Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe

Technical review report for project TACTIC

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 731166.

INTRODUCTION

Technical review report is part of GeoERA's Monitoring and evaluation process for co-funded projects (*hereinafter: project*). The aim of a technical review is to assess the work carried out under the project over a certain period and provide recommendations. Such technical review evaluates the project reports and deliverables, the proper use of resources, the management of the project and the expected impact.

Technical review report consists of four sections, each representing one level of monitoring and/or evaluation of the project:

Level	Monitor / Reviewer	Input	Aim
1 – Monitoring of progress indicators	Monitoring and reporting officer (GeoZS)	MPPR* FPPR**	Monitoring of the effectiveness of implementation of selected projects with respect to finance, time and administration.
2 – Scientific review	Reviewers (GeoZS)	Submitted deliverables MPPR FPPR	Quality review of the deliverables and review of achieving scientific and professional goals.
3 – Review of the theme progress	Theme coordinators	MPPR FPPR	Review of achieving theme objectives.
4 – GeoERA Progress evaluation	Stakeholder Council member(s)	Sections 1 and 2 of this report Review meetings	Overall project progress and general recommendations.

*MPPR = Midterm Project Progress Report (see PI doc no 2)
**FPPR = Final Project Progress Report (see PI doc no 2)

Monitoring and evaluation process:

M0 = End of reporting period
M1 = Submitted (Final) Project progress Report (MPPR / FPPR)
M2 = 1 – Monitoring & 2 – Evaluation
M3 = 3 – Evaluation of the theme progress
M3 = (Final) Review Meeting & 4 – Progress evaluation

Each project will be reviewed twice: for first project period M1-M18 – Technical review report, and second project period M19-M36 – Final review report.
Technical review report is based on Horizon 2020 templates but adopted to GeoERA needs. Technical reviews of projects shall be carried out on a confidential basis.

GENERAL INFORMATION

ERA-NET Cofund Grant Agreement:	731166
ERA-NET Cofund acronym:	GeoERA
Call identifier:	H2020-LCE-2016-2017/H2020-LCE-2016-ERA
Project full title:	Tools for Assessment of ClimaTe change ImpacT on Groundwater and Adaptation Strategies
Project acronym:	TACTIC
Project reference number:	GeoE.171.008
Project topic:	Groundwater
Project specific topic:	GW2-Tools for climate change impact assessment and adaptation
Lead partner:	GEUS Geological Survey of Denmark and Greenland
Project website:	https://geoera.eu/projects/tactic9/

☐ Technical review report
☒ Final review report

Period covered	01/01/2020 – 31/10/2021
Review meeting date	10.12.2021; start at 13:30

Contributor:	Role:	Approved on:
Barbara Simić	Monitoring and reporting officer	10.12.2021
Aleksandra Trenchovska	Monitoring and reporting officer	12.12.2021
Mateja Jemec Auflič	Scientific reviewer	12.12.2021
Ela Šegina	Scientific reviewer	13.12.2021
Jasna Šinigoj	Scientific reviewer	12.12.2021
Matija Krivic	Scientific reviewer	12.12.2021
Klaus Hinsby	Theme coordinator	21.12.2021
Ad de Roo	GeoERA Stakeholder	/
Karen Villholth	GeoERA Stakeholder	7.1.2022

1 LEVEL 1 – MONITORING OF PROGRESS INDICATORS

In this section the project is monitored "remotely" on the basis of the respective reports. This part is filled in by Monitoring and reporting officer with aim to monitor the effectiveness of implementation of the selected projects with respect to finance, time and administration, based on submited MPPR and FPPR.

	Yes	Partially (comment needed)	No
PROJECT MANAGEMENT			
Has the MPPR / FPPR report been submitted on time?	☒	See comment no. 1	☐
Have there been any changes in project partnership?	☒	See comment no. 2	☐
Has the project management been performed as required?	☒		☐
Has the collaboration between partners been effective?	☒		☐
Do you identify evidence of underperforming partners, lack of commitment or change of interest of any partners?	☐ (see comment)		☒
DELIVERABLES and MILESTONES			
Have the planned deliverables for the period been submitted on time according to timeline in Project Agreement?	☐	See comment no. 3	☒
Have the planned deliverables for the period been completed (from MPPR / FPPR, sheet 4)	☒		☐
Have any changes to deliverables occurred (type/ dissemination level)? (from MPPR / FPPR, sheet 4 and 5)	☒		☐
Have planned milestones been achieved for the reporting period? (from MPPR / FPPR, sheet 4)	☒		☐
Have the project partnership identify any difficulties achieving any of the deliverables / milestones?	☐		☒
DEVIATIONS (from MPPR / FPPR, sheet 5)			
Has the project partnership identify any deviations that will not affect projects outputs?	☒		☐
Have any deviations occur on the project, with impact on project outputs?	☐		☒
In case of deviations, have the project adopted corrective measures?	☒		☐

DISSEMINATION, COMMUNICATION			
Has the project adopted its dissemination plan?	☒		☐
Have the planned dissemination activities been completed for the reporting period? (from MPPR / FPPR, sheet 6)	☒		☐
Have the partners' disseminated project results and information adequately?	☒		☐
Is the project following dissemination plan?	☒		☐
Is the project interacting in a satisfactory manner with other GeoERA projects?	☒		☐
Is the project interacting in a satisfactory manner with national/international bodies?	☒		☐

FINANCE			
To the best of your estimate, have the resources used been utilised for achieving the project? (according to MPPR / FPPR, sheet 9)	☒		☐
To the best of your estimate, have the resources used been in a manner consisted with the principle of economy, efficiency and effectiveness?*	☒		☐
Are there any major deviations in the budget consumptions from the financial plan? (zero consumption in M18; deviation from plan exceeding 20% in M36)	☒	See comment no. 4	☐
Are there any major deviations in the Person - Months consumptions from the plan? (zero consumption in M18; deviation from plan exceeding 20% in M36)	☒		☐
Are any budget modifications for the project needed? (from MPPR / FPPR, sheet 5)	☐		☒

***The principles of economy, efficiency and effectiveness**: refers to the standard of "good housekeeping" in spending public money effectively. Economy can be understood as minimising the costs of resources used for an activity (input), having regard to the appropriate quality and can be linked to efficiency, which is the relationship between the outputs and the resources used to produce them. Effectiveness is concerned with measuring the extent to which the objectives have been achieved and the relationship between the intended impact and the actual impact of an activity. Cost effectiveness means the relationship between project costs and outcomes, expressed as costs per unit of outcome achieved.

Comments (highlighting the project progress) / deviations / recommendations:

The project TACTIC aimed to improve support to EU decision and policy making by contributing to the development of coherent and transparent assessments of the impacts of climate change on groundwater and surface water, using common and integrated approaches, methodologies and tools that are consistent across European countries. The project addressed several critical geohazards such as groundwater-dependent floods and droughts, interactions between groundwater and surface water, including groundwater-dependent ecosystems and problems of seawater and saltwater intrusion, changes in groundwater recharge and groundwater depletion, which can have profound economic, environmental and social costs. The project consortium focused on scientific methods to identify and assess potential adaptation strategies and their impacts on groundwater resources by collecting and harmonizing data available in different EU Member States to develop strategies and tools for decision makers. The tools were tested in 41 pilot projects. The result is 57 tools and data needed to assess the impacts of climate change. The tools are described in detail in the guidelines along with a description of their use. The results have been published and are available online. There is a room for improvement to make the results more easily accessible and findable, the direct links will be published on project's website. The project consortium has started to link its database with external data providers by securing additional funding from IFD (Denmark), and to link with data providers of near real-time sensor data and to implement an early warning system for geohazards in some countries (Spain, Ireland, France and the UK).

The Covid 19 epidemic has impacted the progress of the project TACTIC. In December 2020, the project was extended by 4 months, from 30.6.2021 until 31.10.2021. The postponed project activities were appropriately communicated to the GeoERA Executive board, which reviewed and approved the changes in light of achieving the project outcomes. A detailed list of changes is part of the project documentation in the project plan History of changes.

The project management structure was well defined and efficient. In December 2020, the project management was changed without any negative impact on the ongoing project activities. The pandemic impacted the project by limiting travel and field trips, resulting in fewer meetings and unspent budgets in the travel category. To ensure the achievement of the set targets, partners increased their personnel efforts by changing partner budgets through reallocations between categories and taking the unspent budget from other partners and projects, increasing the initial project budget by 6.64% in mid-2020. Overall, partners GSI, GTK, LEGMC and OPM increased their budget, while partner GEOINFORM decreased it. The project did not identify any underperforming partners that could affect the quality of the project outputs.

Communication and dissemination activities focused on decision-makers and policy-makers, reaching them through scientific publications, presentations at conferences

and also through social media. Some publications will be published after the end of GeoERA. The project has mainly collaborated with other projects under the GeoeRA groundwater theme and the GIP -P project, as well as with national research projects, e.g. MASS-IGLOO, funded by the Spanish National Research Programme, and TOPSOIL, funded by Interreg North Sea Region.

Comment no. 1: The Final Project Progress Report was submitted in draft form by the deadline. Partners still have the opportunity to recalculate their finances by the end of the calendar year to include the final data, so minor variations can be expected. The changes will not affect the content of the project.

Comment no. 2: In December 2020, Mr Peter van der Keur took over the leadership of the project from Mr Anker Lajer Højberg. During the implementation of the project, a change in partnership occurred: the IGME-Sp Geological Survey of Spain was integrated into the CSIC Agencia Estatal Consejo Superior de Investigaciones Científicas. At the end of reporting period 1, the project partner GEOINFORM State Research and Development Enterprise State Information Geological Fund of Ukraine ended its activities and did not participate in the second period.

Comment no. 3: Due to the pandemic situation, some activities were delayed and deliverables had to be submitted later than planned. The revised dates were communicated to the Monitoring team and the GeoERA Secretariat by amending the project plan.

The deliverable changes in the project implementation period are:

Reporting period 1:
D2.3 postponed from M10 (30.4.2021) → M12 (30.6.2019)
D1.1 postponed from M15 (30.9.2021) → M16 (31.10.2019)

Reporting period 2:
D1.2 postponed from M23 (31.5.2020) → M28 (31.10.2020)
D2.5 postponed from M29 (30.11.2020) → M40 (31.10.2021)
D4.4 postponed from M30 (31.12.2020) → M34 (30.4.2021)
D1.7 is deleted
D3.2 postponed from M31 (31.1.2021) → M33 (31.3.2021)
D3.4 postponed from M31 (31.1.2021) → M33 (31.3.2021)
D4.2 postponed from M31 (31.1.2021) → M33 (31.3.2021)
D5.3 postponed from M31 (31.1.2021) → M33 (31.3.2021)
D6.3 postponed from M31 (31.1.2021) → M33 (31.3.2021)
D3.3 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D3.5 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D4.3 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D4.5 postponed from M36 (30.6.2021) → M40 (31.10.2021)

D5.4 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D6.4 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D6.5 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D1.4 postponed from M38 (31.8.2021) → M43 (31.01.2022)
D1.8 postponed from M38 (31.8.2021) → M43 (31.01.2022)

Comment no. 4: Some project partners spent less than 80% of their planned budget. Partners that spent less than their planned budget are BGR and SGU. The consumption of man-months followed the EUR consumption.

The project has coped well with the negative external factors and has overcome its challenges in such a way that it has achieved its planned objectives and project results. For this reason, the project is rated "excellent" at level 1 and thus receives a rating of 4 - Objectives and targets fully achieved.

Overall assessment of the project:

☐ 5 - **Overachiever** (the project has achieved all objectives and goals for the period and has even exceeded expectations)
☒ 4 - **Excellent progress** (the project has fully achieved its objectives and goals for the period)
☐ 3 - **Good progress** (the project has achieved most of its objectives and goals for the period with relatively minor deviations)
☐ 2 - **Acceptable progress** (the project has achieved some of its objectives)
☐ 1 - **Unsatisfactory progress** (the project has failed to achieve critical objectives)

Summary of dissemination activities:

	SCIENTIFIC COMMUNITY	GENERAL PUBLIC	POLICY MAKERS	EUROPEAN INSTITUTION	NATIONAL INSTITUTION	REGIONAL INSTITUTION	INTERNATIONAL INSTITUTION	LOCAL INSTITUTION	PRIVATE COMPANIES	OTHER	Total Target Group reach
EVENTS	1700	5	120	70	30	30	30	25	35	25	2070
MEETINGS	205		125	20	20	15	5	5	15	15	425
ONLINE_MEDIA	42100	5000	51	50	50	50	50	50	50	240	47691
PUBLICATIONS	21600	100	40	140	200	150	170		130	130	22660
Total	**65605**	**5105**	**336**	**280**	**300**	**245**	**255**	**80**	**230**	**410**	**72846**

	ABSTRACTS	**BLOG**	**CONGRESS**	**FACEBOOK**	**LINKEDIN**	**MEETING**	**MEETING WITH OTHER PROJECTS**	**POSTER**	**RESEARCHGATE**	**SCIENTIFIC PUBLICATION**	**TECHNICAL REPORT**	**TWITER**	**WEBINAR**	**WEBSITE**	**Ttotal**
EVENTS			5										3		8
MEETINGS						5	1								6
ONLINE_MEDIA		1		10	1				1			2		1	16
PUBLICATIONS	7							4		16	1				28
Total	**7**	**1**	**5**	**10**	**1**	**5**	**1**	**4**	**1**	**16**	**1**	**2**	**3**	**1**	**58**

Are the dissemination activities adequate?

☐ 5 - **Overachieved** (the projects dissemination activities have exceeded expectations)

☒ 4 - **Excellent** (the projects dissemination activities have fully achieved its expectations)

☐ 3 - **Good** (the projects dissemination activities are adequate)

☐ 2 - **Acceptable** (the projects dissemination activities are acceptable)

☐ 1 - **Unsatisfactory** (the project has failed to disseminate)

Cummulative financial statement:

	Person months	Total eligible costs	Reimbursement rate	GeoERA contribution	In-kind contribution
Plan	**280,76**	**1.919.535,80**	**29,7 %**	**570.099,91**	**1.349.435,86**
1st period consumption	104,7	714.165,69	29,7 %	212.107,21	502.058,48
2nd period consumtion	174,17	1.009.462,31	29,7 %	326.540,31	772.922,00
TOTAL	**278,87**	**1.813.628,00**	**29,7 %**	**538.647,52**	**1.274.980,48**

2 LEVEL 2 – SCIENTIFIC REVIEW

In this section the project is reviewed ”remotely” on the basis of the respective reports. This part is filled in by reviewer with aim to review the quality of the deliverables and review of achieving scientific and professional goals. Scientific review is based on submitted deliverables and reported Impact statement in MPPR/FPPR.

Impact statement (from MPPR / FPPR, sheet 8):

The expected impact of TACTIC was first and foremost to provide: “Improved support to EU decision and policy making by contributing to the development of coherent and transparent assessments of climate change impacts on groundwater and surface water using common and integrated approaches, methodologies and tools consistent across the different European countries”.
To achieve this, TACTIC contributed to the population of the common GeoERA Information Platform (GIP), whereby data and results from the project were made findable, accessible, interoperable and reusable data according to the “FAIR” principles. Results included standard results from assessments e.g. in the form of tables of hydraulic parameters, maps, cross sections and model results. In addition to this, results included a TACTIC toolbox with tools relevant for climate change impact assessments and evaluate effect of adaptation strategies as well as a guidance document for undertaking the assessments. Through GIP data and results from the project were made easily accessible primarily for stakeholders involved in the development of sustainable management of Europe’s water resources and climate change adaptation. Hence, it provided data for the development of on-top services by e.g. private consulting companies contracted by authorities to develop services at local to Pan-European scale, and it promoted the development of new monitoring instruments and networks required for cost-efficient monitoring and assessment of the chemical and quantitative status of the water resources according to the Water Framework and Groundwater directives and the Blueprint to Safeguard Europe’s Water Resources.
In addition to the impact to the external stakeholders and future users, an important impact for TACTIC is to advance the climate change impact assessments and adaptations in the individual GSOs and harmonise the assessments among the GSOs. This is achieved through the development of a TACTIC Toolbox, common protocols and guidelines, as well as direct contacts through physical project and online meetings, with experience sharing, discussion of progress and demonstration of tools and approaches.
The impacts to the external community can only be realised at the end of the project, were project products have been finalised and made accessible in the information platform. The impact among the TACTIC partners are, on the contrary, experienced during the project. Through online webinars various tools have been demonstrated and taken up by TACTIC partners with no previous experience in climate change impact assessments, and 11 partners are working with multiple tools in their pilots. Common climate change scenarios have further been developed making it possible

for all TACTIC partners to estimate effect of future climate changes. The project has thus already had a significant impact in advancing and harmonising the assessments among the partners.

Expected impact (from Project Agreement):

The expected impact of TACTIC is first and foremost to provide: “Improved support to EU decision and policy making by contributing to the development of coherent and transparent assessments of climate change impacts on groundwater and surface water using common and integrated approaches, methodologies and tools consistent across the different European countries”, as required in the GeoERA call text for the groundwater specific research topic “Tools for climate change impact assessment and adaptation”. TACTIC will do so by compiling and harmonising European subsurface databases on the common GeoERA Information Platform providing findable, accessible, interoperable and reusable data according to the “FAIR” principles e.g. in the form of tables of hydraulic parameters, maps, cross sections and model results in collaboration with the GeoERA Information Platform and the other GeoERA themes. These data are required for scientifically sound climate change impact assessments, decision and policy making, and the developed databases and maps will demonstrate where e.g. data for sound assessments are missing in order to be able to make projections with an acceptable uncertainty. The improved decision support data and tools will be easily accessible via the GeoERA information Platform primarily for stakeholders involved in the development of sustainable management of Europe’s water resources and climate change adaptation. Hence, it will provide data for the development of on-top services by e.g. private consulting companies contracted by authorities to develop services at local to Pan-European scale, and it will promote the development of new monitoring instruments and networks required for cost-efficient monitoring and assessment of the chemical and quantitative status of the water resources according to the Water Framework and Groundwater directives and the Blueprint to Safeguard Europe’s Water Resources. In addition to the expected impacts mentioned in the call text for the specific research topic covered by this proposal, TACTIC will contribute to support, provide data and improve the understanding of the following important issues related to climate change impacts on the status of European water resources and hence sound decision making, sustainable management and adaptation in relation to: • Potential consequences, hazards (e.g. land subsidence) of groundwater abstraction and interactions with other subsurface activities as well as climate change, droughts and floods; • Open access to modelling results enabling private companies and/or research institutions to develop new groundwater services on top of the integrated climate, groundwater-surface water models and results e.g. in public-private partnerships and competitive and collaborative environments; • Improved role of Europe in developing innovative solutions and products for sustainable water management, conjunctive use, adaptation strategies and protection of freshwater resources, globally; • Improved

access to downloadable hydraulic parameters of main European aquifers and aquitards (or groundwater bodies) needed for e.g. model development; • Improved tools for assessment of groundwater quantitative and chemical status based on good status objectives of groundwater dependent terrestrial and associated aquatic ecosystems according to EU directives and guidance; • State-of-the-art tools for decision support that allow to elaborate the cost-effectiveness of measures and to support sustainable decision making in relation to the water-food-energy nexus.

Evaluation of deliverables

No.	Title	Status (Approve/Reject)	Comments
D1.2	Summary report for the third TACTIC Advisory Board	Approved	
D1.3	Project progress report	Approved	Level 1 MT
D1.4	Final project report	Approved	Level 1 MT
D1.6	Cumulative expenditure report 2019	Approved	Level 1 MT
D1.8	Final financial project	Approved	Level 1 MT
D2.5	Protocol for guidelines	Approved	
D3.2	Pilots description and assessment report for groundwater-surface water	Approved	
D3.3	Journal paper on climate change assessment in EU	Approved	
D3.4	Technical note on propagation of climate change projections in integrated models	Approved	
D3.5	Guideline for integrated modelling	Approved	
D4.2	Pilots description and assessment report for recharge and groundwater vulnerability	Approved	
D4.3	Journal paper on aquifer recharge variability and trends	Approved	
D4.4	Pan-European net precipitation map	Approved	
D4.5	Guideline for groundwater recharge and vulnerability	Approved	
D5.3	Pilots description and assessment report for sea/salt	Approved	
D5.4	Journal paper demonstrating the application of the method in pilots	Approved	
D5.5	Guideline for assessment of salt/sea water intrusion	Approved	

D6.3	Pilots description and assessment report for adaptation	Approved	
D6.4	Journal paper on adaptation strategies to reduce impacts on droughts	Approved	
D6.5	Guideline on adaptation strategies	Approved	

Has the quality as a whole been achieved according the objectives? Has the project as a whole been making satisfactory progress?

☐ 5 - **Overachiever** (the project has achieved all objectives and goals for the period and has even exceeded expectations)

☒ 4 - **Excellent progress** (the project has fully achieved its objectives and goals for the period)

☐ 3 - **Good progress** (the project has achieved most of its objectives and goals for the period with relatively minor deviations)

☐ 2 - **Acceptable progress** (the project has achieved some of its objectives)

☐ 1 - **Unsatisfactory progress** (the project has failed to achieve critical objectives)

Comments (highlighting the project progress) / deviations / recommendations:

The project partners are analysing different climate change scenarios and their impacts on groundwater levels, groundwater recharge, assessment of seawater and saltwater intrusion and vulnerability in more than 40 pilot areas across the EU. All developments include the background, objectives and methodology used, including numerous equations. As part of the project, the partners have developed the TACTIC toolbox, which contains approaches and tools for assessing and adapting to the impacts of climate change. In addition, several scientific papers have already been published in renowned journals with high IF. The project partners have achieved all scientific goals.

Comment 1: The methodology and metadata of Pan-European recharge groundwater, net precipitation and evapotranspiration map development is not presented within the Deliverables. We reccomend adding such data when publishing the maps at EGDI, GIP-P and elsewhere.

Comment 2: Based on results from numerous pilot areas elaborated and presented in this project, the reviewers suggested a short summary on the state of the impact of climate change on Europe. We recommend the project partners to summarize their findings in a scientific paper and as a report available to the stakeholders.

3 LEVEL 3 – REVIEW OF THE THEME PROGRESS

In this section the project is reviewed ”remotely” on the basis of the respective reports. This part is filled in by Theme coordinator with aim to review the achieved scientific goals in accordance with theme objectives, on the basis of Sheet 3 in MPPR / FPPR – Project contribution to GeoERA project.

Project contribution to GeoERA project (from MPPR / FPPR, sheet 3):

The GeoERA groundwater projects including TACTIC “Tools for assessment of climate change impacts on groundwater and adaptation strategies” responds to groundwater research needs described in the ERA-NET on Applied Geoscience (LCE-26-2016), which was partly inspired by and elaborated based on a Concept Note on Groundwater Research Needs previously developed by the Water Resources Expert Group (WREG) of the EuroGeoSurveys in collaboration with science and policy officers of DG Research and DG Environment. The Concept Note intended to assist and realize climate proof and resilient groundwater management and contribute to bridging the gap between science and policy and sustainable use of the subsurface. Competing uses of the subsurface is expected to increase as a result of secondary impacts of climate change such as CO2 storage and geothermal energy and requires improved understanding of the geological, physical and chemical characteristics of the subsurface.

The TACTIC project focused on the issues related to climate change impact and adaptation as described in the LCE-26-2016 and the corresponding final GeoERA proposal. focusing on (i) groundwater quantity issues (groundwater recharge, availability, droughts and floods), and (ii) salt water intrusion in primarily coastal aquifers e.g. in relation to requirements and guidelines of the Water Framework and Groundwater directives and guidelines

TACTIC contributes to GeoERA by considering and contributing to most (in bold) of the following goals and deliverables requested by the original LCE-2016 call in Horizon 2020 for an ERA-NET on Applied Geoscience and it makes the results from the assessments in the pilots available at the GeoERA Information Platform complying with FAIR data and INSPIRE principles – including (extracts from the original call):

develop and enhance the knowledge and the predictive capacity needed to assess the impact of climate change and human activities on groundwater resources and dependent surface waters and ecosystems, and the consequences for groundwater quantitative and chemical status assessed according to the Water Framework and Groundwater directives. High quality models including estimated simulation and projection uncertainties are required tools for decision support systems that allow e.g.:

Elaboration of cost-effective measures and assessment of their (cost) effectiveness; sustainable decision making taking into account the water-food-energy nexus;

And provide the following deliverables:

Improved tools and models for subsurface characterisation, risk assessment and assessment of the impact of climate change, human activities and other uses of the subsurface on groundwater resources and dependent terrestrial ecosystems;
3D maps of groundwater resources;
Groundwater and surface water flooding risks;
Saltwater / seawater intrusion and the resulting impact on dependent terrestrial ecosystems;
Groundwater abstraction needs for water supply and irrigation and the resulting impact on dependent terrestrial ecosystems (including soils), surface waters, and groundwater associated aquatic ecosystems, the groundwater ecosystem itself, and the built environment (e.g. damage of infrastructure due to land subsidence

Theme objectives:

The main objective of the GeoERA groundwater theme is to provide data, information and decision-support tools for the long-term protection, sustainable management and improvement of groundwater resources across Europe, within the framework of societal challenges and EU policies. These include the European Green Deal, the Water Framework and Groundwater directives, and the UN Sustainable Development Goals. Innovative methodologies and digital map viewers and information products are developed to tackle the diversity of hydrogeological settings at a range of scales from points or boreholes to the whole of Europe; primarily visualized in two or three dimensions providing access to all the compiled data and information including 3D hydrogeological models. By jointly developing effective and harmonized tools and methodologies for monitoring, modelling, data management and visualization, in close collaboration with the other GeoERA themes, this work will improve our understanding of groundwater chemical and quantitative status across Europe and how this is affecting or affected by groundwater legitimate uses and nature. “Legitimate uses” include e.g. drinking water abstraction, irrigation, heating and cooling of buildings and mining; and “nature” include the ecological status and biodiversity of groundwater dependent terrestrial and associated aquatic ecosystems as well as groundwater ecosystems. The mission of the GeoERA groundwater projects is to contribute to and initiate the development of a world leading digital groundwater and subsurface information platform with free and easy access (FAIR data) to groundwater data across Europe relevant for assessing groundwater chemical and quantitative status according to EU directives and support sustainable management of groundwater and other subsurface resources in a changing climate.

Has the project as a whole achieved the objectives and expected impact of the theme?

☒ 5 - **Overachiever** (the project has achieved greater impact on project theme and/or other themes than expected)

☐ 4 - **Excellent progress** (the project has fully achieved its objectives and goals towards the theme as expected)

☐ 3 - **Good progress** (the project has achieved most of its impact towards the theme for the period with relatively minor deviations)

☐ 2 - **Acceptable progress** (the project has minor impact)

☐ 1 - **Unsatisfactory progress** (the project has failed to achieve critical objectives and/or has no impact on the theme)

Comments / deviations / recommendations:

The reason for the high rating is that the project is expected to ultimately publish more than 15 scientific papers – all the technical work packages have already or will publish in total more than 15 papers within the next half a year (12 is already published) – as only four research papers were listed as deliverables from the TACTIC project this is a significant additional achievement, which increase the impact of the project and improve the chances for the partners in the consortium to get involved in other Horizon Europe proposals related to the TACTIC topics e.g. In the anticipated new European Partnership – "Water4All – water security for the planet".
Several TACTIC partners have already been using their new collaboration experiences and research products related to climate change impacts on groundwater in new Horizon Europe proposals, which have been submitted or are in the pipeline.

4 LEVEL 4 – GEOERA PROGRESS EVALUATION

In this section the project is reviewed on the Review meetings, where projects present their overall progress and achievements. This section relates to particular project, broader impact of GeoERA as a whole on policies will be covered at the Final Review meeting with questionnaire and interview with Evaluator.

Based on technical review summaries provided by Sections 1 – 3 of this report, and project presentation on the (Final) Review meeting:

Has the project as a whole been making satisfactory progress according to your own understanding and expectations of the GeoERA project?

☐ 5 - **Overachiever** (the project has exceeded expectations)
☒ 4 - **Excellent progress** (as expected)
☐ 3 - **Good progress** (minor recommendations given below)
☐ 2 - **Acceptable progress** (below expectations)
☐ 1 - **Unsatisfactory progress** (the project did not meet expectations)

Overall comments for the project (overall recommendations, modifications, corrective actions, or re-tuning the objectives to optimize the impact or keep up with the State of the Art, re-focusing, or a simple praise)

Stakeholder one evaluation:

One of the Stakeholders informed the GeoERA Coordinator and the Monitoring team of their serious illness after the Review meeting was conducted. Due to the illness, they will not be able to provide an evaluation, and due to the late notification, no other stakeholder could be invited. This project is evaluated by one stakeholder.

Stakeholder two evaluation:

Congratulations to the GeoERA Network and the TACTIC project team on the significant and positive outcomes of the project. The approach, which combined climate impact assessments on groundwater at various scales, while providing guidance tools and some harmonization in terms of e.g. applied climate scenarios, sets a good foundation for comparison and further coordinated assessments across Europe. The recharge map is a welcome first-ever overview of this parameter pan-Europe, and it adds nicely to the EGDI platform in terms of full-coverage maps at the European level. One observation is that discussing or assessing this map under climate change, i.e. the impact of climate change on GW recharge at the European level, could be very valuable, while it is acknowledged that this may be a large undertaking, likely for a future project.

On the technical side, I was looking for the spatial resolution of the datasets/maps online and could not easily find it. Could this be made more upfront visible/clear in the EGDI viewer for easy reference by users. This may be combined with some intro-notes and descriptions more broadly of what the system provides, in easily-read text. This could also provide links to the datasets/maps directly from within this text, so one gets a quick snapshot of what the tool can provide. This could work as an appetizer and easy induction to the system. Thinking of ways to make the tool/maps most user-friendly is a critical part of the FAIR principle. Obviously, some coordination across various GeoERA project/partners on these aspects is needed.

Would it be possible to enter some of the modelling results in EGDI. E.g. a map of risk of seawater intrusion; even if in certain areas, would be a strong addition.

The Information Platform offers great opportunities for expansion, e.g. with more GW quality data, 3D visualization, and opportunities are basically endless. One observation in terms of databases is that the International Groundwater Resources Assessment Centre (IGRAC) already is collating and mapping data and information on GW/aquifers globally, and it appears there is room for coordination in order to avoid parallel systems, which may not speak to each other. However, it may appear that IGRAC has more of an extra-European focus. In any case, coordination and alignment going forward appear both feasible and beneficial.

Finally, the present deliverables form a solid basis on which to strengthen scientific work and collaboration on groundwater and climate change across Europe, to expand data/the knowledge base, develop best climate adaptation measures and develop/retain strong partnerships. Options for building capacity in countries and regions outside Europe, where needs are high and transboundary work is becoming more pressing, is also something to consider. E.g., funding to groundwater projects at EU level could be linked to North-South cooperation and incentives/requirements for training as well as globally agreed standards and harmonization of GW information, for the overall benefit of promoting sustainable development.

In general, capitalizing on the achievements and investments made in TACTIC will be a major measure of success of GeoERA Project going forward.

Annex 1: Review meeting list of participants

Name	Role	Organisation
Joop Hasselman	GeoERA coordinator	Netherlands Organisation for Applied Scientific Research
Karen Villholth	GeoERA Stakeholder	IWMI – South Africa
Barbara Simić	Monitoring and Reporting Officer	Geological Survey of Slovenia
Aleksandra Trenchovska	Monitoring and Reporting Officer	Geological Survey of Slovenia
Jasna Šinigoj	Scientific Reviewer	Geological Survey of Slovenia
Matija Krivic	Scientific Reviewer	Geological Survey of Slovenia
Mateja Jemec Auflič	Scientific Reviewer	Geological Survey of Slovenia
Ela Šegina	Scientific Reviewer	Geological Survey of Slovenia
Klaus Hinsby	Groundwater Theme coordinator	Geological Survey of Denmark and Greenland
Peter van der Keur	Project manager	Geological Survey of Denmark and Greenland
Jacob Kidmose	Project member and WP3 lead	Geological Survey of Denmark and Greenland
Hélène Bessiere	Project member and WP4 co-lead	The French Geological Survey
Majdi Mansour	Project member and WP4 co-lead	British Geological Survey
David Pulido-Velázquez	Project member	Geological Survey of Spain
Ida Karlsson Seidenfaden	Project member	Geological Survey of Denmark and Greenland
Evaluation with remotely with help of recording:		
Ad de Roo	GeoERA Stakeholder	JRC-ISPRA