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Techinal note

THE NATURALISTIC RECOVERY OF A OLD LANDFILL: THE CASE OF VIZZOLO PREDABISSI, MILAN, ITALY

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ABSTRACT
The naturalistic redevelopment of an old landfill appears to be one of the most interesting solutions for returning an area used over time for waste disposal to the environment. This choice, anyway, should already be considered during the design stage in order to avoid extremely artificial capping lining solutions that would not allow the growth of the desired phytocoenosis. On the Vizzolo Predabissi (Milan, Italy) landfill site, after an initial post-management phase, the environmental rehabilitation of the site was set through the elimination of the artificial superstructures and through a design of the forest landscape that allowed an evolution towards a naturalistic oasis with ecosystemic target. This article illustrates the techniques used, the challenges encountered and the management perspectives of the area, unfortunately still undefined by the public administration.

1. INTRODUCTION

Build a landfill, fill it, close it. This is the cycle that designers and administrators know well, and that is now well regulated and organized both from a technical and administrative / regulatory point of view.

However, if we try to investigate the last portion of the life of a landfill, we very often discover a stage that is not well defined, corresponding to the end of the so-called "post-closure" phase. Usually the final "destiny" of that portion of territory often wide and including the related service structures, on which the landfill rests, is left undetermined. In the best case scenario it is left to a stable meadow destination.

The target design of an environmental recovery with an ecosystem-naturalistic intent constitutes an interesting final destination perspective because it is "projected" into its future as well as it represents perhaps the best compensation to the land that hosted the landfill (Di Fidio, 1985). Today, our landscapes, often spoiled by an uncontrolled building sprawl and by a soil consumption that has reached alarming levels (Casa, 2017), have an absolute need for restoration with green areas that can become hubs of ecological networks and that could be able to mend and reconnect the remaining green areas, as well as redevelop from the landscape point of view, areas that nowadays are often characterized by negative and impacting elements.

In this context, the ecosystemic conversion of the surface of an old landfill is an interesting starting point for the enrichment of the local environment, as well as a point of possible peri-urban use for the inhabitants of the closest suburbs.

In order to achieve such a result this solution must be planned and studied already at the landfill design level, with an appropriate capping stratigraphy and with technical infrastructure choices made so that they are already compatible with future landscape function.

The experience conducted at the old Vizzolo Predabissi (Milan) landfill, whose environmental recovery was precisely guided by the criteria mentioned above, is presented below (Figure 1).

Today, the area presents an interesting ecosystem / landscape features that give it a particular and important role in the naturalistic context of the surroundings. Its 22 hectares extension and its morphology of the embankment (20 m above the countryside level) determine relevant ecosystem opportunities (Figure 2) in an area characterized historically by extensive agriculture and more recently by a wide industrial/logistic settlement, in addition to the construction of the new Milan Eastern Ring Road. Furthermore this highway presents here some of the most invasive and impacting features, such as the large railway and the Emilia road overpass (Figure 3).

2. LANDFILL DESCRIPTION

The landfill is located in the territory of Vizzolo Preda-

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FIGURE 1: Current view of the former landfill from the North-West side.

FIGURE 2: The top of the closed landfill is now home to hundreds of tall trees.

FIGURE 3: The top of the closed landfill is now home to hundreds of tall trees.

bissi, in an area between the Lambro river and the current Milan-Rome high-speed railway line. The first deliveries of waste started in the late Seventies, on an area that was not waterproofed but which had a fair amount of natural protection thanks to a clay bench. In accordance with the first regional Lombardy law on the matter, the company Sacagica was authorized to cultivate a first portion of the landfill, subsequently expanded in 1987 by raising and waterproofing the old lots. The landfill has gradually become larger with successive lots up to a total area of 22 hectares. The last authorization, issued in 1996 by the Milan Delegated Commissioner for the waste emergency, brought the landfill to the current configuration, with an overall discharge estimated at around 4 million tons of urban waste. Disposals ended on the 30th of November 1999. The final testing of the closing works took place in December 2003 with the supervision of the Politecnico Geotechnical Lab.

The ownership of the landfill has always been held by the Municipality of Vizzolo, which - with subsequent resolutions - has entrusted the different phases of construction and management to private companies, starting precisely from Sacagica Srl, which later merged into the Waste Management Group. The post-closure phase was carried out by Vizzolo Ambiente Srl, a related company, with the support of Cofathec (later Cofely) for biogas management and energy recovery. The fifteen-year post-closure, penalized by a financial plan that had heavily underestimated the management costs, ended in 2015 with the withdrawal by the Municipality of the financial guarantees issued by the management Company, due to the lack of leachate removal and with the current management assigned to a local Consortium.

2.1 The capping

The number of subsequent construction activities over the years on the Vizzolo landfill has also produced some different choices in the final closing layers of the individual lots, which reflects the technical / construction knowledge of the related design time period. It isn't therefore possible to identify a unique typology of the closing stratigraphy, even if, from the legislative point of view, the common reference was the Delibera Comitato Interministeriale issued on July 27th, 1984. However, despite some differences, especially in regard to the thickness of the materials and the types of geotextiles used, it is possible to bring these variants back to a common denominator of components, i.e. (from top to bottom): topsoil ; drainage layer rain water; bentonite mattress (not everywhere); clay; biogas drainage layer; waste regularization layer (CTD, 1997).

For assessments on the suitability to install a naturalistic phytocoenosis, the thickness of the surface soil of the capping is clearly of vital importance, and it was indicated in the project documents ranging from 50 cm to one meter. In 2007, in anticipation of a new substantial tree planting activity, an extensive survey campaign was conducted to assess the actual thickness of the soil on the landfill capping. This survey has been carried out in order to assess both the areas where any settlement phenomena and / or surface erosion had reduced the thickness of the soil and to identify the areas where possible greater carryovers would have ensured the best conditions for the planting of trees and shrubs with greater need for substrate. The outcomes were particularly encouraging, since in all 27 surveys carried out a higher soil thickness than the designed one was found, with a minimum of 57 cm and a maximum of 137 cm, and with an average thickness of 84 cm (Figure 4). In all the surveys a good development in depth of the roots of the grassy turf was found, with the absence therefore of anoxia phenomena, biogas leaks or water stagnation.

2.2 First interventions

The testing of the closure of the Vizzolo landfill, carried out with the support of the Politecnico geotechnical laboratory, took place at the end of 2003. From 2007, after a period of management by the firm that carried out the works, the real post-management phase started, based on a naturalistic recovery criteria and an ecosystem / landscape target. A series of interventions were therefore set up with the goal to "lighten" the landfill from concrete structures and various infrastructures which, perhaps useful in the management phase, were now an obstacle to the full recovery and to the new management plan of the area. In particular, it was evaluated the actual need of the concrete wall, with a height varying from 50 cm to more than 2 meters, which bounded almost the entire perimeter of the landfill for over a kilometer. The wall had been built during the management of the active landfill in order to support the slopes in cultivation. In addition to the evident impact on the landscape, the presence of that low wall had led to a significant worsening of the drainage and external conveying capacity of rainwater, both from surface runoff and from those collected by the drainage layer existing in the capping between clay and soil. Considering the very large quantity of leachate produced and its evident dilution, there were therefore reasonable grounds for believing that a good part of the rain water - although drained and effectively collected by the apposed systems and infiltrated along the inner side of the wall at the end of their existing path - bypassed the waterproofing systems. Through the formation of a hydraulic head the water was flowing into the mass of waste, with the consequent abnormal production of leachate. This hypothesis has been verified through the performance of some tests that have shown how, even in a not particularly rainy period, a strong accumulation of water formed close to the inner side of the walls, evidently destined to infiltrate the landfill despite the presence of some drainage holes, which were completely insufficient for this purpose. A complete demolition (Figure 5) of the perimeter wall was then studied, replacing it with a permeable structure (Benini, 1990), consisting of stone cages (50 cm high and 1 meter deep), "moving" the edge of the landfill (i.e. modifying the slope) outside the anchoring of the bottom sheets of the landfill and resealing the area with a new clay fill, on which a draining mat and new cultivation ground have been placed (Figure 6).

After this work, the internal and superficial drainage

FIGURE 4: The layer of soil reported on the capping proved to be suitable for the growth of even tall trees.

FIGURE 5: Demolition of the perimetric concrete wall.

of the landfill has thus been much improved. The terminal part of the banks has been softened and the naturalistic appearance of the area has been strongly developed, thus starting it towards the final configuration, in line with the intended objectives.

3. DISCUSSION AND RESULTS

3.1 Reforestation Criteria

The last activity of the landfill closure, as planned in the original design, was the sowing of stable lawn and the planting of some patches of shrubs chosen simply on the basis of their strong chromatic impact during blooming season (broom and forsythia).

Instead, at the beginning of the new post-closure management phase, a naturalist, member of a local environmental association, had been involved. With his help, a list of native trees and shrubs that could constitute an interesting phytocoenosis was studied, as a premise for the transformation of the former landfill into a hub of the local ecosystem network (Figure 7).

The opportunity to foresee the planting on the capping not only of shrubs but also of trees has been evaluated in order to ensure over time a necessary and fundamental interpenetration between plant associations and waste bodies during the landfill mineralization phase, contrary to what it is often stated about the risks of "drilling" of the capping by the root apparatus. Even the possible risk of instability of the trees once grown, often cited as discouraging the planting of highly developed tree species, to date has never materialized, despite the presence of several hundred trees even at the top of the landfill, many of which are now over seven / eight meters high (Figure 8).

The absence of waterproof polyethylene sheets in the capping package, often designed to contain hypothetical excessive leachate production, was also found to be fundamental to ensuring the correct environmental recovery of the landfill in decades, allowing an important naturalistic requalification and also preventing phenomena of uneven surface layers, situation that never happened in Vizzolo despite the succession of periods of heavy rainfall over the years.

During several planting campaigns, which lasted from 2007 to 2013, approximately 9,000 specimens of trees and shrubs, belonging to native species and selected also on the basis of direct experience on the adaptability to the still difficult conditions of a landfill capping, were planted (Figure 9).

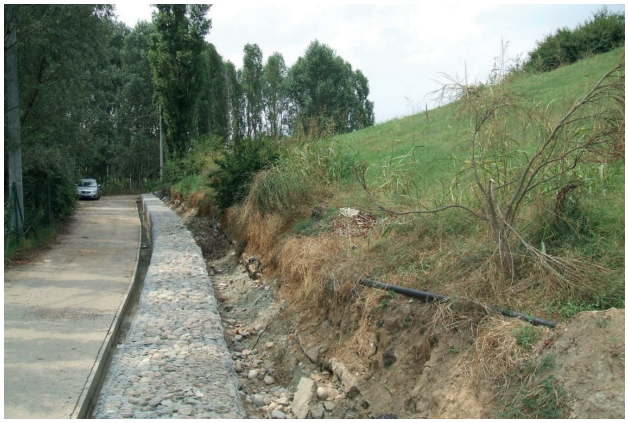

FIGURE 6: After the demolition of the wall, a permeable containment gabion is realized.

FIGURE 7: The side of the landfill sloping towards the Lambro river.

FIGURE 8: The absence of a waterproof sheet in the capping has allowed the growth of trees without compromising slope stability.

FIGURE 9: Phytocoenoses established on the landfill.

In particular, the resistance and growth capacity of the elm (*ulmus minor*) and of the field maple (*acer campestre*) have confirmed that these trees are extremely suitable for landfills recovery, while among the shrubs excellent results have been obtained with the hawthorn (*crataegus monogyna*) (Figure 10).

Therefore the usage of native species considered "pioneers" has been favored, deferring the enrichment with more demanding essences to subsequent management phases (Schiechtl & Stern, 1992). For the shrubs, the essences able to provide berries to the birds have been preferred (Figure 11). The essences planted during the different planting campaigns are indicated in Table 1.

For the planned planting activities, the use of small and medium-sized forest plants has been preferred, supplied in pots with a diameter variable from 9 to 15 cm. Their costs are truly paltry compared to the ones budgeted in some other landfill greening projects.

In fact, these dimensions guarantee a better rooting and recovery compared to specimens of greater development supplied with ground bead (Lassini, 1996). Even smaller dimensions, such as phytocell seedlings, although perhaps even more preferable from a strictly forestry and planting point of view, would have been too exposed to damage, considering however the strong presence of wild rabbits and also the need of performing periodicals mowing.

Plants such as those defined above still ensure a better survival rate compared to those in sod ("ready for effect") and grow in a regular and consistent manner. More developed plants, on the contrary, suffer from the disproportion between root system and branch apparatus, reacting with a stop or a strong slowing down of apical growth for the first years. Different choices have been made over the years on the protections to be applied to the planted trees, evaluated on the direct acquired experience. In a first phase, coconut fiber biodiscs were laid (small mats of 40-50 cm in width which should provide a good protection, maintaining humidity and preventing grass growth around the growing tree). Although the mats have been fixed to the ground with iron pegs, problems have been found essentially related to their instability in the face of intense winds and to their lifting by the grass still present under them. The solution

TABLE 1: Essences planted during the different planting campaigns.

Trees		**N°**
Ulmus minor	Elm tree	900
Acer campestre	Field maple	800
Carpinus betulus	White hornbeam	100
Quercus robur	Oak	100
Fraxinus excelsior	Ash tree	100
Prunus avium	Wild cherry	200
Shrubs		
Crataegus monogyna	Hawthorn	3200
Cornus mas	Dogwood	800
Prunus spinosa	Blackthorn	800
Rosa canina	Rosehip	800
Ramnus catarthica	Buckthorn	800

that gave the absolute best results – sometimes really surprising - was to prepare strips of mulching green polypropylene cloth (like the one used in agriculture), fixed to the ground with iron pegs, cross-cut to plant the seedlings. Each strip, with a width of 1.65 m and a length of 8, allowed for the staggered planting of seven trees, alternating trees and shrubs. The objective complexity of laying the sheets has been amply repaid by the results of protection from excessive soil drying and effective control of grass growth (Figure 12).

3.2 The Forest Landscape Design

The goal of recreating a natural environment has led to a careful evaluation of the design of the new plantings on the former landfill. It was therefore favored an irregular planting, without any geometric pattern, in order to mimic the natural configuration of the "patches of field", or spontaneous plant associations consisting of trees and shrubs (Lassini & Pandakovic, 1996) (Figure 13).

Even in the succession of laying the mulching sheets any straight line was deliberately avoided, favoring sinuous traces. The result was therefore a succession of wooded areas and clearings, i.e. the naturalistic configuration that

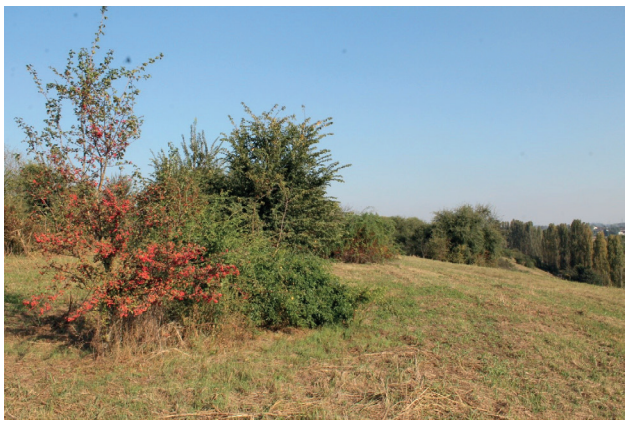

FIGURE 10: Hawthorn has proved to be an extremely resistant species with a great naturalistic and landscape value.

FIGURE 11: Field maple (left) and elm (right) have given excellent results resistance result and fast growth.

maximizes the ecosystem value of an area. It is in fact known that the wood-clearing transition bands are the richest from a naturalistic point of view, just as it has been demonstrated by an experimental thesis on the Lepidoptera population conducted on the former Vizzolo landfill by the Department of Ecology of the Territory of the University of Pavia.

The planting results, ten to twelve years later, testify the achievement of an interesting green cover on the former landfill (Figure 14).

The sequence of clearings and wooded areas proved its effectiveness in achieving an environment of great naturalistic richness: the area was immediately populated by wild rabbits, hares and foxes. Last spring (2018) a specimen of roe deer was also spotted, having arrived through the remaining protected areas of the nearby Parco Sud Milanese (Figure 15).

4. CONCLUSIONS

The future of the old Vizzolo landfill is today closely linked to the possible management choices of the local Consortium that is in charge of the area. It is advisable that the absurd hypothesis of a complete remaking of the capping with waterproof polyethylene sheets is dismissed definitely. This solution was proposed to contain as much as possible the production of leachate, but it would be devastating for what has been achieved so far and it is also contrary to the most recent indications for post-management of the landfills (Cossu, 2012).

Instead, all the interventions that can "lighten" the area from pre-existing structures that are no longer necessary and are completely incoherent with the naturalistic redevelopment in progress should be promoted. In particular, concrete slabs, premises and service sheds that are no longer needed, biogas substations and wells no longer in use should be removed. The current service tracks can be transformed into cycle paths, to be connected to the existing cycle path network of the Parco Sud Milanese, in collaboration with this park management (Toccolini, 2004) (Figure 16).

Furthermore, the system of future management of the area must be defined, in particular with respect to the ownership of the area, still held by the old management company, and to the possible collaboration between the territorial Authorities involved (Municipality, Metropolitan City of Milan, Consorzio Parco Sud Milanese). Recently contacts have been opened with an important national naturalistic association, which had publicly declared itself willing to start a project for the direct management

FIGURE 12: The mulching sheet used for the planting of trees and shrubs.

FIGURE 13: "Patch of field" forest design. In the foreground, heather bloom.

FIGURE 14: Alternation of lawn and wooded areas.

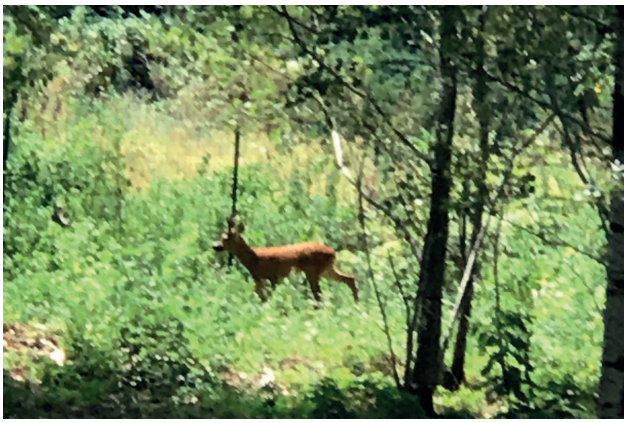

FIGURE 15: The roe deer sighted inside the former landfill.

FIGURE 16: The internal service tracks may constitute the future network of cycle paths connected to the South Milanese Park.

of the area. The subsequent choices recently made by the Municipality and the local Consortium have unfortunately momentarily stopped this collaboration opportunity, which will hopefully be recovered as soon as possible, with a specific aim at reestablishing an important part of the sought-after ecological network of the South Milan area and its local Park.

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