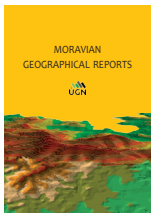

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# How to find a suitable location for a cemetery? Application of multi-criteria evaluation for identifying potential sites for cemeteries in Białystok, Poland

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**Abstract:**

*Valorisation of land is an important tool for countries around the world to help regulate land use planning and ensure sustainable development. Cemeteries are multifaceted spaces, providing a keystone community infrastructure. Poorly located cemeteries can generate adverse environmental, landscape and community outcomes. Identifying optimal sites for cemeteries will become an increasing concern for land use planners as population numbers and consequent death rates increase while the amount of available land decreases. This study was conducted with the aim of proposing multi-criteria analysis for identifying some optimal sites for cemeteries. This analysis was implemented in Białystok (297,585 inhabitants, in Podlaskie Voivodeship, Poland), where 11 potential areas for the location of a new cemetery were assessed. Through a comprehensive process of investigation, engagement, and analysis, four options in different locations were identified as suitable for further consideration. Two sites (options 7 and 11) had fatal flaws – high risk and effects associated with development and were not recommended to be taken forward.*

***Keywords:*** *cemetery; site selection; suitability levels; multi-criteria analysis; feasibility study; localisation; Poland*

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## 1. Introduction

Cemetery land is becoming an important issue in many localities all over the world (Lehrer, 1974): in East Asia (Dian, 2004; Lotfi, Habibi and Javad Kooshari, 2009; Al-Anbari, Thameer, Al-Ansari and Knutsson, 2016; Doi, Chai, Xu, and Wang, 2021); in North America (Salisbury, 2002; Basmajian and Coutts, 2010; Larkin, 2011); in New Zealand (Judge, 2012) and Australia (Dent, 2002; Purdon, 2009); in South Africa (Croucamp and Richards, 2002; Dippenaar, 2014); and in Europe (Environment Agency, 2002; Cemetery Development Services, 2017). Urbanisation along with the growth of population, has led to new challenges for humanity (WHO, 1998; World Urbanisation Prospects, 2018).

The number of deaths is currently increasing whilst the amount of available land has decreased due to growing population, urban sprawl, and the ongoing battle between various types of land-uses (Capels and Senville, 2006; Coutts, Basmijan and Chapin, 2011; Bennett and Davies, 2015). As WHO (1998, p. 5) stated: "today, sufficient land area for cemeteries is difficult to find in populated areas, and in the near future sufficient space for cemeteries may not be found at all in cities in most parts of the world". A cemetery is a multi-faceted space (Francaviglia, 1971; Rugg, 2000; Długozima and Kosiacka-Beck, 2020) and can be considered an essential public service that plays an important role in social infrastructure (Shaker Ardekani, Akhgar and Zabihi, 2015; Nordh and Swensen, 2018; Długozima, 2020a).

A cemetery's primary function is to provide a physical space for commemoration and a final resting place of the deceased (Rugg, 2000; Dian, 2004; Larkin, 2011). Nevertheless, the multi-layered character of cemeteries results in many factors impacting decision-making processes, and undoubtedly makes planning procedures more time-consuming. Finding the optimal location for a cemetery is a difficult task even when experienced planning professionals are involved (Lehrer, 1974; Bennet and Davies, 2015; Nguyen, Chou, Van Hoang, Fang and Nguyen, 2019). It is the lack of clearly articulated and consistent land use planning policy that often hampers the development of new cemeteries. Clearly in many cases, the

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inappropriately placed infrastructures have decreased the efficiency and sustainability of the settlement units. The consequence of wrong cemetery location is waste of land and environmental pollution (Pacheco, Mendes, Martins, Hassuda and Kimmelmann, 1991; WHO, 1998; Uslu, Baris and Erdogan, 2009; Zychowski and Bryndal, 2015; Neckel, Costa, Nunes Mario, Saggin Sabadin and Bodah, 2017).

The unsuitable location of graveyards also generates numerous social problems (e.g. the NIMBY syndrome) which prevents this type of investment from gaining public support, and strengthens the taboos related to the phenomenon of death and burial sites (Thomas, 1980; Iserson, 1994; Larkin, 2011). Very often, contemporary cemeteries exist as separate entities far removed from daily life (Dian, 2004; Larkin, 2011; Sheppard-Simms, 2012; Reza, 2012; Reza, 2019), which also contradicts the objectives of their establishment: the cemetery as public green spaces for special purposes (Quinton and Duinker, 2018; Nordh and Swensen, 2018; Rae, 2021). The lack of systematised tools that could support the selection of an optimal site for a new cemetery is the reason why historical cemeteries must remain active and face the threat of being redeveloped. It leads to the degradation of trees and old cemeteries composition (Reza, 2012; SAO, 2016; Pilarczyk and Nowak, 2019; Długozima and Kosiacka-Beck, 2020). It is difficult to establish the best location for a new cemetery: hence the need for an optimal location selection procedure supporting the process of cemetery land use planning is essential (Lehrer, 1974; Capels and Senville, 2006; Basmajian and Coutts, 2010; Bennett and Davies, 2015).

The objective of this research is to develop a multi-criteria evaluation tool that can be used to rapidly and accurately assess a given area, ultimately facilitating the identification of several potential cemetery sites that are sustainable. To achieve such an aim, several criteria to identify appropriate locations for new cemeteries were developed and the multi-criteria evaluation procedure was applied, scrutinising the town of Białystok in Poland as a case study. The aim of the study is an attempt to create an analysis for assessing the location of cemeteries, considering the multi-faceted character of cemeteries. The proposed analysis can be used as a supportive tool in spatial planning processes for officials, planners, and investors. Therefore, it can reduce the potential environmental and social hazards posed by incorrectly sited cemeteries.

## 2. Theoretical background: Conditions relating to the location of cemeteries

A cemetery, as a specific spatial structure, requires a well-thought space for proper implementation of its functions (Sheppard-Simms, 2012; Black, Dubyna and Rapke, 2016; Rocque, 2017; Reza, 2019). Considering a wide range of designations (green area, construction object, buildings serving religious purposes, venue, site of therapy, regeneration, open air museum, thanatotourist object) a cemetery is distinguished from other land use categories, and as such requires an individual approach during the research or planning phase (considering developing criteria to identify appropriate sites for new cemeteries: see Tab. 1). A cemetery determines the development and character of its surrounding. Therefore, it is important to locate it properly – with respect for natural conditions (Cottle, 1997; Dent and Knight, 1998; Rocque, 2017), using available infrastructure and building conditions (Ismali, Omar and Majeed, 2007; Długozima, 2020b), at the same time with adjustments to its social context (Salisbury, 2002; Dian, 2004; Shaker Ardekani, Akhgar and Zagihi, 2015): see Figure 1.

In terms of natural conditions, the most important are geotechnical and hydrological aspects (Fisher, 1992; Dent, 2002; Purdon, 2009; Maloy and Nelson, 2020). Researchers recommend not to locate cemeteries near water bodies, geologically unstable areas, ecologically sensitive areas, or in areas with steep gradients. The site should be located at least 100 m from the 50-year flood line. Moreover, soils of an intermediate range of properties, such as a clayey sand or sandy clay, are ideal for cemetery sites (Fisher, 1992; Dippenaar, Olivier, Lorentz, Ubomba-Jaswa,

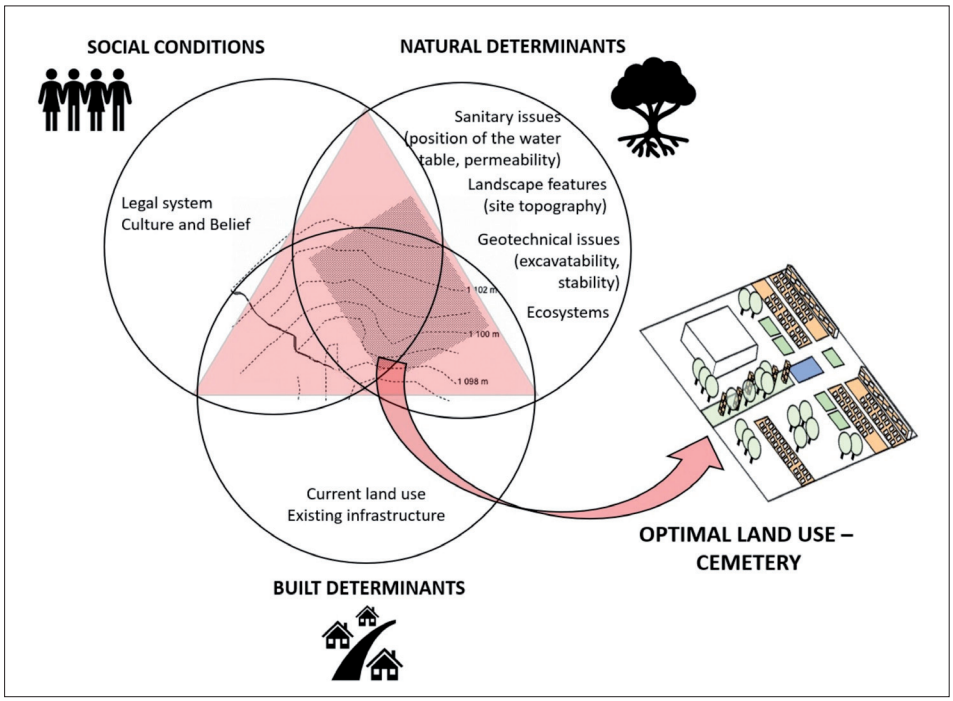


*Fig. 1: Diagram showing the main groups of conditions determining a cemetery's location*
*Source: author's conceptualisation*

| Conditions (aspects taking into account in cemetery site selection) | References (chronological) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fisher, 1992 | Environment Agency, 2002 | Croucamp and Richards, 2002 | Salisbury, 2002 | Dian, 2004 | Capels and Senville, 2006 | Ismail et al., 2007 | Coutts et al., 2011 | Larkin, 2011 | Judge, 2012 | Sheppard-Simms, 2012 | Shaker Ardekani, 2015 | Black et al., 2016 | Al-Anbari et al., 2016 | NEPA, 2007; PURDON, 2009; CDS, 2010 | Rocque, 2017 | Dippenaar et al., 2018 | Nguyen et al., 2019 |
| **Natural conditions** | | | | | | | | | | | | | | | | | | |
| Geotechnical and hydrological (sanitary) aspects: stability, workability, excavatability, position of the water table, subsoil permeability | X | X | X | | X | X | X | | | X | X | X | | X | X | X | X | X |
| Landscape features (site topography) | X | | X | | | | | | | | | | | | X | | X | |
| Valuable vegetation with unique features, important to construct a local cemetery integrated with landscape (biodiversity) | | | | | | | | | | | | | | | X | X | X | |
| Landscape coherence – location in relation to the natural system | | | | | | | | | | | X | | X | | | X | | |
| Landscape features – variety of natural landscape (presence of hills, slopes, wooded areas) | | | | | | | | | | | | | X | | X | X | X | |
| Visual assessment | | | | | | | | | | | | | | | X | | | |
| **Socio-cultural conditions** | | | | | | | | | | | | | | | | | | |
| Social accessibility (location in relation to settlement unit, centre, community) | | | | | X | X | | | X | | | X | | | | | | |
| Size (estimate cemetery acreage need) | X | | X | | X | X | | X | | | | | | | | | | |
| Land ownership | | | | | X | X | | | X | X | | | | | | | | |
| Relevant policy (consistency with relevant legislation) | | | | | X | X | X | | X | | | | X | | | | | |
| Death rate, the rate of various interment methods | | | | | X | X | X | X | | | | | | | | | | |
| Cultural heritage | | X | | | X | | | | | | | | | | | | | |
| **Built conditions** | | | | | | | | | | | | | | | | | | |
| Engineering services (powerlines, telecommunications lines) | | | | | X | | X | | | | | | | X | | | X | |
| Access, transport | | | | | X | | X | | | | | | | X | X | X | X | |
| Context (Land use) | | | | | X | X | X | | | X | X | | | | | | | |

*Tab. 1: List of criteria important for the study of cemeteries location in the literature review*
*Source: author's elaboration*

Abia and Diamond, 2018). In terms of building conditions researchers consider location in relation to the transportation system (transport accessibility) (Cemetery Development Services, 2017) and current land use (Dian, 2004; Ismali, 2007; Nguyen, 2019). Equipment and access to engineering services (availability of services) is also considered. Social factors for cemetery location are related to accessibility (connections with the local community). Cemeteries were once part of community structure; they now exist as separate entities far removed from daily life (Thomas, 1980; Iserson, 1994; Larkin, 2011; Shaker Ardekani, Akhgar and Zabihi, 2015). Deemed essential to the social infrastructure of communities, cemeteries need to be established in accessible locations to meet the needs of the populations they serve (Larkin, 2011). Alexander (1977) recommends not to build vast cemeteries, but to allocate pieces of land throughout the local community to them instead.

Consequently, location in relation to settlement unit centre (Shaker Ardekani, Akhgar,and Zabihi, 2015), distance to build-up areas and to residential areas (Niţă, Iojă, Rozylowicz, Onose and Tudor, 2014) is considered. As Black, Dubyna and Rapke (2016) stated: a cemetery proposal should demonstrate a community's demand for cemetery space that has not been met yet. Cemetery acreage depends on mortality trend and burial practices (cremation rates) (Croucamp and Richards, 2002; Dian, 2004; Coutts, Basmajian and Chaplin, 2011). A reasonably estimate of space needed for burials with cremation rates at the level of 70–80%, would be the size of 2 to 4 hectares for 50 years (Future Numbers of Death and Cemetery Site Requirements). When the cremation rate is lower, the demand for burial space is higher – at least 5 ha (in Poland the estimated cremation rate is approximately 30%) (Długozima, 2020c).

## 3. Data and methods

The research process encompassed three stages to answer the question: "How does one find suitable locations for new cemeteries?". In order they were:

- To develop criteria to identify suitable locations for cemeteries (Section 3.1) and fatal flaws (criteria that would immediately render a site unsuitable for the development of a cemetery) (Section 3.2);
- To develop a multi-criteria evaluation process for identifying some optimal positions for cemeteries (Section 3.2); and
- To apply multi-criteria evaluation in Białystok. Poland, where from 2018 a public debate on the location of a new cemetery began (Section 3.3).

### *3.1 Phase 1: Develop criteria to identify appropriate locations for cemeteries*

Research of the literature enabled the development of criteria – features of the optimally located cemetery. The indicators were assigned to five groups of criteria, including spatial criteria (4 indicators), legal criteria (3 indicators), environmental criteria (3 indicators), socio-cultural criteria (3 indicators), and landscape and aesthetic criteria (3 indicators): in total 16 indicators (see Tab. 2).

The developed method of land sustainability analysis for burial functions is consistent with the research assumption that the cemetery should be planned in accordance with the idea of sustainable development. Therefore, the assessment considered spatial, legal, environmental, socio-cultural, landscape and aesthetic criteria:

- Environmental criteria: Due to the necessity to ensure epidemiological safety, a cemetery must fulfil a number of location indicators standardised in provisions relating to geotechnical aspects (ground conditions, quality of soil, land relief) and hydrological aspects;
- Landscape and aesthetics criteria: Aesthetics are a very important consideration when choosing a cemetery site (Sheppard-Simms, 2012; Black, Dubyna and Rapke, 2016; Rocque, 2017). The landscape character will be affected in a number of ways by development of a new cemetery. Neat and clean sites that look natural and peaceful with desirable viewscapes seem to be preferred by most cemetery consumers (Al-Akl, Nasser Karaan, Al-Zein and Assaad, 2018). The literature review shows that the research rarely considers the landscape and aesthetics criteria, while from the social point of view, they should be important in the final location decision (Rocque, 2017);
- Legal criteria: According to the literature review, it is important to verify the legal status of the land and consider the presence and location of protected natural and cultural resources on and adjacent to the property;
- Socio-cultural criteria: According to the Polish Classification of Building Facilities (1999) "Buildings intended for religious worship and religious activities" (class 1272) include cemeteries. For this reason, burial facilities should be incorporated in social infrastructure; and
- Spatial criteria: Due to high costs of investments related to the construction of cemeteries, the availability of services (access to infrastructure) is one of the key location factors. The location should exclude the possibility of harmful impact of the cemetery on its vicinity.

### *3.2 Phase 2: Develop fatal flaws and multi-criteria evaluation for identifying some optimal positions for cemeteries*

A staged approach to cemetery site selection process is proposed: identification the fatal flaws (Phase I: preliminary site assessment) and multi-criteria assessment (Phase II) when selecting a cemetery site (Fig. 2).

The main research phase is the evaluation based on five groups of criteria. Since the multi-criteria analysis relies on weights and these, according to Xu and Zhang (2013) are an element of uncertainty, Phase I was added: the identification of fatal flaws associated with cemeteries. The fatal flaws are criteria that would immediately render a site unsuitable for the cemetery development and therefore are important criteria to consider (Judge, 2012, p. 44). The fatal flaw analysis removes areas with inherent fatal flaws and thus reduces the search area and saves on time as well as resources spent on an area that would prove unacceptable for cemetery establishment. The determination of fatal flaws was based on the following sources: interviews with experts (including, the manager of the South Municipal Cemetery in Antoninów – one of the newest and the largest of Warsaw's cemeteries, members of the Polish Funeral Association, and the Polish Chamber of Funeral Industry); the literature review (Tab. 1); and legislation (applicable provisions of law and judicial decisions – available online at https://isap.sejm.gov.pl/, http://orzeczenia.ms.gov.pl/). The issues regarding the selection of a proper area for a cemetery are governed by the Regulation of the Minister of Municipal Economy of August 25, 1959 on Determining which

Areas in Terms of Sanitation are Suitable for Cemeteries, Act of January 31, 1959 on Cemeteries and Burial of the Deceased, Regulation of the Minister of Infrastructure of March 7, 2008 on Requirements for Cemeteries, Graves and other Places of Burial of Corpses and Remains, Spatial Planning and Land Development Act of March 27, 2003 (Pilarczyk and Nowak, 2019; Długozima, 2020b). The above-mentioned Regulation (1959) indicates that before establishing a cemetery one should analyse the features and conditions of the area considered as a place where burials are located. The following factors are analysed: water system of the area, type of land, minimum distance from potable water source (e.g. well, spring, borehole), housing development and other facilities on which a cemetery may have a negative impact.

The following exclusion criteria have been defined as the so-called fatal flaws (Phase I):

- Site laying on slope > 10° (30% or more of the site has slopes exceeding 10°) or site located in a depression, below the surrounding area;
- Site lying within flood risk (cemetery should not be located below the 1 in 50 year flood line of a river, in close proximity to water bodies such as wetlands);
- National park, nature reserve, strict conservation protection zone extends on the site (cemetery should not be situated in or near sensitive ecological, historical areas);
- Level of underground water is less than 2.5 meters (shallow groundwater);
- Distance from potable water source is less than 150 metres;
- Distance from housing development and other facilities on which a cemetery may have a negative impact is less than 150 metres (or 50 metres if the area is connected to a water supply system);
- The site has only highly permeable soils;
- There are no possibilities to develop adequate buffer zones separations between the site boundary and other land-uses (at least 50 m around the site).

| Idem | Indicator (criteria description) | Criteria significance | Data collection |
|---|---|---|---|
| K1 | Spatial criteria | | |
| K1.1 | Land use character of surrounding area (current land use) | Cemetery should be located far from national highways, railways, production facilities emitting excessive noise, odours. The greater the distance from incompatible land uses, the lower the risk of nuisance problems and hence resistance to facility. | Cartographic data: aerial photographs, digital maps<br>Open Geoportal Geospatial Data https://polska.e-mapa.net/<br>Spatial analysis using QGIS: boundary analysis, buffer analysis, calculate area and distance |
| K1.2 | Existing infrastructure (availability of engineering services: powerlines, waterworks) | Reduction of investment cost by linking cemetery to existing infrastructure. | |
| K1.3 | Accessibility | The bereavement process is made easier for relatives by visiting a cemetery well laid out. This is associated with cost, convenience and environmental implications, especially if a new road is to be constructed. The shorter the distance to the site through residential areas, the more acceptable the site. | |
| K1.4 | Land available | Larger sites tend to be more economically attractive. | |
| K2 | Legal criteria | | |
| K2.1 | Legal status of land | Status of land (public/private; regulated/unregulated) affects cost and duration of the investment. | Cartographic data: land and building register, cadastral map<br>Spatial Information System of the Białystok Poviat – https://bialostocki.e-mapa.net/ |
| K2.2 | Constraints resulting from protected areas (natural and cultural forms of protection) | Maximise the distance to natural, historical, cultural relics. | Cartographic data: digital map<br>Geospatial data from: The General Directorate for Environmental Protection – http://geoserwis.gdos.gov.pl/mapy/ (natural environment), the National Institute of Cultural Heritage (cultural environment) – https://mapy.zabytek.gov.pl/ |
| K2.3 | Compliance with local policy (Spatial Development Conditions and Directions Study, local spatial development plan) | Including areas predestined for cemeteries in spatial policy document allows to shorten the time of completing documentation of planned cemetery. | Non-cartographic data: spatial policy documents (spatial development conditions and directions study and local land use plans) [63–65]<br>Spatial Information System of the Białystok Poviat – https://bialostocki.e-mapa.net/ |

*... Tab. 2: continuing on the next page ...*

| Idem | Indicator (criteria description) | Criteria significance | Data collection |
|---|---|---|---|
| K3 | Environmental criteria | | |
| K3.1 | Hydrological aspects: flood area, the distance to ground or surface water, presence of hydrographic objects | The greater this distance, the more suitable the site is in terms of lower potential for water pollution; maximise the distance to sources of surface water. | Cartographic data: ground water level, hydrogeological maps<br>the National Water Management "Wody Polskie" https://wody.isok.gov.pl/ |
| K3.2 | Land relief, topography | The steeper the terrain, the more levelling costs will be. Cemeteries should be located on elevated ground, above the surrounding area, in order to protect the groundwater. | Cartographic data: digital maps, physical map<br>Elevation profile, slope analysis using Open Geoportal Geospatial Data https://polska.e-mapa.net/ |
| K3.3 | Geotechnical aspects: ground conditions (the quality of on-site soil) | Low permeability soils reduce pollution migration and are therefore favoured. | Cartographic data: soil type, geological maps<br>the Polish Geological Institute, the Central Geological Database https://geologia.pgi.gov.pl/<br>"Explanations to the geological map of Poland" |
| K4 | Socio-cultural criteria | | |
| K4.1 | Acceptance of investment/ community's attitude to cemetery | If construction of cemetery is initiative of local community (community-friendly investment), the risk of NIMBY syndrome is reduced. | Public Information Bulletin, website of the local government unit, local community (Internet forum of residents) |
| K4.2 | Social accessibility (location in relation to centre and residential areas) | It is ideal to find a balance between close proximity to communities while not limiting urban development. | Cartographic data:<br>Open Geoportal Geospatial Data https://polska.e-mapa.net/<br>Determining distance of site from residential areas and settlement unit centre |
| K4.3 | Social accessibility (location in relation to important places in community, in particular religious facilities) | Essential to social infrastructure of communities, need to be established in accessible locations to meet the expectations of the populations they serve. | Field visit (identification of landmarks, nodes, community's important places) |
| K5 | Landscape and aesthetics criteria | | |
| K5.1 | Location in relation to natural system | Cemetery can often enhance natural heritage and provide opportunities for enhanced biodiversity and connectivity of the natural heritage system. Cemeteries can have positive impacts on natural and hydrological features, and contribute to enhanced natural features as well as preservation of open space. | Cartographic data: digital maps<br>Non-cartographic data: documents of spatial planning policy (analysis of local development plans and spatial development conditions and directions study)<br>Geospatial data from: The General Directorate for Environmental Protection http://geoserwis.gdos.gov.pl/mapy/<br>Open Geoportal Geospatial Data https://polska.e-mapa.net/ |
| K5.2 | Landscape features/character | New cemeteries should be located to be compatible with natural, cultural, visual and open landscape character of the area. | Field research<br>Landscape identity assessment including: visual perception characterisation and dominating landscape elements characterisation (Landscape Character Assessment, 2002; Ode, Tveit and Fry, 2008; Nitavska, 2011) |
| K5.3 | Visual assessment (views from site, views into site) | The landscape character will be affected in a number of ways by development of a new cemetery. Highly visible sites will result in additional costs to be incurred for screening. Exposed sites with high visibility (these are less desirable than sites that are secluded or naturally screened). | Field research<br>Views' sequence analysis (Cullen, 1995; Królikowski, 2016)<br>Analysis of panoramas (Wejchert, 1974) |

*Tab. 2: List of criteria and indicators (required data) that are relevant for the research*
*Source: author's conceptualisation*

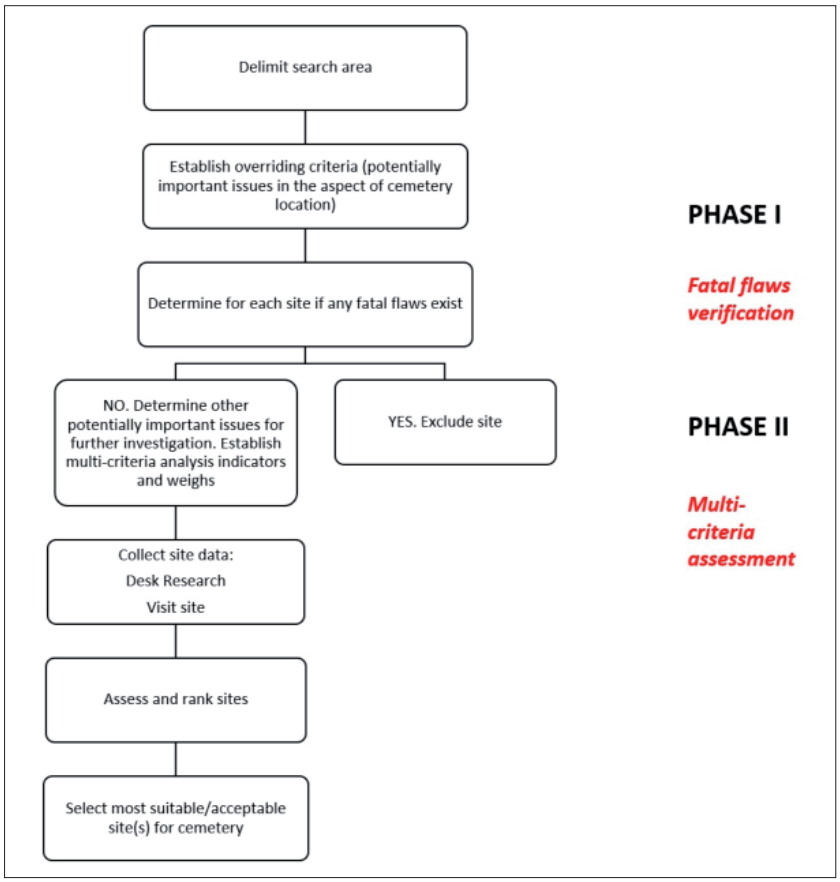


*Fig. 2: Cemetery site selection flow chart*
*Source: author's conceptualisation*

Sites which do not have fatal flaws are qualified to enter Phase II of the research. So far, a multi-criteria ranking matrix has been developed, allowing for an objective method of assessing individual sites and thus indicating which sites are more suited for the establishment of a cemetery.

The multi-criteria assessment (MCA) is applied to support a decision-making process when several or more than criteria are at hand (WSP Opus, 2019). The proposed method contains elements of the AHP (Analytical Hierarchy Process) method. The AHP method is hierarchically structured. Therefore, in using it, the weights of the main criteria (five groups) were determined. The first step, in this phase, was to determine the criteria which lead to the achievement of the set aim (Yoon and Hwang, 1995; Šelih, Kne, Srdić and Žura, 2008; Figueira, Greco and Ehrgott, 2016). The criteria were adapted to the assessment purpose. Therefore, they were precisely formulated. Some criteria refer to measurable phenomena, hence they can easily be defined. Others, however, need to be described with linguistic methods and require an adequate scale as well as identification methods (see Tab. 3). After selecting the influencing criteria (Section 3.1), the next step and one of the most important ones was to calculate the importance of each criterion. As mentioned above, weights are an element of uncertainty (Xu and Zhang, 2013): hence, the calculation of weights was determined by 30 experts from the fields of cemetery management, funeral services, landscape design and land use planning. Experts have determined which criteria, in their opinion, are the most important and which are less important in the decision-making process of identifying suitable options for cemeteries (the sum of the weights of a criterion is 1) (Tab. 3). All sites qualified for Phase II were assessed by scoring 0–2, with scores of 2 being most favoured. Scores of 0 fulfil the criterion to the least extent and involve the necessity of undertaking specific activities generating additional costs and environmental, technical and spatial consequences (Tab. 3).

The suitability was calculated from the formula:

$$s_i = \sum_{j=1}^{m} (z_{ij} \cdot v_j)$$

where $s$ = output (suitability), $z_{ij}$ = value of a parameter, $v_j$ = weight of a criterion, $i$ = a criterion, and $m$ = number of criteria.

The output was divided into four main categories to facilitate the determination of a suitable cemetery: I. High suitable level; II. Moderate suitable level; III. Less suitable level; and IV. Unsuitable level.

### 3.1 Phase 3: Application of multi-criteria analysis in Białystok

Elimination of sites with fatal flaws and the application of a multi-criteria analysis was carried out to select an appropriate site for burials. The implementation was carried out for Białystok, a city with 297,585 inhabitants (2020), which is the capital of Podlaskie Voivodeship. The choice of research area was determined by the city's spatial policy aimed at providing local burial facilities. Despite the shortage of space at the only municipal cemetery, the local authorities of Białystok have been pressurised since 1999 to find cemetery space within the city's borders. Finally, a cemetery was built on the grounds of the Supraśl

| Idem | Criterion | Value of a parameter ($z$) | Scores | Criteria weight ($v$) | Final weight |
|---|---|---|---|---|---|
| K1 | Spatial | | | | |
| K1.1 | Land use character of surrounding area (current land use) | Industrial areas with facilities where noise level exceeds the recommended noise limit; other nuisance in the buffer zone (railway, waste water treatment plant, waste recycling site) (the need for isolating by greenery planting) | 0 | **0.253** | 0 |
| | | Built-up areas: residential, service facilities | 1 | | 0.021 |
| | | Vacant land/clear land/undeveloped area (wastelands, agricultural land) | 2 | | 0.042 |
| K1.2 | Existing infrastructure, availability of services (access to infrastructure) | Overhead power lines 110 kV, 220 kV (the need to establish safety/technical zone) | 0 | | 0 |
| | | Lack of infrastructure, in the proximity access to services (water, electricity) | 1 | | 0.021 |
| | | Existing infrastructure on the site, overhead power lines not in collision with the planned investment | 2 | | 0.042 |
| K1.3 | Accessibility | Out of town, no public transport access and no direct entrance to major roads of streets (the need to build transport infrastructure that improves site accessibility) | 0 | | 0 |
| | | • In town but with no ease of access for public transport or<br>• out of town with public transport access (including cycle paths) near to site (< 500 m) or<br>• out of town with direct entrance to major roads of streets | 1 | | 0.021 |
| | | In town with access to public transport (< 500 m) | 2 | | 0.042 |
| K1.4 | Land available [ha] | 3–5 ha (no space for future expansion; the need for arrangement the site with columbaria domination; the need to purchase surrounding land) | 0 | | 0 |
| | | 5–10 ha | 1 | | 0.021 |
| | | > 10 ha, space for adequate future expansion | 2 | | 0.042 |
| K2 | Legal | | | | |
| K2.1 | Legal status of land | Land divided into smaller plots with unknown owner or several owners (the land is private property and must be purchased) | 0 | **0.230** | 0 |
| | | Land is owned by local government unit other than the one that is planning the investment (the need to establish an inter-municipal cooperative); property of Church or religious associations (one established owner) | 1 | | 0.026 |
| | | Land is owned by local government unit or the Treasury | 2 | | 0.051 |
| K2.2 | Constraints resulting from protected areas (natural and cultural forms of protection) | There are less restrictive forms, zones of natural, cultural protection on the site (need to prepare of environmental impact assessment) | 0 | | 0 |
| | | Site is adjacent to natural, cultural forms of protection | 1 | | 0.026 |
| | | Site has no protection or conservation restrictions; site has elements of natural or cultural system, but without protection | 2 | | 0.051 |
| K2.3 | Compliance with local policy (spatial development conditions and directions study, local spatial development plan) | No entries regarding the cemetery in planning documents (spatial development conditions and directions study, local spatial development plan) (the need to change provisions) | 0 | | 0 |
| | | Cemetery included in spatial development conditions and directions study as a public aim investment | 1 | | 0.026 |
| | | Cemetery or public greenery is included in planning documents, no need to change the documents provisions | 2 | | 0.051 |

*... Tab. 3: continuing on the next page ...*

| Idem | Criterion | Value of a parameter ($z$) | Scores | Criteria weight ($v$) | Final weight |
|---|---|---|---|---|---|
| K3 | Environmental | | | | |
| K3.1 | Hydrological aspects: flood area, the distance to ground or surface water, presence of hydrographic objects | The whole site outside flood risk, but site slopes down towards the line of watercourse or water reservoir (possibility of negative water impact on this area and paying special attention to proper protection of newly-designed cemetery) | 0 | **0.184** | 0 |
| | | The whole site outside flood risk, but, the site adjoints wetlands | 1 | | 0.020 |
| | | The whole site outside flood risk, no water issues | 2 | | 0.041 |
| K3.2 | Land relief, topography | Very steep (slope angle more than 5°) or very flat (less than 1°) topography (the need for earthworks, implementation of drainage systems or hydrophilic plant species) | 0 | | 0 |
| | | Flat land (slope angle between 1° and 2° | 1 | | 0.02 |
| | | Gently sloping lands (slope angle between 2° and 5°) | 2 | | 0.041 |
| K3.3 | Geotechnical aspects: ground conditions (the quality of on-site soil) | Domination of unsuitable soils, high permeability (sand, gravel) (zones with poor to medium water permeability are also present); at least 30% of the site has unfavourable ground conditions (need for earthworks) | 0 | | 0 |
| | | Locally unsuitable soils; at most 30% of the site has unfavourable ground conditions | 1 | | 0.02 |
| | | Domination of suitable soils; low and moderate permeability but low water-holding capacity and low soil absorbing capacity (silty sand, clayey sand, silt, peat); favourable ground conditions | 2 | | 0.041 |
| K4 | Socio-cultural | | | | |
| K4.1 | Acceptance of investment/community's attitude to cemetery | Lack of information (need for social consultation) | 0 | **0.172** | 0 |
| | | Popularisation of burial needs in local media | 1 | | 0.019 |
| | | Community-based project (community submits applications for cemetery construction to local government council) | 2 | | 0.038 |
| K4.2 | Social accessibility (location in relation to centre and residential areas) | Isolated, away from human settlements (need for social consultation) | 0 | | 0 |
| | | Close to settlement unit centre, cemetery's buffer zone includes single plots of land with residential buildings | 1 | | 0.019 |
| | | Between settlement units, designed cemetery as integrating space | 2 | | 0.038 |
| K4.3 | Social accessibility (location in relation to important places in community, in particular religious facilities) | Not related to socially important places (need for social consultation) | 0 | | 0 |
| | | Visually connected with temple and (or) existing cemetery | 1 | | 0.019 |
| | | Located in direct vicinity of temple, cemetery or important for local community objects of small religious architecture | 2 | | 0.038 |
| K5 | Landscape and aesthetics | | | | |
| K5.1 | Location in relation to natural system | No relationships identified (need for link with natural system by greenery) | 0 | **0.161** | 0 |
| | | Cemetery will complement existing ecological corridor | 1 | | 0.018 |
| | | Cemetery will support the basic natural system | 2 | | 0.036 |

*... Tab. 3: continuing on the next page ...*

| Idem | Criterion | Value of a parameter ($z$) | Scores | Criteria weight ($v$) | Final weight |
|---|---|---|---|---|---|
| K5.2 | Landscape features/ character | Monotonous, uniform (need to create, diverse layout of cemetery by greenery) | 0 | | 0 |
| | | Moderate number of elements, plans | 1 | | 0.018 |
| | | Great variety of elements, plans | 2 | | 0.036 |
| K5.3 | Visibility in the landscape | Due to the human scale development in cemetery's buffer zone, cemetery on this site will be a spatial dominant (the object may have a negative impact on site landscape values) (need to create an earthen berm or a perimeter buffer zone with greenery) | 0 | | 0 |
| | | Cemetery will be exposed in open landscape | 1 | | 0.018 |
| | | Cemetery will be integrated with local landscape | 2 | | 0.036 |

*Tab. 3: Assessment criteria with the parameter values and the weights (in the rows "0": the necessity of undertaking specific activities is highlighted). Source: author's conceptualisation*

community, in the village of Karakule. The new facility, established in 2010, is located to the north-east of city borders, and therefore, it is difficult to access for residents of the southern and western districts of the Białystok. In 2018–2019, a public debate on a new cemetery was initiated. The proposals to establish a new cemetery in Las Turczyński (the Choroszcz community) provoked opposition from the residents, expressing concerns about the prospect of a decrease of the natural and social values of the area (deforestation of the area of 29 ha). It was decided to verify whether an alternative location could be proposed in the suburban area of Białystok, allowing protection of areas with high natural and social values. Eleven objects were covered by the study. The sites were proposed by the Association of Polish Architects Białystok branch (Polish: SARP). According to Polish law, a cemetery may be established on the local government unit's land. The law also allows for the possibility of establishing an inter-municipal cooperative in the event of problems with obtaining an appropriate site. Establishing inter-municipal cooperation takes place to jointly perform public tasks in the field of cemeteries. Among the proposed locations there are both some areas within the city boundaries (sites 1, 2), as well as in the neighbouring communities of Choroszcz (sites 3, 4, 5, 6, 7, 8, 9, and 10) and Turośń Kościelna (site 11) (see Tab. 4, Fig. 3). The search for areas suitable for a cemetery was carried out in the suburban area of Białystok. As Dent and Knight (1998, p. 451) have stated:

> "There is little room for expansion of existing sites and most included space is either full or being rapidly consumed. Most of our capital cities are now seeking land for cemetery dedication in the urban fringe areas, which to some extent goes with expanding populations and urban sprawl".

Initially, a list of key criteria was developed to verify whether they were present at the 11 sites. Later, a multi-criteria analysis was applied using the criteria in accordance with Table 3. The assessment was undertaken using GIS analysis software (QGIS), utilising data layers containing information on the site selection criteria, by investigating existing literature, legislation or reports relating to the relevant area, or through field research. Data for the multi-criteria analysis for identifying potential sites for cemeteries were collected from the following

| Site number | Localisation (community/geodesic precinct) | Area [ha] | Development direction in the planning document | Land use, elements of development in buffer zone |
|---|---|---|---|---|
| 1. | Białystok city/ Klepacze | 18.0 | Agricultural land | Railway, residential areas |
| 2. | Białystok city/ Ścianka | 6.6 | Industrial area, service facilities | Heating plant, railway |
| 3. | Choroszcz/ Ogrodniki | 22.0 | Agricultural land | Railway, residential areas |
| 4. | Choroszcz/ Czaplino | 12.0 | Agricultural land | Forest |
| 5. | Choroszcz/ Czaplino | 18.7 | Agricultural land | Forest, wasteland |
| 6. | Choroszcz/ Barszczewo | 20.0 | Agricultural land | Homesteads, the East of Poland Cycling Trail GreenVelo, wayside shrine |
| 7. | Choroszcz/ Barszczewo | 9.7 | Agricultural land | Agricultural land, wasteland |
| 8. | Choroszcz/ Sienkiewicze | 16.7 | Agricultural land | Wasteland, homesteads, service facilities |
| 9. | Choroszcz city | 18.0 | Church area | Agricultural land, wasteland, wayside shrine |
| 10. | Choroszcz city | 27.0 | Church area | Agricultural land, wasteland |
| | Turośń Kościelna/Niewodnica Kościelna | 22.0 | Church area | Sacral complex: church, cemetery, homesteads |

*Tab. 4: List of potential areas for the location of the new cemetery in Białystok Source: author's elaboration*

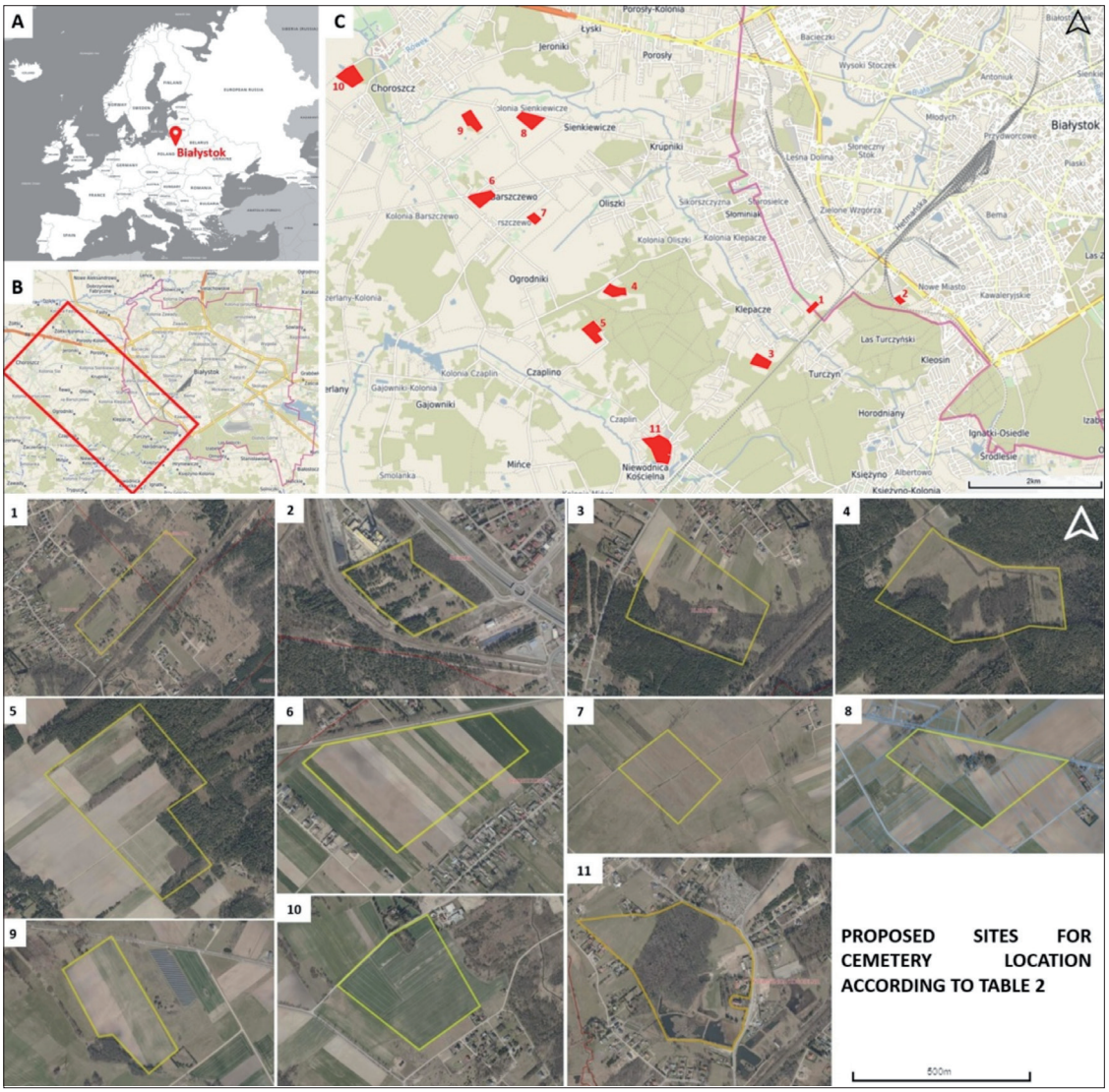


*Fig. 3: Research area: Białystok in the map of Europe (A); the spatial distribution of selected sites in relation to the city boundaries (B, C); and their landscape setting (see below)*
*Source: author's elaboration based on https://polska.e-mapa.net/*

institutions: the General Directorate for Environmental Protection, the National Institute of Cultural Heritage, the Białystok Poviat, the National Water Management "Wody Polskie", the Polish Geological Institute, the Central Geological Database, the Municipal and Communal Offices of Białystok, Choroszcz and Turośń Kościelna. A number of criteria and their corresponding indicators, which concern legal (local policy), landscape and aesthetic characters were elaborated based on local spatial policy documents (Spatial Development Conditions and Directions Studies of Białystok, Choroszcz and Turośń Kościelna and the local spatial development plans). To assess and evaluate proposed sites for cemeteries, an evidence card in the form of a table consisting of a descriptive part as well as a graphic one were created (see Tab. 5 and Fig. 6 as samples). The data were divided into the categories that directly relate to the scope of the assessment criteria.

## 4. Results and discussion

Eleven potential cemetery areas were analysed according to the defined criteria (5 groups, 16 indicators). Within the 11 options considered potentially suitable for cemetery development, seven areas were identified as potential development options (highly and moderately suitable) (sites 2, 4, 5, 6, 8, 9, and 10). Having verified the overriding criteria (the so-called fatal flaws) the following table summarises the non-qualifying sites based on legal, environmental and spatial considerations as listed below in Table 6.

Sites for which no overriding criteria apply were selected for further assessment. Nine of the 11 sites qualified for multi-criteria analysis. Exclusionary conditions for site selection purposes were identified on the sites 7 and 11 (Fig. 4). Burials must not cause pollution and therefore should not take place below the water table, according to defined fatal flaws. Sites 7 and 11 are situated below the surrounding areas, in close proximity to water bodies (shallow groundwater). Sites evaluated in the reports prepared by WRC (1994) and WSP Opus (2019) were excluded from further study for the same reasons. As Dover District Council stated (2010) environmental issues, especially groundwater is a major part of land assessment for cemeteries. This approach is consistent with the recommendation that "There is a need of building appropriate cemeteries to adequately receive dead bodies and minimise the effects of juxtaposition between residential and cemeterial areas" (Neckel et al., 2017, p. 218).

<table>
<tr><td rowspan="2">Map of the location of site<br>Location of the site in relation to settlement units – especially to Białystok, and communes Choroszcz, Turośń Kościelna</td><td colspan="2">Environmental criteria (K3)</td><td>Legal criteria (K2)</td></tr>
<tr><td>K3,3<br>Geological map with soil types</td><td>K3,1<br>Hydrological map (with flood risk)</td><td rowspan="3">Local land use plan with land register data and buffer zone (150 m)</td></tr>
<tr><td rowspan="2">Spatial criteria (K1)<br>Map with spatial data (land use, existing infrastructure, accessibility)</td><td rowspan="2">K3,2<br>Hypsometric map</td><td>Elevation profile 1</td></tr>
<tr><td>Elevation profile 2</td></tr>
<tr><td colspan="2">Socio-cultural criteria (K4)<br>Orthophoto map with identification of community's important places</td><td>Graphic card<br>.....<br>(site number)</td><td>K5,1<br>Location in relation to natural system (extract from Spatial Development Conditions and Directions Study)</td></tr>
<tr><td colspan="4">Landscape and aesthetic criteria (K5,2; K5,3)<br>Photos showing landscape character and views from site</td></tr>
</table>

*Tab. 5: Graphic card template*
*Source: author's elaboration*

| Site number | Fatal flaw (– No) (+ Yes) | Specification |
|---|---|---|
| 1 | - | Qualified to phase II |
| 2 | - | Qualified to phase II |
| 3 | - | Qualified to phase II |
| 4 | - | Qualified to phase II |
| 5 | - | Qualified to phase II |
| 6 | - | Qualified to phase II |
| 7 | + | Site in depression, below the surrounding area |
| | | Site lying in close proximity to water bodies such as wetlands |
| 8 | - | Qualified to phase II |
| 9 | - | Qualified to phase II |
| 10 | - | Qualified to phase II |
| 11 | + | Site in depression, below the surrounding area |
| | | Site lying in close proximity to water bodies such as wetlands |
| | | Site has soils with high permeability; the vast majority of the area covered by the investment project slopes down to the adjacent wetland; hydrographic objects on the site; on the lowest parts of the site local waterlogging appeared |

*Tab. 6: The list of non-qualifying sites*
*Source: author's elaboration*

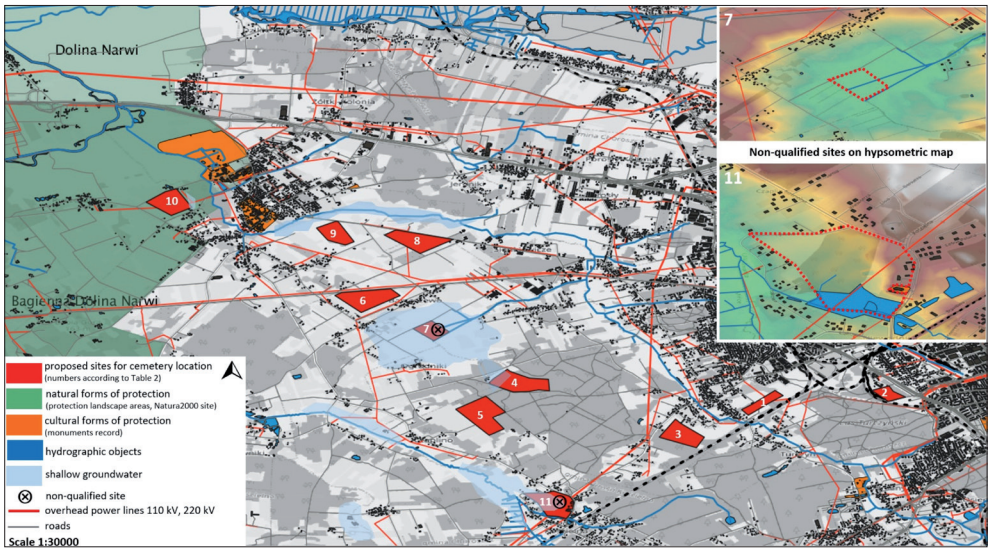


*Fig. 4: Spatial, environmental and legal conditions for the analysed sites*
*Source: author's elaboration*

The top four highest ranked sites were as follows: 5, 6, 8, 9 and these sites may require further detailed investigation (Fig. 5, Tab. 7).

One highly suitable candidate for a cemetery is site 9 (the highest score and the highest number of fulfilled indicators). Currently, the structure of this site is dominated by agricultural land. This site (Fig. 6) is regarded as the best as it is directly adjacent to the Choroszcz city centre (700 m), the road from Choroszcz to Białystok (Białostocka Street: along this road there is the Green Velo bicycle way and the Zygmunt Gloger walking trail); the housing area (nearest buildings 200 m from the site boundary); as well as religious objects (church and wayside shrine).

Similarly, a perfect location is a flat, diverse, and attractive area in terms of landscape values. Having scrutinised a range of assessments of the proposed sites, option No. 9 would

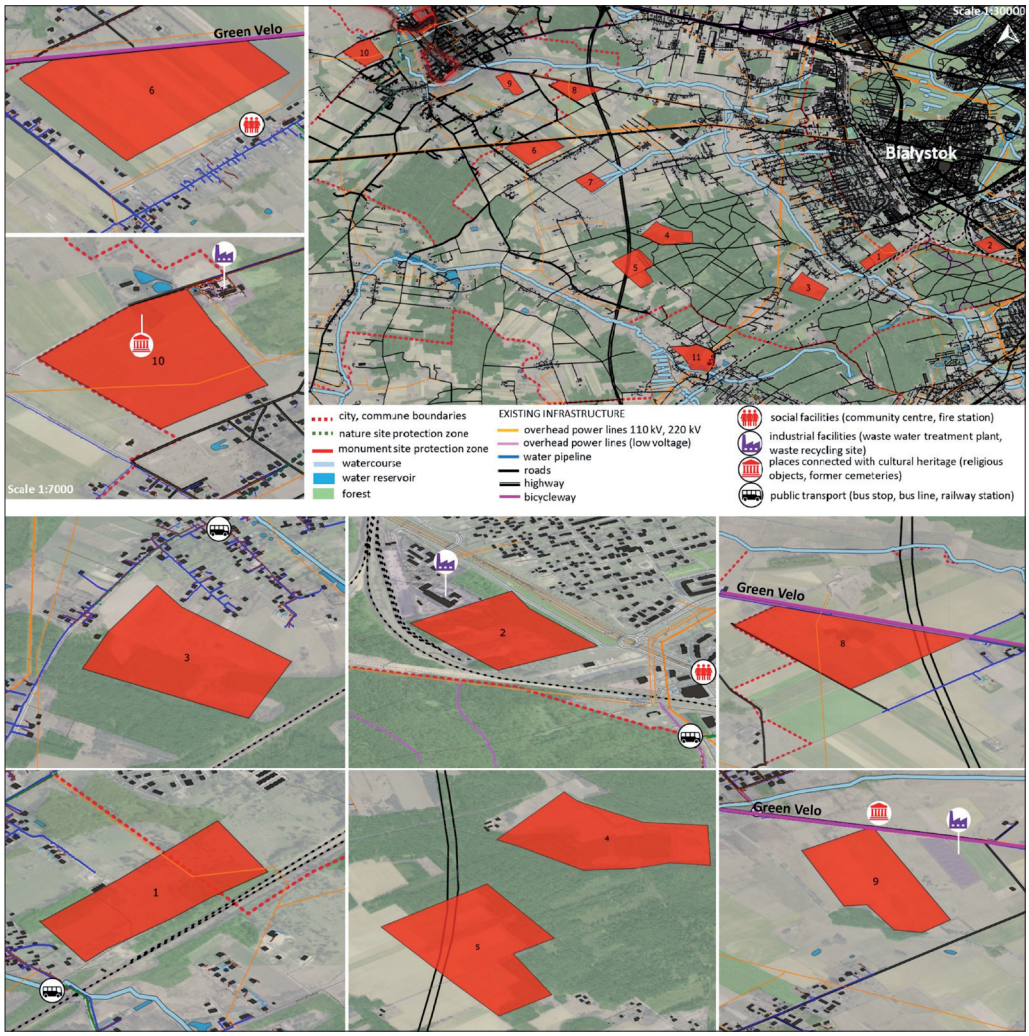


*Fig. 5: Spatial analysis presenting the characteristics of qualified sites for a cemetery (including context)*
*Source: author's elaboration*

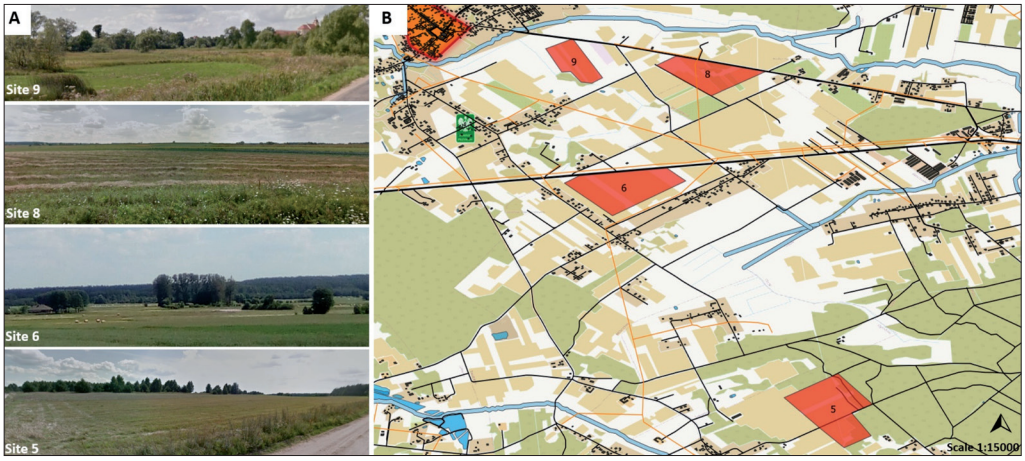


*Fig. 6: Sites 5,6,8,9 as the highest rated options showing on representative photographs (A) and on QGIS map (B)*
*Source: author's elaboration*

serve best the public interests with its size, location access and social, landscape considerations. The site would have to be developed with minimum impact on current visual aspects and vistas. It can be proposed and discussed with the local authorities and community.

Moreover, site 6 is classified as moderately suitable and ranked in second place in terms of the number of fulfilled indicators. The main features of this area are accessibility (location near social facilities and the tertiary road – Kruszewska Street, with Green Velo bicycle way), land structure (agricultural land and wastelands), distance to human settlements (circa 50 m), varied landscape and existing infrastructure (water pipeline, electricity).

Both sites were highly rated for their accessibility, which corresponds with the Cemetery Development Services (2010) site assessment report. Many visitors to cemeteries are the elderly and infirm that may, for whatever reason, not have access to private transport. Therefore, the cemetery site location should be within easy access of local bus stops with short taxi routes from the town centre, as well as being close to the proximity of the settlement unit for pedestrian and cycle ways.

| Criterion | Indicator | Proposed sites for cemetery location (according to Tab. 2) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| K1 | K1.1 | 0 | 0 | 1 | 2 | 2 | 1 | | 2 | 2 | 2 | |
| | K1.2 | 2 | 2 | 1 | 1 | 1 | 2 | | 0 | 2 | 0 | |
| | K1. | 2 | 2 | 0 | 0 | 1 | 1 | | 1 | 1 | 1 | |
| | K1.4 | 2 | 1 | 2 | 2 | 2 | 2 | | 2 | 2 | 2 | |
| | X | 0.253 | 0.253 | 0.253 | 0.253 | 0.253 | 0.253 | | 0.253 | 0.253 | 0.253 | |
| | ∑ | 1.518 | 1.265 | 1.012 | 1.265 | 1.518 | 1.518 | | 1.265 | 1.771 | 1.265 | |
| K2 | K2.1 | 0 | 2 | 0 | 0 | 0 | 0 | | 0 | 2 | 2 | |
| | K2.2 | 2 | 2 | 1 | 2 | 2 | 2 | | 2 | 2 | 0 | |
| | K2.3 | 0 | 0 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | |
| | X | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | | 0.23 | 0.23 | 0.23 | |
| | ∑ | 0.46 | 0.92 | 0.46 | 0.69 | 0.69 | 0.69 | | 0.69 | 1.15 | 0.69 | |
| K3 | K3.1 | 2 | 2 | 2 | 2 | 2 | 2 | | 1 | 0 | 0 | |
| | K3.2 | 1 | 1 | 1 | 2 | 1 | 2 | | 1 | 2 | 1 | |
| | K3.3 | 0 | 0 | 1 | 2 | 2 | 2 | | 1 | 1 | 1 | |
| | X | 0.184 | 0.184 | 0.184 | 0.184 | 0.184 | 0.184 | | 0.184 | 0.184 | 0.184 | |
| | ∑ | 0.552 | 0.552 | 0.736 | 1.104 | 0.92 | 1.104 | | 0.552 | 0.552 | 0.368 | |
| K4 | K4.1 | 0 | 0 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | |
| | K4.2 | 1 | 1 | 1 | 0 | 1 | 2 | | 2 | 2 | 1 | |
| | K4.3 | 2 | 2 | 0 | 0 | 1 | 2 | | 2 | 2 | 2 | |
| | X | 0.172 | 0.172 | 0.172 | 0.172 | 0.172 | 0.172 | | 0.172 | 0.172 | 0.172 | |
| | ∑ | 0.516 | 0.516 | 0.344 | 0.172 | 0.516 | 0.86 | | 0.86 | 0.86 | 0.688 | |
| K5 | K5.1 | 0 | 2 | 1 | 2 | 1 | 2 | | 2 | 2 | 2 | |
| | K5.2 | 1 | 2 | 1 | 2 | 1 | 2 | | 2 | 2 | 2 | |
| | K5.3 | 0 | 2 | 1 | 2 | 2 | 1 | | 2 | 2 | 2 | |
| | X | 0.161 | 0.161 | 0.161 | 0.161 | 0.161 | 0.161 | | 0.161 | 0.161 | 0.161 | |
| | ∑ | 0.161 | 0.966 | 0.483 | 0.966 | 0.644 | 0.805 | | 0.966 | 0.966 | 0.966 | |
| | **Total score** | **3.207** | **4.219** | **3.035** | **4.197** | **4.288** | **4.977** | | **4.333** | **5.299** | **3.977** | |

*Tab. 7: The results of multi-criteria evaluation for nine sites, where suitability levels (Tab. 8) are marked in colour and fulfil criteria in grey (Tab. 9)*
*Source: author's elaboration*

| % | Scores | Suitability levels | Site number |
|---|---|---|---|
| 0 ≤ x < 25 | 0 ≤ x < 1.626 (0–25%) | Unsuitable | 7,11 (non-qualifying sites) |
| 25 ≤ x < 50 | 1.626 ≤ x < 3.253 (25–50%) | Marginally suitable | 1,3 |
| 50 ≤ x < 75 | 3.253 ≤ x < 4.880 (50–75%) | Moderately suitable | 2,4,5,8,10 |
| 75 ≤ x ≤ 100 | 4.880 ≤ x ≥ 6.506 (75–100%) | Highly suitable | 6,9 |

*Tab. 8: The results – the site suitability levels*
*Source: author's elaboration*

| Site number | Fulfilment of: | | Score |
|---|---|---|---|
| | criteria (x/5) | indicators (y/16) | |
| 1 | 0/5 | 9/16 | 3.207 |
| 2 | 1/5 | 12/16 | 4.219 |
| 3 | 2/5 | 13/16 | 3.035 |
| 4 | 2/5 | 12/16 | 4.197 |
| 5 | 4/5 | 15/16 | 4.288 |
| 6 | 4/5 | 15/16 | 4.977 |
| 8 | 3/5 | 14/16 | 4.333 |
| 9 | 4/5 | 15/16 | 5.299 |
| 10 | 2/5 | 13/16 | 3.977 |

*Tab. 9: The results. Fulfilment of criteria, indicators, and final output. The sites that fulfil criteria to the largest extent are marked in grey*
*Source: author's elaboration*

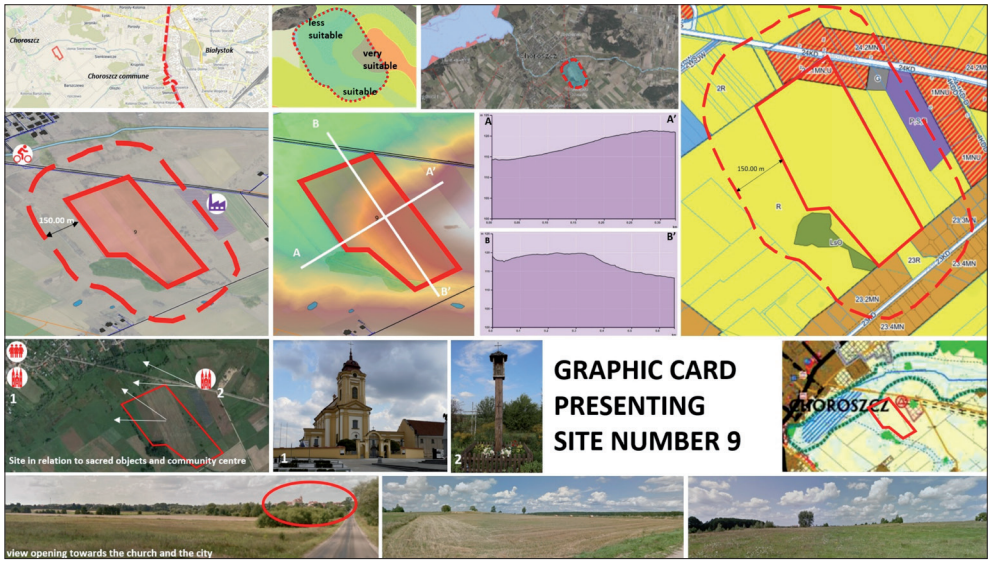


*Fig. 7: Site No. 9 as highly suitable for new cemetery*
*Source: author's elaboration*

There is no proper landfill site that fulfils all criteria/indicators, especially with respect to the legal requirements (local policy). For the highest rated sites, where the criteria are met less – some recommendations were developed on possible modifications that could be undertaken (Tab. 10).

The conducted multi-criteria analysis and four selected sites indicate that many sites suffer from constraints related to topography (land relief), groundwater levels, and soil permeability. As a result, these constraints in effect define a restricted development of ground suitable for burial use (interment of ashes, caskets). The results allow stakeholders to initiate in-depth studies in relation to the highest ranked sites. Currently, no investment activities are carried out in their vicinity, so they can be assigned in spatial policy documents as cemeteries for the local community. The peripherical location of the site in the settlement structure determines the need for expansion of its transportation infrastructure. On the other hand, too much exposition of the site in the landscape relates to a recommendation of visual intrusion managed by creating an earthen berm or a perimeter buffer zone with greenery. An overhead power line runs through the site No. 8 and is a barrier in cemetery planning processes (the need to establish safety/technical zone).

The multi-criteria analysis provided a comparative feasibility study for a new cemetery. The analysis of proposed sites in accordance to multifaceted criteria showed the most suitable options to provide burial facilities once the current Białystok cemeteries have become full. The 'essential elements' of the analysis are to: verify the fatal flaws, exclude sites with fatal flaws (a number of potential sites should be identified from the areas determined as not exhibiting a fatal flaw); review the current cemetery provision within the city and adjacent municipalities; undertake the research study to identify new sites that conform to the basic requirements for new cemetery space and the associated pre-defined analysis criteria; the site data collection; the evaluation of sites in line with the development criteria for a future cemetery development and classification into the suitability levels.

Further detailed investigation is undertaken on the highest-ranking sites. The areas considered potentially suitable for cemetery development should be subject to consultation to canvass the views of the community and key stakeholders. This stage also involves a detailed geotechnical investigation. As time and resources are limited, this stage should be realised only on a limited number of sites and, on the other hand, one must bear in mind an alternative option if the one selected first turns out to be flawed (Fig. 8).

| Site number | Not fully met criteria | | Type of costs | Recommendations |
|---|---|---|---|---|
| 5 | K2.1 | Land divided into smaller plots with unknown owner or several owners; the land is private property and must be purchased | Economic, legal (extended investment time) | Because of peripherical location - the need to develop the communication infrastructure connecting the site with the vicinity |
| 6 | K2.1 | Land divided into smaller plots with unknown owner or several owners; the land is private property and must be purchased | Economic, legal (extended investment time) | Because of high visibility of site - Visual intrusion can be managed by creating earthen berm or perimeter buffer zone with greenery |
| 8 | K2.1 | Land divided into smaller plots with unknown owner or several owners; the land is private property and must be purchased | Economic, legal (extended investment time) | Because of high permeability of soils in southern part of site – arrangement with columbaria are recommended* |
| | K1.2 | Overhead power lines 220 kV (the need to establish safety/technical zone) | | |
| 9 | K3.1 | The whole site outside exposed to flood risk, but site slopes down towards the line of a watercourse or a water reservoir (possibility of negative water impact on this area and pay special attention to proper protection of newly-designed cemetery) | Environmental, economic (drainage works, bunds, drains may be necessary) | Increasing the number of columbaria in the part of the cemetery located closer to the hydrographic facilities |

*Tab. 10: List of the highest ranked sites for burial purposes with recommendations*
*Source: author's elaboration based on NEPA (2007), PURDON (2009), CDS (2010)*
** Cremation burials usually pose a lesser risk to the water environment than conventional burials (SEPA, 2017)*

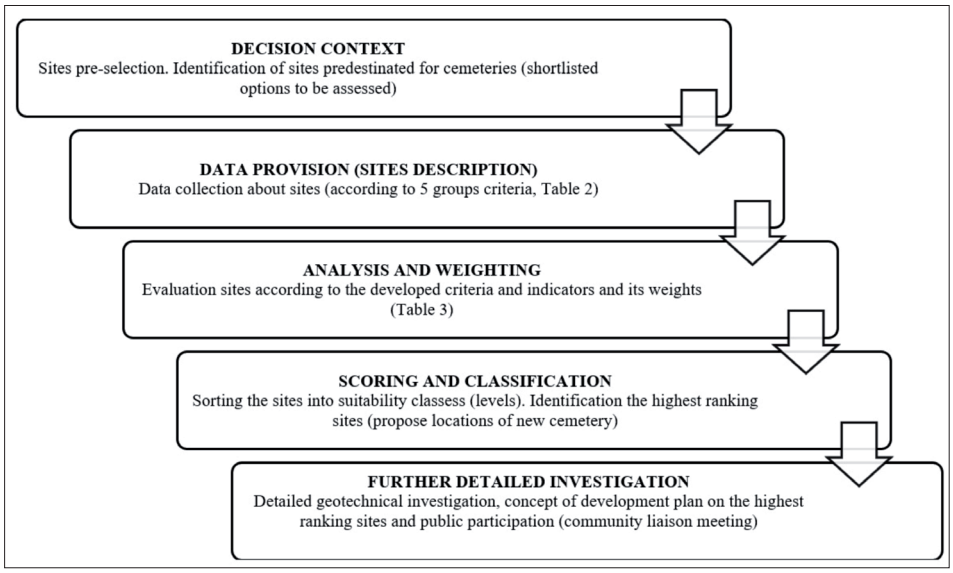


*Fig. 8: Methodology diagram – multicriteria analysis of shortlisted options*
*Source: author's conceptualisation*

Based on the conducted research, and with reference to world practice (CDS, 2010; Judge, 2012), it is recommended that a minimum of four sites should be identified and carried forward for further investigation (in case fatal flaws appear in the next phases: geotechnical investigations and community consultations are required). Due to the N-I-M-B-Y (Not-In-My-Back-Yard) syndrome, it is very important to include public participation in the cemetery site selection process. Community consultation should take place whereby a meeting is held to present the highest ranked sites and so that the affected communities are given the opportunity to voice their opinions and feelings about the proposed sites.

The methodology presented here aims at identifying areas that are most appropriate for the establishment of a cemetery and eliminating those areas that are most unsuitable. In this way, the financial burden associated with detailed site investigations is avoided by assessing only the most suitable sites. The multi-criteria analysis assists in the final decision made by aggregating a wide range of data to present recommendations which can be used to assist in the design phase.

The proposed procedure is partly based on the assessment procedures developed by the WRC (1994), WHO (1998), CDS (2010), and Judge (2012), using the fatal flaws and multi-criteria assessment approach. What distinguishes the developed method from the above-mentioned ones is its multifaceted nature: considering not only environmental, legal and spatial criteria, but also socio-cultural, landscape and aesthetics criteria – in accordance with the idea of sustainable development. The literature review shows that

previous research rarely considers landscape and aesthetics criteria, whereas from a social point of view, they should be important in the final location decision (Rocque, 2017).

As a cemetery is a landscape element, a vital element of natural and cultural heritage, it should be subjected to principles of landscape integrated design. Landscape design is focused on holistic, durable and sustainable development. As a result, a new burial site in line with landscape design aims at preservation of human environmental quality because of its efficient use and is based on rules of durable and sustainable development (spatial, legal, environmental, socio-cultural and landscape requirements). This research shows that several important factors are required for a new cemetery site. Any new facility should be located at an adequate distance from the current city to allow for cemetery development unimpeded by urban growth, as well as ensuring proximity to affordable transport options for mourners.

## 5. Conclusions

The proposed multi-criteria analysis can be used as a supportive tool in the spatial planning process for officials, planners, urban geographers, landscape architects, social activists and other experts. Therefore, it can reduce the potential spatial and socio-cultural problems posed by incorrectly sited burial grounds. As Capels and Senville stated (2006, p. 1): "Cemeteries deserve the same attention and should be incorporated into the planning processes that cities and towns undertake for other types of infrastructure, community facilities, and services". In this research, several considerations and recommendations were provided to address the main issues in choosing a burial ground. Cemeteries are challenged with the pressures of urban development. Planners, designers, local officials, and the public should be equipped with such methods that allow an evaluation of sites with respect to of suitability for burials. Cemeteries, as the inevitable form of land use, should be planned, designed, and maintained in order to protect landscape, spatial values and to create liveable spaces.

It should be noted that regulations regarding cemeteries, as much as funeral services, vary between countries, but the phenomenon of cemetery is common. The general nature of this research should be of universal character and applicable to all jurisdictions across the field of land planning (Fig. 6). One important consideration in the location of cemeteries is its relative universality and permanence. That is why the issue of planning location and cemetery design should be in the special interest of the general public.

As population and mortality rates increase in Europe, the need arises to develop new cemeteries. This method allows for the selection of several suitable cemetery sites as soon as possible, at lowest possible cost and taking into consideration geotechnical and environmental constraints. The level of accuracy in the process, however, is largely dependent on the availability and accuracy of the data used, any specialist investigations undertaken and finances available to undertake such investigations. This methodology should be supplemented with education, educating both authorities and the general public of the risks associated with poorly sited cemeteries.

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