Deliverable 11.3: Outcomes to Member States and End Users

Work Package 11

DOI: 10.5281/zenodo.22079934

Co-funded by the European Union under Grant Agreement n°101166718.

Document information

Project Acronym	**EURAD-2**
Project Title	**European Partnership on Radioactive Waste Management-2**
EC grant agreement No.	**101166718**
Work Package Title	**CLIMATE**
Deliverable No.	**11.3**
Deliverable Title	**Outcomes to Member States and End Users. WP11 CLIMATE**
Lead Beneficiary	**Amphos 21 Consulting S.L.**
Contractual Delivery Date	**September 2026**
Actual Delivery Date	**August 2026**
Dissemination level	**Public**
Authors	**Sáinz-Garcia A. (AMPHOS21), Kelsay T. (AMPHOS21), Vercelli M. (AMPHOS21), Peti L. (BGE), Strusińska-Correia A. (BGE), Park J. (VTT), Beerten K. (SCK CEN), Geisler-Roblin A. (NTW).**

To be cited as:

Sáinz-Garcia A., Kelsay T., Vercelli M., Peti L., Strusińska-Correia A., Park J., Beerten K, and Geisler-Roblin A. (2026): Outcomes to Member States and End Users. WP11 CLIMATE Deliverable D11.3 of the European Partnership EURAD-2. EC Grant agreement n°:101166718.

Disclaimer

Acknowledgement

This document is a deliverable of the European Partnership on Radioactive Waste Management 2 (EURAD-2). EURAD-2 is co-funded by the European Union under Grant Agreement N° 101166718.

Status of deliverable		
	By	Date
Delivered (Lead Beneficiary)	Amphos21	01/06/2026
Verified (WP Leader)	Alvaro Sainz-Garcia	21/07/2026
Reviewed (Reviewers)	Johan Liakka	27/07/2026
Approved (PMO)	Peter Ormai	13/08/2026
Submitted to EC (Coordinator)	Andra	24/08/2026

Executive Summary

WP11 CLIMATE examined existing knowledge gaps regarding how climate change impact on the safety and resilience of radioactive waste storage and disposal facilities across Europe during construction, operation, and post-closure. Its central message is that climate change can directly affect infrastructure performance, barrier functions, hydrological and hydrogeological conditions, erosion processes, and the long-term robustness of radioactive waste disposal facilities. For Member States, regulators, waste management organisations, and other End Users, this means that climate change needs to be integrated into both near-term programme decisions and long-term safety assessments.

The Work Package shows that climate-driven risks differ by location, facility type and timescale. Surface and near-surface facilities are more directly exposed to extreme weather, erosion, and changing surface conditions, while deep geological repositories are more sensitive to long-term hydrogeological and geological evolution. WP11 also shows that approaches to climate-driven risk assessment across Europe still vary considerably. Some programmes already use structured climate scenarios and dedicated climate studies, while others continue to rely on simplified or qualitative approaches.

Overall, WP11 CLIMATE provides a stronger basis for integrating climate change into programme development, safety assessment, and regulatory review across different national contexts. Its main practical message is that future work should focus on four priorities: more harmonised assessment methodologies, clearer links between climate evolution and safety-relevant processes, more robust site-specific data and process understanding, and improved modelling and uncertainty treatment.

Keywords

DGR	Deep Geological Repository
DI	Domain Insight
EURAD	European Partnership on Radioactive Waste Management
FEP	Features, Events, and Processes
HLW	High-Level Waste
LILW	Low- and Intermediate-Level Waste
LIMS	Large Inventory Member States
R&D	Research and Development
RWM	Radioactive Waste Management
SIMS	Small Inventory Member States
SRA	Strategic Research Agenda
TSO	Technical Safety Organisations
WMO	Waste Management Organisation
WP	Work Package

Table of content

1. Introduction

The EURAD-2 Work Package (WP) 11 CLIMATE addressed an aspect of growing importance: how climate change may affect the safety and resilience of radioactive waste management facilities over both short and long timescales. By identifying key knowledge gaps, including methodological and regulatory aspects, and by proposing recommendations for future research on climate-driven risks assessment across European programmes, WP11 CLIMATE provided Member States with a stronger technical basis for decisions on design, licensing, implementation, and long-term safety demonstration. The scope and structure of WP11 CLIMATE are summarised in Appendix A.

CLIMATE brought together experts from 23 organisations in 13 countries, representing the different EURAD-2 colleges as well as civil society organisations, to examine the significant challenges shared across national programmes. This broad participation gave the WP access to a wide range of disposal concepts, regulatory settings, and climate contexts across Europe, strengthening the relevance of its findings beyond any single national case.

Its core technical work focused on both near-term climate-related risks affecting the infrastructure during the construction and operations phases, and the longer-term post-closure implications for repository evolution under changing climate conditions. In addition, the WP considered how to improve climate risk assessment methodologies, reviewed regulatory and institutional approaches, supported knowledge transfer, and fostered dialogue with stakeholders and civil society. WP11 CLIMATE provided value not only by describing the problem, but also by showing that climate change needs to be addressed differently across facility phases and timescales within a coherent overall safety framework.

The topic is relevant to all European national Radioactive Waste Management (RWM) programmes. Across Europe, RWM relies on a range of facility types, including surface, near-surface and deep geological repositories, and associated surface installations. These facilities are planned, operated and assessed over very different timescales depending on their type, ranging from decades and centuries to periods extending up to one million years. In this context, climate change introduces hazards and long-term environmental changes that may affect all facility types and waste types across the Member States.

For Member States and End UsersEnd Users, this means that climate change is no longer only a scientific or environmental concern, but a practical issue that can influence programme planning, design assumptions, regulatory confidence, and the robustness of long-term safety cases.

A further objective of CLIMATE was to ensure that its results could be used by the wider community beyond the WP itself. In addition to the technical synthesis, the WP contributed to knowledge management through the preparation of a White Paper (Peti et al., 2026), a Synthesis Report (Sáinz-García et al., 2026), two civil society workshops, a training course, and a Domain Insight (Marcos and Liakka, 2026) document, following the EURAD Roadmap Domain on climate change. These outputs were designed to help translate the findings of CLIMATE into forms that are more accessible and useful for Member States, End UsersEnd Users and the broader RWM community, so that the results can support future decision-making, knowledge transfer, and continued methodological development beyond the life of the project. A concise overview of the main knowledge management and training outputs is provided in Appendix B.

2. Key Findings

WP11 CLIMATE shows that climate change is not a peripheral issue for RWM. On the contrary, it is a cross-cutting consideration that affects siting, construction, design, operation, closure and post-closure safety across all repository types and climate conditions for all Member States. The WP confirms that climate change must be treated as an external driver in both operational and long-term safety assessments, since it can influence engineered barriers, surrounding hydro(geo)logical conditions, surface processes, and future exposure pathways. This applies to surface, near-surface and deep geological disposal systems alike, although the dominant risks and relevant timescales differ between them. In the wider context, climate change is not a separate environmental issue to be considered in

isolation, but a multifunction factor that can directly affect the credibility, resilience, and long-term robustness of radioactive waste programmes.

A first generic finding, relevant across all Member States, is that climate change needs to be addressed over both short and long timescales. In the short term, i.e. during design, construction and operation, the main concerns are increased frequency and intensity of extreme weather events, including heavy rainfall, flooding, drought, heatwaves, erosion and coastal hazards, all of which can disrupt operations, damage infrastructure and affect surface barriers. In the longterm, i.e. during the post-closure phase, the key issue for safety is the long-term system evolution, including changes in infiltration, groundwater recharge and flow regimes, water table position, and landscape variations, all of which may be affected by climate-related changes, such as sea-level change, permafrost development and, in some regions, glacial cycles. WP11 CLIMATE therefore reinforces the need for safety cases that consider not only present-day climate, but also a range of plausible future climate conditions relevant to the facility lifetime and assessment period. For ministries, regulators and waste management organisations, the practical implication is clear: climate change needs to be considered both in near-term planning and licensing and in the long-term demonstration of repository safety.

A second generic finding is that the level of methodological maturity still varies considerably across Europe. The WP shows that some national programmes already integrate climate change into safety and licensing work through structured climate scenarios, dedicated climate reports, and explicit links to safety functions. Others still rely more on qualitative treatment, more limited sensitivity testing, or broad screening approaches. This means that the main benefit of WP11 CLIMATE for Member States is not only the consolidation of scientific knowledge, but also the identification of a clearer methodological direction for future work. The practical implication is that there is a need for more systematic climate scenario development, stronger coupling between climate variables and safety-relevant processes, and more explicit treatment of uncertainty. For smaller or earlier-stage programmes in particular, this highlights the importance of progressively moving from a general consideration of climate change to a more structured treatment within safety assessments.

A third key finding is that harmonisation matters. WP11 CLIMATE does not suggest that all Member States need identical assessments, since national programmes differ in inventory, repository concept, regulatory framework and geographical setting. However, it does show that more harmonised approaches would improve transparency, comparability and confidence across RWM programmes. The WP highlights the value of using structured scenario methodologies, explicit links to Features, Events and Processes (FEPs), and clearer translation of climate information into decision-relevant inputs for safety assessment. This is especially important for Member States with smaller or earlier-stage programmes, where climate change may not yet be fully integrated into disposal planning and assessment. This points to the value of more consistent methodological frameworks across Europe while still allowing assessments to remain proportionate to the national context.

A fourth broad lesson is that climate resilience is not only a technical issue, but also a programme management and decision-making issue. The WP makes clear that climate change should be considered early, i.e. during site screening, site characterisation and design, rather than being treated only as a later compliance exercise. Early integration helps to avoid under-design, reduce the risk of costly redesign, and strengthen the technical basis for regulatory dialogue and long-term programme decisions. In that sense, the main impact of WP11 CLIMATE for Member States is to support more robust and future-oriented decision-making across the full lifecycle of radioactive waste storage and disposal facilities.

Finally, several general trends emerge from the WP.

- Surface and near-surface facilities are more directly exposed to atmospheric hazards, with climate-driven changes affecting cover performance and infiltration processes. In contrast, deep geological repositories are more protected from direct surface impacts but remain sensitive to longer-term hydrogeological and geological responses to climate evolution.

- Across facility types, uncertainty remains a central issue, particularly regarding future climate evolution and how climate-related changes propagate through safety-relevant processes and model boundary conditions. The WP therefore points to the need for continued monitoring of climate conditions and its associated environmental and system responses, improved characterisation of extreme events, where local records remain limited and additional observations are especially valuable, and assessment approaches that explicitly address uncertainty. In practical terms, climate resilience should be supported by sustained data acquisition, process understanding, and iterative review as new observations and projections become available.

The following two examples of Finland and Lithuania illustrate why outcomes of WP11 CLIMATE are relevant across the full range of Member States. For advanced programmes, it supports continued refinement, traceability and regulatory robustness. For smaller or earlier-stage programmes, it helps clarify priorities, reveal methodological gaps, and provide a strong basis for proportionate but credible climate risk assessment. One of the main strengths of the results of the WP is therefore that it turns a broad and potentially abstract challenge into a more structured set of lessons that can be adapted to different national contexts.

2.1 Advanced programmes or Large Inventory Member States (LIMS) Case Study: Finland

Finland provides one of the clearest examples in WP11 CLIMATE of how climate change can be integrated into an advanced national disposal programme. In Finland, climate has been incorporated into regulatory requirements, safety assessment and licensing in a structured way. The Finnish regulator, STUK, has approved the Onkalo® repository while emphasising resilience to future climate changes, including glacial periods and rising groundwater levels. Finnish regulation also requires that long-term safety be based on complementary barriers so that foreseeable changes in bedrock or climate do not jeopardise safety, and that assessment scenarios explicitly cover climate-related evolutions.

The CLIMATE Domain Insight (Marcos and Liakka, 2026) strengthens this picture by showing that Posiva, Finland's spent fuel disposal company, produced dedicated climate reports to support the operational licence application and that those reports were used in scenario formulation for both the deep geological repository and the low- and intermediate-level waste repository. It also notes that, in programmes such as Posiva's, climate scenarios have remained broadly consistent through successive safety assessments while being refined as scientific understanding has improved. This is important because it shows climate change being handled not as an isolated study, but as an integral and evolving part of the safety case.

For Member States, the main lesson from Finland is that climate change can be integrated in a practical, consistent and traceable way. The value of this example lies less in the specific Finnish climate setting and more in the methodological approach: dedicated climate analysis, explicit scenario selection, linkage to safety assessment, and alignment with licensing needs. This makes Finland a strong illustration of how advanced programmes can build confidence in long-term safety while keeping climate assumptions transparent and open to refinement as new knowledge emerges.

2.2 Early-stage RWM programmes or Small Inventory Member States (SIMS) Case Study: Lithuania

Lithuania provides a useful contrasting example for earlier-stage or smaller RWM programmes. In the CLIMATE Synthesis Report (Sáinz-García et al., 2026), Lithuania is highlighted as a case where future climate states were not formally integrated into the safety assessment through a defined sequence of climate evolutions. Instead, the assessment relied on "what-if" sensitivity analyses using extreme boundary values for temperature, precipitation and infiltration to test how climate-related changes might affect engineered barriers, vault performance and radionuclide migration. This approach provided useful

insight into system robustness under selected climate-related changes, while also showing the potential added value of a more structured scenario-based treatment for long-term impacts.

The lessons drawn from this case are especially relevant for smaller or early-stage programmes. WP11 CLIMATE highlights the need to move beyond qualitative treatment or isolated boundary-condition testing toward methodologies that explicitly link climate-driven parameters, such as temperature, precipitation, sea-level rise and potential glaciation, to safety-relevant processes. It also points to the need for capacity building, methodological harmonisation, long-term climate scenario development and stronger interdisciplinary networking with climate research initiatives and institutions to bring smaller programmes closer to advanced European practice.

For Member States with smaller inventories or less advanced programmes, Lithuania (transiting from LIMS to SIMS due to final decimissioning of Ignalina Nuclear Power Plant) is therefore a valuable case study because it shows both the usefulness and the limitations of a simplified approach. The message is not that smaller programmes need to replicate the full complexity of the most advanced national safety cases immediately. Rather, WP11 CLIMATE shows that even smaller programmes benefit from progressively accounting for climate change in a more systematic way, especially where long-term performance depends on infiltration, barrier degradation, groundwater behaviour or evolving surface conditions. In that sense, the Lithuanian case illustrates the practical added value of the WP: it helps identify useful next steps for programmes that are still building methodological capacity.

3. Evaluation of Impact

WP11 CLIMATE remained well aligned with the impact priorities identified at the start of the WP and delivered its strongest contribution in the selected Strategic Research Agenda drivers: Implementation Safety, Knowledge Management, and Societal Engagement. The final outputs of the WP addressed all three, while also providing a broader contribution to future methodological development on climate change in radioactive waste management. For Member States and End Users, this means that WP11 produced a structured set of results that can support future programme decisions, regulatory developments, and knowledge-transfer.

The strongest impact was achieved under the **Implementation Safety** driver. WP11 showed that climate change is not a secondary issue, but one that must be considered in all phases, including site selection, construction, operation and post-closure safety assessments, because it can affect infrastructure performance, engineered barriers, hydrogeological conditions, erosion processes, and long-term repository evolution. It also highlighted the need for more structured development of climate scenario for long-term safety assessment, stronger links between climate variables and safety-relevant processes, and better climate data traceability in safety assessments. This gives regulators, Waste Management Organisations (WMOs), and programme owners a stronger basis for integrating climate change into safety reviews, licensing, and long-term safety demonstration.

A second significant area of impact was **Knowledge Management**. WP11 was designed not only to generate technical findings but also to turn them into usable knowledge products. The Synthesis Report (Sáinz-García et al., 2026) consolidated the technical basis and the White Paper (Peti et al., 2026) focussed on knowledge gaps, research needs and actions to close those gaps. The training materials and Domain Insight (Marcos and Liakka, 2026) added outputs to support knowledge transfer across programmes and generations of experts. Incorporing outcomes from previous EURAD and international projects, WP11 increases the usability of the results, helps organise previously fragmented expertise, and reduces the risk that climate-related knowledge remains scattered across projects and specialist communities.

The third selected driver was **Societal Engagement**, reflecting the recognition that climate change raises not only technical questions, but also stakeholder concerns about uncertainty, resilience, and long-term safety under changing conditions. Confidence in radioactive waste management depends not only on technical robustness, but also on the credibility of the dialogue around uncertainties and programme resilience. In this respect, the WP helped create space for dialogue and for a more

transparent exchange on how climate-related uncertainties may be considered in radioactive waste programmes.

Beyond these three selected drivers, WP11 also generated a broader impact relevant to the EURAD Strategic Research Agenda by strengthening scientific insight into how climate change may influence different repository systems across European climate zones and over very different timescales. It also supported more tailored solutions by showing that climate risk assessment should be proportionate to programme maturity, repository concept, and national context, rather than identical across all Member States. At the same time, such tailored approaches would benefit from a more common European framework to improve consistency, transparency, and comparability.

Overall, WP11 CLIMATE remained well aligned with its intended impact profile and, in some respects, broadened it. The WP provided a stronger basis for climate-informed safety assessment, improved the transfer and structuring of knowledge, and created space for dialogue with civil society and other stakeholders. At the same time, it went beyond a simple gap analysis by clarifying methodological directions for future work, especially the need for more harmonised scenario development, clearer treatment of uncertainty, and stronger links between climate evolution and safety-relevant processes. In practical terms, this gives Member States and End Users a stronger basis for integrating climate change into programme development, safety assessment, knowledge transfer, and climate-informed programme planning.

4. Education and Training

WP11 CLIMATE developed a focused set of education and training activities, with the aim of ensuring that the knowledge generated by the WP can be reused by the EURAD-2 community and the wider RWM community in the future. This included not only capturing knowledge relevant to the WP, but also transferring it through structured knowledge products and training activities linked to EURAD-2 Roadmap Domain 4.3.2 Climate change. The main outputs of value for educational and knowledge-transfer purposes were the Domain Insight (Marcos and Liakka, 2026), the White Paper (Peti et al., 2026) and the Synthesis Report (Sáinz-García, et al., 2026), as well as dedicated training activities and materials. Together, these outputs help ensure that the results of WP11 remain accessible and usable beyond the life of the WP.

The first published key output is the Domain Insight (Marcos and Liakka, 2026) for EURAD Roadmap Domain 4.3.2 Climate Change. This document was developed to help structure and transfer knowledge at roadmap level, building on the WP's results and translating them into a form that can support future users of the EURAD Knowledge Management system. A Domain Insight on climate impacts on radioactive waste management facilities had not been produced previously within EURAD, and WP11 therefore developed this output as a concrete knowledge product to support longer-term access to the topic beyond the immediate lifetime of the WP, particularly for new users and future experts entering the field.

The second key output, the White Paper (Peti et al., 2026), was conceived as the principal knowledge-capture product of the WP. Its purpose is to explore gaps in the state of knowledge on climate change impacts and in regards to data management, protocols, methodologies, and practices for robust climate risk assessment. It was also intended to provide recommendations and proposals for actions to address such identified gaps. In this sense, the White Paper is not only a strategic document to prioritise future work, but also a reusable educational resource for Member States and End Users seeking an accessible overview of the topic and of the main methodological needs identified by the WP.

The third key CLIMATE output, the Synthesis Report (Sáinz-García et al., 2026), brings together the evidence base to assess climate change impacts across different facility types, timescales, and assessment contexts. The assessment is introduced by the previous studies on climate change and RWM, and a comparison of the regulatory framework on RWM applying to several international institutions (International Atomic Energy Agency and Nuclear Energy Agency) and national regulations across European Member States. The main value of this document lies in the in-depth analysis of short-

and long-term climate-driven risks affecting different RWM facilities across European climates, depending on their type (surface, near-surface and deep geological repository). Finally, the report gives an overview of the main natural analogues useful to establish a range of plausible future climate conditions for all assessed locations.

Finally, training was retained as a key component of the WP's educational contribution. The training was structured as two half-day consecutive online sessions in May 2026, combining lectures and interactive elements. It brought together introductory and advanced material into a coherent programme. Overall, it provided a compact but technically grounded synthesis of the WP outcomes, linking climate science, modelling approaches, safety assessment practices, and future research needs.

The first session addressed the fundamental basis of climate change, including its drivers, variability across past and future timeframes, and the use of climate models to define scenarios relevant for RWM. Particular emphasis was placed on how climate information can inform safety assessments across all phases of disposal systems, from construction and operation to the long-term post-closure period. The treatment of uncertainty, including its sources and propagation within climate projections and safety analyses, was a central component.

The second session focused on the analysis of specific climate-driven processes and their implications for the safety of RWM facilities. It was organised around case studies addressing key mechanisms such as changes in precipitation affecting engineered cover systems, the influence of climate variability on groundwater flow and radionuclide transport, and the role of climate in driving landscape evolution over extended temporal and spatial scales. These case studies were supported by practical exercises aimed at improving the understanding of process dynamics, timing and magnitude of impacts, and associated uncertainties.

Taken together, these materials form the main education and training legacy of WP11 CLIMATE. The Domain Insight (Marcos and Liakka, 2026) supports structured long-term knowledge access within the EURAD roadmap framework, the White Paper (Peti et al., 2026) provides a concise strategic synthesis, the Synthesis Report (Sáinz-García et al., 2026) defines technical results obtained, and the training course translates the WP's findings into a form that can be used for capacity building and knowledge transfer. Collectively, they help ensure that the outcomes of WP11 remain available and useful beyond the duration of the WP itself, particularly for Member States, End Users, and future experts working on climate-related aspects of radioactive waste storage and disposal.

5. Conclusions

WP11 CLIMATE has provided Member States and End Users a coherent European basis for understanding and addressing climate change in radioactive waste management. By combining technical analyses, methodological recommendations, knowledge management activities and stakeholder engagement, the Work Package has strengthened the basis for integrating climate change into programme planning, safety assessment and regulatory decision-making across Europe.

Further development is needed to strengthen climate-informed safety assessments, improve comparability across programmes, and support proportionate implementation in different national contexts. The main remaining need is not simply more data, but a more consistent and harmonised framework for translating climate change into safety-relevant assumptions, scenarios, and decision-making tools. This includes the harmonisation of procedures for selecting climate scenarios, defining representative climate conditions for safety assessment, and deriving associated parameters across different timeframes and disposal concepts. Existing approaches still vary substantially across Member States, both in methodology and in how explicitly climate change is addressed, which limits transparency, comparability, and confidence in long-term assessments.

Four priorities emerge for future work.

- Methodological harmonisation is needed to support structured, scenario-based assessment frameworks that can address long-term uncertainty, support the selection of representative

climate conditions and relevant climate stressors, and provide clearer links between climate evolution and safety-relevant processes. This should explicitly include consistent approaches for translating climate scenarios into boundary conditions used in safety assessments.

- Further work is needed to improve the selection, interpretation and use of climate-relevant information, strengthen site-specific characterisation and understanding of climate-sensitive processes and system responses. This is particularly important for infrequent extreme events, and compound hazards, and for understanding long-term hydrogeological and geomorphological changes driven by climate evolution.
- Modelling and risk assessment tools should better represent interactions between climate drivers and safety-relevant system components. They should also explicitly address uncertainty in future climate evolution and its propagation through model boundary conditions and system responses. Synthetic or representative case studies should be used to test these tools and identify key processes, tipping points, safety margins, and implications for design and site selection.
- Continued European cooperation is needed through shared guidance, joint R&D, representative case studies, and ongoing interaction with regulators, End Users, and civil society, as well as through the development of common reference databases of climate-dependent processes and interoperable frameworks.

The overall recommendation is therefore clear: future R&D should prioritise harmonised methodologies, more robust climate and site data, improved modelling of climate-driven processes and interactions, and adaptive assessment approaches that can support more robust programme planning, safety cases, and regulatory confidence over both operational and geological timescales. This should be complemented by the development of practical, decision-oriented outputs for End Users, including shared databases, example libraries, and safety guidance, to ensure that advances can be consistently implemented across Member States and directly support decision-making in disposal system design, assessment, and licensing.

Collectively, the outcomes of WP11 CLIMATE provide a solid basis for future European cooperation on climate-resilient radioactive waste management. They support more transparent, scientifically robust and harmonised approaches to safety assessment while providing practical resources that Member States, regulators, waste management organisations and technical support organisations can directly use in future programme development and licensing activities.

6. References

Debayle, C., Kudriashova, Y., Miron, D., Hansen, J., Maugis, V. (2025). Data Management Plan. Final version as of 30/04/2025 of deliverable D1.3 of the European Partnership EURAD-2. DOI: https://doi.org/10.5281/zenodo.17086728. Co-funded by the European Union under Grant Agreement n°101166718.

EURAD Bureau. (2023). Update of the EURAD Strategic Research and Knowledge Management Agenda (SRA), of deliverable D1.9 of the HORIZON 2020 project EURAD. EC Grant agreement no. 847593.

Marcos, N., Liakka, J. (2026). 4.3.2 Climate change, Domain Insight. EURAD Roadmap Domain Insight Series, Version 1.0, 23/02/2026. DOI: 10.5281/zenodo.1878718. Co-funded by the European Union under Grant Agreement n°101166718.

Peti, L., Reijonen, H., Železnik, N., Horvat, B. (2026). White Paper on climate change impacts on nuclear waste management facilities. Deliverable D11.1 of the European Partnership EURAD-2. DOI: https://doi.org/10.5281/zenodo.19328485. Co-funded by the European Union under Grant Agreement n°101166718.

Sáinz-García A. et al. (2026). Synthesis report on climate change impacts on nuclear waste management facilities. Deliverable D11.2 of the European Partnership EURAD-2. DOI: https://www.ejp-

eurad.eu/sites/default/files/2026-03/EURAD2_WP11_CLIM_T02_01_D11_01_WHITE_PAPER.pdf. Co-funded by the European Union under Grant Agreement n°101166718.

Théodon, L., Holt, E., López, M., Matuzas, V., Ormai, P., Pellegrini, D. (2025). Quality Management Plan. Final version as of 27/03/2025 of deliverable D1.2 of the European Partnership EURAD-2. DOI: https://doi.org/10.5281/zenodo.18887071. Co-funded by the European Union under Grant Agreement n°101166718.

Appendix A. Scope and structure of WP11 CLIMATE

Work Package 11 CLIMATE focuses on the impact of climate change on RWM facilities, during construction, operation, and post-closure. The WP11 was organised around five tasks combining technical analysis, knowledge management, coordination, and interaction with civil society. The main technical work is carried out in Task 3, which addressed climate impacts during construction and operation, and Task 4, which addresses post-closure impacts. Tasks 1, 2, and 5 supported overall coordination, knowledge capture and transfer, and stakeholder interaction.

Task	Title	Lead	Key outputs
1	Management and Coordination	Amphos 21	• Coordination, dissemination and quality control • Coordination of the D11.2 Synthesis Report and D11.3 Outcomes to Member States. • Collaboration and interaction with other WPs
2	Knowledge Management	BGE	• Knowledge Management activities • Coordination of the D11.1 White Paper • Organization of the training course
3	Construction and Operational Phases Climate Impacts	VTT	• Construction and operation climate impacts on RWM facilities
4	Post-closure Phase Climate Impacts	SCK CEN	• Post-closure climate impacts on RWM facilities
5	Interaction with Civil Society	NTW	• Interaction with civil society • Organisation of two pluralistic workshops to interact with civil society

Moreover, CLIMATE worked in strict collaboration with other EURAD-2 WPs, especially

- WP3 ASTRA aimed at analysing the readiness, feasibility and challenges of alternative RWM solutions
- WP13 OPTI aimed at developing a mutual understanding and providing recommendations on methodologies and further activities for the design and optimisation of specific underground repository systems, structures, components and procedures
- WP14 SUDOKU aimed at understanding the behaviour and performance of multi-layer covers and cementitious barriers of near-surface disposal facilities as a basis for optimisation of these barriers and ensuring long-term disposal safety

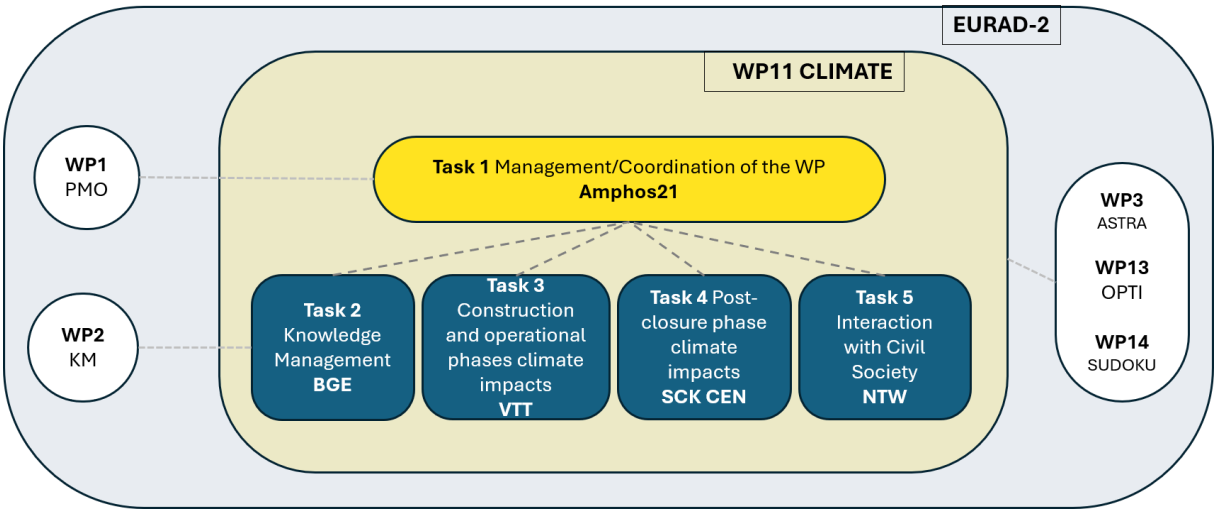

Figure 1. Structure of the EURAD-2 CLIMATE WP.

Appendix B. Knowledge Management, Training and Outreach

WP11 CLIMATE developed the following main knowledge management and training outputs: the White Paper (Peti et al., 2026), the Synthesis Report (Sáinz-García et al., 2026), the Domain Insight (Marcos and Liakka, 2026) for EURAD Roadmap Domain 4.3.2 Climate Change, the training course, and this final deliverable on Outcomes to Member States and End Users. Together, these outputs were intended to support knowledge capture and transfer, during and beyond the WP lifetime.

Domain Insight

Purpose: long-term knowledge resource linked to EURAD Roadmap Domain 4.3.2 Climate Change, helping structure access to the topic beyond the immediate life of WP11.

Intended audience: early career professionals, new starters, and roadmap users seeking a structured entry point into the climate-change domain.

Link: https://www.ejp-eurad.eu/publications/eurad-2-domain-insight-432-climate-change

White Paper

Purpose: strategic synthesis of climate change impacts on radioactive waste storage and disposal facilities and sites, including recommendations on data, protocols, methodologies, and practices for robust climate risk assessment.

Intended audience: Member States, End Users, and other stakeholders seeking an accessible overview of the topic and of future methodological needs.

Link:https://www.ejp-eurad.eu/publications/eurad-2-d111-white-paper-impact-climate-change-radioactive-waste-management

Synthesis Report

Purpose: technical synthesis of the main findings of WP11 CLIMATE, bringing together the evidence base on climate change impacts across different facility types, timescales, and assessment contexts.

Intended audience: WP participants, Member States, End Users, and other technical readers seeking a fuller and more detailed account of the WP's methods, findings, and conclusions.

Link:https://www.ejp-eurad.eu/publications/eurad-2-d112-synthesis-report-climate-change-impacts-radioactive-waste-management

Training course

Purpose: transfer of WP11 knowledge through a two half-days course covering climate change impacts on radioactive waste storage and disposal, from fundamentals to methodological issues and future research needs.

Intended audience: both general users seeking a broad grounding in the topic and specialists requiring deeper methodological discussion.

Link:https://www.ejp-eurad.eu/publications/eurad-2-milestone-78-online-basic-training-course-climate-change-fundamentals and modelling, impact on radioactive waste facilities and climate risk assessments

Outcomes to Member States and End Users

Purpose: concise final deliverable aimed at summarising the main findings, impacts, lessons learned and future needs of WP11 CLIMATE.

Intended audience: Member State governments and ministries, WMOs, regulators, End Users, and European-level stakeholders seeking a short, accessible and decision-oriented overview of the relevance of climate change for radioactive waste management programmes.