

Concept Paper

Connecting Existing Cemeteries Saving Good Soils (for Livings)

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Abstract: Background: Urban sprawl consumes and degrades productive soils worldwide. Fast and safe decomposition of corpses requires high-quality functional soils, and land use which competes with both agriculture and buildings. On one hand, cremation does not require much land, but it has a high energy footprint, produces atmospheric pollution, and is unacceptable to some religious communities. On the other hand, as exhumations are not practiced, “green burials” require more surface area than current burial practices, so a new paradigm for managing land use is required. Conclusions: In this paper, we propose a concept for ‘green belt communalities’ (i.e., ecological corridors with multiple, yet flexible, uses and services for future generations). With the expansion of urban centers, ecological corridors gradually disappear. Cemeteries for burial plots preclude alternative uses of the land for a long time. By combining these two aspects (need for connectivity and land take imposed by cemeteries), two positive results can be achieved: protecting memories of the past and connecting ecosystems with multiple-use corridors. This new paradigm works best in flat or hilly terrain where there are already several urban agglomerations that contain traditional cemeteries. Stakeholders who might consider this concept are local administrators, planners, and the communities of individuals who share specific beliefs on burial systems.

Keywords: urban ecology; urban areas; urban environments; disposal practice; religion

1. Introduction

The fact of our mortality ensures a never-ending need for a method of disposing of our mortal remains [1]. With the premise that soil is a finite resource undergoing increasing degradation and that cemeteries lock up valuable land, the objectives of the present work are to raise awareness of issues concerning human burial and propose alternatives that may balance the significance of community burial sites, with respect to various religious faiths, and protect the local ecological systems in which we live in a world with increasingly limited resources.

The exponential growth of humankind [2] necessarily implies the expansion of cities [3]. Soils involved in such an expansion, whatever their features and properties may be, completely dismiss their productive and buffering functions [4,5]. Expansion and incursion of urban development into natural areas is partially due to cemeteries which are historically bound to human settlements.

For public health reasons, burial grounds require quality soil that is deep, well-drained, and biologically active [6–8] (Figure 1). As valuable soils become rare due to urbanization and other diverse and general soil degradation [9,10], new strategies aimed at optimizing soils are required when disposing of corpses, as happens with other basic human activities. To bury dead bodies in soil is an ancient practice, even preceding the time when soil was specifically managed for producing

food [11]. Rendu et al. [12] recently revealed the presence of Neanderthal burial sites and speculated on Neanderthals' cognitive capacity to create them. One of the oldest burial grounds is located in a cave at Mount Carmel, Palestine where a man, woman, and child were laid to rest with deliberation and great care [13].

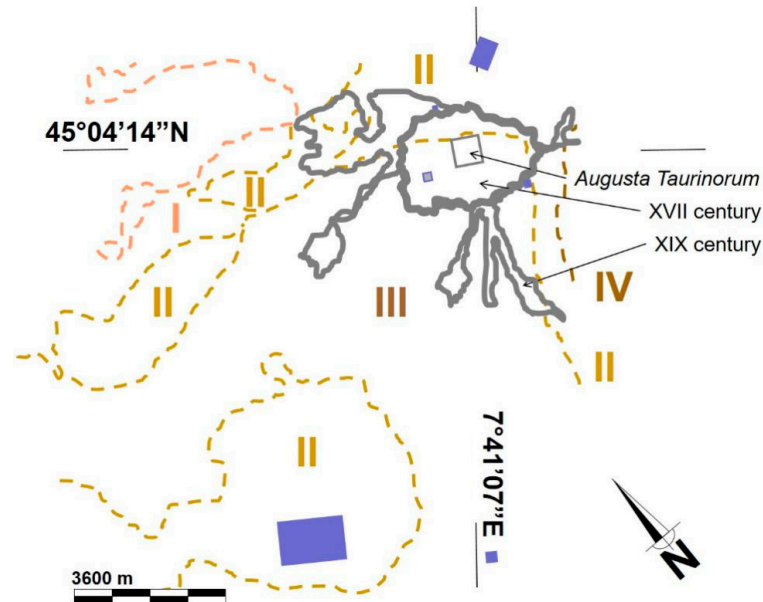


Figure 1. The historical development of the city of Turin, Italy, which presently occupies ~130 km² hosting some 908,000 citizens. The continuous grey lines indicate the perimeters of the town when it was: (i) Augusta Taurinorum (conventionally 28 AD), inhabited by less than 5000 citizens (the grey square, W of the Roman quadrilateral is the probable necropolis); (ii) the capital of the Duchy of Savoy (seventeenth (XVII) century) with about 40,000 inhabitants; and (iii) the capital of the Kingdom of Sardinia (nineteenth (XIX) century) with about 90,000 inhabitants. The current main cemeteries are the quadrilaterals filled in violet. Brown Roman numerals indicate the classes of Land Capability Classification, which depend on soil limitations to various uses: class I does not have any limitation to crops, class II and III show moderate to severe limitations that require special conservation practices, and class IV requires careful soil management due to severe limitations (source: Regione Piemonte, www.regione.piemonte.it/agri/suoli_terreni/suoli1_50/carta_suoli/gedeone.do).

Cremation is another way to dispose of corpses as an alternative to burial. The oldest known cremation as an alternative to burial is probably the one in New South Wales, Australia [14] where a couple (40,000 BP) were discovered as a fully articulated skeleton (Mungo Man) and cremated remains (Mungo Lady). Since 2002, cremation has been the dominant form of bodily disposal in the Netherlands [15].

With time, land set aside for burials (cemeteries) have become systematically designated in specific areas [16]. In addition to burial of corpses, cemeteries are places where the memories of the dead are supported by enduring funerary monuments. This is perhaps one of the main reasons that people prefer burial to cremation, although preference for the latter is increasing worldwide. In the past, human remains were considered as ‘waste,’ therefore burial sites located some distance from cities became popular in the nineteenth century and cremation became popular at the end of twentieth century.

Nowadays some innovative ‘dispersal’ practices are challenging the idea of containing the dead within special death spaces separated from everyday environments for the living [17]. However, care is needed when implementing initiatives and policies in order to balance the various demands and expectations of a cemetery’s purpose and use [18].

The degradation of high-quality “prime” soils and the growing interethnic and interreligious population centers create the need for a new paradigm in the management of corpses because the

conflict between land use for the living and that of the dead is becoming increasingly stringent. The purpose of this paper is to propose a new paradigm focusing on integration and propose new relationships among constructs, between respect for religious beliefs, environmental limitations of a growing world, and possible opportunities offered by these constraints.

2. Issues Related to Current Disposal Practices

2.1. Religion Related Issues

Burial sites are often marked with architectural artefacts that perform several practical and symbolic functions such as aid in locating the site and/or marking out places of ongoing social obligation and care, and to respect the specific traditions that imbue symbolic meaning. Artefacts may become concealed; however, once disclosed they nevertheless continue to mark the presence of an underlying corpse [19], thus signifying a specific land use with its relevant privileges and taboos. The religious experience as an appropriation of a symbolic place is particularly important in the case of multiethnic contexts [20]. Many religious faiths prescribe burial as the only acceptable form of inhumation (Figure 2). For instance, from a philosophical and ritualistic perspective, the Jews bury to honor and burn to destroy. Even if there is no explicit doctrinal opposition to alternative methods of burial, few cultures or religions (such as Buddhism) prefer cremation, while many others, from Zulu to Russian Orthodox Christians and Islamic Muslims, either dislike or forbid it [21,22]. In Islam, burial above ground [21] and future exhumation are strictly forbidden.

A futuristic burial of human remains on the Moon [23] may seem far-fetched, but a more “down-to-earth” approach for managers of cemeteries would be to balance social and cultural expectations with environmental issues [24]. In fact, from a collective point of view, it would be advantageous to harmonize planning efforts between cemeteries and the management of green space [25].

With respect to burial location, a Muslim prefers to be buried where he or she died. To travel a long distance can be expensive and shows a lack of humility which is considered improper behavior. If available, a burial site separated from similar places belonging to other faiths is also preferred. The deceased is laid in the grave on his/her right side facing Mecca. This orientation could present a problem in existing Western cemeteries, which have been planned without taking into account this need. The grave site, the funeral, and the fabrics used for the deceased must not be conspicuous. Grave rotation is not permitted, and areas without trees and separated from other cemeteries must be provided. Also, buffer zones between different cemeteries or between strips belonging to different beliefs in the same cemetery should be anticipated.

For Jewish people, separate burial places are mandatory. In common with other beliefs and common sense, there is the concept of corpses as impure; in this particular case, the impurity is transmitted to the burial area. Therefore, following a funeral, there is a ritual washing of hands so the burial area must have a convenient water supply. Customarily, cemetery locations are acquired in perpetuity from local communities, since the recycling of graves is not permitted. Only in Prague, where local spatial constraints oblige people to place new layers of soil above existing graves, is this practice permitted.

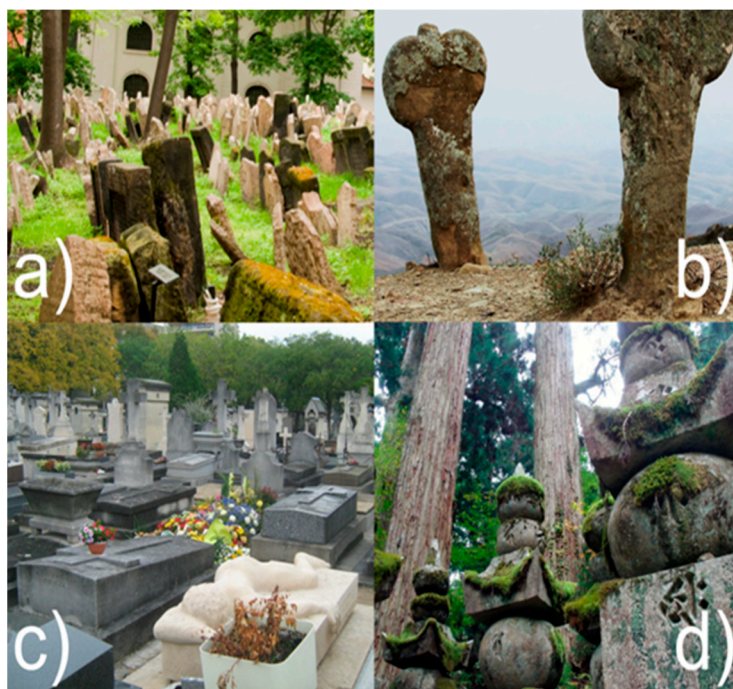


Figure 2. Type of cemeteries. (a) Jews are not allowed to remove the tombstone. When extra cemetery land is not available, soil layers are placed on the existing graves, the old tombstones are taken out and placed upon the new layer of soil. Old Jewish cemetery, Prague (photo courtesy A. Meijer). (b) The body of deceased Muslims are placed in the grave without a casket, lying on their right side, and aligned perpendicular to the Mecca. Shadow on the grave soil is not allowed. Khalid Nabi cemetery, Golestan, Iran (photo courtesy E. Mohsen). (c) A burial of a deceased Christian person occurs in consecrated soils. Christians, in particular Orthodox churches, are commonly opposed to cremation. Montparnasse cemetery, Paris, France. (d) In Buddhism, forest burial began from 500 AD. The choice of burial or cremation is strictly a personal choice. Okunoin cemetery, Mount Kōya, Wakayama, Japan (photo courtesy M. Takeshi).

Both Jewish and Islamic cemeteries express similar concerns about overhanging tree branches and circumventing tree branches that overhang the cemetery or access roads, including walkways; attention to this detail is recommended. In Hinduism, cremation of the corpse on a pyre is considered mandatory with a few exceptions: sannyasin, hijra, and children under five. In Confucianism, burial is common.

Three-quarters of European citizens believe in God or in “some sort of spirit” [26]. The most religious European Union (EU) member states in terms of percentages of believers are Malta, Cyprus, and Romania. Christianity is the EU’s most populous religion, with Catholics being the largest group followed by Protestants, and Eastern Orthodox. Apart from Muslims, the second largest religious group, other world religions are also represented in the EU population (Table 1).

Table 1. Principal religious groups in the European Union (total population 2015 estimate is 507 million; source: EUROSTAT).

Faith	Believers (Million)	Reference
Christians	360	[26]
Muslims	44	[27]
Buddhists	4	[28]
Hindus	2	[29]
Jewish	1	[30]

2.2. Environmental Issues

Cemeteries imply long-term occupation of quality soils which are a basic natural resource whose sustainability is beginning to be felt because of the exponentially-increasing human population. It is readily apparent that the greater the number of people living on Earth, the greater the amount of land required for the living as well as the dead. Since land use is a serious contemporary issue [31], inhumation cannot be ignored as a contributor to it.

Today the body is buried in a casket which in turn is often placed inside a concrete vault or liner before burial; all of that implies the occupation of some square meters of land. Such land is subtracted from both agriculture and urban uses. In inhabited zones, furthermore, the proximity of a cemetery decreases the value of the real estate nearby. The designation of additional land to burial grounds has become a complex task, especially in confined areas, such as islands (Figure 3) and densely-populated countries [32,33]. In 2007, a whole debate of the UK House of Commons focused on issues of space in burial grounds [34]. In Singapore, the competition for space was featured as a significant hot topic on the state planning agenda given both the country's limited area and the need to promote economic and urban growth since optimizing land use is a priority for Singapore's government. In this context, the extensive burial grounds of the Chinese community have often been regarded as a waste of space. Detractors require governmental control to minimize their proliferation [35].

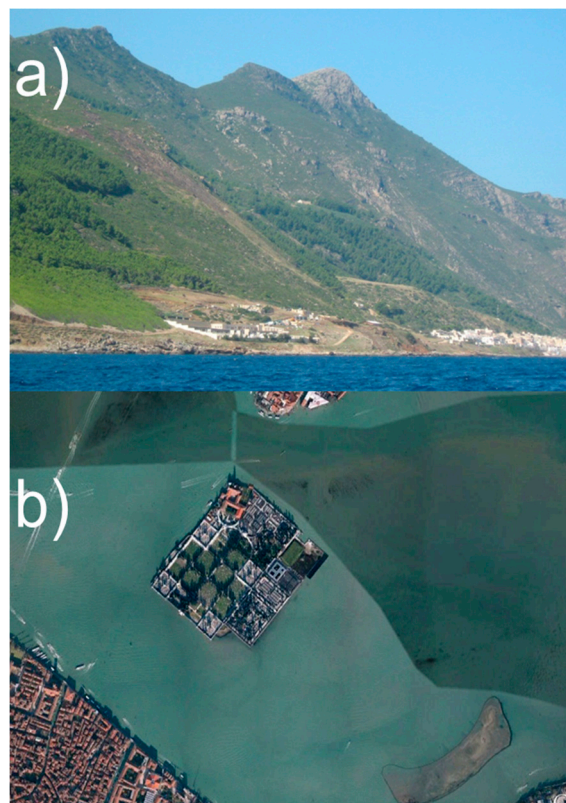


Figure 3. (a) The cemetery of Marettimo, Italy facing the sole human settlement in this 12 km²-wide island. The cemetery wraps 5% of the artificially sealed soils of the island. (b) The cemetery of San Michele, Italy entirely occupies the homonymous island of the Venetian lagoon between Venice and Murano (Google Earth image).

Another enlightening case of the “livings’ greed on dead’s land” is the dispute over Bukit Cina [36], the oldest and largest Chinese graveyard outside China, in Malacca City, Malaysia with over 12,000 graves spread on a hill. Due to its topographical prominence and beauty due to man-made and natural features, Bukit Cina mimics the set of landscape characteristics idealized by feng shui, the ancient Chinese system of aesthetics believed to incorporate laws of Heaven and Earth to help people

improve their life by receiving positive energy. Nevertheless, in the 1980s, such a valuable burial ground was scrutinized by government officials who wanted to transform it into a site for housing, amenities, and commercial properties. The Chinese community succeeded in saving it after difficult and long negotiations.

The issue of relocation of cemeteries currently crops up in many urban areas [37]. It comprises a number of logistic, sanitary, ethical, and economic challenges [38], without substantially reducing land depletion. Although modern cemeteries introduce a number of materials into the soil, some of which are pollutants that make it hard to reclaim, land cover classification systems often compute them as green space [39]. Heavy metals from coffins and caskets [40–43], formaldehyde from embalming fluids [44], and radioisotopes in the body from medical procedures and radiopharmaceuticals, are dangerous pollutants difficult to remove from the soil [45,46]. The severity of these impacts governs both the likelihood and rate of future ecological recovery. Harm caused by stressors such as contamination will result in slower recovery of healthy soil functions [47]. Across the United States, for instance, it is estimated that every year 2700 tons of copper and 105,000 tons of iron are buried in cemeteries (*source* CFAA/CANA/Doric/RAN/PPS), some of which unavoidably find their way into the soil due to weathering. Conditions relevant to pollution include soil type, depth of water table, depth of inhumation, density of inhumation, and climate [48,49].

Cemeteries sometimes go well beyond their basic role of disposing corpses, making themselves a priority in land use. That is the case of commemoration cemeteries (Figure 4), a collective historical memory, presumably a warning to avoid the tremendous mistakes of the past, being however controversial in the attempt to hide the pain of the past [50,51]. War memorials were erected not only in attempts to ‘fit in’ with these existing and traditional spaces of commemoration, but also to alter and create new spaces, which inspired later commemorative strategies [52].

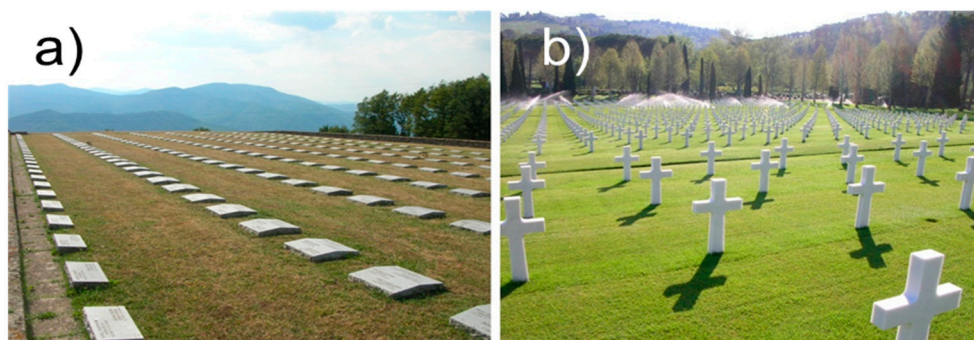


Figure 4. The burial grounds at (a) La Futa and (b) Falciani near Florence, Italy, hosting respectively thousands of German and U.S. soldiers who died during World War II (photo courtesy G. Certini).

Ancient necropolises, such as the Egyptian Valley of Kings, Danish Jelling or Mount Auburn in Maryland, as well as artistic cemeteries (e.g., Staglieno in Genoa, Italy) or ones hosting celebrities (e.g., Montparnasse, Montmartre, and Père Lachaise in Paris, France; Graceland Cemetery in Chicago; La Recoleta in Buenos Aires) are part of an inviolable cultural heritage [53,54] (Figure 5). In such cases, preservation is the proper channel for communicating messages from the past to the future [55] (Figure 6). Apart from these exceptions which are worth preserving, general policies should seriously consider that expansion of burial grounds is contributing to the dangerous hunger for land to develop.



Figure 5. The tombs of (a) Jim Morrison, (b) Oscar Wilde, (c) Fryderyk Franciszek Chopin at the cemetery of Père-Lachaise, (d) Jean Paul Sartre and Simone De Beauvoir, (e) Jean Seberg at the cemetery of Montparnasse, two of the most visited places in Paris. A plaque (f) inside La Recoleta cemetery in Buenos Aires says “paying homage to the dead is a way to love them again, find them, relive with them”.



Figure 6. Mozu-Furuichi Kofun Group burial mounds in Sakai ($34^{\circ}33'44''$ N $135^{\circ}36'34''$ E) provide testimony to the culture of the Kofun period of Japan’s ancient history (third to sixth (III–VI) centuries BC). The intactness of the components, the material evidence and their context, and their state of conservation have made them part of the UNESCO World Heritage list (image courtesy ASTER/NASA).

In terms of soil consumption, cremation seems optimal, having little impact in terms of land use and soil contamination. However, cremation does contribute significant amounts of nitrogen, sulfur and carbon oxides, particulate matter, hydrofluoric and hydrochloric acids, mercury, heavy metals, and possibly persistent organic pollutants such as dioxins and furans, into the atmosphere which eventually contaminate soil and groundwater [56,57]. Furthermore, cremation requires a minimum of 0.4 GJ per body, which is equivalent to four-fifths of a barrel of oil, and it releases at least 100 kg of CO₂ [58]. Even if such negative ramifications can be mitigated in the future, they must be considered as not independent of the religious beliefs of the people [59].

Despite a general consciousness about the finiteness of Earth’s resources, cemeteries do not require a less-impactful modus operandi, which nowadays is standard in many land uses (urbanization, agro-forestry, etc.). In the future, environment- and landscape-friendly methods to dispose of corpses must be considered as well.

3. A New Paradigm

Current burial practices are not substantially different from 50 years ago, when the global population was half of the current one. The current practice will eventually fail because the land per capita (and in particular good soils) has decreased more than proportionally in the same period. At the same time, society has become increasingly multiethnic, with diverse needs. Especially in the Western-style worldview, burials in the 1960s did not respect all the social components in the same way and used too much land for the dead.

It is time for new burial practices; we must make better use of what we have, both in social and environmental terms. With the expansion of urban centers, ecological corridors gradually disappear. Cemeteries lock up land and preclude alternative use of the land for a long time. By combining these two aspects (the need for connectivity and land-take imposed by cemeteries), we can achieve positive results with two goals: protecting memories of the past and connecting ecosystems with multi-use corridors. This new paradigm could work well in flat or hilly terrain where several urban agglomerations containing traditional cemeteries already exist. Stakeholders who might want to entertain this new paradigm are local administrators, planners, and the communities of individuals who share specific beliefs on burial systems.

A growing trend is the concept of natural burial, also known as a “green funeral.” The corpse is placed in a biodegradable coffin and interred. Vegetation, often a tree, is planted in the proximity of the grave instead of artefacts. Green cemeteries include woodland cemeteries, eco-cemeteries, and memorial nature preserves [60–62], and can serve as buffers between high-use areas and the adjacent surroundings. In this idealization (Figure 7), in several densely-urbanized areas, the natural burial could be achieved with linear geometry with perimeter infrastructures and services similar to those of traditional cemeteries starting in the current generation (I) as an extension of existing cemeteries. The second generation of citizens (II) might build further extensions and manage the partial conversion of the initial segments to areas of mixed fruition. The third generation of citizens (III) might ideally connect the segments made available as natural/recreational areas in the first portions of the segments. Community and site-specific requirements can be used to establish the type and size of different portions and related design constraints.

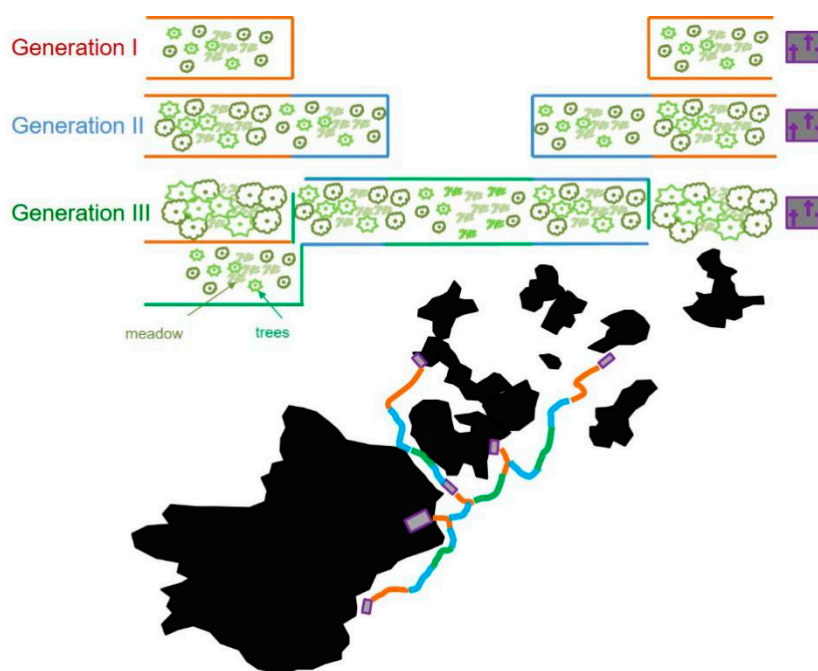


Figure 7. Schematization of an idealized linear linkage between existing cemeterial areas. Densely urbanized areas (black) are normally required by legislation to plan urban cemeteries, enclosed

within a perimeter of walls (violet). Starting with the generation I, or cohort I, with an average length from 20 years to 30 years, the succession of generations can undertake the passage from the urban cemetery towards garden cemeteries that use landscaping in a park-like setting. After two generations (generation III), in which direct contact between the living and the dead no longer exists and there are no more health problems due to the burial of corpses, the first expansion areas (generation I) preserving the memory of the dead (for example in trees, where religious beliefs allow it), can become recreational areas for mixed use. A community-based choice must accompany the planning of the expansions. For example, creating areas without trees where the religious belief includes burials that can never be in the shade.

Since the land occupied by green cemeteries is inherently multifunctional and highly appreciable in terms of landscape and biodiversity, we propose that green cemeteries be implemented as an alternative use along ecological corridors and green belts with the aim to form a continuous sustainable park [63]. Green space contributes to quality of life and healthy lifestyles of those who make use of them [64]. Traditionally, corridors and green belts were based on a linear linkage between two conservation areas. Ecological connectivity today is a measure aimed at stitching together fragmented environments, thus linking habitats, communities, and ecological processes [65]. Although some implicit social ambiguities are present [66], natural burial grounds provide a lively physical witness of the immaterial memory of the dead [67] in that they suggest, more than common graves, a consolatory, motivating sense of being part of the wheel of life on Earth. Furthermore, they represent an investment in the future, a programmatically multifunctional land space.

Cemeteries are often overlooked by planners and are seldom considered as critical land use [32,68]. Nevertheless, cemeteries consume soils in time and space, as we all together are consuming soils faster than nature can regenerate them [69]. Soils and landscapes co-evolve with human cultures [70] and our idea of interconnected linear natural burials is concerned with short- and medium-term futures of Western societies and their environment, providing alternative futures for human endeavors in the unavoidable field of trespassing. As in many other fields of human activity, corpse disposal is an ad hoc combination of strategies that must be chosen on a case-by-case basis as an interactive process, thus redefining the connotation of infrastructure and magnifying the linearity of a reconnected biophysical landscape [71]. Negotiations among stakeholders [72] is the common task to curtail an irresponsible run to consume a finite budget of fertile soils.

The proposal to establish a long narrow area of natural burials connecting urban areas to protect the environment must not clash with the religious beliefs and customary behaviors of the inhabitants. Based on the fact that Europeans are increasingly accepting of diversity in the public sphere, and that today, the majority of Europeans have friends or acquaintances with religious beliefs and/or ethnic origins different from their own [26], we report some of the issues from a European point-of-view as learned from Roman Catholics, Muslims, Jews, and Hindu believers living in Europe in order to raise the debate, and hopefully avoid gross mistakes in urban planning.

For Catholics, visits to graveyards are frequent and socially acceptable, almost mandatory both from a social and religious perspective. The recycling of graves is generally permitted, with a residence time of 10 to 30 years. The expectancy of an afterlife would seem to preclude cremation as an option [73], even if it is gaining popularity in Western countries. One of the problems of incineration is its cost and efficiency.

The historical tendency for the planning of new cemeteries has been to place them at the peri-urban border [74]. Extreme and paradoxical situations exist, for example, in addition to the existing cemetery located northwest of the town of Caselle Torinese in Italy, the PRGC (Piano Regolatore Generale Comunale) development plan includes the creation of a new cemetery on the extreme outer edge of the municipal area, immediately next to the municipal boundaries of two neighboring municipalities, Settimo Torinese and Borgaro Torinese [75].

The expansion of existing cemeteries with a design that over time allows the creation of connections between them is our proposal for the future of cemeteries in densely-populated, multi-ethnic and multi-religious contexts, as inclusive and heterogeneous public space [76]. The actual scheduling of exhumations from graveyards in traditional cemeteries could be integrated with the conversion of segments in which natural burials can occur. After at least three decades, the natural burial areas can be managed progressively more and more as natural wooded areas reestablishing their function while preserving their repository of natural and cultural diversity.

Issues that remain unresolved include those related to design, as local inhabitants should have input in the design phase. Furthermore, contingencies relating to compatibility with existing legislation are not discussed.

This paper provides a new perspective on existing practices with respect to traditional burials, personal beliefs, and ecological concepts. Such new insights lead to new research questions on cemetery design legislation, the metrics of ecological corridors, the accessibility and usability of an area, and the different stages of its use. To highlight directions for future inquiry, for example, it is necessary to understand to what extent different burial customs can coexist or how they can coexist by planning for commonalities that build coherence.

One of the demands of the #FridaysForFuture movement is for synchronicity (“we don’t need to all agree, but we need to sync our efforts, timelines and goals”). The individual contribution of each of us, synchronized to the values of future generations, might be a practical way to pay respect to memory while restoring the connection between ecosystems.

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