EURAD-2 WP description Template #2

Please see Instructions for Work Package Preparation Team, public document for guidance (available on EURAD and PREDIS websites)

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Short Acronym and full Title	CLIMATE: Impact of climate change on nuclear waste management		
Type of activity	☐R&D	☒Strategic Study	Knowledge Management – covered by a separate committee and template
Budget estimation (total budget in M€, i.e ~ 1.5 M€)	~1.5 M€	Duration of the WP (in months) 24	
Links with EURAD SRA / Roadmap Themes (if multiple choices, indicate the primary link **in bold – maximum 3**)	☐Programme Management (Theme 1) ☐Pre-disposal (Theme 2) ☐Engineered Barrier Systems (Theme 3) ☒**Geoscience (Theme 4)** ☐Disposal facility design and optimisation (Theme 5) ☐Siting and Licensing (Theme 6) ☒Safety Case (Theme 7)		
Links with EURAD SRA topics (if multiple choices, indicate the primary link **in bold – maximum 3)**	- 4.1.1 Site descriptive model - **4.3.2 Climate change** - 7.3 Safety assessment and tools		
SRA drivers **(maximum 3)**	☒Implementation Safety	☐Tailored Solutions	☐Scientific Insight
	☐Innovation for Optimisation	☒Societal Engagement	☒Knowledge Management
Objective (What) – **1 sentence**	Identify knowledge gaps and provide recommendations for future research needs of the impact of climate change on waste management facilities (predisposal, shallow, and near surface LLW, DGR LILW, HLW) during construction, operation and on post-closure site evolution.		

Justification: impact / innovation / added-value (Why) – bullet points or short paragraph **(maximum quarter of a page)**	Climate change increases the risks of climate-related hazards that may affect the safety of all types of nuclear waste management facilities (from interim storage and predisposal to waste repositories) during construction, operation, and post-closure. The change in precipitation and temperature patterns, sea level rise and increased wind intensity have potential to increase the severity and frequency of floods, landslides, wildfires, snowstorms, freezing rain, tornados, etc. in Europe, posing serious risks to nuclear waste management facilities and, consequently, potentially affecting the citizens' health and the environment. Climate is one of the major long-term site evolution drivers that has controlled 1) thermal conditions, 2) local and regional geomorphological evolution resulting from erosion and deposition processes, 3) alteration processes that affect the geological formations, 3) evolution of the local and regional hydrogeological and hydrological contexts, and 4) evolution of natural and anthropogenic ecosystems which, combined with all the other modifications, determines the characteristics of the typical biospheres possible in the future. Climate change increases the uncertainty in the site evolution and, therefore, increases the risks related to nuclear waste management. The assessment of the impacts of climate change during construction, operational and post-closure phases is a novel research topic in the nuclear waste management sector, although climate scenarios are considered in long-term safety assessments. To contribute to the development of the work in this topic at the European level, the work package aims to identify knowledge gaps and provide recommendations for future research needs of the impact of climate change on all types of nuclear waste management facilities and sites across Europe during short and long timescales. Climate change is issue of importance for the design and operation of nuclear waste management facilities and sites and for Safety Case, as well as a concern of Civil society.

List of planned tasks / subtasks with % of effort per task (5% increments)
 	
(Maximum 10 bullets)
	• Task 1: Management/coordination of the WP, 10%
	• Task 2: Knowledge Management, 10%
	• Task 3: Strategic gap analysis 20%
	  o Subtask 3.1. Collection of current understandings and regulations in relation to climate impacts and climate risk assessment in the construction and operational phases of radioactive waste management facilities and sites.
	  o Subtask 3.2. Collection of current understandings and regulations in relation to climate impacts and climate risk assessment in the post-closure phase of radioactive waste management facilities and sites.
	• Task 4. Construction and operational phase climate impacts (hazard screening, climate modelling and climate risk assessment) 25 %
	  o Subtask 4.1: Climate scenarios definitions. Climate scenario definitions in different climate zones over Europe during the construction and operational phases.
	  o Subtask 4.2: Selection and profiling of representative nuclear waste management facilities and sites in different climate zones across Europe for construction and operational phases case studies.
	  o Subtask 4.3: RWM facility data collection. Information relevant for the construction and operational phases about

	predisposal, LILW (surface/shallow and underground) and HLW facilities and sites over Europe. o Subtask 4.4. Collection of natural analogues relevant for the selected sites in different climate zones (similar bioclimatic geographical area, bedrock, and soil types, geo- and hydromorphological characteristics etc.). o Subtask 4.5: Collection of physical hazard screening and hazard identification and scoring methodologies for climate impact assessments during the construction and operational phases. o Subtask 4.6. Collection and assessment of climate modelling and risk assessment methodologies, and identification of needs and gaps for the selected construction and operational phase case studies, including using natural analogues. o Workshops to discuss the results will be organized to gather the feedback from stakeholders. • Task 5: Post-closure phase climate impacts, 25 % o Subtask 5.1: Climate scenario definitions. Climate scenario definitions in different climate zones over Europe during post-closure timescales. o Subtask 5.2: Selection and profiling of representative nuclear waste management sites in different climate zones across Europe for post-closure phase case studies. o Subtask 5.3: RWM site data collection. Information relevant for the post-closure phase about LILW (surface/shallow and underground) and HLW facility sites over Europe. o Subtask 5.4. Collection of natural analogues relevant for the selected sites in different climate zones (similar bioclimatic geographical area, bedrock, and soil types, geo- and hydromorphological characteristics etc.). o Subtask 5.5: Collection of physical hazard screening and hazard identification and scoring methodologies for climate impact assessments during post-closure phase. o Subtask 5.6. Collection and assessment of climate modelling and risk assessment methodologies, and identification of needs and gaps for selected post-closure phase case studies, including using natural analogues. o Workshops to discuss the results will be organized to gather the feedback from stakeholders. • Task 6: Interaction with Civil Society - Stakeholders view, 10 % o Subtask 6.1. Interaction with Civil Society experts (also possibly outside nuclear field) on socio-technical challenges and associated uncertainties in Tasks 3-5. o Subtask 6.2. Dissemination activities with Civil Society.
List of expected outcomes linked	• Implementation Safety o Collection of understanding from scientific community and visions from stakeholders of the climate change impacts on

to the identified SRA drivers **(Maximum 6 bullets)**	predisposal, LILW (surface/shallow and underground) and HLW facilities and sites in Europe during the construction, operational and post-closure phases. o Enhanced understanding of climate change impacts on predisposal, LILW (surface/shallow and underground) and HLW facilities in Europe during the construction, operational and post-closure phases through hazard and risk assessments for improved confidence in safety case and operational safety. • Societal Engagement o Engagement with Civil Society and increased exchange of knowledge and visions on climate change impacts between different stakeholders. • Knowledge Management o A deeper integration among different fields (climate change, biosphere, hydrological evolution, etc.) for better evaluation of climate change impacts on radioactive waste management.
Deliverables **(Maximum 6 – including the prescribed deliverables)**	• D1: Gap analysis report. Collection of understanding from scientific community, and visions and regulations from stakeholders of the climate change impacts to predisposal, LILW (surface/shallow and underground) and HLW facilities in Europe during the construction, operational and post-closure phase to identify knowledge gaps. (8 months) • D2: White paper on climate change impacts on radioactive waste management facilities and sites during construction and operational phases, on disposal sites during post-closure period and on tools and methodologies for climate change impact assessment. (18 months) • D3: Outcome report. Construction, operational and post-closure phase climate scenarios, RWM facility information, RW disposal site information, hazard and risk screening methodologies, climate modelling and risk assessment methodologies, and natural analogues. The report contains background information for the white paper (D2). (22 months)
Critical input requirements & identified risks	• Input needed from other disciplines (for example, climate scientists, data scientists and statistics, infrastructure management, risk management experts) • Learning from other industries, sectors who face related challenges for critical infrastructure. May lead to overlapping work by the other industries and nuclear waste management sector. • Obtaining and sharing data on facilities and sites.
Major achievements expected by end of Year 2	• The work package will be finalised within 24 months.

(Go/No Assessment)[1] **(Maximum 5 bullets)**	
(Optional - Explain what is out of the scope?)	
List of preliminary interested organisations as partners in the WP contributing effort; **% of effort (person months, by College)**	REs (40%): Amphos 21 (Spain), Mitta Oy (Finland), SCK CEN (Belgium), CV_REZ (Czech Republic), BGS (Great Britain), TUSOFIA (Bulgaria), TNO (Netherlands), ENEA (Italy), BRGM (France) TSOs (30%): VTT (Finland), GI-BAS, (Bulgaria), NTW (France), GRS (Germany), SURO (CZ), IRSN (France), FTMC (Lithuania), EIMV (Slovenia), MKG (Sweden), SSTC NRS (Ukraine) WMOs (30%): Andra (France), BGE (Germany), COVRA (Netherlands), POSIVA (Finland), NAGRA (Switzerland), NWS (UK), SKB (Sweden), SURAO (Czech rep.), NES (Austria)
If applicable - links with previous projects / work packages	IGD-TP project on Climate change integration to safety case EC projects BIOCLIM, BIOMOSA, EURAD UMAN
WP Preparation Team (1 member per College) contact (**organisation + person**, email)	RE: Aina Bruno (Amphos 21), aina.bruno@amphos.com TSO: Veli-Matti Pulkkanen (VTT), veli-matti.pulkkanen@vtt.fi WMO: Friedrich Ego (Andra), frederic.ego@andra.fr CG observer: Astrid Göbel (BGE), astrid.goebel@bge.de

[1] EC budget being only allocated for the first 2 years, each work package progress will be reviewed at the end of Year 2, to assess its continuation based on the total budget that EURAD-2 will be granted.