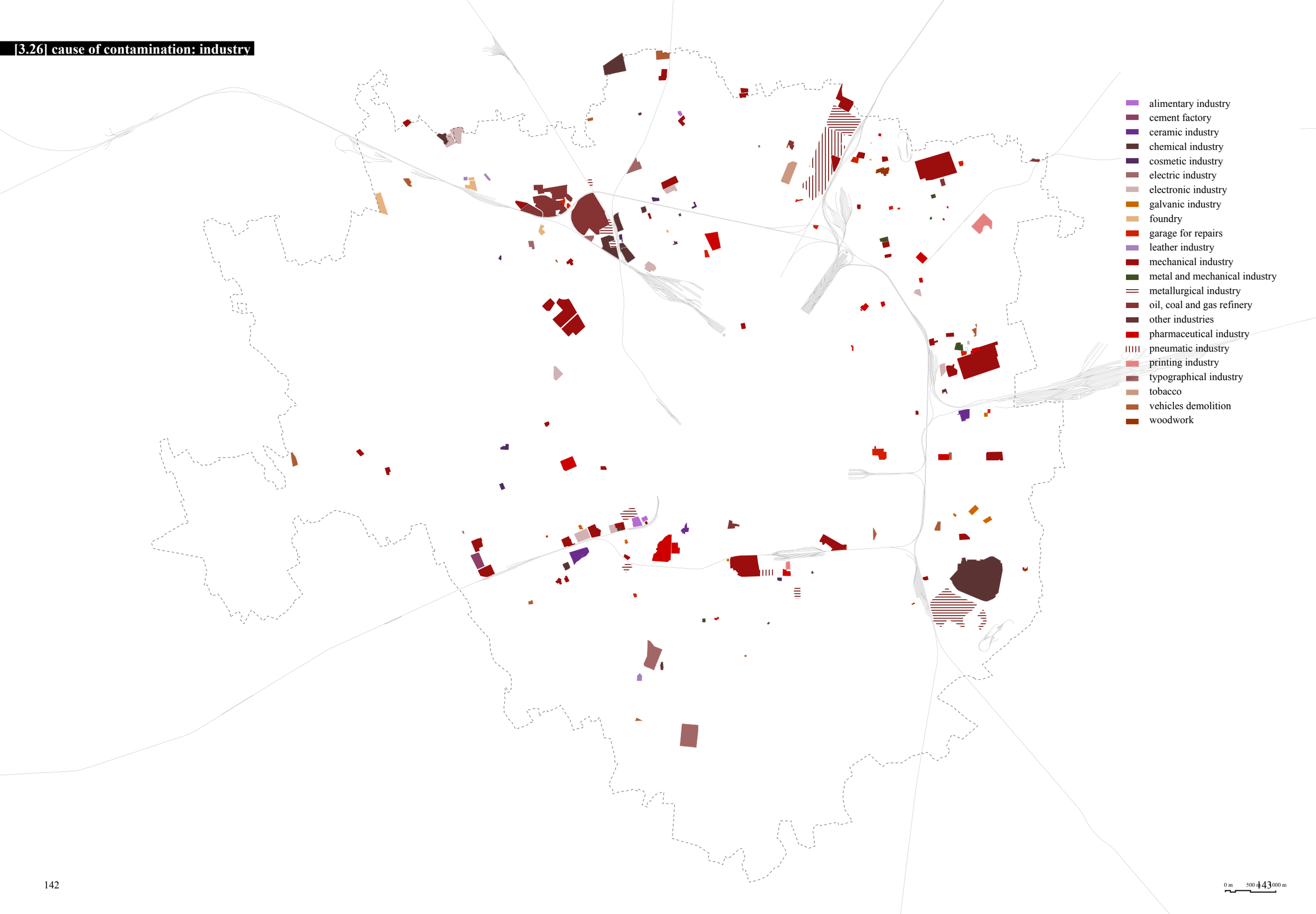
[3.24] causes of contamination layer by layer..



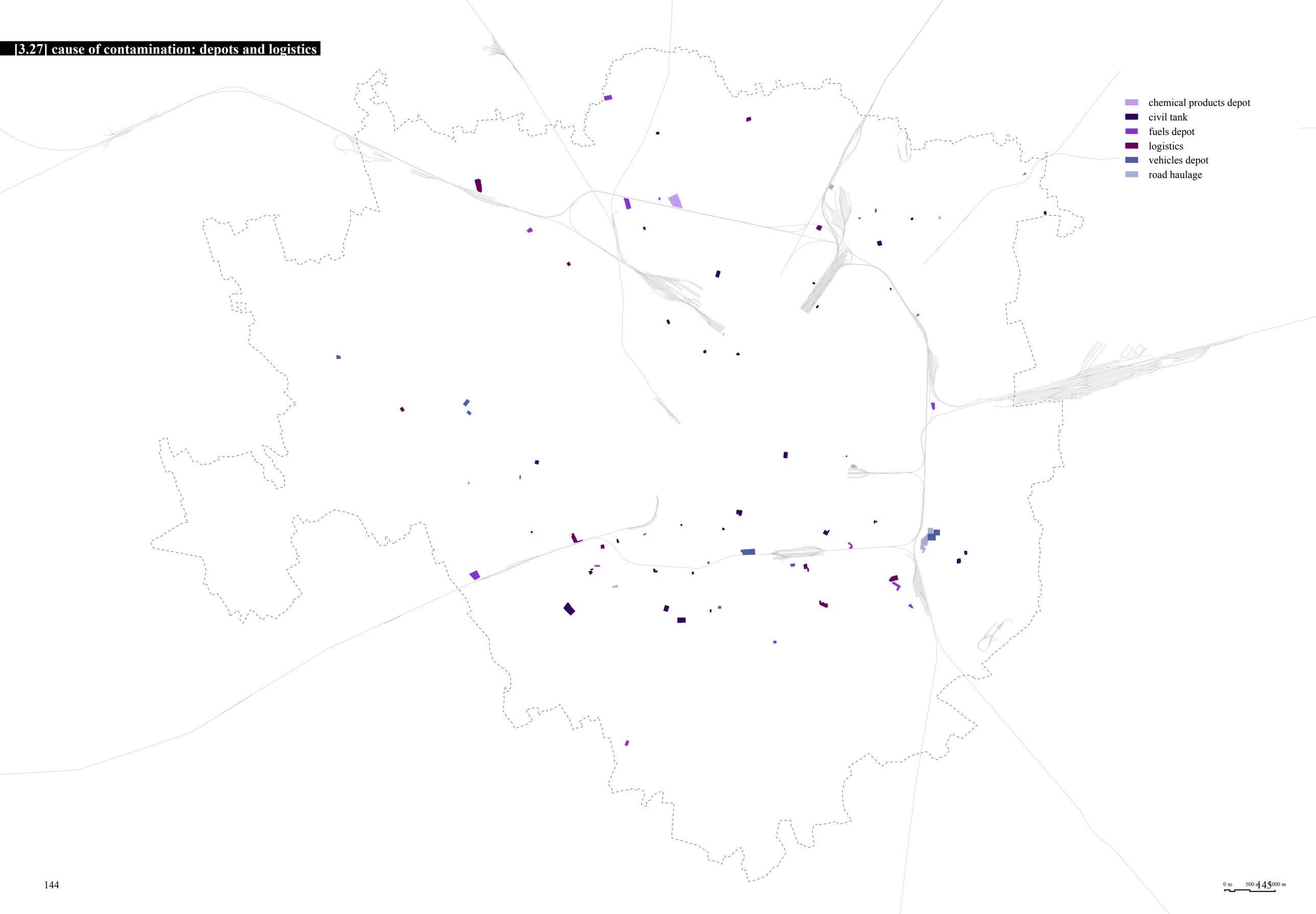
[3.25] cause of contamination: general



[3.26] cause of contamination: industry



[3.27] cause of contamination: depots and logistics



[3.28] 3’.56’’ - deserto rosso, michelangelo antonioni, 1964

[3.29] a rail yard: porta vittoria

3.4 a rail yard: porta vittoria

soil contaminants

		mg/kg	A (mg/kg)	B (mg/kg)		
metals	Cd	2,5	2	15	overcoming A:	1,3 times bigger
	Pb	144	100	1000	overcoming A:	1,4 times bigger
	Zn	201	150	1500	overcoming A:	1,3 times bigger
hydrocarbons	heavy hydrocarbons C>12	64	50	750	overcoming A:	1,3 times bigger

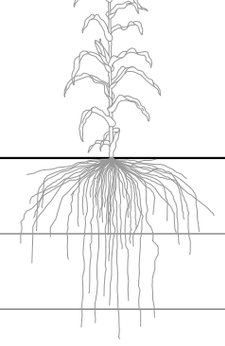
A = threshold limit values for residential and green land use

B = threshold limit values for commercial and industrial land use

Notice that the threshold limit value do not apply to land dedicated to agriculture or breeding, in these cases the valuation need to be performed site by site.

Data source: Servizio Piani di Bonifica del Comune di Milano. Threshold limit value: d. lgs 3 aprile 2006, n. 152 norme in materia ambientale. (Suppl. Ordinario n. 96)

[3.30] porta vittoria: contaminants depth



1.00

Pb Cd Zn

2.00

3.00

4.00

hydrocarbons C>12

5.00

6.00

7.00

8.00

9.00

10.00

11.00

12.00

13.00

14.00

15.00

16.00

17.00

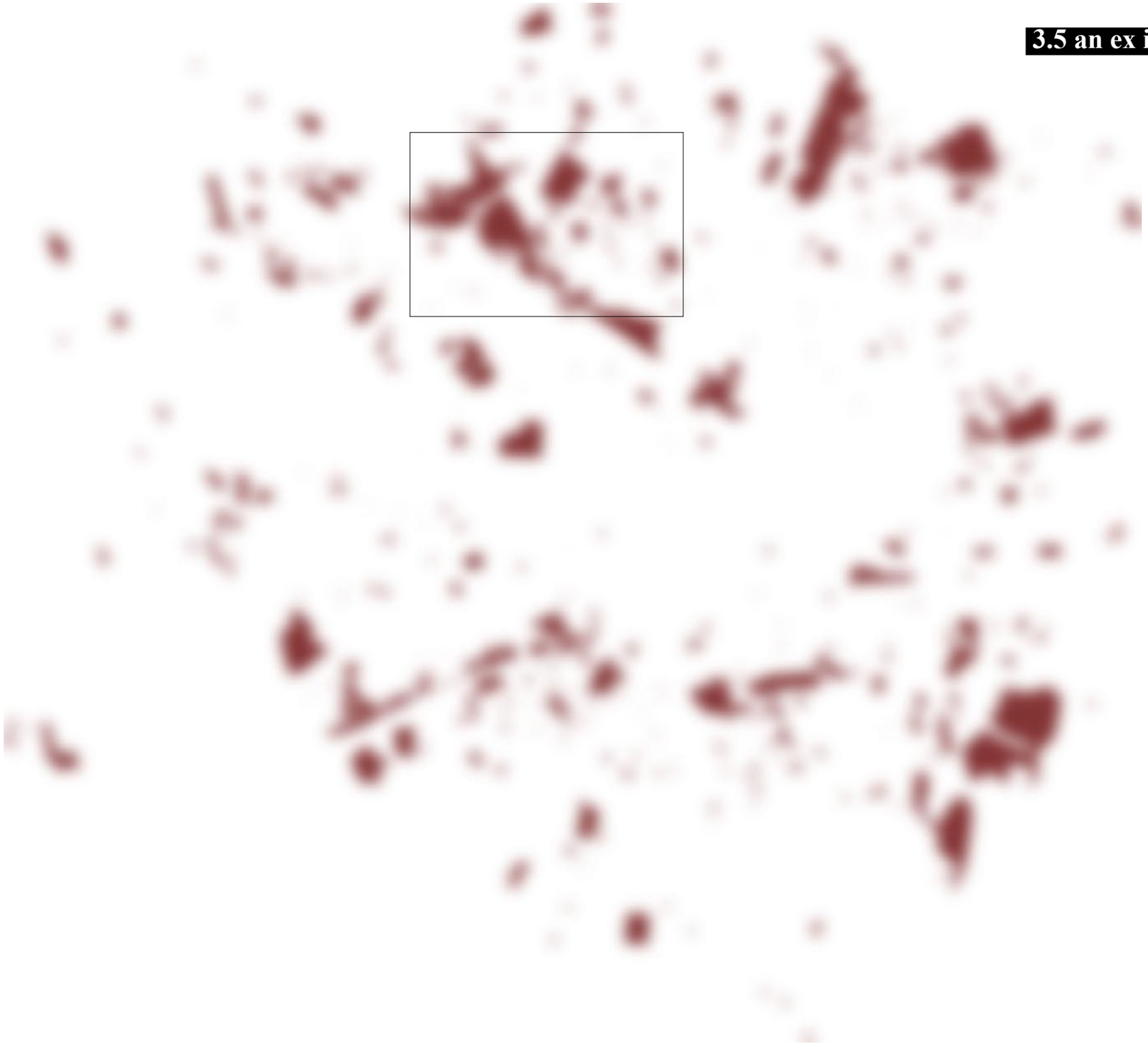
18.00

19.00

20.00

21.00

3.5 an ex industrial area: bovisa



soil contaminants

		mg/kg	A (mg/kg)	B (mg/kg)				
metals	As	21	20	50	overcoming A:	1,1 times bigger		
	Cu	3021	120	600	overcoming A:	25,2 times bigger	overcoming B:	5 times bigger
	Pb	7525	100	1000	overcoming A:	75,3 times bigger	overcoming B:	7,5 times bigger
	Ni	247	120	500	overcoming A:	2,1 times bigger		
	Zn	7334	150	1500	overcoming A:	48,9 times bigger	overcoming B:	4,9 times bigger
inorganic compounds	free cyanide	1022	1	100	overcoming A:	1022 times bigger	overcoming B:	10,2 times bigger
aromatic compound	**benzene**	370	0,1	2	**overcoming A: 3700 times bigger**		**overcoming B:185 tim**	
	toluene	8420	0,5	50	**overcoming A: 16840 times bigger**		**overcoming B:168,4 ti**	
polycyclic aromatic compound	PAHs	2084	10	100	overcoming A:	208,4 times bigger	overcoming B:	20,8 times bigger
hydrocarbons	heavy hydrocarbons C>12	6000	50	750	overcoming A:	120 times bigger	overcoming B:	8 times bigger
	light hydrocarbons C<12	9700	50	750	overcoming A:	194 times bigger	overcoming B:	12,9 times bigger

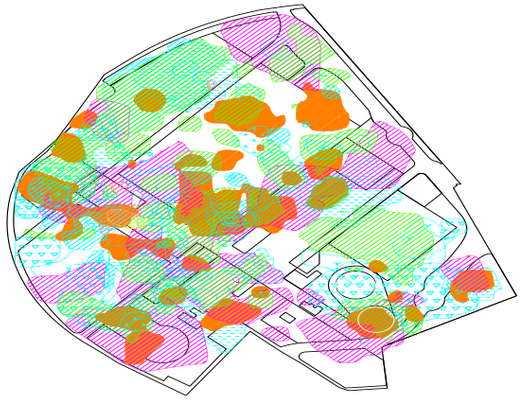
underground water contaminants

		µg/l	C (µg/l)	
aromatic compound	**benzene**	7141	1	**overcoming C:7141 times bigger**
	toluene	23,4	15	overcoming C: 1,6 times bigger
	xylene	143	10	overcoming C: 14,3 times bigger
other	n-hexane	2171	350	overcoming C: 6,2 times bigger

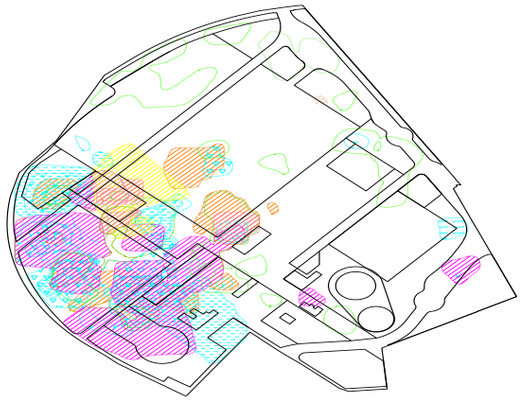
A = threshold limit values for residential and green land use B = threshold limit values for commercial and industrial land use C = water's threshold limit values

Source: Servizio Piani di Bonifica del Comune di Milano.

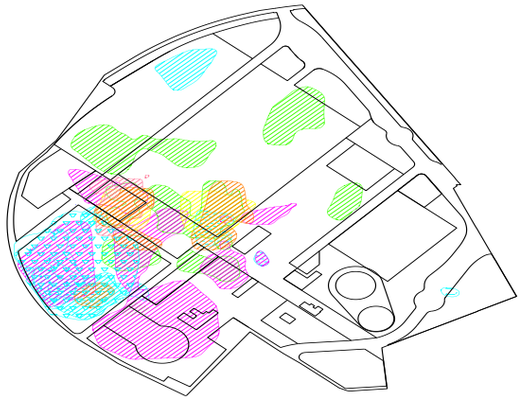
[3.32] overcoming A



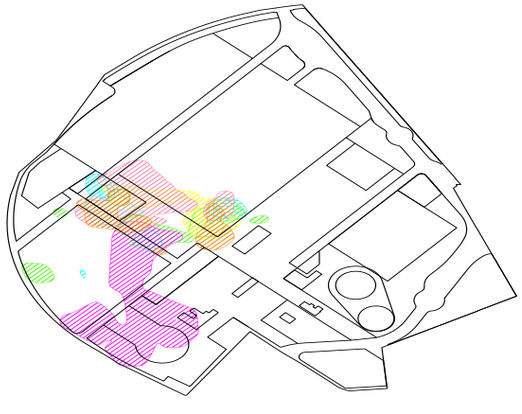
- 3m



-3m / - 7m

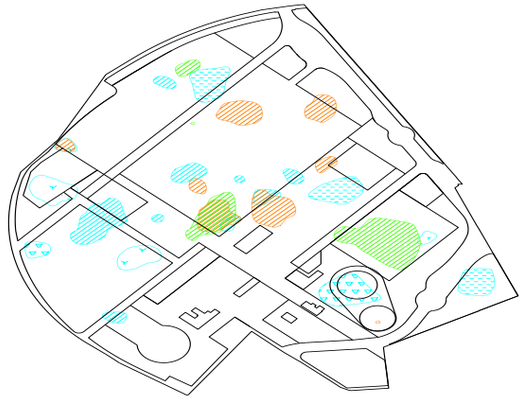


- 7m/ -12m

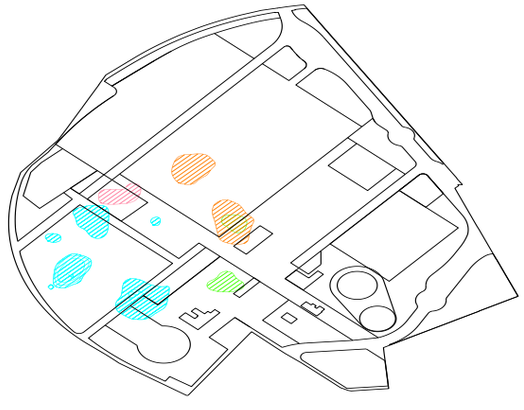


> -12m

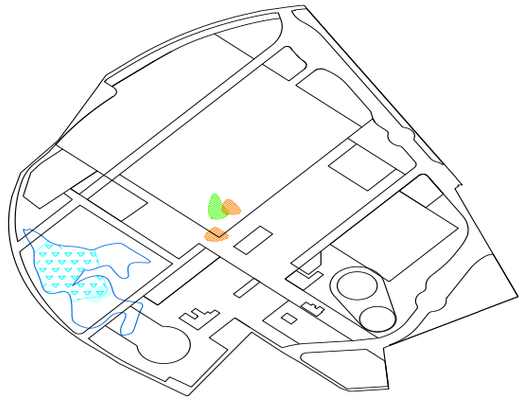
[3.33] overcoming B



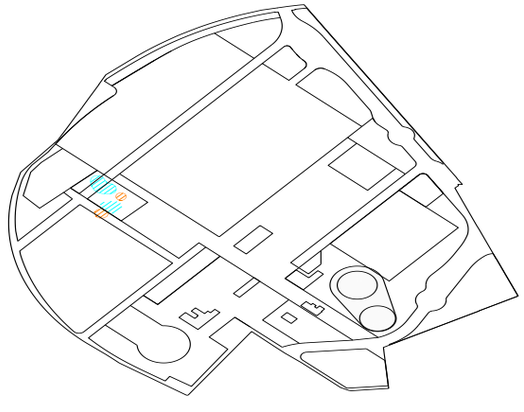
- 3m



-3m / - 7m



- 7m/ -12m



> -12m

PAHs
hydrocarbons C12
hydrocarbons C12
phenols
BTEX
cyanide
As
Cd
Ni
Pb
Cu
Zn

[3.34] bovisa: contaminants depth

1.00

2.00

3.00

4.00

5.00

6.00

7.00

8.00

9.00

10.00

11.00

12.00

13.00

14.00

15.00

16.00

17.00

18.00

19.00

20.00

21.00

Ni

Pb

Cu

free cynide

benzene

toluene

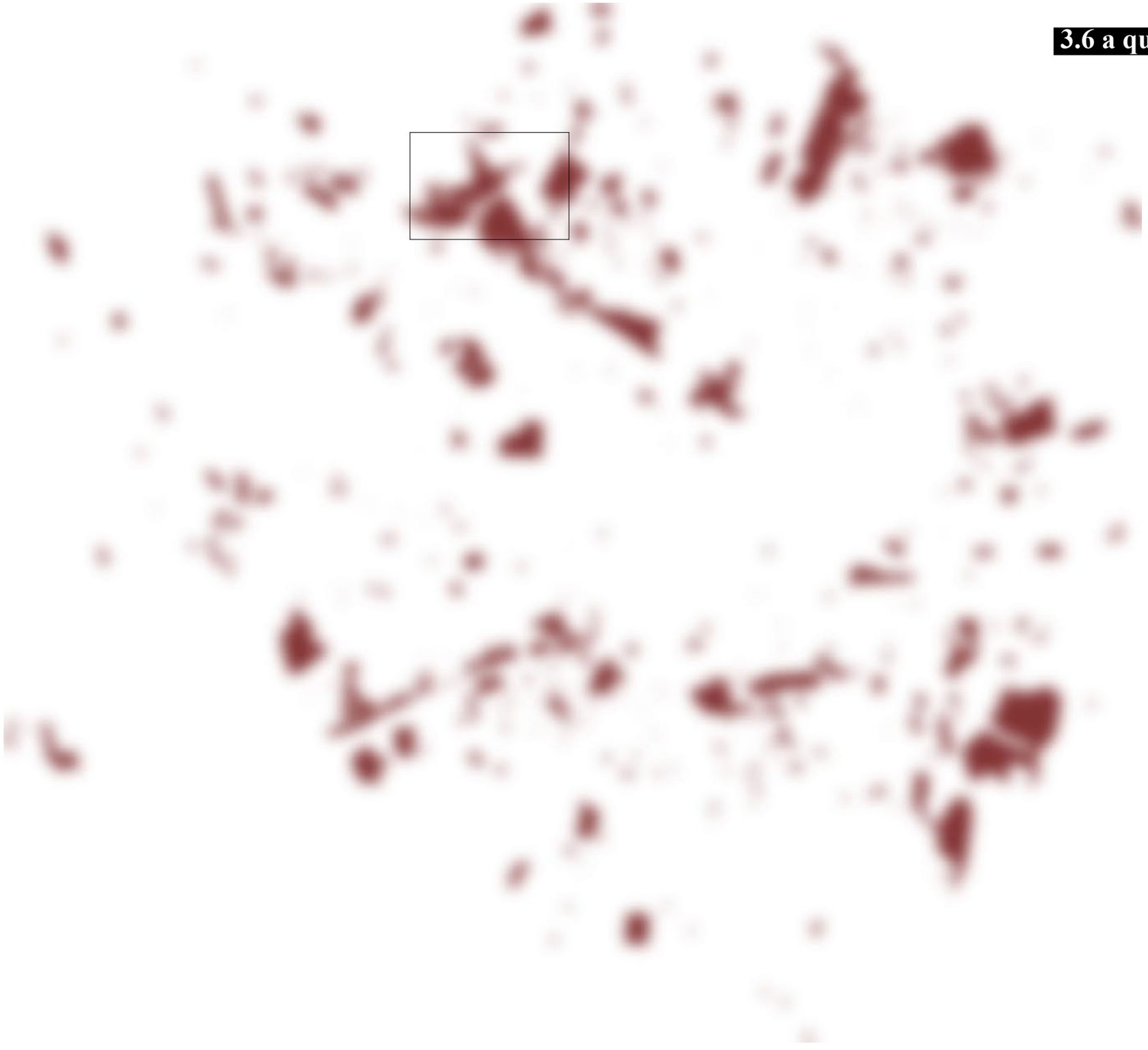
hydrocarbons C<12

hydrocarbons C>12

Zn

PAHs

As



3.6 a quarry: cava chiasserini

soil contaminants

		mg/kg	A (mg/kg)	B (mg/kg)				
metals	Cd	7,9	2	15	overcoming A:	4 times bigger		
	Cu	28750	120	600	**overcoming A: 239,6 times bigger**		**overcoming B: 47,9 times bigger**	
	Ni	1145	120	500	overcoming A:	9,5 times bigger	overcoming B:	2,3 times bigger
	Pb	3158	100	1000	overcoming A:	31,6 times bigger	overcoming B:	3,2 times bigger
	Zn	37020	150	1500	**overcoming A: 246,8**	**times bigger**	**overcoming B: 24,7 times bigger**	
aromatic compound	xylene	6,6	0,5	50	overcoming A:	13,2 times bigger		
polycyclic aromatic compound	benzo(a)pyrene	0,315	0,1	10	overcoming A:	3,2 times bigger		
	benzo(ghi)perilene	0,194	0,1	10	overcoming A:	1,9 times bigger		
	indeno pyrene	0,219	0,1	5	overcoming A:	2,2 times bigger		
dioxine	PCB	12	0,06	5	overcoming A:	200 times bigger	overcoming B:	2,4 times bigger
hydrocarbons	heavy hydrocarbons C>12	3788	50	750	overcoming A:	75,8 times bigger	overcoming B:	5,1times bigger
	light hydrocarbons C<12	240	50	750	overcoming A:	4,8 times bigger		

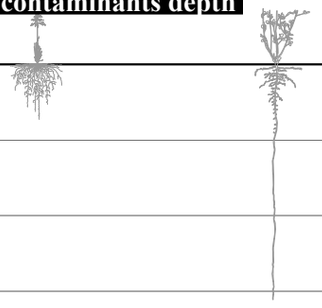
underground water contaminants

		µg/l	C (µg/l)		
metals	As	35	10	overcoming C:	3,5 times bigger
chlorinated aliphatic compound	trichloromethane	7,9	0,15	overcoming C:	52,7 times bigger
	trichloroethylene	3,1	1,5	overcoming C:	2,1 times bigger

A = threshold limit values for residential and green land use B = threshold limit values for commercial and industrial land use C = water's threshold limit values

Source: Servizio Piani di Bonifica del Comune di Milano.

[3.36] cava chiasserini: contaminants depth



1.00

2.00

3.00

4.00

5.00

Cd

6.00

PCB

7.00

Cu benzo(a)pyrene benzo(ghi)perilene indeno pyrene

Ni xylene hydrocarbons C<12

8.00

Zn

9.00

Pb

10.00

hydrocarbons C>12

11.00

12.00

13.00

14.00

15.00

16.00

17.00

18.00

19.00

20.00

21.00

m: perchè quel fumo è giallo?
g: perchè c'è il veleno.
m: ma allora se un uccellino passa di lì in mezzo muore?
g: ormai gli uccellini lo sanno e non ci passano più.

[3.37] 01 .55'.50'' - deserto rosso, michelangelo antonioni, 1964

4. TAKE CARE OF THE EARTH

Regeneration: vision, courage and patience.
N. Kirkwood, 2001, p.82

is it fair to dispose of contaminated soil in landfills?

[4.1]milan, porta vittoria rail yard, december 2009

[4.2] land reclamation methods in the province of milan

Source: Provincia di Milano - Servizio Bonifiche Siti Contaminati (June 2005)

4.1 enhancing non-standard methods

In humid climates 500 years are needed to produce 2,5 cm of soil .
The Tutzing project[1]

In 1972 the European Council document "European soil map" individuated soil as the most precious resource for humanity. Soil is a limited and non-renewable resource since its regeneration through chemical and biological weathering of underlying rock requires a long time.
Several techniques for the reduction of the risks caused by soil contamination are currently available. According to the analysis of EEA in Europe there is a balance in the application of innovative in situ and ex situ techniques. The most-frequently applied techniques, defined as traditional, are the so-called "**dig and dump**" techniques and the containment of the contaminated area. **contaminated soil is** thus frequently **treated as waste to be disposed of rather than a resource** to be reclaimed and reused.

In Milan many cases of land reclamation followed by redevelopment projects require a short time for the clean up. In these cases the reclamation is reduced to dig and dump operations, without a real clean-up of the site, and to physically "moving the problem" to another place.
Anyway different models exist, the reclamation of the ex refinery Agip in Rho (Milan), for instance, has been carried out in situ and represent an important case study both for the size and the complexity of the intervention.
In the Province of Milan the most diffuse reclaiming techniques are ex-situ (57%): dig and dump (74% of the cases), soil vapor extraction (9%) and composting (6%) .

The **rules** currently in force[2] in Italy aim the enhancement of in situ techniques. The criteria to chose the remediation technology in the preliminary project[3] , for instance, are the following: to **encourage** those methods that are able to reduce contaminants on a permanent basis by adopting **in situ treatments**; to encourage those techniques that allow **soil re-use**, reducing the risks related to soil transportation and disposal in landfills; to encourage those methodsthat are able to **reduce decontamination costs** as well as post-reclamation monitoring. It should be noted that reclamation procedures imply dealing with dangerous and non- dangerous urban waste. For this reason the **transfer of soil in landfill must be minimal**.

1 cit. in M. Bregante et al. (2002), p. 25

2 Decree 5 February 1997, n. 22 (known as Ronchi Law) "Implementation of Decision 91/156/EC n wastes, 91/689/EC on dangerous wastes and 94/62/EC on packing and packing waste"; Law 9 December 1998 n. 426 "New measures for the protection of the environment"; Decree of the Ministry of the Environment 25 October 1999, n. 471 "Regulation on the procedures to secure, to decontaminate and to recover polluted sites in accordance with art. 17 of the Decree 5 February 1997"; Decree of the Ministry of the Environment 18 September 2001, n. 468 "National Programme for the decontamination and recovery of polluted sites".

3 Annex of Decree 471/99

4.2 bioremediation: growing bacteria

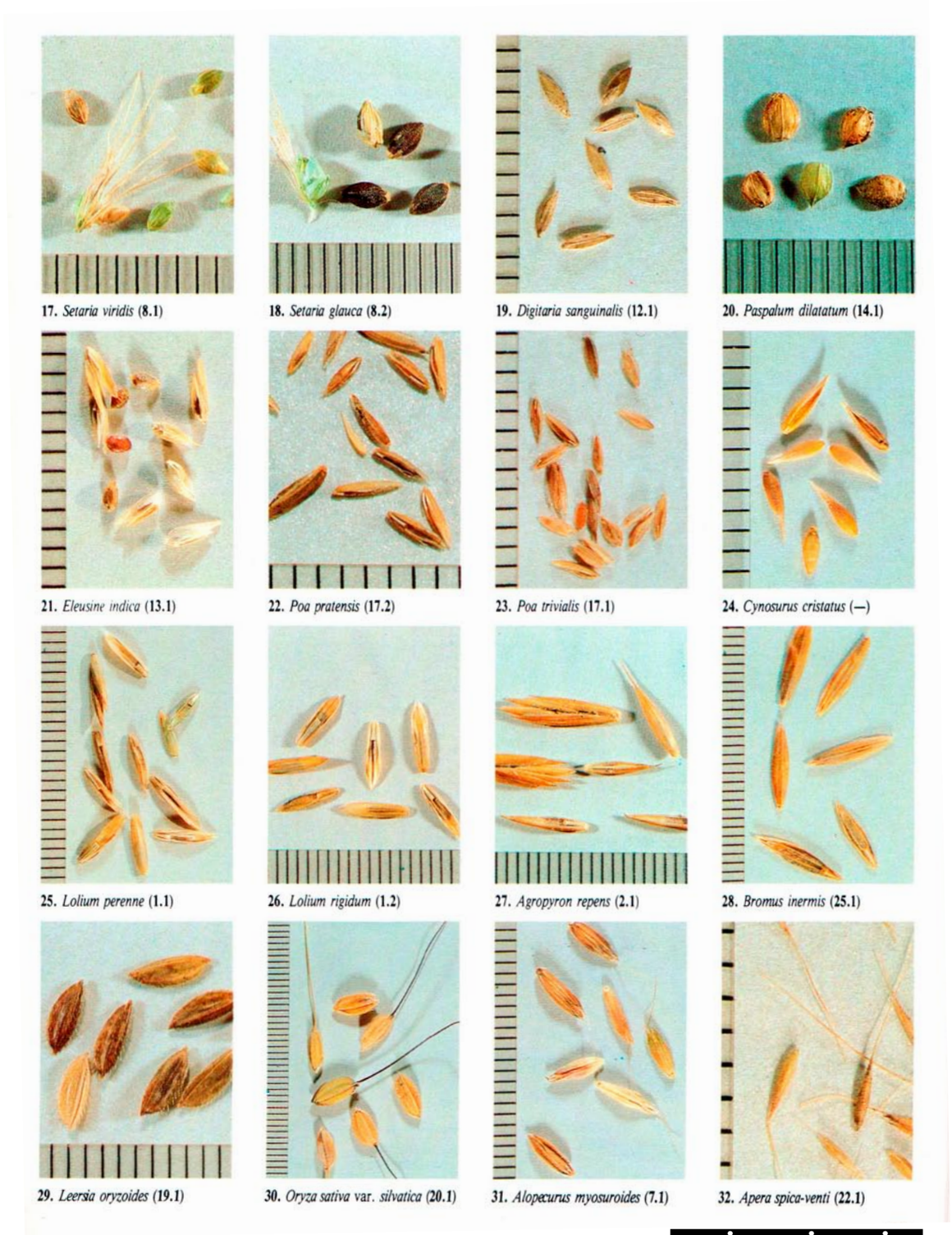
Bioremediation is a biological method of land reclamation **in situ** or **on site** (seldom off site) that exploits the microorganisms' ability to return a natural environment altered by contaminants, generally hydrocarbons, to its original conditions. Common practice consits in **stimulating** the multiplication of the microbic population in the soil (see bioenhancement) or in injecting specific microorganism (see bioaugmentation)

The protagonists of bioremediation are **bacteria: autochthonous populations**, able to attack organic substance and to multiply themselves extremely quickly. The bioremediation of a site is based on a sequence of different phases of transformation of organic contaminants and microbic populations. The principle is based on the acceleration of natural processes of degradation obtained by using common **agricultural practices** such as the **fertilization** and the **oxygenation** of the soil.
The biodegradation consist in the transformation of the hydrocarbons in carbon dioxide and water.
In case of contamination by organic substances the substances themselves are able to select the populations l that may serve to their degradation. The microorganisms use the contaminants as "food": a source of nourishment and energy obtained by the oxidation of the substance in presence of oxygen (aerobic digestion).
The most common practices of bioremediation, to decontaminate soil mostly polluted by hydrocarbons, are: bioventing, biosparging, natural attenuation, **landfarming**,biopile and bioslurry.

The steps of a bioremediation process given an initial propagation are:
1. **growing microorganisms** able to use the contaminants as a source of carbon by oxygenating the soil and/or enhancing the microbic population
2. reduction of contaminants' concentration
3. creation of the conditions where at least one group of **predators** can **came back** (able to multiply itself thanks to the contaminants digesters)
4. new equilibriums and **continued adaptation** allow the growth of a population similar to the one present before the contamination

[4.3] bioremediation working system

[4.4] infesting plants' seeds



seminar zizzania..

4.3 phytoremediation: an agricultural scale of application

Many of the phytoremediation techniques involve applying information that has been known for years in agriculture, silviculture, and horticulture to environmental problems.

U.S. EPA, 2000, p. 3

Phytoremediation is a new technology that uses the plants and the microorganisms present in rhizosphere in order to degrade, remove or mitigate the contaminants present in soil and water. The **term** phytoremediation (phyto = plant and remediation= correct evil) was **coined in 1991**.

Phytoremediation techniques have several advantage that might make it more appealing than other land reclamation techniques[4]: **energy saving** (the process run on solar energy); **simplicity** of the operation; reduction of landfill volumes; minimum intervention of specialized people; easy to perform on extensive contaminated surface; the **public opinion response** is generally good**; costs** are reduced if compared to high tech solution of land reclamation; possibility to apply the technique to a wide range of contaminants; possibility of recycling the product in case of phytoestraction process; landscape improvement.

The **critical** points are linked to: **waste** management and disposal; possible site difficulties (such as unexpected weather conditions); **time** necessary to the remediation (around 10-15 years).

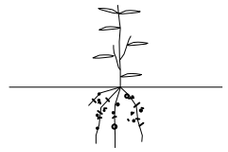
Among the most innovative studies linked to phytoremediation there are 3 project. In USA EPA is studying the application of phytoremediation to soil contaminated by TPH while in Europe the most important project are: Phytorem and Phytodec. The first is the most interesting: it aims to study the process of metals hyperaccumulators plant trying to improve the production of their biomass.

phytoremediation applications can be classified based on the mechanisms involved to deal with the contaminants. Such **mechanisms** include extraction of contaminants from soil or groundwater; concentration of contaminants in plant tissue; volatilization or transpiration of volatile contaminants from plants to the air; immobilization of contaminants in the root zone (**estraction**); degradation of contaminants concentrated in rhzosphere; (**degradation**); hydraulic control of contaminated groundwater (plume control); and control of runoff, erosion, and infiltration by vegetative covers (**containment and immobilization**).

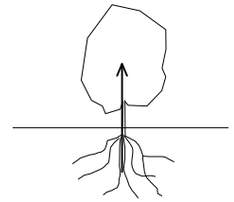
4 Schnoor cit in M. Bregante et al. (2002), p. 45

degradation

[4.5] rhizosphere degradation soil - CONTAMINANT DESTRUCTION - organic compounds

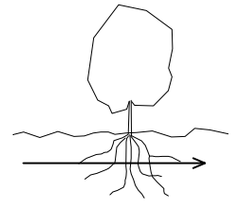


[4.6] phytodegradation water/soil - CONTAMINANT DESTRUCTION - organic compounds (TCE, herbicide, insecticide, explosive TNT) and inorganics (nutients)

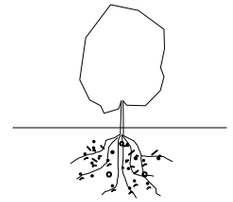


containment and immobilization

[4.7] idraulic control water - CONTAMINANT DEGRADATION OR CONTAINMENT - water soluble organic and inorganic comounds

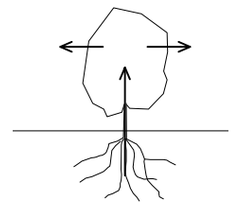


[4.8] phytostabilization soil - CONTAMINANT CONTAINMENT - metals (As, Cd, Cr, Cu, Hs, Pb, Zn)

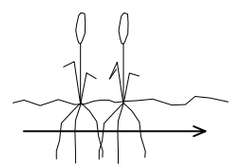


estraction

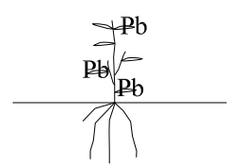
[4.9] phytovolatilization water/soil - CONTAMINANT EXTRACTION FROM MEDIA AND RELEASE TO AIR - organic compounds (TCE, TCA) and metals (Se, Hg, As)



[4.10] rhizofiltration water - CONTAMINANT EXTRACTION AND CAPTURE (is necessary to remove the plant) - metals (Pb, Cd, Cu, Ni, Zn, Cr) and radionuclides (U, Cs, Sr)



[4.11] phytoestraction soil - CONTAMINANT EXTRACTION AND CAPTURE (is necessary to remove the plant) - metals (Ag, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Zn) and radionuclides (Sr, Cs, Pu, U)



degradation

[4.12] rhizosphere degradation soil - CONTAMINANT DESTRUCTION - organic compounds

contaminants:
pesticide, TPH, hydrocarbons, chlorinated solvents (TCE and TCA),
pentachlorophenol(PCP),
benzene, toluene, ethylbenzene and xylenes (BTEX),

[4.13] bromus erectus huds.

trinitrotoluene (TNT)

[4.14]stenotaphrum secundatum

[4.17] secale cereale

crude oil

[4.15] kochia

atrazine, metolachlor, trifluralin (herbicide)

[4.16] medicago sativa

tnitrogen, TCE, TCA

AEROBIC
A microbiologic process or a microorganism that requires / tolerates the presence of oxygen.

AIR SPARGING
The use of compressed air for the ventilation of underground environments. The movement of air bubbles rising towards the surface causes volatile organic components to desorb and volatilize.

ANAEROBIC
A microbiologic process or a microorganism that doesn't require / doesn't tolerate the presence of oxygen.

AUTOCHTHONOUS
Preexisting population or bacterial flora able to survive and reproduce by degrading pollutants.

BALLAST
Crushed stone, as found in nature or obtained by crushing rocks, that is used for railway roadbeds, also known as "ballast". It is required that it doesn't contain asbestos.

BIOARGUMENTATION
A depuration system consisting in the immission of natural microbial strains (or a genetically modified variant) for the treatment of contaminated grounds or refluent waters.

BIOAVAILABILITY
Those chemicals (organic and inorganic) in the soil that are present in forms and amounts that plants or organism can absorb during the time they are growing, it is a time-dependent mechanism for chemical elements to enter the food chain. The best measure

rhizosphere degradation soil - CONTAMINANT DESTRUCTION - organic compounds

polychlorinated biphenyls (PCBs)

[4.18] mentha spicata

[4.19] morus rubra

[4.20] festuca arundinacea

[4.21] agropyron smithii

[4.22] medicago sativa

PAHs

PAHs (benzo[a]pyrene and chrysene)

[4.23] cannabis sativa

of bioavailability is to analyze organisms living in the territory studied and see how much of target chemical ended up in the organism.

BIODIVERSITY

The variety and variability among living organisms and the ecological complexes in which they occur. Diversity is the number of different items and their relative frequencies. For biological diversity the items range from complete ecosystems to the biochemical structures. Thus, the term regards ecosystems, species, and genes.

BIOENHANCEMENT

Biodegradation of soil pollutants by means of natural microorganisms, in aerobic or anaerobic conditions, paired with the employment of natural surfactants.

BIOMASS

Biologic materials that are burned to obtain energy. In this group belong: dedicated energy crops, residues from agriculture or forestry, waste from food processing, refluent waters from animal farming, urban waste, etc.

BIOPILE

A technique of bioremediation consisting in the controlled introduction of air, water and nutritious substances into heaps of dirt that need to be depurated. The method is similar to landfarming, the difference is the way the air is injected in the soil: with the use of perforated pipes.

BIOREMEDIATION

Process that exploit the microorganisms'ability to return the natural environment altered

degradation

phytodegradation water/soil - CONTAMINANT DESTRUCTION - organic compounds (TCE, herbicide, insecticide, explosive TNT) and inorganics (nutients)

contaminants:

atrazine (herbicide)

[4.24] populus

[4.25] salix nigra

[4.26] leguminous

PAHs

[4.27] myriophyllum aquaticum

[4.28] populus

[4.29] datura innoxia

[4.30] lycopersicon peruvianum

trinitrotoluene (TNT)

[4.31] populus deltoids x nigra

trichloroethylene (TCE)

by contaminants (soil and water) to its original condition. It can be applied in situ, on site and, seldom, off site.

BIOSLURRY

A bioremediation techniques that consist in moving the contaminated soil in a reactor where the microorganisms are injected. The process is useful for an accurate reclamation.

BIOSPARGING

A procedure employed in the treatment of saturated soils or subterranean waters, in which the depurative activity of existing microbial flora is accelerated through the direct injection of air and/or oxygen into the soil.

BIOVENTING

A natural in situ biodegradation of any aerobically degradable compounds in soil by providing oxygen to existing soil microorganisms and, eventually, nutrients. Oxygen is commonly supplied through direct air injection in soil. It is particularly useful for soil contaminated by hydrocarbons with petroleum origin

BRASSICACEAE

Brassicaceae, or Cruciferae, are a large family of flowering plants found in all continents. Some species have proved effective as metal hyperaccumulators.

BRASSICA JUNCEA

Indian mustard: the most useful and relatively high biomass hyperaccumulator plant that can accumulate metals and radionuclides.

BTEX

Benzene, toluene, ethylbenzene, and xylenes

containment and immobilization

idraulic control water - CONTAMINANT DEGRADATION OR CONTAINMENT - water soluble organic and inorganic comounds

contaminants:

pesticide, herbicide, nutrients

[4.32] populs

phytostabilization soil - CONTAMINANT CONTAINMENT - metals (As, Cd, Cr, Cu, Hs, Pb, Zn)

contaminants:

metals

[4.33] cyperus

[4.34] populs aegiros (cottonwoods)

[4.35] forage plants

Cd, As

[4.36] populs

CAPPING

The covering of soil with a waterproof system in order to prevent and contain the diffusion of pollutants. Geosynthetic sheaths and geofabric are the most common solutions.

CARBON FOOTPRINT

Measure of the impact of human activities on the environment, with a focus on climate changes due to the greenhouse effect (carbon dioxide) resulting from combustion.

CARBON OFFSET

A compensation of the carbon footprint obtained by reducing carbon dioxide by natural and/or artificial methods.

CHELATING AGENT

Substance that form stable compound with metallic ions. Chelates incorporate metal ions into a soluble form, to make them available to the plant. Treatment with chelating agents (such as EDTA, HEDTA) can enhance metal accumulation in large-biomass crop plants.

COGENERATION

Technology allowing to obtain at the same time, through a single production process, different kinds of energy, such as: thermal energy, electricity, mechanical energy. However, it generally refers to the simultaneous production of electricity and thermal energy for urban heating (it. teleriscaldamento).

CONTAMINANT FATE

Natural phenomena of migration, transformation and separation of the components of soil (interstitial gas, solid particles, water),

estraction

phytovolatilization water/soil - CONTAMINANT EXTRACTION FROM MEDIA AND RELEASE TO AIR - organic compounds (TCE, TCA) and metals (Se, Hg, As)

contaminants:

trichloroethylene(TCE)

[4.37] populs

Hg

[4.38] arabidopsis

[4.39] populs

hydrocarbons

[4.40] populus deltoides xnigra

[4.41] tamarix parviflora

[4.42] medicago sativa

Se

[4.43] brassica juncea

and attenuation of the pollutants released into the soil.

CREOSOTE RAILROAD TIES

Railway ties are timber boards employed by Ferrovie dello Stato: they are laid transversally on the railroad track, and metal rails are bolted on them to ensure stability. Creosote is a derivate of oil employed to waterproof the wood of the ties, to shield them from a quick degradation due to atmospheric agents. Creosote oil may contain up to 30 different polycyclic aromatic hydrocarbons (PAHs). The total concentrations of PAHs may reach 85%.

EEA

European Environment Agency is an agency of the European Union. They provide sound, independent information on the environment. They are a major information source for those involved in developing, adopting, implementing and evaluating environmental policy.

EPA

The Us Environmental Protection Agency (EPA or sometimes US EPA). American federal agency dealing with human health and the environment. It issues specific regulations according to laws approved by the Congress, and enforces them.

EXCLUDERS

Those species where metal concentration in the plant are maintained at a constant level if compared to the metal present in soil.

FITODEPURATION

A method for the removal of pollutants from drain waters, super-

estraction

rhizofiltration water - CONTAMINANT EXTRACTION AND CAPTURE (is necessary to remove the plant) - metals (Pb, Cd, Cu, Ni, Zn, Cr) and radionuclides (U, Cs, Sr)

contaminants:

U, Cs, Sr, Cr, Mn, Cd, Ni, Cu, Pb; Zn

[4.44] heliantus annuus

Se

[4.45] typha latifoglia

[4.46] schoenoplectus robustus

Ni, Cd, Cu, Zn, Pb

[4.47] myriophyllum aquaticum

ficial waters and stratum waters: contaminants are absorbed or precipitated by the root apparatus of plants, and/or absorbed by the roots themselves. Different from phytoextraction, where pollutants are concentrated in the epigeal parts of the plant exclusively.

HECTARE

An area unit (ha) equal to the surface of a square with a side of 100 m (10.000 m2). A hectare corresponds to 15 milanese pertiche approximately.

HYDROCARBON

Organic compounds originating from oil or natural gas in a liquid, gaseous or solid form. They consist of two elements: carbon (C) and hydrogen (H), forming an unlimited number of components that can be divided in homogenous groups: aliphatic, forming a long linear or branching chain, and cyclic, forming closed chains called rings.

HYDROPONIC

Vegetable farming employing a water solution that contains all the nutritious substances usually supplied by natural nutrition. Cultivation is carried out without soil, replaced by inert substrata (expanded clay pellets, vermiculite, coconut fiber, mineral wool, zeolite, etc.) that ensure the anchorage of the root apparatus and protect it.

HYPERACCUMULATORS

Plants able to concentrate metals in the above-ground plant parts from soil levels. Indicators are those species with a concentration of metals that reflect the one in the soil.

estraction

phytoestraction soil - CONTAMINANT EXTRACTION AND CAPTURE (is necessary to remove the plant) - metals (Ag, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Zn) and radionuclides (Sr, Cs, Pu, U)












[4.48] **mainly agronomics species**

IDRAULIC CONTROL

It's a method of phytoremediation that consist in absorbing groundwater in order to control and mitigate the contaminants. In agricultural realities, for instance, the plants present at the edge of cultivated plots are able to absorb the contaminants with agrarian origin.

IN SITU

Depuration of soil or water carried out in loco, not implying the handling or movement of soil and the drainage of water.

INDICATOR PLANT

Those species where plant concentrations of metals reflect those in the soil.

LAND RECLAMATION

A procedure of recovery for contaminated sites.

LANDFARMING

Technology for in situ reclamation of soil. The contaminated soil, one meter thick, is placed on a waterproof layer. The oxygenation of the subsoil and the supply of nutritious substances are carried out though farming operations (milling, ploughing, fertilization).

LANDSAT

A system of satellites monitoring the Earth. The data they provide are examined to study the environment, resources and natural or artificial changes affecting the surface of the planet.

NATURAL ATTENUATION

A natural process of attenuation of pollution, resulting from phenomena of biodegradation and a reduction of the concentration of

[4.49] alyssium wulfenianum

Ni

[4.50] arabidopsis

Cd, Fe, Zn

[4.51] artemisia princeps

Cd, Zn, Cu, Pb

[4.52] arundo donax

Cd, Ni, Hg, Pb, Zn

[4.53] beta maritima

Pb, Cu, Zn

degradable pollutants. It consist of an accurate monitoring activity of spontaneous phenomena.

NITRATE

NO3-, or nitrate, is an inorganic salt resulting from a combination of nitric acid (HNO3) and a base. Nitrates are extremely soluble in water, and therefore they can only be found on the surface in extremely arid territories. The most common nitrates in nature are sodium nitrate and potassium nitrate. Some microorganisms (denitrifying bacteria) are able to decompose nitrates to obtain oxygen.

OFF SITE

Operations of processing and depuration carried out away from the site, implying the handling, movement and storage of materials.

ON SITE

Processing, depuration or storage operations carried out on site.

PAHs

PAH stands for “polycyclic aromatic hydrocarbons”. They are characterized by two or more interconnected aromatic rings. Some are carcinogenic for man, especially when containing benzo(e)pyrene. In Italian: IPA, Idrocarburi Policiclici Aromatici

PCB

Polychlorinated biphenyls (PCBs) are a class of organic compounds. They were used as coolants, adesives and insulating fluids

PCP

Pentachlorophenol is an organochlorine compound. It has been used as a herbicide, insecticide,

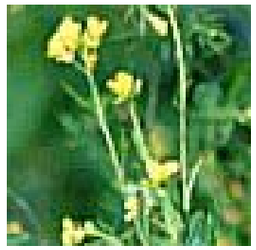
[4.54] brassica,
brassica campestris,
brassica oleracea

Pb

[4.55] brassica carinata

Pb, Cd, Cr

[4.56] brassica hirta



Hg, Pb

[4.57] brassica juncea

Pb, Zn, Cd, Cu, Ni, Cr, Sr, B, Se

[4.58] brassica napus

Ni,, Se, Sr, Cr, B, U

fungicide, algaecide and disinfectant.

Pb

Pb is the 82nd element in the periodic table, it is a shiny, bluish metal. Under natural condition it has a really low geo-chemical mobility in soil staying for as long as thousands of years in the upper soil layers. Today the natural cycle of Pb is affected by environmental contamination, it's more influenced by human activities than by natural processes. Pb in its inorganic form is absorbed through respiration, contact with the contaminated soil and food, it is largely excreted but almost 20% is absorbed and distributed amongs the tissues.

PEDOLOGY

Pedology is a branch of earth science dealing with the topography, genesis, composition and modifications of soil related to natural and/or anthropic factors.

PERTICA

Ancient roman linear unit, equivalent to 2,964 m. Also, area unit currently employed in Milan and province, equal to 654 m2.

PHITOVOLATISATION

The removal of pollutants from the soil as carried out by plants, through the air that is expelled by the natural transpiration of leaves. Useful for volatile organic and inorganic contaminants such as benzene and some chlorinated solvents.

PHYTODEGRADATION

The term refers to the degradation of contaminants taking place inside a plant as a result of metabolic or enzymatic processes. An

[4.59] brassica nigra

Se, Cd, Zn, Pb,Hg

[4.60] brassica rapa

Cd, Cr

[4.61] cannabis sativa

Cd, **Ni, Hg, Pb, Zn**

[4.62] cyperus

Pb, Sr, Cs, Zn,As,

[4.63] Festuca arundinacea

Pb, Zn

effective method for the depuration of waters and soils with organic contaminants or pesticides.

PHYTOEXTRACTION

Extraction of metal contaminants from the soil, by means of agronomic species that are able to accumulate them within their bodies (up to 1% of their dry biomass). The metals are absorbed and transported from the soil to the harvestable tissues of plants. In order to facilitate the accumulation of contaminants and guarantee a more effective absorption of metals, chelating agents are also employed.

PHYTOREMEDIATION

Technology with low environmental impact and sustainable costs. Plants and microorganisms related to the rhizosphere are employed to degrade, remove or contain the contaminants found in the soil.

PHYTOSTABILISATION

A procedure consisting in the stabilization of the soil by inhibiting the dispersion of pollutants into the air or the soil itself by means of plants or shrubs. It is a mechanism that immobilizes contaminants, mainly metals, within the root zone, limiting their migration.

PIEZOMETER

Consists in a shaft, usually of small diameter, allowing to monitor the level of a phreatic stratum by means of a sensor.

PIO’

Agrarian area unit, corresponding to the surface of arable land that two oxen are capable of ploughing in a workday. The

[4.64] helianthus annuus

Cd, Cs, Sr

[4.65] lactuca sativa

Cd

[4.66] linum usitatissimum

Cd, Pb

[4.67] medicago sativa

Cd, Pb

[4.68] miscanthus

Cd, Zn, Cu, Pb

exact value of the piò varies from zone to zone. In the province of Brescia, it's equivalent to a third of a hectare.

PIONEER SPECIES

are species which colonize previously uncolonized land leading to ecological succession. They are the first organisms to start the chain of a livible ecosystem. Since uncolonized land may have poor quality soils with few nutrients, pioneer species (such as robinia) are able to survive thanks to long roots and root nodes containing nitrogen-fixing bacteria. These species will die after some time, making new soil for secondary succession.

PRECISION FARMING

Precision farming is a new method used in modern agriculture: specific data from satellite observations and computer simulations are used to improve the efficiency and effectiveness of agricultural practices. The results are an increase of productivity and the optimization of resources.

PRIMARY SAMPLING UNITS (PSU)

Fractioned surfaces or units subjected to specific standardized sampling.

RHIZODEGRADATION

The degradation of contaminated chemicals due to the bacterial activity in the rhizosphere (the area of influence of the root apparatus of a plant), owing to compounds the plant releases in that zone, creating a favorable environment for the growth of bacteria.

RHIZOSPHERE FILTRATION

[4.69] nicotiana tobacum

Cd, Cu, Zn

[4.70] poa annua
poa pratensis

Cd, Cu, Ni, Pb, Cd, Zn
Mn

[4.71] populus

As, Cd

[4.72] raphanus sativus

Cd, Cu, Pb, Zn, Cr

The mechanism is similar to phytoestraction but is root accumulation and harvest
using hydroponic (soil-less) growing techniques. This is useful for separating metal contaminants from water

SAFETY MEASURES

A system of activities and measures calculated to prevent contamination from spreading to nearby areas and causing additional damage.

SECONDARY SUCCESSION

is the series of community changes that occur on a previously colonized but damaged habitat The process usually start by an event (forest fire, harvesting, hurricane for instance) that alters an already present ecosystem to a smaller population of species. It constitute one of the two kind of ecological succession of plant life (primary and secondary succession).

SOIL WASHING

A system of reclamation for contaminated soils consisting in the removal of the same, followed by their washing in a water solution, where pollutants are separated and put in suspension, or concentrated and precipitated by gravity. Water employed in the process is subsequently treated.

SPRINKLER IRRIGATION

Sprinkling irrigation through solid-set or moving irrigators (rotors, traveling sprinklers, central pivot sprinklers).

SRF

Short Rotation Forestry: fast growing energy crop, characterized by a high plantation density

[4.73] sorghum

Cd, Zn

[4.74] thalaspi caerulescens

Ni, Zn

[4.75] thlaspi rotundifolium

Pb,Ni, Zn

[4.76] zea mays

Cd, Cu, Ni

and frequent cutting.

SUPERFUND ACT

It is the common name for the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, a United States federal law designed to clean up derelict land. It was the first normative regarding the protection of soil.

TCE

trichloroethylene is a chlorinated hydrocarbon commonly used as an industrial solvent. It is a clear non-flammable liquid.

TOTAL PETROLEUM HYDRO-CARBON (THP)

A qualitative and quantitative evaluation of pollution from hydrocarbons that is obtained by measuring this value though the extraction of hydrocarbons found in soil or water

TWIN-ROW PLANTING

A planting system for trees of various species in which plants are arranged in two close parallel rows, called twin rows, each pair separated from the next one by wider intervals. Generally employed for poplar groves and in the production of biomass.

URBAN FRINGE

The definition of what counts as “urban fringe landscape” is controversial.
According to some researchers of the Bartlett School of Planning in London, a urban fringe is “a territory between city and countryside with specific features”. The definition is not entirely accurate, because it’s not possible to clearly define a urban fringe.

Pb accumulation in leaf. Image source: M. bregante et al. (2002)

4.4 focusing on phytoestraction: waste treatment

Most of the contaminated sites in Milan are characterized by the presence of heavy metals, and phytoestraction is a technique that can deal with these contaminants.

Some plants are able to tolerate higher concentrations of metals in soil than others

The species used in phytoestraction are: Hyperaccumulators and Agronomic species.

The **hyperaccumulators** species have generally a low biomass and a slow growth, for this reason **agronomic species** can be used: they make up for their scarce capacity in accumulation thanks to their biomass.

Hyperaccumulators are species endemic in mineral soils. In temperate zones, particularly in Europe, most of the metal tolerant plants belog to the Cruciferae or Bressicaceae families (such as Alyssum, Thlaspi). These species have a good capacity of metal accumulation but a low biomass and a slow growth.

Agronomic species are characterized by high biomass production and growth rate. They have a good capacity of metal accumulation but not comparable with the one of hyperaccumulators. The most relevant species are: Helianthus annuus zea Mays, Nicotiana tabacum and brassica juncea.

The best plant to extract metals from soil is Brassica Juncea (or Indian mustard), it is able to take up Pb up to 1% in aerial shoots and 10% in roots. Helianthus annuus and Zea Mays showed good capacity as well. The former is able to reach 6% in roots while the latter 2%. The tree species are able to increase their capacity after treating the soil with chelating agents.

The phases of phytoestraction are:

preliminary phases: characterization of the site, selection of plant and chelating agents, organization of the site, sowing, monitoring plants; testing: soil treatment, system monitoring, harvest; post testing: site safety operation, waste management, system monitoring

Particular attention should be dedicated to the wastes. The process of phytoestraction involves: **extraction, harvest and disposal.** According to the Ronchi Decree the wastes are classified in urban/special and hazardous/non hazardous.

In phytoestraction vegetable wastes coming from small plots (not treated with chelates) are considered urban wastes while materials coming from large scale applications (treated with chelates) are considered special wastes.

The wastes are considered hazardous if they are generated by the decontamination of soil containing highly toxic substances (Pb included).

The Ronchi Law states that phytoestraction-produced wastes “can be stored temporarily at the production facility”[5] .

hazardous wastes: can be placed for one year in storage equal or less than 10 m³ or two month in a storage bigger than 10 m³;

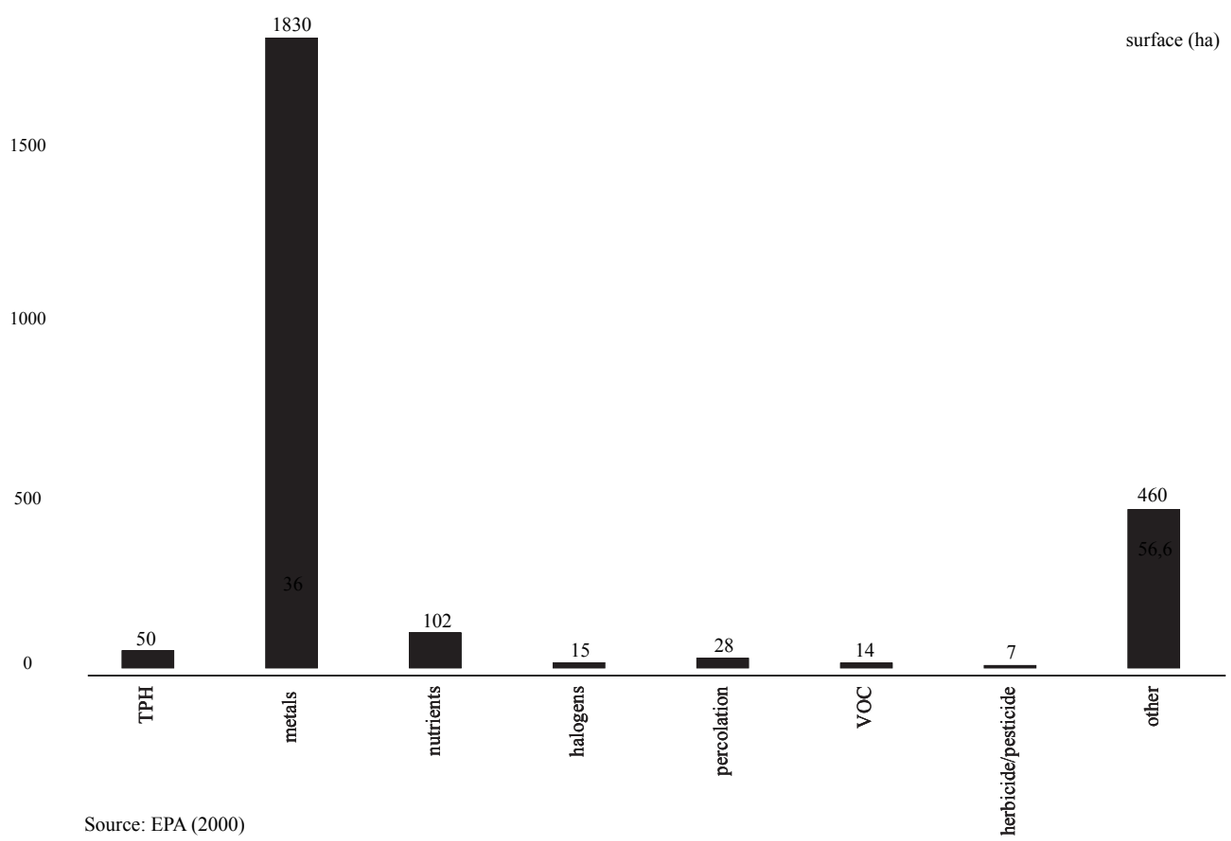
non hazardous wastes: can be placed for one year in storage equal or less than 20 m³ or three month in a storage bigger than 20 m³.

The waste treatment process involves: **incineration, recycling or landfill disposal**. One option for vegetable wastes is incineration (with the possibility to recover the metals contained in plants). The ashes produced in this way are considered

5 M. Bregante et al. (2002), p. 110

The graph show that more than 73% of the total phytoremediation projects carried out in the U.S. was contaminated by metals. This means that phytoremediation (in particular the mechanism of phytoestraction) is one of the few alternatives for the remediation in situ of land contaminated by metals.

2000



Source: EPA (2000)

wastes as well. No dispersion of metals in the air occurrs during incineration

Another possibility are solidification/stabilization (S/S) techniques. Solidification means transforming waste into solid while stabilization means blocking the release of toxic components (Portland cement is one of the most used stabilizing agent).

In Italy it's uncommon to recycle neutralized waste even if it's demonstrated that this technology can be applied in road-paving, rail ballast construction and brick making.

Regarding other kinds of pollution, organic compounds for instance, it's plausible to find some specific clones of poplar tree or a specific combination between plant/contaminant (cannabis sativa) that permit the degradation or the volatilization of the contaminants, without almost any absorption of the contaminants.

According to researchers of CNR with whom I discussed, it seems possible to think about a use of the plants biomass after the phytoremediation: poplar's wood as biomass and cannabis sativa as an insulating material.

The incidental presence of little amount of contaminants wouldn't be a problem during the incineration process of biomass (no dispersion will occur).

4.5 costs, time, people involved

Phytoremediation is an emerging technology, for this reason standard cost information are not readily available. The possibility to develop cost comparisons and to estimate project costs should be determined on site specific basis.

	Phytoremediation	Conventional treatment	Project saving
1 acre Pb	Extraction, harvest and disposal 150 000 $ – 250 000 $	Excavate and landfills 500 000 $	**50-65%**
1 acre THP	In situ degradation 50 000 $ – 100 000 $	Excavate and landfills 500 000 $	**80%**

1 acre ≈ 4000 mq 1 dollar (2000) ≈ 1 euro

	Phytoremediation	Conventional treatment	Project saving
100 smq metals	Extraction, harvest and disposal 12 000 €	Excavate and landfills 10 000 €	**- 10 %**

[4.78] Cost comparison examples: 1 acre and 100sqm.
Data source. 1 acre costs: U.S. EPA (2000) p. 9.100 sqm costs: M. Bregante et al. (2002), p. 153

In order to show the potential of this method the costs about a medium plot, a little site and cost for cubes meter has been reported. The data have been mainly found in a EPA document developed in 2000, that is one of the most relevant document for this technology.

According to the analysis of EPA (2000) phytoremediation is a useful method for extensive surfaces: in a plot of 1 acre (4000 mq ≈ 1/2 hectare) it permits to save around 50-80% compared to the costs of conventional treatment (excavation and landfills) for contamination by metals and THP in a “medium” plot size. Most of the current technology of land reclamation implies, in fact, high application costs and the excavation of the contaminated soil. Phytoremediation appears to be an interesting technique because is an in situ, plant-based clean up method. . Among the different Phytoremediation methods “phytoestraction appears to be the most advantageous” [6]

The data elaborated by PhyLes project in 2002 for a small plot hypothesize a total cost for the remediation of a 100sqm plot based on phytoestraction of around 12000 € on a period of 10 years . This costs doesn’t take into account labour costs since it assumed that the remediation could be carried out by the landowner or by a public organization. The cost for the removal and landfilling of 25 tons of soil (100 sqm excavated to a depth of 20 cm) is 5000 €. This cost become at least 10000 € if one takes into account the cost of the soil necessary to replacethe removed material.
Phytoestraction doesn’t seem convenient for little plots especially because the method is quite new and several investigations about

6 M. Bregante et al. (2002), p. 14

($/m³)	Little plot		Big plot	
	Easy	Difficult	Easy	difficult
Bioventing	900	970	80	110
Phytoremediation	620	2300	**150**	**500 $/m³**
Biopile			130	260
Landfarming			<100	
Soil vapor extraction (Sve)	1300	1500	400	1000
Inertizzazione	50	80	200	350
Soil washing	190		70	
Desorbim termico	80	250	50	110
Excavate and landfills	500	800		

[4.79] Land reclamation cost ($/m³)
Data retrieved from: http://www.clu-in.org/remediation/ (2000)

plant/contaminants need to be carried out before remediation can start. No large scale decontaminations using this strategy have taken place as of today, but this could reduce the costs, another margin for cost reduction is related to the volume of vegetable wastes.
It should be noted that phytoremediation restores the original conditions of the soil while landfilling shouldn't be considered a remediation action proper

Regarding the cost for cube meter a graph elaborated by EPA has been considered. As concerns this parameter, it's interesting to notice that phytoremediation appears as a sustainable techniques for big plots, in all the cases for which it doesn't make sense to remove the contaminated soils. Other biological remediation techniques appear interesting for their low costs: landfarming, for example, is useful for soil contaminated by organic compound up to a depth of 1 meter. Bioremediation techniques can integrate phytoremediation process, the inoculation of microorganisms, for instance, can collaborate with plant roots in order to degrade the contaminants.
Phytoremediation therefore seems to be appealing if applied to a large scale plot. Once standardized the technique could be competitive as an alternative to traditional methods of land reclamation.

time

Thanks to a pilot system of phytoestraction carried out in Liguria (PhyLeS Project), considering a contamination range of Pb, for instance, between 100ppm-1200ppm it was possible to hypothesize a remediation time of around 17 years. The researchers of PhyLes states that if the technique will be improved

it will be reasonable to reach the remediation of soil polluted by **metals in 5-10 years**. In case of contaminations by **organic compound** it is reasonable to think about a term of **4-6 years** with the use of high density planting system, such as 8-10000 poplar for hectare.

About the theme of time/phytoremediation another issue should be taken into account: the utility of phytoremediation in order to immobilize the contaminants and **avoid** their **transfer to the food chain**. In this perspective it seems better to start an intervention of phytoremediation than to do nothing for years in area faced with uncertainty and disuse.

people

agricultural engineers / agronomists / botanists / ecologists / environmental and civil engineers / food scientists / foresters / hydrogeologists / land reclamation specialists / landscape architects / seed companies / soil scientists / soil microbiologists.

4.6 root depth

Root depth is a primary limitation on phytoremediation applicability. It changes greatly among different types of plants. It can also vary significantly for one species depending on local conditions. The depth of in situ contamination or of excavated soil should not exceed the depth of the root zone. Exceptions to this could be made if it's possible to plough and to move up the contaminated matrix

The root depth ranges representing the maximum depths: legumes roots, such as Medicago sativa, can extend to about 6m7;

7 Roots drawing and information available in L. Kutschera (1960) Wurzeletlas

grasses' fibrous root systems can extend 2,5m to 3m deep; populus tree roots can be as deep as 5m; brassica juncea roots generally are about 0,5m deep; miscanthus untill 5m. The maximum depths are, generally, not reached because of site conditions. The maximum depths considered of tree roots are extended from 1m to 1,8 m with almost 90% of the roots in the top 0,6 m[8].

the effective depth for phytoremediation by nonwoody plant species is about 0,3m or 0,6m while the effective depth of tree roots is less than 3m or 6m . Trees are useful for extraction of

8 U.S. EPA (2000) p. 9

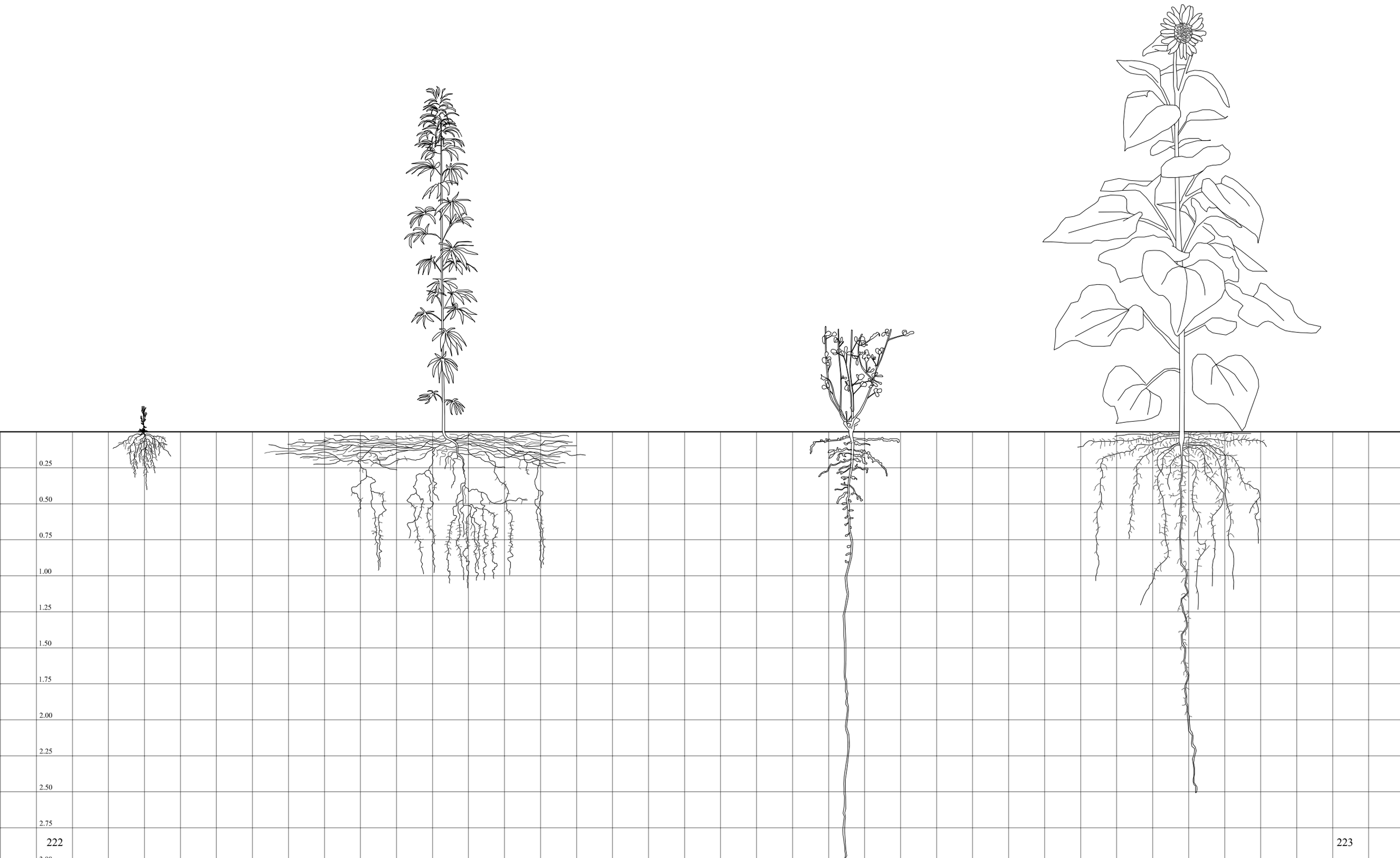
arabidopsis thaliana

cannabis sativa

medicago sativa

helianthus annuus

[4.80] plants' root depth



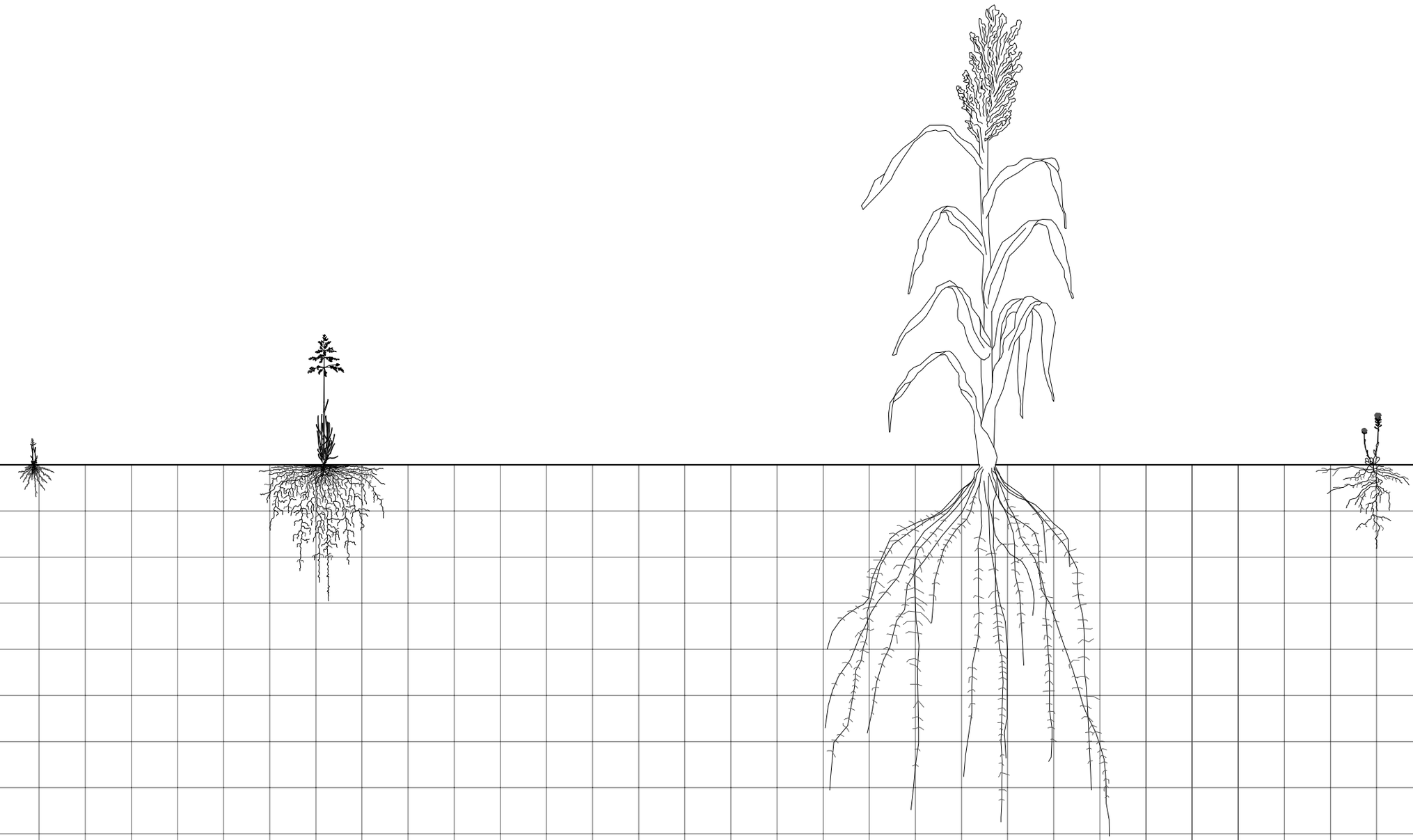
poa annua

poa pratensis

sorghum vulgaris

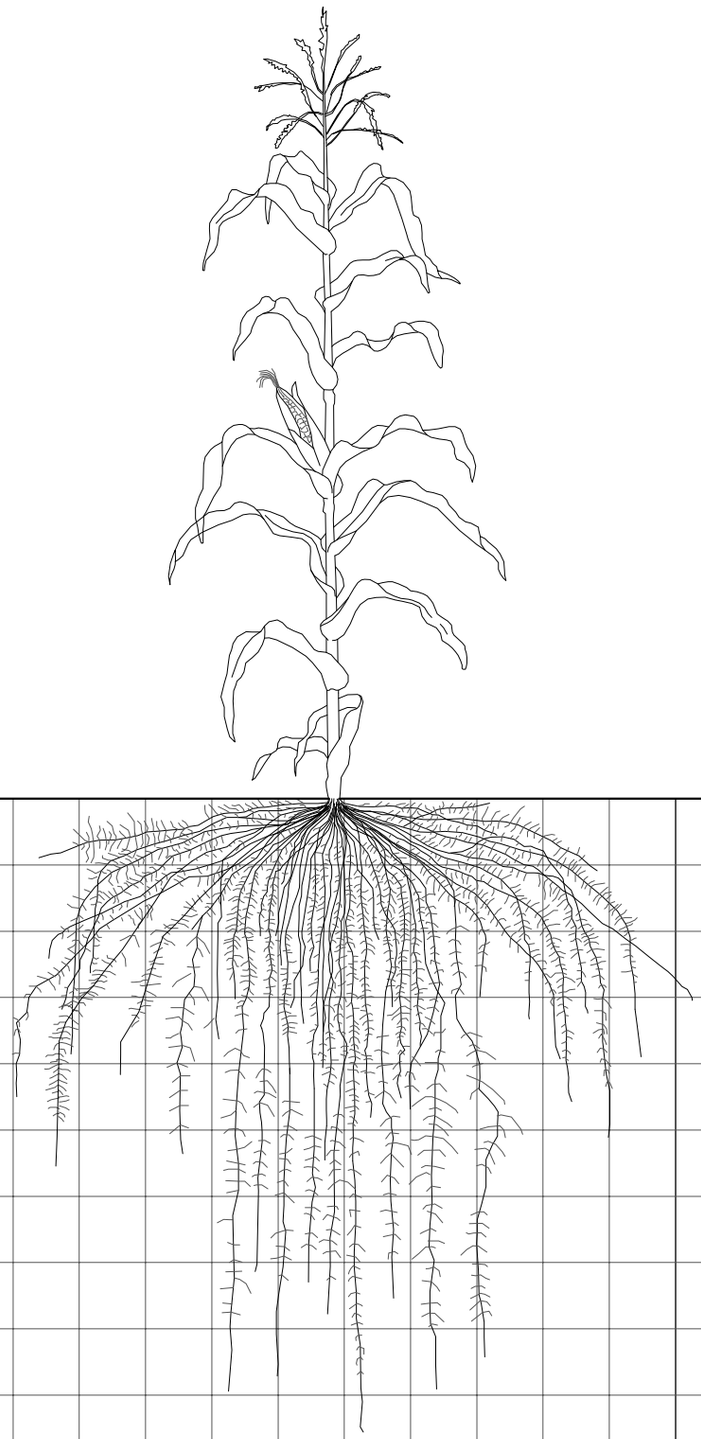
thlaspi caerulescens

[4.81] plants' root depth



zea mays

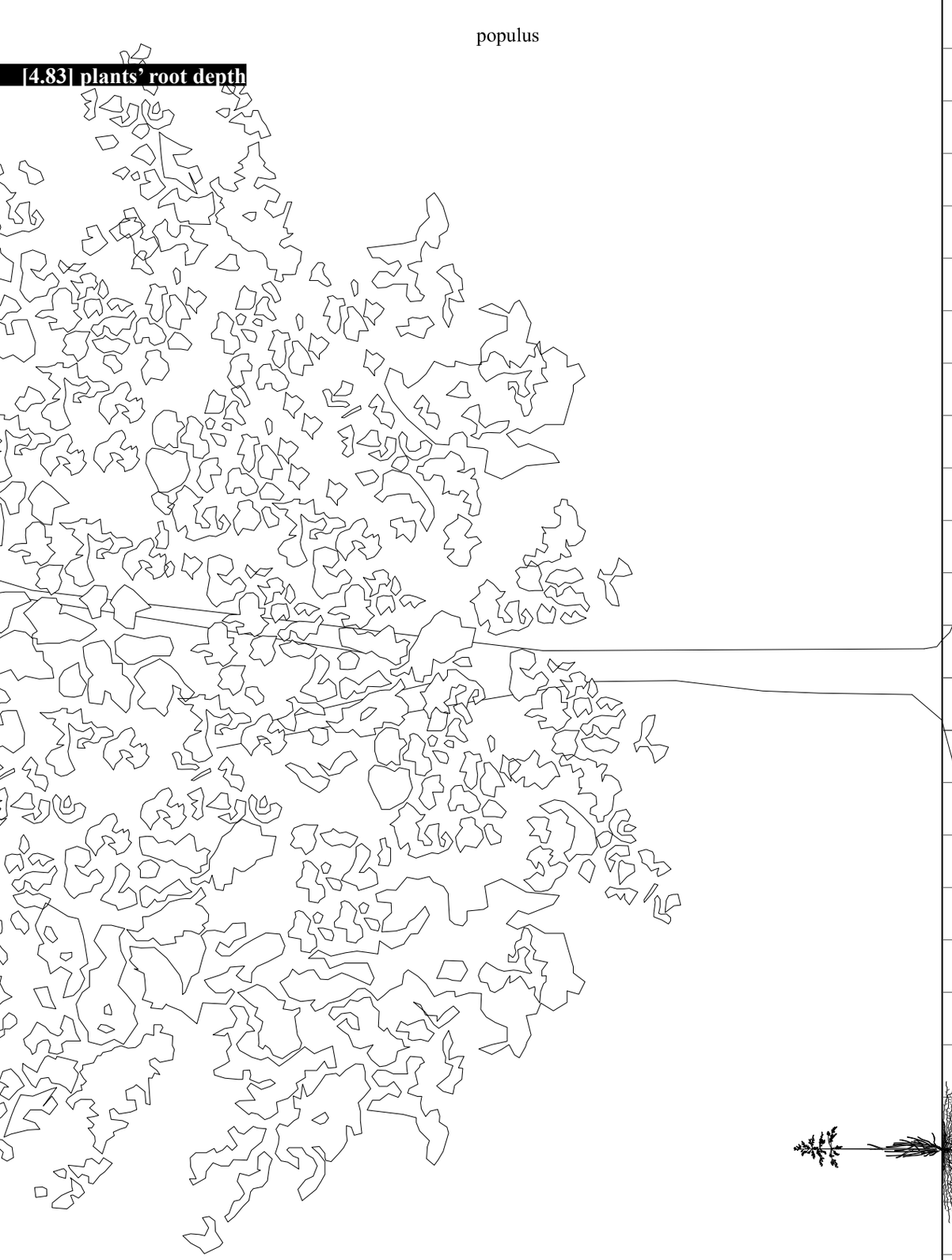
[4.82] plants' root depth

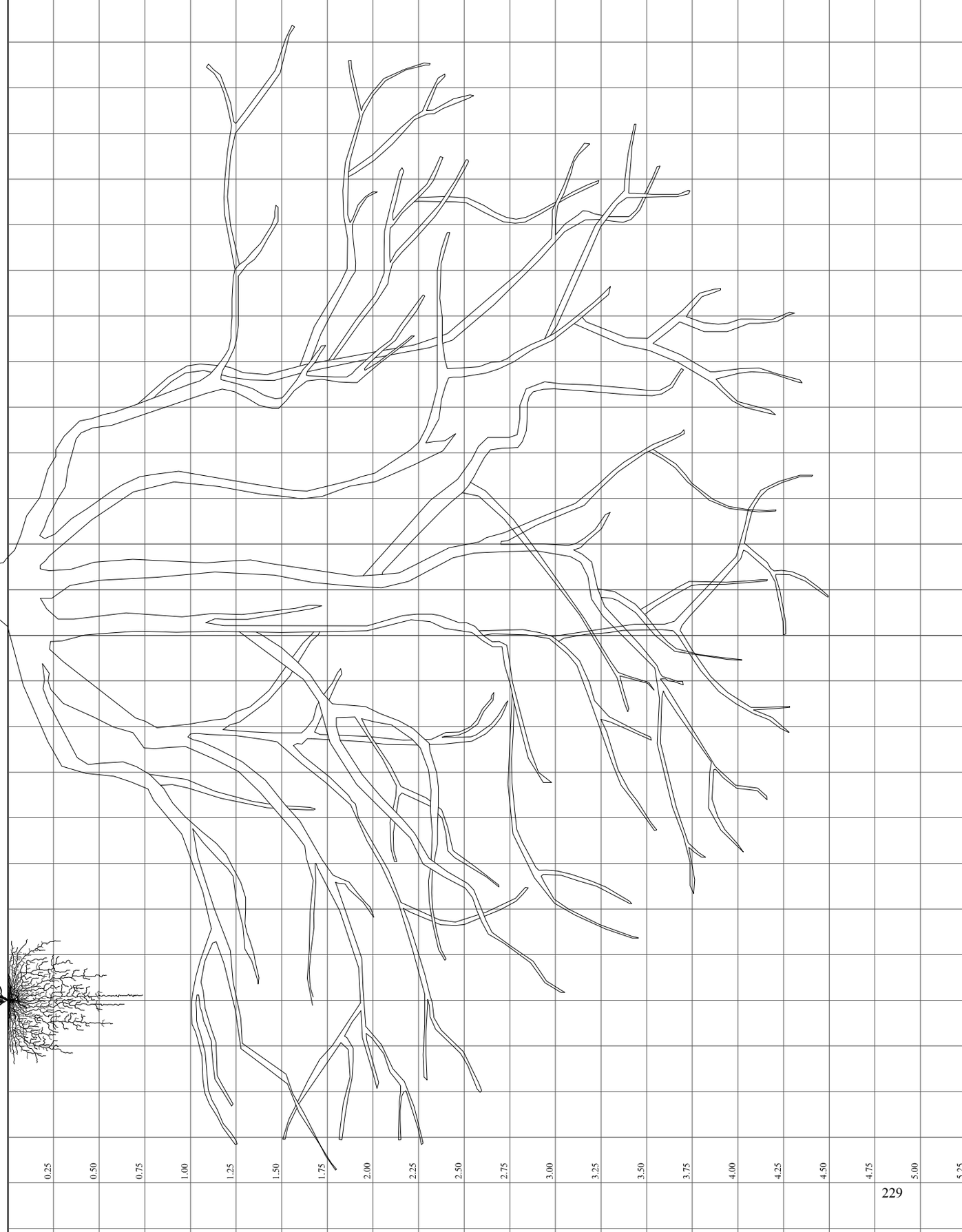


0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00

populus

[4.83] plants' root depth





[5.1] parks map

5. CASES STUDIES

The tasks of dealing with run-down industrial areas and open cast mines requires a new method – one that accepts their physical quality but also their destroyed nature and topography.
Peter Latz cit in N. Kirkwood (2001) p.158


can landscape be a remediating prac-
tice?
Milano
Porta Romana

The study cases analysed concerns the **transformation of post industrial sites/disused areas into parks or reclaim experiment**

Three of the study case are deliberately technical, they illustrate three experiments carried out to decontaminate radionuclide (Chernobyl), TCE (New Gretna) and heavy metals (Acola) with respectively agronomic species, woody plants and herbaceous plants. The study wants to highlight the potential of this strategy for both the reclamation of soil and the creation of habitats. The scale of the project is small because most of the remediation projects are still experimental.

Five of the study case have been chosen as representative of different strategies involving time, choices regarding the urbanize land and reclamation strategies sharing a common final use: green.

Unimetal park and Downsview park are representative of two urban/landscape strategies of redeveloping brownfields the first “equate the site with building lots driven by property ownership” the second “preserve the voids by understanding them as a landscape that operates at different spatial and temporal scale”.

The others are representative of an high attention dedicated to vegetative process, bioremediation practice and spontaneous landscape.

From the analysis it’s possible to highlight several **common features**:

paradoxically the **previous activity have preserved the area from fragmentation and urbanization;**

sites that were previously at the edge of the city have **become embedded in the city and are now strategical** for its development;

the sites work at a really **vast scale**, involving natural and technological processes;

the **strategies are really slow**, from 10 until 30 years for the total implementation;

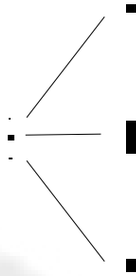
the projects deal with **III landscape** grew in the disused land that conduct to different strategy aiming at the creation of an habitat (destruction/reconstruction or maintenance of the spontaneous landscape, use of native species, phytoremediation);

the projects deal with **uncertainty**, the pressure of real estate and contamination.

The project analysis is not exhaustive.

The strategy to use landscape as a remediating practice is clear especially in the analyse of contemporary architects Peter Latz (Duisburg nord in Emscher park) or J. Corner/Field Operation (High line and Fresh Kills landfill) but also in Hargraves Associates, DIRT studio or analysis carried out by Alan Berger, about the post mining landscape of America.

Other fundamental project that involves agricultural strategy, more generally reflecting on the relationship city/countryside, are Agronica by A. Branzi (Strijp Philips masterplan in Eindhoven) and projects by M. Desvigne (such as the Saône and Rhône rivers in Lyon Carried) where “dispersed and mobile” system of parks allowing a flexible occupation as parcels available for different programmes.



phytoremediation

40 mq

chernobyl, ukraine: Cs and helianthus annuus

1350 mq

new gretna, new jersey: TCE and populus

240 mq

arcola, italy: Pb and brassica juncea

urbanize land/landscape strategy

220 ha

unimetal park: temporary urban agriculture

232 ha

downsview park: trees as catalyst of urbanization

vegetation choices, habitats

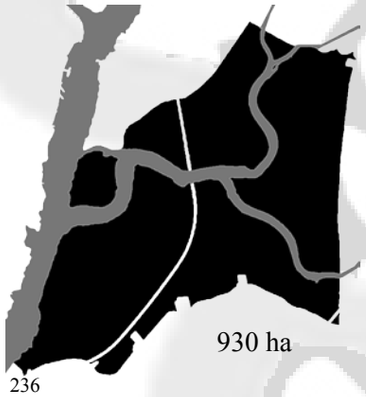
230 ha
(emscher park: 1550 ha)

IBA landscape park duisburg nord: coexistence of park and poison

IBA Emscher park

2,3 km

high line: park and rail yard



930 ha

fresh kills landfill: landscape in process

■■ years

ex - nuclear plant

■■■■■■■■

ex - storage/repackaged of military material

■■■

ex - industrial activity (metals)

■■■■

ex - industrial activity (iron and steel)

■■■■■■■■■■■■■■

ex - military air base

ex - industrial activity (iron, steel and mining)

■■■■■■

ex - industrial transportation (rail truck)

ex - landfill

5.1 chernobyl, ukraine: Cs and helianthus annuus

[5.3] Chernobyl, Exclusion Zone, Ukraine, 1999

An experimental plot was established on the heavily contaminated soil 10 km south of the fourth reactor that was damaged in 1986.

A 40sqm plot (5m x 8m) contaminated by ^{137}Cs was established for the phytoestraction, the soil was tilled to 15cm depth (field observation showed that the majority of the ^{137}Cs remains in the top 5 cm of the soil). A portion of the experimental plot was subdivided into 2m x 2m in order to screen high biomass crop for ^{137}Cs accumulation (helianthus annuus, zea mays, brassica juncea and amaranthus). Among the tested crops **helianthus annuus** showed the best results, it **had the capacity to extract ^{137}Cs** especially in roots, radiocesium concentration was found four time higher in roots than in the shoots.

It has been demonstrated that the greatest potential of phytoremediation for ^{137}Cs contaminated areas occur during the first few years after the radionuclide deposition, when ^{137}Cs remains bioavailable.

There was a general trend for ^{137}Cs in soil to decline, the laboratory and field experiments demonstrated “that plants may be used to remove ^{137}Cs from soil contaminated with radionuclides during the Chernobyl Nuclear Power Plant accident in 1986”[1].

1 S. Dushenkov et al. 1999, p. 474

5.2 new gretna, new jersey: TCE and populus

[5.4] New Gretna, Edward Sears property site, New Jersey 1996-2004t

Edward Sears from the mid 1960s to1992 re-packaged and sold expired paints, adhesive and various military surplus material in his backyard in New Gretna. Toxic material and hazardous wastes were stored for many years and, after his death no one could be found responsible for the remediation of the site. On Scene Coordinators from EPA were called to clean up the site (1/3 acre ≈ 1350mq), the site was judged as a candidate for a phytoremediation pilot-scale system due to the nature of the soil and the ground water. The groundwater site was polluted by **volatile organic compound** (TCE), an hybrid poplar was selected its the remediation: **populus charkowiieensis x incrassata, NE 308**.

Site preparation was initiated in October of 1996, the poplars were spaced at 10 feet x 12.5 feet (3 m x 3,8m) in a planting grid of 113 x 100 feet. (≈ 35 m x 30,5 m). After eight growing seasons the average tree height from 50 cm increase to 43.7 feet (13.3m), the tallest tree was 59.2 feet tall (18 m). The roots continue more than 12 feet (4 m) from the tree base.

The result of the remediation showed: a reduction of Trimethylbenzene1890 µg/l to 19.1 µg/l, a reduction of Xylenes from 545 µg/L to nondetectable, a shrunk in size of all VOC contamination. The total cost for the installation was 25 000 $ and for one year of on site maintenance was 15000 $ (in total 40000 $ equal to 40000 € in 2000)

5.3 arcola, italy: Pb and brassica juncea

[5.5] Arcola, PhyLes Project, Italy 1999-2002

Phyles, Phytoestraction of lead from soil, is a pilot project aiming at an evaluation of the opportunity of in-situ application for the **clean up** of soil contaminated by **heavy metals trough the use of agronomic species**, it was carried out by the institute of Biophysics of the Genoa branch of CNR.

The experiment site has been carried out on a private plot on a flatland known as Arcola Plain, an industrial area in the lower valley of the Magra river (Liguria region). The town suffers from a metal pollution caused by Cermet. This cooperative was set up after the bankrupt of Italpiombo (established around 1970) and the failure of the following society: Metalli e Derivati.

Investigations showed that the main form of **exposure to Pb** in the proximity of Cermet was **through food**. The experiment site was contaminated by Pb, Cd, Cr, Cu, Zn, Ni; the concentration was twice as big as the average of non contaminated soil. The Pb, given its poor mobility, was mainly present at depth of 40 cm. The tested crops have been: Brassica Juncea, Helianthus Annuus and Zea mays. At the end of the experiment the plants have been harvested one by one. The results shows that Indian mustard (Brassica Juncea) was the most suitable for the phytoestraction.

They **estimate a time of 17 years** and a cost of 12000 € for 100 sqm (see “cost”). The research show that Pb has really low availability, phytoestraction seems therefore more interesting for metals with great bioavailability and, thus, posing greater risks to humans. In Italy another pilot test of phytoremediation has been carried out in Porto Marghera (Venice).

5.4 unimetal park: temporary urban agriculture

[5.6] unimetal park: temporary urban agriculture

Unimetal Park, D. Perrault, Caen, France, 1994-1997

the disappearence of the société métallurgique de normandie (SMN) has given the opportunity to work at a geographic scale to reclamate a vast ex industrial site in caen.

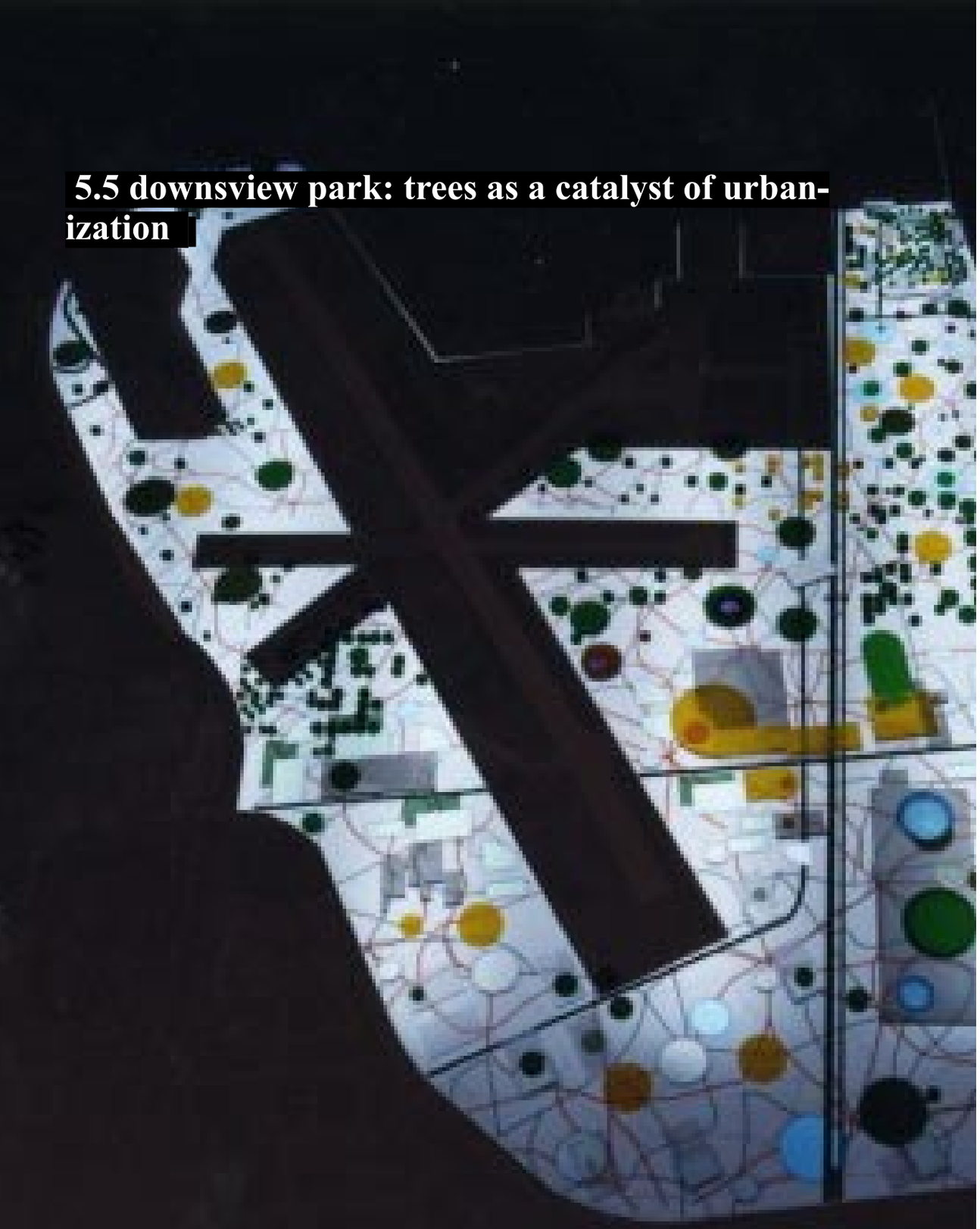
Dominique Perrault was called to remediate the wasteland left over by an iron and steel plant (Unimetal iron), the task was to create a guide plan of redevelopment of the disused industrial areas.The site is located in a 700 ha area situated along the River Orle strategical for the development of the city. Perrault developed the site as a **“pre-landscape”** , an antecedent to the town a texture that established the basis for future infrastructure. On the site was superimposed a grid of 100 x 100 m that gives it a geometrical and a reference scale. Each hectare was planted alternatively with grass and herbaceous trees “forming a tapestry that will become urbanized over time”[2] .A large refrigeration tower, considered as the icon of the site, and other selected structures have been restored: they stand inside a 300 x 900 meter void, the “central park” of the site, with a clear reference to the Olmsted’s one.

The urban void was occupied by temporary fields, that could be transformed in the future into as yet unforeseeable constructions. Here **urban agriculture** is here implemented **as a temporary land use.** The gardens work as a intermediary stage, this means to “**equate the site with building lots** driven by property ownership”.[3]

2 K. Shannon cit. in Waldheim, C. (2006) p.150

3 J. Czerniak cit. in Waldheim, C. (2006) p.107

5.5 downsview park: trees as a catalyst of urbanization



[5.7] Downsview park, OMA, Canada, Ontario, 2000

the canadian forces base downsview closed on april 1, 1996 after almost fifty years of activity.

It was announced that the land was to become a unique urban recreational green space of almost 232 ha, 572 acres (29 ha remained to the department of National Defence). An international design competition was held in 1999 to realize the vision for first national urban park of Canada.

OMA/Bruce Mau/Inside Outside/Oleson Wortland were the winner with Tree City, a phased plan able to gradually change the former base. They propose to use **“trees rather than buildings as catalyst of the urbanization”**, cluster of trees instead new building to provide the site identity. Thus the urban domain will be constituted by landscape elements.

The project seemed to fit the budget. The landscape in fact will be planted gradually, according to the funding, in cluster of trees separated by undesignated areas.

The project will be realized in 3 long term phases (15 years): preparation of site and soil; pathway construction and cluster landscaping.

The result is the presence of circular tree clusters (25% of the area) surrounded by meadows and gardens. They propose that **“capital generated from the park’s appreciated land value be spent to manage the park’s infrastructure and to support future development in an evolving cycle of implementation and speculation”**[4].

The urbanization will be stimulate by tree City growing the park into Toronto. This means that will be the landscape to drive process of city formation, having a catalytic effect on the surroundings, as Central Park for instance.

Tree city aim to “do more by building less” and exploring the low density of metropolitan life.

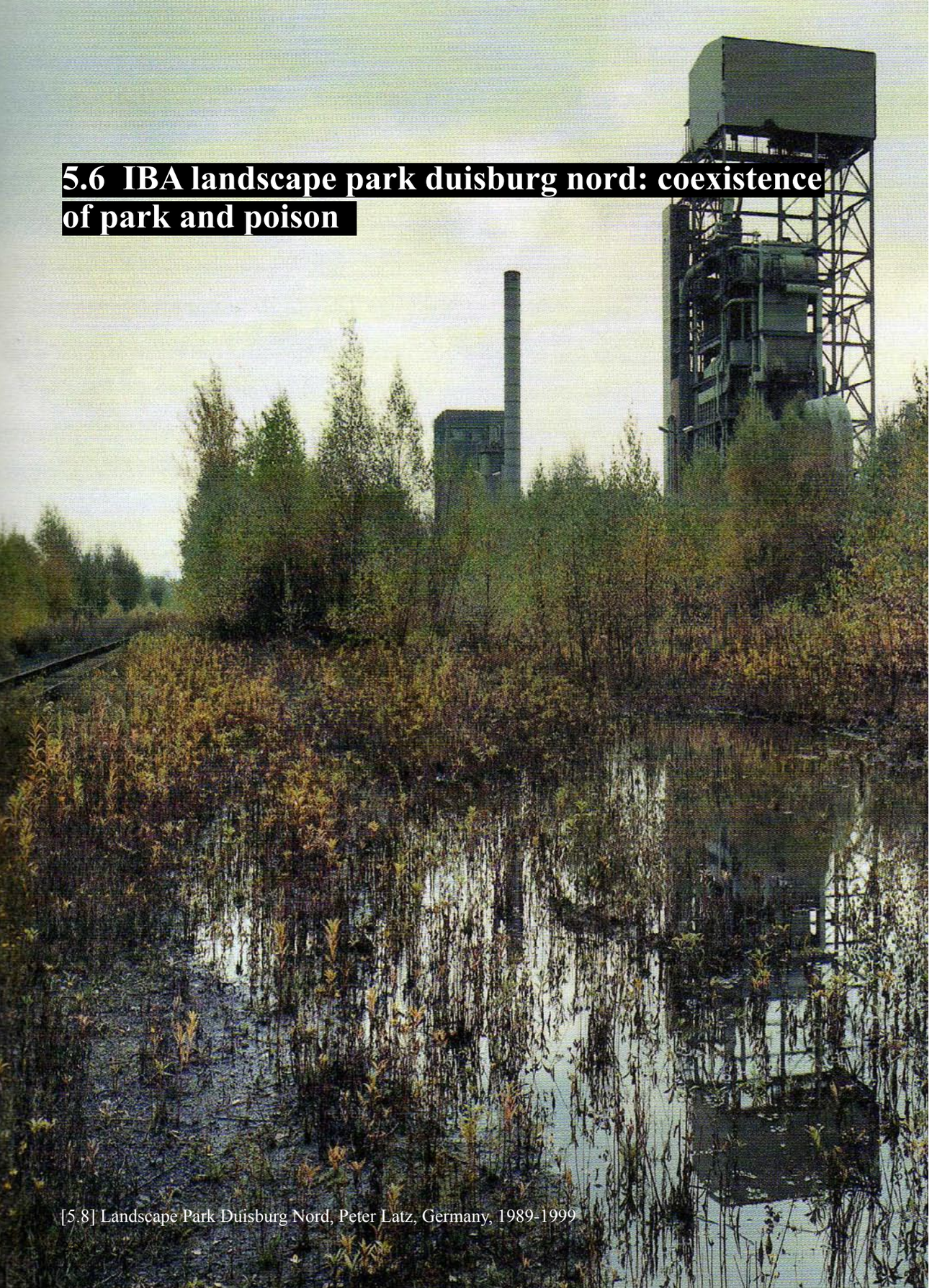
Sacrifice and save: tree city sacrifice the construction of new building to save funds for an infrastructure of landscape elements.

Grow the park: the city “plants the seed for environmental expansion”

Manufactured nature: means to re-create the nature not to restore it.

4 www.oma.nl

5.6 IBA landscape park duisburg nord: coexistence of park and poison



[5.8] Landscape Park Duisburg Nord, Peter Latz, Germany, 1989-1999

with the last runoff from blast furnace 5 in 1985, production at the thyssen blast furnace works in duisburg meiderich came to an end.

This giving the starting point for a new development on a massive scale of this section of the Ruhr Valley. Thyssen steel works from 1899 to 1985 exposing the site to arsenic mud, hydrocarbons and heavy metals, leaving a urban landscape rich of waste ground highways, railway lines and power lines.

In 1989 emerged the vision for a new project of natural and cultural Landscape Park, including industrial feature thanks to a competition held by Internationale Bauausstellung Emscher Park.

The ten-year project "International Building Exhibition (IBA) Emscher Park" gave a strong impulse to the derelict Emscher. The core of the IBA mission was to coordinate the development on a regional basis, **reutilizing land to prevent additional exploitation of greenfields.**

The program, with around 120 projects, was begun in 1989 and completed in 1999, a period of 30 years has been estimated for the full development of the reserves.

The projects mainly concerns: environmental recovery of water-resources (related to Emscher river), recovery the landscape (Emscher landscape park), preservation and re-use of the historical heritage and housing program. The project have seen the contribution of important architectural office such as OMA (Zvollerein masterplan and museum), Sejima(school of management and design) different landartists (Martha Schwartz for instance) and sculptor like Richard Serra.

An intersecting **reintroduction of natural process** has been carried out in "Landscape park Duisburg Nord (landschaftpark): 230 ha included in Emscher Landscape Park. This park was designed on the basis of Peter Latz & partners, the winner of the competition, with the realization of 9 partial projects, including the artefact "piazza metallica" (49 cast iron plates) symbolizing the metamorphosis of the industrial structure. According to Latze on this site "recycling and the dealing with historical contamination were a major task".[5]

The vegetation is a yellow cover of railways areas, lichens and mosses grow on the stone and sometimes on contaminated ashes. The **preservation of this colourful situation was more considered important than decontamination**, that would have covered the place completely.

"The tasks of dealing with run-down industrial areas [..] requires a new method – one that **accepts** their physical quality but also their **destroyed nature** and topography".[6] This **new vision shouldn't be recultivation**, that can destroy the areas for a second time. According to Latz the vision should seek its justification with the existing form of demolition and exhaustion, choosing which spaces to occupy and which should be changed by the mark of the remediation.

One example of this approach in the park is waste material from a coal washing process site, contaminated by PAHs colonized by birches (it. Betulle). Here was chosen the solution to do not decontaminate accepting gas diffusion over several generation, permitting

5 Peter Latz cit in N. Kirkwood (2001) p.150

6 Peter Latz cit in N. Kirkwood (2001) p.158

[5.9] harp of railyard truck

harp of railyard truck

only a limited utilization (cycling or walking). In another part of the park was represent instead the strategy of recycle: the contaminated material was filled in sealed bags of bunkers and covered with roof gardens. Another example was an area highly contaminated by PAHs, too poisonous for men and animals. The demolition rubbish was sealed in a hills, protected by horticultural plants that will cover the contaminants for the next hundred years.

Another interesting approach is the maintenance of the III landscape in this park. What is called "**wilderness in the city**" is a plot that, once the industrial activity stopped, remained undisturbed becoming the most important biotopes in the park, with a wide variety of **bird species and pioneers plants**. In order to preserve this habitat **visitors are not allowed to enter** this part of the park.

The designers thought it "meaningless to attempt to reclaim all the contaminated land [..] to only end up with decontaminated soil but no project".[7] **"The decision to leave contaminated soils on site offered the opportunity to reveal the patterns of the disturbed vegetation**, thus mapping the contamination"[8] and **to show previously unseen natural process**. The park can be considered as a "narrative story telling the past, present and future of the site".

7 AA.VV. Topos. March, n. 26 (2009) p. 14

8 N. Kirkwood (2001) p.162

5.7 high line: park and rail yard

[5.10] High Line, Field Operations/ Diller Scofidio + Renfro, New York, NY, 2004-2009
NY, gansevoort street, september 2009

no train have run on the high line since 1980.

The High Line was built in the 1930s as a part of a vast infrastructure project called "west side improvement". It is a 1,45 mile long (2,3km) of elevated railway realized to remove dangerous trains from the street of Manhattan. It crosses 22 city block in between and through buildings of Manhattan's today most dynamic neighbourhoods that, 50 years, before were dominated by industrial uses.

The "Friends of the High Line", a non-profit group formed in 1999, works with the city of New York to maintain the structure as an elevated public park when the structure was under threat of demolition.

The design team of landscape architects James Corner Field Operations and Diller Scofidio + Renfro were selected to created the High Line's public landscape. The construction on the park began in 2006, the first section opened in June 2009.

nature was used to reclaim a piece of urban infrastructure.

The strategy was to create an "agri-texture" able to combine soil and building material, accommodating "the wild, the cultivated, the intimate and the hyper-social". A new paving and planting systems was invented to permit the transit between highly used areas (100% hard) to biotopes (100% soft) with different gradient in between.

The **plants selected** for in the High Line were **chosen according to the self-seeded landscape** that grew on the rail tracks during the 25 years of disuse. 210 species of perennials, grasses, shrubs and trees on Section 1 nave been chosen among the native species for their hardiness, sustainability, and textural variation.

Before stating with the new landscape, everything on the structure, including steel rails, ballast, soil, and a layer of concrete, have been removed. Each section of railroad track has been marked, mapped for its location, and later, many of them are returned to their original locations.

5.8 fresh kills landfill: landscape in process

[5.11] Fresh kills landfill competition, Staten Island, NY, Field Operations, 2006

in 1997 the mayor of NY rudolph giuliani announced the closure of the fresh kills landfill, the world's largest landfill.

When the landfill opened in 1948, Robert Moses ensured that it would close within three years. The landfill, instead, received garbage from New York for half a century. The Fresh Kills Landfill was closed in March 2001. It reopened on the 13th September to receive Word Trade Center rubble including the remains of thousand of victims.

The huge land(over 3 times Central Park) with an high symbolic meaning, will be now reclaimed, after over 50 years of inaccessibility. The park will be built on top of the landfill like many parts of Manhattan below the 14th st. The park is continuing a tradition: as Robert Moses states, Fresh Kills will be a remediation project like central park was and it will be constructed in stages in a long term process as well .

The key point underlined by the Draft masterplan carried out by Field Operation, is the idea of a lifescape: an ecological process of **enviromental reclamation on a vast scale**, recovering both the health and the **biodiversity** of ecosystems and the "spirit" of the future users.

Only 45% of the area is landfill, the other 55% is wetland. Paradoxically, **the presence of the landfill offers the opportunity to preserve this huge area from urban sprawl and fragmentation.**

Fresh Kills Park will be a wildlife habitat for the region, "reengineered overtime as a self-sustaining ecosystem". The project, guided by the landfill closure operations, will show **"the state of the art environmental reclamation techniques"**[9] . The implementation of the project will involve three phases of 10 years each: a park growing over time for **30 years** (time for garbage decomposition).

The masterplan wants to create on these environment diverse adaptive parks using **large-scale agricultural methods**. The habitat type proposed are: wetlands, grasslands and woodlands.

The main goals for the restoration are to increase soil quality, reduce invasive species, introduce native plants. The idea is to cap and farm to improve the soil (15 cm depth over the cap layer). By 1997 two of the four mounds were covered with an impermeable cap, the other two mounds will be covered by the end of 2014. Gas (methane, co2 and others), the main product of the landfill, is collected trough pipes to be burned or processed for energy use.

Long term-field test demonstrated the benefit **of reintroducing native woody plants to accelerate the reclamation** at Fresh Kills. Fields trials has been carried out by the NYC Department of Sanitation. They installed native plants, local pioneers and mid succession species. Among the experiments the most interesting, even if it was technically not allowed, was a large scale planting 6 acre (2,4 ha) in 1988 of big quantities of trees on top of the landfill cap to see what happened. They create a prairie invaded by woody plants that shows a wildlife recolonizing the area.[10]

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in lombardy 5000 ha of soil disappear every year / in the province of milan the land consumption today is equal to 35% / regional parks contribute to safeguard from urbanization / relevant scenarios / parco agricolo sud milano / what's soil consumption? / natural level / rural level urban level / the city of milan is 18178,75 ha, most of which urbanized. according to the analysis of pgt, today the urbanized land in milan is 78% (14.191 hectares), while non urbanized land is 22% (3987 hectares)/ urban density is 7122 people/sqkm / parco agricolo sud avoids the welding with the nearby urbanized municipalities / urban fringes / infrastructural networks / urban sprawl is a horizontal landscape phenomenon / densify the historical tissue in order to protect greenfields / pgt / perequazione / urban voids / manufact, memory, labour culture, third landscape and informal uses / residual spaces / diversity / abandonment / landscape ecology / pioneer plants / stable plants / equilibrium / indicators / bird species / landscape is a process / information technology no longer needs storage / between 1960 and 1974 around 180 hectares occupied by productive plant have been identified as abandoned/underutilized in the city of milan. in 1984 the sites grow to 320 ha, in 1988 to 440 ha until the last survey carried out in the 1995 that highlight 510 ha / the shutdown of productive areas in the city / was combined with their outplacement /the process of deindustrialization is one of the main producers of waste landscapes / bequeathing their legacy / brownfields / taxonomic approach / the european environment agency estimates the number of contaminated sites at approximately 250000 sites. this number is expected to grow to nearly 3 million sites . "if current investigation trends continue, the number of sites needing remediation will increase by 50% by 2025" / difficulties / heterogeneous criteria / diffuse contamination / close to places of intensive agriculture / local contamination due to industrial activities / according to agenzia per la protezione dell'ambiente e per i servizi tecnici (apat) in italy there are 4400 contaminated sites, 8600 potentially contaminated sites, 1500 disused mines and 54 sites of national interest. the site of national interest represent around the 2,2% of the italian territory and 130000ha of sea water areas / in the centre and north of italy there are 34 sites (269309 ha) while in the south 20 sites (405526ha) / manly caused by industrial activities / huge areas / distributed along the main routes / in lombardy sites are linked to previous industrial activities / the "ufficio bonifiche" of the municipality of milan has located in the city 674 sites subjected to contamination for a total surface of almost 1450ha. excluding the areas already reclaimed the surface is equal to 1054 ha: 320,3 ha of potentially contaminated land, 236,7 ha of land to be reclaimed and 496,5 ha of land where reclamation is in progress / little contaminated plots / due to fuel depots, fuel stations and civil tanks / extensive polluted surface / due to quarry landfills / industry / and rail yards / most of the soil of the city of milan is filling material coming from demolitions due to the second world war / pollution can be found randomly in the city / land reclamation status / cause of contamination / dig and dump / contaminated soil is / treated as waste to be disposed of rather than a resource / rules / encourage / in situ treatments / soil re-use / reduce decontamination costs / transfer of soil in landfill must be minimal / in situ / on site / stimulating / bacteria: autochthonous populations / agricultural practices / fertilization / oxygenation / landfarming / growing microorganisms / predators can came back / continued adaptation / term / coined in 1991 / energy saving / simplicity / public opinion response / costs / critical / waste / time / phytoremediation / mechanisms / estraction / degradation / containment and immobilization / hyperaccumulators / agronomic species / extraction, harvest and disposal / incineration, recycling or landfill disposal / time / metals in 5-10 years / organic compound / 4-6 years / avoid / transfer to the food chain / the effective depth for phytoremediation by nonwoody plant species is about 0,3m or 0,6m while the effective depth of tree roots is less than 3m or 6m / transformation of post industrial sites/disused areas into parks or reclaim experiment / common features / previous activity have preserved the area from fragmentation and urbanization / sites / have become embedded in the city and are now strategical / vast scale / strategies are really slow / III landscape / uncertainty / helianthus annuus / had the capacity to extract 137Cs / volatile organic compound / populus charkowiieensis x incrassata, NE 308 / clean up / heavy metals trough the use of agronomic species / exposure to Pb / through food / estimate a time of 17 years / the disappearence of the société métallurgique de normandie (SMN) has given the opportunity to work at a geographic scale to reclamate a vast ex industrial site in caen / pre-landscape / urban agriculture / as a temporary land use / equate the site with building lots / the canadian forces base downsview closed on april 1, 1996 after almost fifty years of activity / trees rather than buildings as catalyst of the urbanization / capital generated from the park's appreciated land value be spent to manage the park's infrastructure and to support future development in an evolving cycle of implementation and speculation / with the last runoff from blast furnace 5 in 1985, production at the thyssen blast furnace works in duisburg meiderich came to an end / reutilizing land to prevent additional exploitation of greenfields / reintroduction of natural process / preservation of this colourful situation was more considered important than decontamination / accepts / destroyed nature / new vision shouldn't be re-cultivation / wilderness in the city / bird species and pioneers plants / visitors are not allowed to enter / The decision to leave contaminated soils on site offered the opportunity to reveal the patterns of the disturbed vegetation / to show previously unseen natural process / no train have run on the high line since 1980 / nature was used to reclaim a piece of urban infrastructure / plants selected / chosen according to the self-seeded landscape / in 1997 the mayor of NY rudolph giuliani announced the closure of the fresh kills landfill, the world's largest landfill / enviromental reclamation on a vast scale / biodiversity the presence of the landfill offers the opportunity to preserve this huge area from urban sprawl and fragmentation / the state of the art environmental reclamation techniques / 30 years / large-scale agricultural methods / of reintroducing native woody plants to accelerate the reclamation

[5.11] Porta Romana railyard