Journal of
Nuclear Engineering

MDPI

Article

AHP-Based Methodological Proposal for Identifying Suitable Sites for the Italian Near-Surface Repository

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Abstract

The selection of suitable sites for the disposal of radioactive waste constitutes a critical component of nuclear waste management. This study presents an original methodological proposal based on the Analytic Hierarchy Process (AHP), designed to support early-stage site screening for a near-surface repository in Italy. AHP could be used to identify appropriate locations, focusing on 51 areas that have already undergone a preliminary screening phase. These areas, included in the National Map of Suitable Areas (CNAI), were selected as they fulfill all the technical requirements (geological, geomorphological, and hydraulic stability) necessary to ensure the safety performance of the engineering structures to be implemented through multiple artificial barriers, as specified in Technical Guide N. 29. The proposed methodology is applicable in cases where multiple sites listed in the CNAI have been identified as potential candidates for hosting the repository. A panel of 20 multidisciplinary experts, including engineers, environmental scientists, sociologists, and economists, evaluated two environmental, two economic, and two social criteria not included among the criteria outlined in Technical Guide N. 29. Pairwise comparisons were aggregated using the geometric mean, and consistency ratios (*CR*s) were calculated to ensure the coherence of expert judgements. Results show that social criteria received the highest overall weight (0.53), in particular the “degree of site acceptability”, followed by environmental (0.28) and economic (0.19) criteria. While the method does not replace detailed site investigations (which will nevertheless be carried out once the site has been chosen), it can facilitate the early identification of promising areas and guide future engagement with local communities. The approach is reproducible, adaptable to additional criteria or national requirements, and may be extended to other countries facing similar nuclear waste management challenges.

Keywords: analytic hierarchy process (AHP); site selection; radioactive waste; near-surface repository; environmental impact; economic feasibility; social acceptance; Italy

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Academic Editor: Dan Gabriel Cacuci

Received: 20 May 2025
Revised: 5 August 2025
Accepted: 19 September 2025
Published: 26 September 2025

Citation: Guidi, G.; Violante, A.C.; Macioce, F.R. AHP-Based Methodological Proposal for Identifying Suitable Sites for the Italian Near-Surface Repository. *J. Nucl. Eng.* **2025**, *6*, 39. https://doi.org/10.3390/jne6040039

1. Introduction

By choosing to halt nuclear energy production following the 1987 referendum [1], Italy became one of the first countries in the world to address the industrial activities associated with the decommissioning of a nuclear power plant. The lack of a national repository has significantly impacted the timeline and strategy of Italy's decommissioning activities. The current activity program developed by Sogin is based on a strategy that, even in the absence of a national repository, involves the dismantling of the plants, with temporary storage of the generated waste on site and its subsequent conditioning by the end of the next decade [2].

Despite political efforts to revive nuclear energy between 2008 and 2011, including the approval of Legislative Decree N. 31/2010 the Fukushima accident and the 2011 referendum resulted in a definitive halt to new projects [3–5].

Italy, despite the 1987 and 2011 referendums banning the use of nuclear energy, needs to swiftly find a solution for the final disposal of radioactive waste, generated both during the operation of now-decommissioned nuclear facilities and because of its decommissioning activities, i.e., to identify the site and construct a National Repository for radioactive waste, as established by Legislative Decree N. 31/2010. While waste from decommissioning constitutes the most significant portion of the radioactive waste present in Italy, attention must also be given to the waste produced in the past and to that which continues to be generated, at a rate of several hundred cubic meters per year, by medical, industrial, and scientific research activities.

In June 2014, the then-competent regulatory authority, ISPRA, published Technical Guide N. 29 [6], entitled "Siting criteria of a Near-Surface Disposal Facility for Low and Intermediate-Level Radioactive Waste". The siting process outlined in the guide involves three main phases: (1) application of exclusion criteria to the entire national territory to identify potentially suitable areas, potentially ranked by priority; (2) solicitation of expressions of interest and establishment of institutional agreements to select candidate sites within the areas identified in the first phase for detailed investigation; and (3) execution of in-depth technical studies on one or more of these sites to determine the most appropriate location for the facility.

Technical Guide N. 29 was developed following consultations with international agencies, including counterparts in several European countries and the IAEA, as well as national institutions. The guide defines 15 Exclusion Criteria (EC) and 13 Investigation Criteria (IC), addressing factors such as (a) the geological, geomorphological, and hydraulic stability of the site; (b) the capacity of natural barriers to ensure radionuclide containment; (c) compliance with environmental and cultural protection regulations; (d) the isolation of the facility from human activities and infrastructure; (e) protection from natural resource exploitation; and (f) resilience to extreme weather conditions.

The ECs serve to eliminate areas that do not meet fundamental safety requirements, using available regulatory frameworks, data, and technical knowledge, particularly Geographic Information Systems (GIS), to generate a preliminary map of non-excluded areas. These areas are then subjected to the ICs, which involve more localized analysis.

The ICs are designed to facilitate the evaluation of areas remaining after the application of exclusion criteria. Their implementation may result in further refinement of potentially suitable areas through additional exclusions and contribute to the identification of sites of interest. Applied via targeted investigations and assessments, the IC are instrumental in ranking the relative suitability of these areas and in supporting the detailed characterization of selected sites.

The outcome of this process is the National Map of Potentially Suitable Areas (CNAPI). In January 2015, Sogin prepared a proposal for the National Map of Potentially Suitable Areas (CNAPI) [7], identifying locations that met the siting criteria defined in Technical Guide N. 29 and those established by the IAEA. This map was subsequently updated by Sogin, while ISIN validated the cartographic outcomes for consistency with the defined criteria. At the request of the Ministry of Economic Development, seismic classifications provided by the Regions were also incorporated into the assessment of socio-environmental suitability. The revised version was again validated by ISIN. Ministerial authorization issued on 30 December 2020 approved the publication of the CNAPI, including the ranking of identified sites and a preliminary plan for the Technology Park.

The Technology Park is a research and development center established alongside the National Repository, intended to host activities in the areas of nuclear decommissioning, radioactive waste management, radiological protection, environmental protection, and sustainable development. Its mission is to promote scientific and technological advancement in close alignment with the environmental, social, and economic characteristics of the host region.

The CNAPI proposal represents the initial stage of a participatory siting process for the National Repository and Technology Park (DNPT). It identifies 67 potentially suitable areas, classified into four categories based on socio-environmental, logistical, and seismic criteria: (1) A1—Very suitable continental areas; (2) A2—Suitable continental areas; (3) B—Insular areas; (4) C—Areas located in seismic zone 2.

For each area, a regional-scale report presents geological, environmental, and anthropogenic characteristics.

The National Seminar marked Italy's first formal public consultation on a major infrastructure project, focusing on the National Repository for radioactive waste (DNPT) and the CNAPI, published in January 2021. Held online from September to November 2021, it involved national and regional institutions, local authorities, unions, industry, academia, and the public. The seminar emphasized safety, environmental compliance, and regional development, and its outcomes informed the preparation of the National Map of Suitable Areas (CNAI), published in December 2023 on the official website of the Ministry of the Environment and Energy Security (MASE) [8].

Following the publication of the CNAI, entities whose territories are not among the 51 identified areas may submit self-candidatures to host the National Repository. Sogin evaluates proposals and the regulatory authority gives its opinion within 30 days. Based on this, Sogin drafts the CNAA (National Map of Self-Candidate Areas) proposal, ranking candidate areas by suitability, and submits it to the Ministry, which starts the Strategic Environmental Assessment (VAS) procedure within 30 days. Upon final approval, Sogin engages in local negotiations, conducts technical studies, and, with regulatory consent, proposes a final site. In absence of agreement, national authorities may intervene in accordance with Article 27 of Legislative Decree N. 31/2010 [4].

The proposed methodology is based on the assumption that a number of applications to host the National Repository are available, all of which meet the requirements set forth in Technical Guide N. 29. Additional environmental criteria, beyond those already included in the aforementioned Technical Guide, have been defined, along with economic and social criteria that may assist political decision-makers in selecting the site for the construction of the National Repository. The use of the Analytic Hierarchy Process (AHP) method is proposed to assign weights to these criteria.

2. AHP Method

The Analytic Hierarchy Process (AHP) is a decision-making technique developed by Thomas L. Saaty in the 1970s. It plays a crucial role in addressing complex problems that involve human perceptions and judgments. AHP is particularly useful when decision components are difficult to quantify or compare, or when diverse areas of expertise create communication barriers in a collaborative environment. It is a widely recognized method for prioritizing alternatives in multi-criteria decision-making problems [9].

AHP structures problems into hierarchical levels, quantifies influences through pairwise comparisons, and iteratively calculates weights. The methodology consists of three key steps:

(a) performing pairwise comparisons;
(b) assessing the consistency of judgments;
(c) computing relative weights.

The foundation of Saaty's methodology is an ordinal pairwise comparison matrix encompassing all criteria and alternatives. This process translates qualitative preference statements into numerical values, facilitating structured decision-making. Decision-makers evaluate the relative importance of criteria using a semantic 9-point scale, which reflects the intensity of preference between elements. A score of 1 indicates equal importance between criteria A and B, a score of 5 indicates a strong importance of criterion A relative to criterion B, while a score of 9 indicates that A is significantly more important than B.

The AHP methodology assigns weights to criteria based on expert judgments regarding the significance of objectives or alternatives. It ensures consistency by aligning weight vector components with initial judgments through pairwise comparisons, forming a comparison matrix. Using the eigenvector method, a weight vector is computed for further evaluation. To verify coherence and reliability, the methodology assesses matrix consistency by calculating eigenvalues. AHP accommodates a certain degree of inconsistency while also quantifying it within judgment sets.

The consistency of the judgment matrix is measured using the Consistency Ratio (CR), defined as:

$$CR = CI/RI \tag{1}$$

where CI represents the Consistency Index and RI denotes the Random Consistency Index. The Consistency Index is defined as:

$$CI = (K_{tot} - n)/(n - 1) \tag{2}$$

where K_{tot} is the sum of the eigenvalues K and n is the number of components.

Saaty established average RI values based on randomly generated matrices for reference [10] (Table 1). According to Saaty, pairwise comparisons are considered acceptably consistent when the CR value is below 0.1. If the CR exceeds this threshold, the judgment may be unreliable and should be reassessed.

Table 1. Average consistencies of random matrices (RI values).

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

The AHP method constitutes a valuable tool for policymakers, offering a scientific foundation to inform and support the decision-making process for site selection.

However, political decisions are sometimes made independently of technical-scientific considerations, as other contextual factors can intervene. The validity of the method has been well established through a broad range of examples documented in academic literature. In the nuclear sector, AHP has been applied in various contexts [11–16], including the selection of sites for radioactive waste repositories, although, in most cases, these consist of geological repositories [17–22]. In [17], potential sites were identified using a Weighted Linear Combination (WLC) analysis within a Geographic Information System (GIS) framework, integrating the improved Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Ten parametric criteria were applied to evaluate the potential areas, while three exclusion criteria were used to eliminate unsuitable regions. Guiller Madeira et al. [18] aim to identify a decision support tool capable of selecting a site for a final deep geological repository. The article presents a comparison of various attributes of the tools considered, ultimately identifying the combined AHP–Delphi method as the most suitable approach. A previous study conducted by some of the present authors [19], proposed an index methodology based on environmental, economic and social factors influencing the siting of a radioactive waste repository. Several environmental factors considered in the earlier study were later integrated into the exclusion and screening criteria established by Technical Guide N. 29. Bilgilioglu [20] creates a suitability map for the repository site selection through a combination of GIS and AHP. In this case as well, the AHP method was employed to reduce the pool of potentially suitable sites, rather than to support the selection among equally suitable alternatives. Pakkar [21] proposes an integrated approach that combines the Analytic Hierarchy Process (AHP) and Data Envelopment Analysis (DEA) within a multi-attribute Grey Relational Analysis (GRA) framework, where attribute weights are entirely unknown and attribute values are represented as fuzzy numbers. An illustrative case study on nuclear waste repository site selection is presented to demonstrate the effectiveness of the proposed methodology. The aim of the study by Gregorcic et al. [22] was to identify the most suitable sites for a new repository in Slovenia, based on selected criteria. To achieve this, a GIS-based Multi-Criteria Evaluation (MCE) method, Ordered Weighted Averaging (OWA), was applied in combination with the TOPSIS method. The evaluation considered eight criteria and five constraints, with criteria weights determined using the Analytic Hierarchy Process (AHP). The application of the TOPSIS method enabled the identification of several high-potential sites, primarily located in the north-eastern region of Slovenia.

3. Proposed Methodology

The general criteria for safety and radiological protection, along with the underlying technical assumptions, constitute the essential reference elements upon which the selection procedure is based, ultimately leading to the identification of a set of suitable sites for hosting the repository for low- and intermediate-level radioactive waste. The screening criteria adopted internationally, despite variations in specific national contexts, have consistently followed common general principles, for example, the initial identification of areas that could reasonably be considered unsuitable. Subsequently, criteria were established for the classification and evaluation of the remaining, non-excluded areas [2]. Due consideration has been given to the guidance provided in IAEA documents [23–25], which, among other recommendations, advise selecting the most appropriate site by progressively narrowing the pool of suitable candidates.

Not all countries that currently operate a near-surface repository for low- and intermediate-level radioactive waste have adhered to the aforementioned screening criteria for selecting the most suitable site. In fact, countries with the most significant facilities, such as France and Spain, primarily selected their sites during the 1980s or earlier, that is, in periods when either computerized criteria had not yet been developed or the siting process was less contentious [2]. Slovenia, Canada, and the United States are among the countries that have adopted the screening criteria set forth in the IAEA documents.

In Slovenia, a four-step screening process applying 43 criteria was used to identify potential sites for a LILW (Low and Intermediate Level Waste) repository. Initial exclusion criteria removed unsuitable areas, followed by preference-based identification of potential sites and comparative evaluation of candidate sites. The final step, involving field investigations, was halted due to public opposition [26]. Analysis showed that insufficient public participation was the main cause of failure. The project lacked adequate information dissemination, meaningful engagement in the site selection process, and consistent communication with local community representatives. A revised approach integrated technical screening with community negotiations and enhanced public engagement, facilitated by an independent mediator, who would facilitate negotiations between the community and the investor, thereby serving as a crucial intermediary between the two parties [27]. Ultimately, Slovenia selected the Vrbina site near the Krško nuclear power plant, co-owned by the Republic of Slovenia and the Republic of Croatia [28].

In the United States, individual states are permitted under federal law to form Compacts in order to establish shared facilities for the disposal of low-level radioactive waste. In 1986, the State of New York enacted the Low-Level Radioactive Waste Management Act. Among its provisions was the establishment of a Siting Commission tasked with identifying a suitable site within the state for the disposal of low-level radioactive waste. The Siting Commission considered technical suitability to be a fundamental and primary criterion in the site selection process. Socio-economic factors were incorporated into the selection process only after technically suitable sites had been identified [2].

In Canada, a central feature of the site selection process was the active involvement of local communities in both the planning and decision-making phases. A two-tiered framework of exclusion criteria was established. Following the initial exclusion of unsuitable areas, selection criteria were subsequently applied to assess the remaining regions and specific sites. Additional criteria incorporated socio-economic considerations. It is important to note that the site selection process did not culminate in a successful outcome [2] until November 2024, when the Nuclear Waste Management Organization (NMWO) selected Wabigoon Lake Ojibway Nation (WLON) and the township of Ignace as the site of a deep geological repository. This repository will host intermediate-level and non-fuel high-level waste, and potentially used nuclear fuel from future reactors. Construction activities are projected to commence in the mid-2030s, with operational readiness expected to be achieved by the early 2040s [29].

With specific reference to the Italian context, all areas listed in the CNAI exhibit characteristics that equally comply with the stringent safety criteria established by Technical Guide N. 29. The national legal framework does not specify which technical, economic, environmental, or social factors should be considered, nor does it prescribe how they should be assessed. Any classification model that is chosen will inevitably entail a certain degree of subjectivity in terms of the selection of classification parameters. The classification model and the procedure for its implementation should be as simple, functional, and easily applicable as possible, while remaining clear to communicate.

The objective of the proposed methodology is to provide the competent authorities with a clear and operational decision-making tool for identifying the most suitable site for the National Repository in the event of there being several candidate sites to host it. This methodology not only integrates environmental considerations, in addition to those already considered in the Exclusion Criteria (EC) and Investigation Criteria (IC) set forth in Technical Guide N. 29, but also incorporates economic and social dimensions.

The assessment framework considers six criteria, classified into environmental, economic, and social dimensions. The selected environmental criteria do not duplicate those already included in the EC and IC. The environmental criteria comprise the magnitude of landscape impact and the spatial proximity to protected areas. The economic criteria include variations in real estate asset values and potential disruptions to local economic activities. The social criteria encompass the degree of site acceptability among the resident population and changes in regional employment rates (Table 2).

Table 2. Environmental, economic and social criteria.

Environmental	Economic	Social
Landscape impact	Variations in real estate asset values	Degree of site acceptability
Spatial proximity to protected areas	Potential disruptions to local economic activities	Changes in regional employment rates

3.1. Landscape Impact

Landscape impact is evaluated in terms of the degree of alteration to the existing landscape morphology resulting from the repository's implementation. The implementation of the repository and related infrastructure, including access roads and transmission lines, is projected to result in modifications to the visual landscape and to introduce adverse aesthetic effects.

3.2. Spatial Proximity to Protected Areas

As protected natural areas are identified as exclusion zones under the provisions of Technical Guide N. 29, the criterion of maintaining an adequate buffer distance, defined as a minimum of 5 km from these areas, has been incorporated into the assessment framework.

3.3. Variations in Real Estate Asset Values

The construction of a near-surface repository for radioactive waste is expected to alter the local economic equilibrium. The influx of employees and their families may increase demand for housing, both in the rental and ownership markets, potentially driving up housing costs and property values. Conversely, concerns associated with the presence of radioactive waste may negatively affect housing market dynamics, potentially leading to a decline in property values.

3.4. Potential Disruptions to Local Economic Activities

The development of a repository generates direct expenditures on goods and services, including materials, equipment, fuel, lodging, and trade services, which may create opportunities for local and regional suppliers and stimulate new business development. Conversely, repository construction may permanently or temporarily displace agricultural land, reducing crop revenues and agricultural employment. Public concern regarding radioactive waste could negatively affect the region's image, potentially influencing the marketability of local agricultural products and deterring tourism, although increased visitation related to repository and Technology Park may partially offset these effects.

3.5. Degree of Site Acceptability

The degree of site acceptability is influenced by public concerns regarding safety, environmental and community impacts, and the transparency of the siting process. Acceptability can be enhanced through early and meaningful involvement of local communities, coupled with effective risk communication delivered by authoritative and credible institutions. Trust in these institutions reduces risk perception and enhances perceived benefits, thereby improving acceptability. Conversely, inadequate public engagement in the site selection process may diminish support for the proposed site.

3.6. Changes in Regional Employment Rates

Repository development is typically associated with the creation of local employment opportunities, with new workers potentially sourced from the host community or surrounding region. These employment opportunities are often perceived as a local benefit;

however, the extent of this benefit is contingent upon the alignment between the required skill sets and the qualifications available within the local labor force.

Given the complexity of assigning appropriate weights to criteria encompassing environmental, economic, and social dimensions, the Analytic Hierarchy Process (AHP) method was employed to facilitate a more objective evaluation. A panel of twenty experts, selected for their diverse disciplinary expertise, including eight engineers (with various specializations), four sociologists, four economists, four environmental scientists and landscape architects, was engaged with the aim of providing as objective an assessment of the selected criteria as possible. Participants received comprehensive information outlining the research objectives and the AHP methodology prior to their involvement in the study.

4. Results and Discussion

The application of the Analytic Hierarchy Process (AHP) enabled a systematic evaluation of the selected criteria, integrating perspectives from a multidisciplinary panel of twenty experts. The panel composed of 20 experts contributed weighted judgments that reflected a balanced consideration of environmental, economic, and social dimensions. The structured elicitation process, supported by prior dissemination of information on the research objectives and AHP methodology, facilitated the derivation of consistent and transparent weighting factors across the criteria.

Each of the twenty experts compiled a matrix, such as the sample matrix shown in Table 3, for a total of 20 matrices, through pairwise comparisons of the criteria listed in Table 2, yielding a priority vector for each criterion, as indicated by the weights shown in Table 3. For each matrix, the indices *CI*, *RI*, and *CR*, as reported in Table 4, were computed in accordance with the definitions provided in Section 2. The consistency ratio (*CR*) was computed to verify the internal coherence of judgements, with all matrices yielding $CR < 0.1$. The methodology culminated in a composite priority vector, obtained by computing the geometric mean of the priority values (weights) assigned to each criterion by the twenty experts, followed by normalization of the resulting values (Table 5).

Table 3. Example of a matrix filled out by an expert.

	Landscape Impact	Spatial Proximity to Protected Areas	Variations in Real Estate Asset Values	Potential Disruptions to Local Economic Activities	Degree of Site Acceptability	Changes in Regional Employment Rates	Geometric Mean	Weight	*K*
Landscape impact	1	1/3	1/3	1/5	1/8	1/6	0.28	0.03	0.78
Spatial proximity to protected areas	3	1	3	1/4	1/9	1/5	0.61	0.07	1.28
Variations in real estate asset values	3	1/3	1	1/2	1/7	1/3	0.54	0.06	0.94
Potential disruptions to local economic activities	5	4	2	1	1/6	1/2	1.22	0.13	1.30
Degree of site acceptability	8	9	7	6	1	4	4.79	0.51	0.92
Changes in regional employment rates	6	5	3	2	1/4	1	1.89	0.20	1.25
Total	26.00	19.67	16.33	9.95	1.80	6.20	9.32	1.00	6.48

Table 4. Index values.

N° of Components	*CI*	*RI*	*CR*	Judgement
6	0.10	1.24	0.08	Acceptable

Table 5. Vector of priorities.

Ranking	Criterion	Priority
1°	Degree of site acceptability	0.38
2°	Spatial proximity to protected areas	0.19
3°	Changes in regional employment rates	0.15
4°	Potential disruptions to local economic activities	0.13
5°	Landscape impact	0.09
6°	Variations in real estate asset values	0.06

Analysis of the priority vector demonstrates that criterion "degree of site acceptability" was assigned the highest priority by the experts, followed by the criterion "spatial proximity to protected areas" and the criterion "changes in regional employment rates". The criterion "Variations in real estate asset values" was assigned the lowest priority.

It is noteworthy that the experts assigned the highest weight to social criteria (0.53), followed by environmental criteria (0.28), with economic criteria receiving the lowest priority (0.19). It is also important to highlight that the two environmental criteria considered are not currently encompassed within the Exclusion Criteria (EC) and Investigation Criteria (IC) outlined in Technical Guide N. 29. The results of the AHP method application underscore the significance of public consent, a factor also evidenced by case studies from Sweden [2], South Korea [2,30], and Canada, contexts primarily related to the siting of deep geological repositories rather than near-surface facilities. Notably, near-surface repositories were often sited in earlier decades, when public acceptance was not regarded as a critical consideration.

5. Conclusions

The proposed methodology, based on the Analytic Hierarchy Process (AHP), may serve as a valuable tool for providing competent authorities with a clear and straightforward approach to identifying the most suitable site for hosting the national repository. The methodology is intended to be applied only to a selection of self-nominated sites, listed in the CNAI, that fulfill all the technical requirements established by Technical Guide N. 29 and are therefore equally suitable. This method could assist policymakers in cases where they do not wish to base their decision solely on political considerations, but rather seek to support their political choice through a more scientific and objective approach.

This methodology encompasses not only environmental considerations, beyond those already addressed in Technical Guide N. 29, but also economic and social dimensions.

The analysis of the matrices compiled by experts revealed that the highest overall weight was assigned to social criteria (0.53), followed by environmental and economic criteria. In particular, the criterion "degree of site acceptability" received the highest individual weight, scoring 0.38.

A comparison with the findings of a previous study conducted by some of the present authors [19], which focused on the factors influencing the siting of a radioactive waste repository, indicates a significant decrease in the importance attributed to environmental criteria. This change is partially attributable to differences in both the number and composition of experts involved. However, a key explanation lies in the fact that several environmental factors considered in the earlier study were later integrated into the exclusion and screening criteria established by Technical Guide N. 29.

The high weight assigned to the "degree of site acceptability" criterion reflects growing awareness of the importance of obtaining the consent of local populations that will ultimately host the national repository. This objective is part of a well-established process in European democracies known as a "participatory governance". This model differs from traditional forms of governance, which are typically hierarchical and top-down, by promoting horizontal and collaborative approaches among public institutions, citizens, and civil society. It responds to the growing public demand for transparency, inclusion, and accountability. The role of participatory governance in the siting of a national radioactive low waste repository is therefore crucial, as it helps ensure that decisions are transparent, inclusive, and sustainable over time.

It is thus evident that the level of public participation in the decision-making process largely depends on the degree of societal acceptance of the facility, which in turn increases proportionally with the quality and availability of information regarding its associated risks and benefits.

In this regard, the Slovenian experience may serve as a relevant example. In Slovenia, the site selection process was initially halted due to public opposition. It was only after the adoption of a new, mixed technical–participatory approach that a suitable site could be successfully identified. A crucial element in this outcome was the introduction of an independent mediator who facilitated negotiations between the local community and the entity responsible for constructing the repository, acting as a liaison between the two parties. This figure exhibited complete independence, commanded broad respect, demonstrated substantial public credibility, and was entrusted with the requisite authority to conduct the negotiations effectively.

This international experience underscores, once again, the importance of involving local communities from the earliest stages of site selection, as well as the need to ensure accurate communication not only about the negligible risks associated with the repository, but also about the potential benefits. Finally, it is essential that such information be disseminated by credible and independent sources.

Author Contributions: Conceptualization, G.G. and A.C.V.; methodology, G.G., A.C.V. and F.R.M.; validation, G.G., A.C.V. and F.R.M.; formal analysis, G.G., A.C.V. and F.R.M.; data curation, G.G. and F.R.M.; writing—original draft preparation, G.G. and A.C.V.; writing—review and editing, G.G., A.C.V. and F.R.M.; supervision, G.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The original contributions presented in this study are included in the article or Appendix A. Further inquiries can be directed to the corresponding author.

Acknowledgments: The authors wish to express their gratitude to all the twenty experts with diverse areas of expertise who participated in the research.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AHP	Analytic Hierarchy Process
BWR	Boiling Water Reactor
CI	Consistency Index
CIPE	Interministerial Committee for Economic Planning
CNAA	National Map of Self-Candidate Areas
CNAI	National Map of Suitable Areas
CNAPI	National Map of Potentially Suitable Areas
CNR	National Research Council

CR	Consistency Ratio
DNPT	National Repository and Technology Park
EC	Exclusion Criteria
EUREX	Enriched Uranium Extraction
GIS	Geographic Information Systems
IAEA	International Atomic Energy Agency
IC	Investigation Criteria
IPU	Plutonium Plant
ISIN	National Inspectorate for Nuclear Safety and Radiation Protection
ISPRA	Institute for the Environmental Protection and Research
ITREC	Treatment and Re-manufacturing Plant for fuel elements
LILW	Low and Intermediate Level Waste
MASE	Ministry of the Environment and Energy Security
OPEC	Boilers Operations
PWR	Pressurized Water Reactor
RI	Random consistency Index
VAS	Strategic Environmental Assessment
VVER	Water-Water Energetic Reactor

Appendix A

Table A1 reports the weights assigned to the six criteria by each of the 20 experts following the completion of the pairwise comparison matrices, as well as the consistency ratio (*CR*) value calculated for each matrix. Table A2 reports the geometric mean of the weights assigned to the criteria by the 20 experts, as well as the normalized geometric mean.

Table A1. Weights assigned to the six criteria by the panel of experts.

	Landscape Impact	Spatial Proximity to Protected Areas	Variations in Real Estate Asset Values	Potential Disruptions to Local Economic Activities	Degree of Site Acceptability	Changes in Regional Employment Rates	*CR*
Expert 1	0.05	0.04	0.09	0.13	0.48	0.21	0.07
Expert 2	0.03	0.07	0.06	0.13	0.51	0.20	0.08
Expert 3	0.05	0.07	0.04	0.17	0.46	0.21	0.06
Expert 4	0.03	0.07	0.10	0.15	0.41	0.25	0.05
Expert 5	0.08	0.36	0.03	0.05	0.38	0.11	0.08
Expert 6	0.27	0.19	0.04	0.04	0.42	0.04	0.06
Expert 7	0.23	0.31	0.04	0.04	0.29	0.10	0.09
Expert 8	0.11	0.43	0.06	0.04	0.29	0.07	0.09
Expert 9	0.22	0.19	0.04	0.04	0.47	0.04	0.08
Expert 10	0.11	0.26	0.05	0.04	0.48	0.06	0.06
Expert 11	0.04	0.07	0.03	0.14	0.46	0.26	0.07
Expert 12	0.04	0.12	0.13	0.36	0.07	0.28	0.02
Expert 13	0.04	0.10	0.05	0.24	0.33	0.23	0.05
Expert 14	0.03	0.26	0.05	0.15	0.41	0.09	0.03
Expert 15	0.12	0.39	0.05	0.06	0.33	0.06	0.07
Expert 16	0.25	0.22	0.03	0.05	0.19	0.03	0.04
Expert 17	0.04	0.09	0.04	0.19	0.39	0.26	0.06
Expert 18	0.03	0.07	0.05	0.24	0.31	0.29	0.07
Expert 19	0.03	0.28	0.09	0.42	0.02	0.15	0.07
Expert 20	0.06	0.23	0.03	0.09	0.47	0.13	0.07

Table A2. Geometric mean and normalized geometric mean of the weights assigned to the criteria by the panel of experts.

Criterion	Geometric Mean	Normalized Geometric Mean
Landscape impact	0.07	0.09
Spatial proximity to protected areas	0.15	0.19
Variations in real estate asset values	0.05	0.06
Potential disruptions to local economic activities	0.10	0.13
Degree of site acceptability	0.31	0.38
Changes in regional employment rates	0.12	0.15

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