



Identification of Suitable Sites for Burial of Animal Carcasses in the Province of Macerata

Matteo Gentilucci*

School of Science and Technology, University of Camerino, Italy

***Corresponding Author:** Matteo Gentilucci, School of Science and Technology, University of Camerino, Italy.

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Abstract

This study aims to solve the problem of the disposal of animal carcasses, firstly through a provincial-based analysis (province of Macerata) to introduce a new landfill suitable for this purpose, while secondly very small sites have been analysed to ensure a possible emergency solution. In addition to the legal constraints, further analyses based on the morphology of the territory and the climate have been introduced in order to avoid any risk to the environment. In addition, the innovation of this research also passes through the extensive use of geographical information systems that have allowed the spatialization of constraints, climate analysis using geostatistical techniques, topographic survey and the screening of the intervisibility.

Keywords: Burial; Animal; Environment; Climate

Introduction

The disposal of animal carcasses is very costly and difficult for operators in the Province of Macerata, given the lack of facilities for this service within the Marche Region; in this context, it is important to set up a system to ensure hygiene and profitability, in order to prevent uncontrolled burial or, even more seriously, abandonment of carcasses directly on pastureland, guaranteeing an economically viable service. These requirements have led to the need to identify one or more specific sites for burying animal carcasses and all products derived from them. The innovation of this research is expressed in the identification of areas suitable for the disposal of animal carcasses, through the use of geographical information systems. The study will be divided into two main sections: the first part will focus on the identification of macro-areas, designed to accommodate large quantities of animal carcasses that will be treated as landfills for hazardous or non-hazardous waste [1]. This analysis must necessarily take note of the current legislation in Italy, which regulates on the one hand the types of landfill, while on the other focuses on the type of waste, indicating specific distances in relation to the hazardousness of the same. The prescriptions coming from the legislation, will be the prescriptions that will guide the analysis operationally, leading to the identification of macro areas, suitable from a geological and environmental point of view, to avoid damage to the ecosystem. In the second part,

a further issue will be examined concerning the identification of micro-sites, treated as mini-dumps (due to the reduced territorial extension and the much lower quantity of material hosted), which should be identified in areas where disposal becomes more onerous and difficult, depending on the harsh morphology and the significant extension of the mountain territory of Macerata province. To regulate this subject there is a specific legislation outlined directly by European Regulation N. 1069 of 2009, which in Art. 19 paragraph 1 derogation from certain environmental constraints provided for by existing legislation. From a methodological point of view, the two analyses will be treated in a similar way, using the GIS software (in this case ArcGis) aimed to the identification of sites following the characterization of the legislative constraint on a digital basis.

Methods

The methodology adopted was based on the retrieval of all the data necessary for the localization of a site suitable for hosting a landfill of hazardous waste within the Province of Macerata.

Therefore, on the basis of the legislation and in particular of Legislative Decree 36/2003, it has been created or, in some cases, only found all the shapefiles necessary for the selection of one or more areas suitable for the location of a hazardous waste landfill, through the use of the software ArcGis.

The first step was to identify all the municipalities in the province of Macerata that are included in the 1st category with regard to seismic risk (Castelsantangelo sul Nera, Montecavallo, Muccia, Pieve Torina, Serravalle di Chienti and Visso) and consequently isolate them in ArcGis. In this way, a new shapefile was created, with the area of the municipalities of 1st seismic category inside.

Secondly, data on hydrogeology, floodable areas and landslides were found, kindly granted by the Regional Basin Authority [2].

The geological situation was then analyzed, through the request of the geological map of the Province of Macerata, to the Marche Region, which granted it, in part, in the form of shapefiles of polygons derived from the project called "unique geological territory". However, the lack of complete information, required a part of editing through ArcGis, on a shapefile called "geologia_mc" georeferencing [3] in advance the PDFs originated from the above project (unique geological territory), to be able to copy the geological limits in their exact position.

Subsequently, the data of the network "Natura 2000" (main tool for the maintenance of biodiversity) which were already in shapefile format, were collected, with a part dedicated to the Sites of Community Importance (SCI) and the other including the Special Protection Zones (ZPS). The next step was to acquire data on the boundaries of the study area of the Sibillini Mountains National Park, by study area we mean the area identified in the Plan of the Park (which has the task of defining the general organization of the territory and its articulation into areas or parts characterized by different types of vegetation). The next step was to acquire data on the boundaries of the study area of the Sibillini Mountains National Park, by study area we mean the area identified in the Plan of the Park (which has the task of defining the general organization of the territory and its articulation into areas or parts characterized by different types of use, enjoyment and protection), through the L.U. (Landscape Unit), ranging from the heart of the Park "Sibillini Mountains Region" to the "Piedmountain Marche Region" and from the "Piedmountain Umbria Region" to the "External Regions" (object of indirect protection), this polygonal shapefile has been assigned a buffer of 1000m from the border, as the minimum distance from a possible landfill

The regional technical map has allowed to isolate countless shapefiles, whose information has been implemented with the use of editing sessions based on the evidence observable through the orthophotos of the Province of Macerata. The shapefiles of points, lines and polygons have been grouped in homogeneous sets with respect to the minimum safety distance from the landfill and are as follows:

- **Water points (points):** Mill - fountain - well - well for oil or methane - intake - tank - perennial source - tank, tank, watering can. The minimum distance adopted for this row is 200m from each point (absolute protection zones 10m).
- **Industrial points (points):** Metal furnaces and towers - monumental object - silos - filling or service station. it does not need any buffer with respect to the landfill, as the industrial buildings are indicated as preferential criteria for the identification of a landfill site.
- **Points no buffer (points):** Energy transformation cabin - chimney - pylons for high voltage line - repeater - tabernacle, isolated cross - pylons for high voltage line. The structures of this file do not need any distance from the landfill, by default it has been assigned a minimum of 10m.
- **Related highways (polylines):** Motorway, ring road, expressway, airport runway, bridge to motorway. From the fast roads, a minimum distance of 300m is prescribed.
- **Asphalted roads (polylines):** Maneuvering tracks - overpass - ordinary double track railway - ordinary single track railway - cable car - level crossing - bridge with railway and road on one level - bridge with railway above and road below - bridge for asphalt road - underpass - asphalt road - asphalt road under construction. It was chosen to give these polylines a safe distance from the landfill of at least 60m, although it would be the distance prescribed by the Highway Code for motorways.
- **Water courses lines (polylines):** Intermittent course water - groundwater - bridle - channel with unrepresentable bed width - channel with unrepresentable bed width - covered channel or tunnel - raised channel - closed with or without walkway - river or stream with unrepresentable bed width - walkway - fishing - jump in penstock - stream, stream with unrepresentable bed width. The regulation prescribes that the minimum distance from the landfill, for these watercourses must be at least 150m and dictates the definition of a watercourse (set out in Law no. 165 of 31/08/2012), understood as "a system of surface or underground waters that, by virtue of their physical connections, constitute a unitary complex that normally flows into the same common point".
- **Valuable crops (polylines):** Row of screws associated with trees - isolated row of olive trees - isolated row of screws - isolated row of olive trees with trees. From the isolated rows of valuable crops, the landfill must be separated by at least 700m.
- **Lines no buffer" (polylines):** Underground aqueduct - elevated aqueduct - high voltage power line - underground gas pipeline - elevated gas pipeline. These lines do not theoretically need a buffer from the landfill, however by default they have been assigned a minimum distance of 10m.
- **Population centre (polygons):** Built-up area. As reported by D.Lgs 36/2003 Art. 2 letter (t), a town is defined as a set of at least 25 buildings and public areas with pedestrian or vehicular access on the road. Populated areas deserve a safety distance of 2 km.

- **Polygons (polygons):** Camping - tennis court - sports ground - church - cemetery - civil building - civil building under construction - indoor or outdoor swimming pool. The buffer compared to the landfill is at least 300m.
- **Polygons built industrial" (polygons):** Industrial building - airport runway - wharf, pier, docks - freight yard - greenhouse - railway station - canopy, isolated barn, shelters, motorway exits. It does not need a minimum space from the landfill, as the industrial areas are indicated as preferential areas for the construction of a landfill.
- **Polygons sweet water (polygons):** Channel covered or in tunnel - closed with or without walkway - dam not passable - dam passable - lake with constant shores - lake with variable shores - swamp, permanent pond - tank, cistern. The gap between these polygons and the landfill is at least 300m.
- **Polygons valuable crops (polygons):** Orchard - vineyard - olive grove - vineyard associated with trees - nursery and forest at planting. In the same way as the polylines, previously treated, a separation of 1000m from the landfill has been adopted.
- **Polygon services no buffer:** Stone quarry - sand or clay quarry - landfill - sewage treatment plant - energy transformation station or substation, power plant. The polygons in question do not need to have a minimum spacing with respect to the landfill.
- Then the map of the Archaeological Parks of the province of Macerata was obtained in PDF format, it was promptly digitized, forming a polygonal shapefile that takes into account the Archaeological Park of Urbs Salvia (Urbisaglia) and that of Septempeda (San Severino Marche).
- Then, by creating additional shapefiles, both the areas above 1200m of altitude (attributing a buffer of 300m), through the specially created Digital Elevation Model, and the coastline (assigning a buffer of 2 Km) were isolated. In addition, using the Corinne Land Cover (a tool resulting from a European project for the detection and monitoring of soil land use), it was possible to isolate the polygonal file of the vineyards, which, as for other valuable crops, has a minimum distance of 1000m from the landfill (important valuable crop) and that of the woods, whose acceptable distance has been much shorter, of only 20m (also protected by law).

In the final analysis, only geological formations with a permeability coefficient k less than or equal to $1 \times 10^{-9} \text{m/s}$ and a thickness equal to or greater than 5m were considered; finally, the acclivity parameter was considered, towards which there was an approach aimed at eliminating the most sloping territories, where both the construction and the management of the landfill is more difficult.

In this way, the polygons out of the regulations were discarded.

However, it is necessary to specify that the areas subject to restrictions have been excluded from the possible territories for the location of a landfill, on the basis of the criterion drawn up by the D.A.C.R. 26/02/2013 n.66 (administrative resolution of the Regi-

onal Council relating to the Marche Region), as shown in the table below:

Finally, as prescribed by D.A.C.R. 15/12/1999 no. 284;

1. It will be very important to have a clear definition of the area from the climate point of view, in order to size the leachate disposal system, to the atmospheric precipitation.
2. The prevailing winds should not be odour-causing at points considered sensitive.
3. The population density in the areas facing the site shall be taken into account.
4. Factors of visual perception of the site will be important.
5. Evaluate the economic resources of the site.
6. Consider the possible presence of botanical-vegetational and faunal factors for the location of the site.
7. If other degradation factors have been present for a previous time.

The results of the research pass through subsequent characterizations and elaborations, through the ArcGis software, below are reported all the maps necessary to verify the correctness of the procedure that led to the conclusions present in the next pages. The additional research was carried out for those municipalities falling completely or partially within the constraint identified for the areas adjacent to the National Park of Monti Sibillini and that relating to the territories of seismic category I: Acquacanina, Belforte del Chienti, Bolognola, Caldarola, Camerino, Camporotondo di Fiastrone, Castelsantangelo sul Nera, Cessapalombo, Fiastra, Fiorimonte, Gualdo, Montecavallo, Monte San Martino, Muccia, Penna San Giovanni, Pievebovigliana, Pieve Torina, San Ginesio, Sant'Angelo in Pontano, Sarnano, Serrapetrona, Serravalle di Chienti, Usita, Visso.

Results

Landfill for animal carcasses

Operationally, using the ArcGis software, work was carried out to effectively find the most suitable areas for the construction of a landfill, within the province of Macerata. The procedure carried out to remove from the polygonal shapefile, representing the boundaries of the province of Macerata, all the various other polygons created on the basis of the regulations (Table 1), was as follows: Arc Toolbox " Analysis Tools " Overlay " Erase (as "input feature" was always inserted the polygonal shapefile of the border of the province, while as "erase feature" were inserted from time to time buffers of the various polygons that were to be excluded from possible landfill sites). The result of this procedure was represented by some polygonal files of the province of Macerata, having at each subsequent step a missing part, relating to the environmental or anthropic evidence to be protected, up to the areas not subject to constraint.

Environmental factor	Criterion
Areas corresponding to soils with primary and secondary diffuse permeability with regard to calcareous lithotypes, calcareous marly	Discarded
Hydrogeological basin supplying one or more perennial springs or wells used for drinking water purposes.	Discarded
Art. 94 of Legislative Decree 152/06 regulates the areas of protection of both surface and groundwater intended for human consumption and prescribes that 2 zones be identified, the first of absolute protection consisting of the area immediately surrounding the abstractions or derivations, must have an extension of at least 10 meters from the point, while the second has a radius of 200m and is called a buffer zone (where the management of waste can not be prepared as we read in the letter (h of paragraph four of the above article. In addition, for the purposes of protecting groundwater, even those not yet used for human use are identified as areas subject to protection: the areas of groundwater recharge, natural and artificial emergencies of the groundwater, reserve areas (Art.94 paragraph 8 letter a), b), c)).	Discarded
Areas with calcareous debris, alluvial cones, of considerable thickness and extension.	Discarded
Areas in correspondence of dolines, sinkholes or other forms of superficial karst.	Discarded
Areas of former quarry sites with primary and secondary diffuse permeability, in relation to calcareous, calcareous marly and marly calcareous lithotypes.	Discarded
Areas subject to hydrothermal activity.	Discarded
Sea terraces and associated deposits.	Discarded
Valley areas with alluvial deposits including alluvial terraces of all kinds.	Discarded
Floodable areas	Discarded
The indication of areas to be subject to special constraints and requirements in relation to specific hydrogeological conditions, for the purposes of soil conservation, environmental protection and prevention against the likely harmful effects of human interventions (Legislative Decree 152/2006 Art.66 paragraph 3 letter n).	Discarded
Areas designated for flood containment or other works identified by the Basin Plans	Discarded
Areas with active, quiescent, paleo gravitational movements of considerable thickness and extension, deep gravitational deformations of the slope.	Discarded
Areas affected by active faults, fractures or tectonic disorders in general.	Discarded
Areas with soliflux, creep, accelerated erosion and disruptions of generally limited extension and thickness.	Penalizing
Seismic areas with acceleration greater than 0.25 g.	Discarded
Areas with superficial geological processes such as accelerated erosion, landslides, slope instability.	Penalizing
Areas subject to river bed migration.	Discarded
Areas that are excessively steep in relation to the characteristics of the substrate, physical state, lying conditions.	Penalizing
Areas with possibility of major subsidence of the sediment plane	Discarded
Surrounding areas of escarpment with h>10m	Penalizing
Narrow valley areas with coverage loose	Discarded
Areas of contact between lithotypes with different physical and mechanical characteristics	Discarded
Areas at risk of potential fires and areas crossed by fire (the area is excluded, but the competent body can authorize the construction of the landfill with a motivated measure).	Discarded
Areas located upwind of the prevailing winds towards an urban centre or sensitive building (e.g. schools, kindergartens, hospitals, retirement homes, etc.).	Discarded
Areas located at distances of less than 2000 m from a built-up area (as defined by Legislative Decree 285/1992.) for landfills for hazardous and non-hazardous waste.	Discarded
Areas located at distances of less than 500 m from sensitive buildings (e.g. schools, kindergartens, hospitals, retirement homes, etc.).	Discarded
Areas located at a shorter distance from those required by current legislation on lifelines.	Discarded
Areas located at a shorter distance from those required by current legislation on communication routes (60 meters from motorways, 40 meters from main roads, 30 meters from the railway line, etc.) and airports (300m).	Discarded
Areas located at distances of less than 500 m from existing and planned tourist and/or sports centres.	Discarded
Coastal areas included in a strip of the depth of 2000 m from the shoreline, even for high areas on the sea.	Discarded
Areas of agricultural value	Discarded

Areas where access roads are absent or scarce.	Penalizing
Areas that are very decentralized with respect to the production poles.	Penalizing
Areas close to existing plants.	Preferential
Areas in existing structures.	Preferential
Areas where current landfill are located.	Preferential
Areas where are quarried with low or no permeability with any artifacts (e.g. ex-furnaces).	Preferential
Degraded areas to be restored and/or restored from a landscape point of view.	Discarded
Production and mixed areas.	Discarded
Areas located at distances of less than 1,000 m from the area pertaining to the cultural heritage identified pursuant to Articles 10, 11 and 54 of Legislative Decree 42/2004, subject to precise identification by the Superintendence.	Discarded
Areas located at distances of less than 500 m from the perimeter of the areas Identified by Articles. 2 and 3 of the Decree of the President of the Republic No 357 of 8 September 1997, as amended and supplemented. (ZPS and SCI areas).	Discarded
Areas located at distances of less than 1,000 m from the perimeter of the territories subject to protection pursuant to Articles 136 and 142 of Legislative Decree 42/2004 and subsequent amendments and integrations. (landscape assets), i.e. buildings and areas of considerable interest (Art. 136): immovable property that has conspicuous characteristics of natural beauty or geological uniqueness; villas, gardens and parks, not protected by the provisions of Part Two of this code, which are distinguished by their uncommon beauty; the complexes of immovable objects that make up a characteristic aspect having aesthetic and traditional value; the panoramic beauties considered as paintings and as well as those points of view or lookout, accessible to the public, from which you can enjoy the spectacle of those beauties. And from the areas protected by law (Art.142): the coastal territories included in a band of the depth of 300 meters from the shoreline, also for the high lands on the sea; the territories bordering the lakes included in a strip 300 metres deep from the shoreline, also for the territories elevated on the lakes; the rivers, streams and watercourses included in the lists provided for in the consolidated text of the provisions of the law on water and electrical installations, approved by Royal Decree No 1775 of 11 December 1933, and the relative banks or feet of the embankments for a band of 150 metres each; the mountains for the part exceeding 1,600 metres above sea level for the Alpine chain and 1,200 metres above sea level for the Apennine chain and the islands; glaciers and glacial cirques; national or regional parks and reserves, as well as the external protection areas of the parks; the territories covered by forests and woods, even if they have been covered or damaged by fire, and those subject to reforestation restrictions, as defined in article 2, paragraphs 2 and 6, of legislative decree no. 227 of 18 May 2001; the areas assigned to agricultural universities and areas burdened by civic use; wetlands included in the list provided for by Presidential Decree No 448 of 13 March 1976; volcanoes; the areas of archaeological interest identified at the date of entry into force of this code.	Discarded
Areas located at distances of less than 1000 m from the perimeter of protected natural areas subject to safeguard measures pursuant to Article 6(3) of Law No 394 of 6 December 1991 (Framework Law on Protected Areas).Any change in the use of land for purposes other than agriculture and anything else that may affect the morphology of the territory, the ecological, hydraulic and hydrogeothermal balances and the purposes for which the protected area was established shall be prohibited outside built-up areas and, for serious reasons of environmental protection, with a justified measure, including in built-up areas, the execution of new buildings and the transformation of existing ones. In case of necessity and urgency, the Minister of the Environment, with a motivated measure, after consulting the Consultation, may allow exceptions to the safeguard measures in question, prescribing the methods of implementation of works and works suitable for safeguarding the integrity of the places and the natural environment. The possibility of carrying out ordinary and extraordinary maintenance operations remains unaffected.	Discarded

Table 1: Areas subject to restrictions, on the basis of the criterion drawn up by the D.A.C.R. 26/02/2013 n.66.

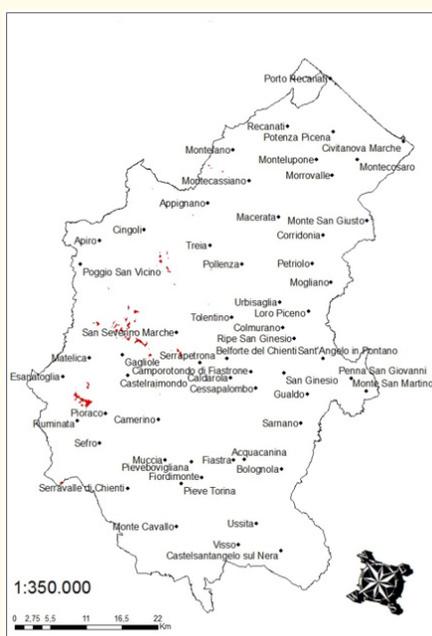


Figure 1: Areas not subject to constraint.

Non-constraint areas have been the focus of further skimming, based on two factors of primary importance for the location of a hazardous waste landfill on a given territory:

- Acclivity of the soil.
- Geological substrate.

As far as the land's acclivity is concerned, it was deduced from the DEM Digital Elevation Model [4], with a simple operation of the ArcGis software. Instead, the geological substrate was reported in the file of the areas not subject to constraint, through the geological map. Both the acclivity and the substrate have been reported in the map of the areas not subject to constraint, establishing a selection criterion in which the protagonists in the same measure are the substrate and the acclivity, favouring the less permeable rocks and the less steep areas. In this way, a map was produced with a classification that highlights the most suitable areas for the installation of a landfill on the basis of the above criteria, with the first number indicating the substrate:

- The number 3 is equivalent to a low permeability of the substrate, corresponding to predominantly clay formations, such as the Formation of Blue Clay, Schlier, Scaglia cinerea, etc.
- The number 2 corresponds to an average permeability of the substrate, represented by formations such as Camerino Formation or the Bugarone Group.
- The number 1 represents the formations with a high permeability, among which are the calcareous ones, such as the red scale, the majolica, etc.

The slope of the ground is the second number that appears in the legend of the classification of suitable areas and has a

- From 0 to 5 degrees.
- From 5 to 11 degrees.
- 11 to 16 degrees.
- 16 to 22 degrees.
- 22 to 28 degrees.
- 28 to 34 degrees.
- 34 to 40 degrees.
- 40 to 51 degrees.
- 51 to 90 degrees.

Due to the availability of areas, waterproof areas were favoured, with a prevailing acclivity between code 1 (0-5 degrees) and code 5 (22-28 degrees).

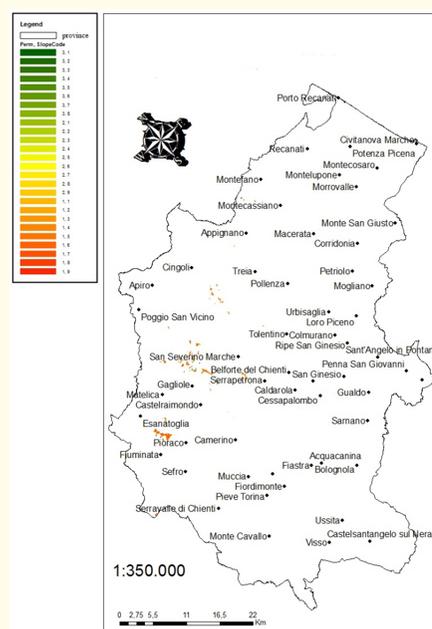


Figure 2: Areas suitable, after the geological and acclivity analysis, to host a landfill.

Microsite for burial animal carcasses

A microsite is a small portion of land intended to host the burial of animal carcasses in a limited and pre-established number (in accordance with European Regulation 1069 of 2009). This would make the management of the mini-disposal much more efficient, and the identification of suitable multiple sites would facilitate the rotation necessary for a reasonable processing time of the carcass transformation. The microsities were identified in the same way as previously. Areas over 1200m, zps, sci, water points, floodable areas, roads, watercourses, wooded areas, valuable crops, civil buildings, landslide areas have been eliminated. Subsequently, all areas with an inclination of more than 15 degrees were discarded, and this information was obtained by working on the Digital Elevation

Model created ad hoc, through the Arc Toolbox - Rastersurface - Slope. Another skimming was carried out on the basis of the geology of the area, in fact the permeable areas, or medium permeable areas (even those with a likely high secondary permeability), were eliminated from the analysis. The result is a map where only the microsities identified remain, in which it would be possible to place mini-discharges for the disposal of animal carcasses, as an exception to the seismic constraint and that of the National Park of the Sibillini Mountains.

Conclusions

Landfill for animal carcasses

The four sites identified can host a landfill of hazardous waste, because there are no constraints on these lands that meet the "exclusion" criteria identified by the regional law.

The road system is adequate or at least existing, and there is no damage to the natural beauty of the landscape.

The four areas identified do not have such a high intervisibility to bring a significant environmental impact on the surrounding areas, although the site of Gagliole is the most disadvantaged from this point of view, because of the location detected.

Although these areas meet the criteria of impermeability of the substrate, according to the surveys of the CARG project, it will still be necessary to carry out further investigations (surveys, etc.), aimed at defining with certainty the exact composition of the subsoil. In addition, always at the design stage, the depth of the aquifer must be established with certainty and the slopes must be regularised if they are too steep to contain and manage properly the leachate that will inevitably be generated. In relation to leachate, the average annual rainfall [5] over the last twenty years has been investigated and some rainfall results for the sites identified have emerged:

1. Montefano: 795 mm of rain (annual average).
2. Tolentino: 855 mm of rain (annual average).
3. Cingoli: 867 mm of rain (annual average).
4. Gagliole: 924 mm of rain (annual average).

Obviously the preference is for less rainy sites, as there is inevitably a lower percentage of leachate, although the areas identified by this research are not very rainy compared to the rest of the province, as you can see on the following page (figure 3).

From the point of view of the population of the various areas, Figure 4 shows the map of population density of the province of Macerata municipality by municipality.

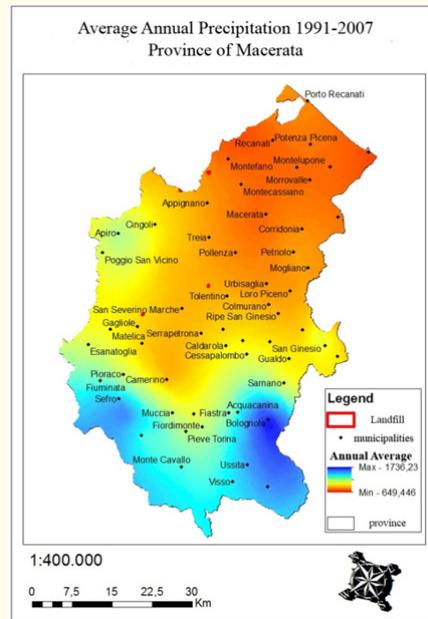


Figure 3: Annual average rainfall in the province of Macerata [6].

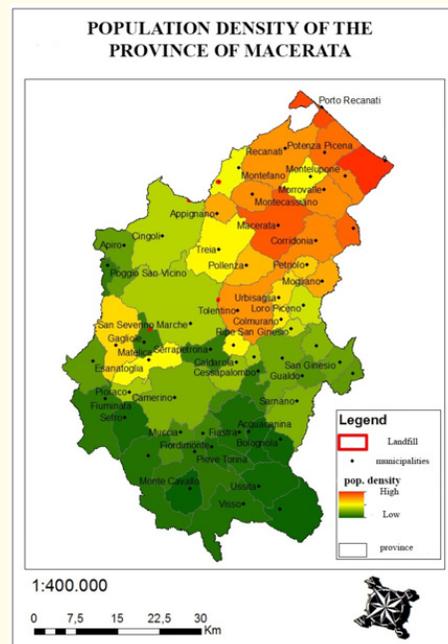


Figure 4: Population density per municipality, in the province of Macerata.

The data that are interesting for this research are reported below in descending order:

1. Tolentino 214 inhabitants per km².
2. Montefano 105 inhabitants per km².
3. Tracks 71 inhabitants per km².
4. Gagliole 27 inhabitants per km².

Obviously in this case they enjoy a privilege factor, those areas that have a lower population density and around which gravitates a smaller number of individuals.

It is important to specify that other sites suitable for the location of a landfill have been identified, but they have been discarded due to one or more discriminatory factors, including:

- Difficulties in the access road to the possible landfill.
- Lack of homogeneity with regard to the impermeable formations making up the geological substrate.

Microsite for burial of animal carcasses

The areas identified classified by territorial continuity are mainly 4, in detail:

1. The area between the “Sanctuary of Macereto” and “Le arette”, on the border between the municipalities of Ussita and Visso.
2. The areas located near the town of Mevale, within the municipality of Visso, very close to the Umbrian border.
3. The areas at the foot of Monte Egina, near Rasenna, a hamlet of Visso.
4. The small portions of land in the municipality of Serravalle di Chienti, respectively at the “Fonte della Romita”, the “Fosso di Balle” and the “Fosso del Fratone”.

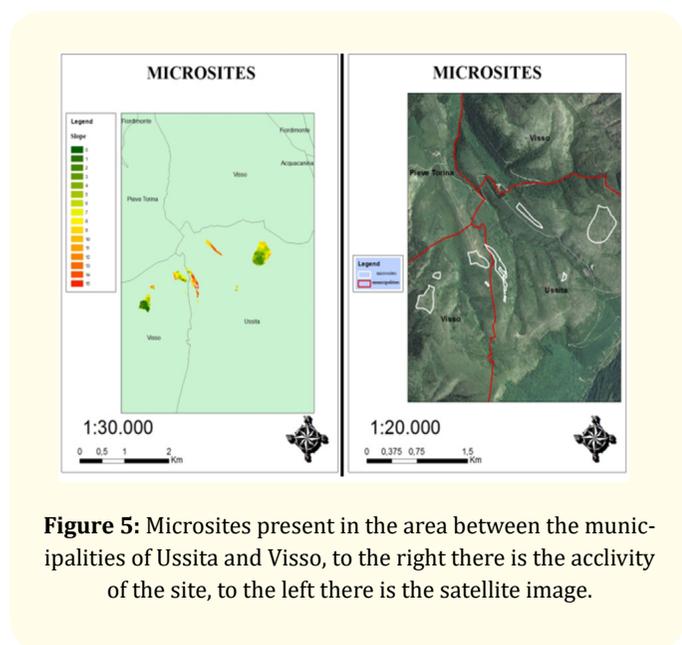


Figure 5: Microsites present in the area between the municipalities of Ussita and Visso, to the right there is the acclivity of the site, to the left there is the satellite image.

These areas identified on the map are provided with all the necessary requirements for the construction of a microsite for the burying of animal carcasses, but it is important to consider that further geological and hydrogeological investigations (aquifer sufficiently deep) will be necessary to have complete certainty on the suitability of the sites. In addition, at the design stage, leachate will have to be considered and a limit set on the number of carcasses in relation to both the surface area (quantity per unit area) and the time of reuse of the same site for further burials. Studies in similar cases show that a bovine carcass produces 20% of its weight in leachate during the first two weeks after death, then the same amount in the following period (a carcass of 500Kg, would give rise to 80-100 liters of leachate immediately and in the following months), until mineralization.

In the final analysis, further measures are needed to ensure safe and risk-free burial [7]:

1. Avoid burials that are too deep, as the degradation of the carcasses is more rapid near the surface due to the increased presence of insects, larvae, etc.; the most suitable depth is between 1m and 1.5m from the surface [8].
2. To accelerate mineralization it is useful to insert manure or straw at the base of the pit, this process favors a rise in temperature that accelerates the composting process, eliminates pathogens and maintains the right ratio between carbon and nitrogen in the soil [9].
3. The pit must be protected from precipitation (corrugated, plastic sheeting), which tends to transport the leachate towards the groundwater and thanks to the humidity (if necessary, provide PVC drainage pipes) favours the proliferation of pathogens.
4. During the covering it is necessary to place the superficial layers of the ground (not very permeable as they are rich in clay) on the bottom, while the more permeable layers on the surface (guarantee greater aeration).
5. Puncture the intestine, stomach or rumen to prevent the carcass from floating.

By following all the above provisions and correctly assessing geology and hydrogeology, it can be argued that burying in single or multiple pits is simple, economical, hygienic and safe to use [10-19].

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