CLIMAAX
climate ready regions

Deliverable Phase 3 – Climate risk management

Climate change floods risk assessment for enhanced preparedness and resilience of vulnerable Putna river basin local communities in Romania (CARE-ROPutna)

Romania, Bucharest

July 2026

HORIZON-MISS-2021-CLIMA-02-01 - Development of climate change risk assessments in European regions and communities based on a transparent and harmonised Climate Risk Assessment approach

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101093864. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Document Information

Deliverable Title	Phase 3 – Climate risk management
Brief Description	This deliverable describes the exploration/evaluation of potential adaptation options and relevant actions at local scale to address the risk and vulnerabilities identified from the multi-risk analysis carried out in Phases 1 and 2
Project name	Climate change floods risk assessment for enhanced preparedness and resilience of vulnerable Putna river basin local communities in Romania
Country	Romania
Region/Municipality	Vrancea
Leading Institution	NIHWM - NATIONAL INSTITUTE OF HYDROLOGY AND WATER MANAGEMENT
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Deliverable submission date	31/07/2026
Final version delivery date	31/07/2026
Nature of the Deliverable	R – Report
Dissemination Level	PU - Public

Version	Date	Change editors	Changes
1.0	…	NATIONAL INSTITUTE OF HYDROLOGY AND WATER MANAGEMENT	Deliverable submitted
2.0	…		
5.0	…		Final version to be submitted

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Abbreviations and acronyms

Abbreviation / acronym	Description
APSFR	Areas of Potential Significant Flood Risk
CRA	Climate Risk Assessment
CRM	Climate Risk Management
EAD	Expected Annual Damage
FRMP	Flood Risk Management Plan
IDF	Intensity Duration Frequency
JRC	Joint Research Centre
FD	Floods Directive 2007/60/EC
GD	Government Decision
GDP	Gross Domestic Product
MEWF	Ministry of Environment, Water and Forests
ML	Machine Learning
NARW	National Administration Romanian Waters
NIHWM	National Institute of Hydrology and Water Management

NMA	National Meteorological Administration
NSMFR	National Strategy for the Management of Flood Risk in the Medium and Long Term
PoM	Programme of Measures
RBA	River Basin Administration
ROFFG	Romania Flash Flood Guidance System
RP	Return Period
TAU	Territorial Administrative Unit
WMS	Water Management Service

Executive summary

This deliverable presents the results of Phase 3 – Climate Risk Management of the CARE-ROPutna project, implemented within the CLIMAAX initiative. Building on the climate risk assessment carried out in Phases 1 and 2, this phase focused on translating the identified flood hazards, exposure, vulnerabilities and risks into a portfolio of proposed climate risk management measures for the Putna River basin. The deliverable demonstrates how the scientific evidence generated during the previous phases was transformed into practical recommendations to support future flood risk management planning and climate adaptation.

The activities carried out during Phase 3 included the identification and assessment of potential climate risk management measures, the organisation of stakeholder consultation workshops, the validation and prioritisation of the proposed measures through participatory processes, and the preparation of communication products to facilitate the uptake of the project results by regional and national decision-makers. The proposed portfolio combines structural measures, nature-based solutions and non-structural actions, following the principles of integrated flood risk management and climate resilience. The measures are intended to support the future update of the Programme of Measures within the Flood Risk Management Plan for the third implementation cycle of the Floods Directive and should be regarded as technical recommendations rather than formally adopted interventions.

Stakeholder engagement represented a key component of this phase. Two consultation workshops brought together representatives of water management authorities, emergency services, regional and local administrations, environmental institutions and other relevant organisations to discuss the proposed measures, identify local priorities and validate the project results. The consultation process confirmed broad support for integrated flood risk management approaches combining grey infrastructure, nature-based solutions, improved early warning systems, increased public awareness and strengthened institutional cooperation. Stakeholder feedback also highlighted the importance of considering local knowledge and implementation constraints when prioritising future investments.

To support the dissemination of the project results, promotional materials and a brochure describing the project's main outcomes were distributed during the workshops and shared with relevant institutions. In addition, two Policy Notes were prepared and disseminated to regional and national authorities responsible for flood risk management, water management, spatial planning and climate change adaptation. These documents translate the project's technical findings into practical policy recommendations aimed at supporting evidence-based decision-making and future planning processes.

Phase 3 also evaluated the usability of the proposed measures and reflected on the lessons learned throughout the project. The results demonstrate that integrating high-resolution climate risk assessments with stakeholder knowledge provides a robust basis for identifying locally relevant adaptation measures. At the same time, the project recognised that the implementation of several proposed measures will require additional feasibility studies, environmental assessments, financial resources and interinstitutional collaboration.

Overall, Phase 3 successfully bridged the gap between climate risk assessment and climate risk management by providing a technically justified and stakeholder-validated portfolio of proposed

adaptation measures for the Putna River basin. The deliverable contributes to the overall objectives of CARE-ROPutna by supporting the future update of flood risk management planning, strengthening climate resilience and providing a transferable methodological approach that can be applied in other Romanian river basins. The project demonstrates that effective climate adaptation requires the integration of scientific evidence, stakeholder participation and coordinated policy support to achieve sustainable flood risk reduction under future climate conditions.

1 Introduction

1.1 Main objectives of the project

The main objectives of phase 3 of the project are:

- involve stakeholders (local and regional administrative authorities) in finalising the new proposals for the program of measures which will include prevention, protection and preparedness measures for existing and future floods, taking into account the effects of climate change.
- make proposals for updating the program of measures for study areas in the Flood Risk Management Plan of the 3rd implementation Cycle of the Floods Directive and for supporting the improvement of General Urban Plans, Urban Planning and Local Development Plans and the updating of the General and Local Urban Planning Regulations;
- increase the general knowledge and awareness of floods and flash floods risk at local and regional scale, as a result of the foreseen workshops;

1.2 Project team

In order to meet the objectives of phase 3 of the project, the main team members working on specific tasks were experts in research supporting water management planning, necessary for informing decisions, policies, and strategies in this field, with experience in research supporting the implementation of the Floods Directive 2007/60/EC in Romania.

In addition, members of the working team with experience in planning and organizing stakeholder engagement events were involved.

Hydrologists with expertise in climate risk assessment, involved in phase 2 of the project, played an important role in organizing the two workshops in phase 3, particularly in increasing the general knowledge and awareness of floods and flash floods risk at local and regional scale during the discussions with stakeholders.

1.3 Outline of the document's structure

This deliverable is organised into five main chapters. Following the introductory section, Chapter 2 presents the methodology applied for identifying and assessing climate risk management measures. Chapter 3 describes the proposed portfolio of measures developed for the Putna River basin, including their prioritisation and expected contribution to flood risk reduction. Chapter 4 summarises the stakeholder consultation process, dissemination activities and policy communication actions carried out during Phase 3, together with an evaluation of the project results and lessons learned. Finally, Chapter 5 presents the main conclusions of the project phase and highlights its contribution to supporting the future update of the Flood Risk Management Programme of Measures.

2 Local profile

2.1 Summary of Key Risk Assessment results

The priority climate risks for the Putna River Basin were identified through the Phase 2 Key Risk Assessment process, which integrated the outputs of the climate risk analyses with the knowledge and experience of regional stakeholders. The assessment combined the results of flood hazard and flood risk analyses, heavy rainfall assessments with the qualitative evaluation performed by stakeholders using the CLIMAAX Key Risk Assessment framework (*Figure 2-1*).

Climate risk in Putna river basin	Severity		Urgency	Capacity	Risk Priority
	C	F		Resilience/ CRM	
River flooding	3	3	3	2	High
Heavy rainfall/flash floods	3	3	3	2	High

Severity	Urgency	Resilience Capacity	Risk Ranking
Critical	Immediate action needed	High	Very high
Substantial	More action needed	Substantial	High
Moderate	Watching brief	Medium	Moderate
Limited	No action needed	Low	Low

Figure 2-1 The key risks evaluation matrics for Putna river basin

The Key Risk Assessment Dashboard identified river flooding and heavy rainfall/flash floods as the two highest priority climate risks affecting the study area. Both hazards were consistently assessed as having substantial severity, reflecting their high potential to disrupt communities, infrastructure, economic activities, and ecosystem functions. Historical flood events, together with projections under future climate scenarios, indicate that these risks are expected to persist and increase in intensity, particularly due to the combined effects of climate change and the high exposure of settlements located along river valleys.

Key findings of the CRA indicate that:

- Flood hazard extent and intensity increase under future climate scenarios, with over 25% of built-up areas affected in some settlements during extreme events.
- Transport infrastructure (roads, bridges) represents a critical vulnerability, with high potential for cascading impacts such as isolation of communities.
- Population exposure and economic damages show significant increases under climate change conditions.
- Heavy rainfall events are projected to become more frequent and intense, increasing flash flood risk across the basin.

The urgency assessment indicated that additional action is required for both priority risks. Stakeholders confirmed that climate conditions contributing to flood occurrence are already changing and acknowledged that are projected to continue worsening over the coming decades. Given the long implementation periods required for structural mitigation measures and adaptation planning, timely action is considered essential to reduce future impacts.

The overall resilience capacity of the Putna River Basin was assessed as medium, indicating that although several flood risk management and emergency response mechanisms are already in place, the region still faces significant limitations in its ability to cope with and adapt to increasing climate risks (small rural communities, elderly population, limited resources, insufficient awareness, high dependence on key transport routes). Existing resilience measures include flood protection

infrastructure, flood defence plans prepared under the Floods Directive, emergency response procedures, hydrometeorological monitoring and warning systems, and institutional coordination mechanisms. However, the capacity of local authorities and communities remains constrained by limited financial resources, uneven institutional capacity, and the high exposure of settlements and critical infrastructure located in flood-prone areas.

The assessment recognised that vulnerable population groups, including elderly people, children, persons with disabilities, socially disadvantaged households, and isolated rural communities, are disproportionately affected during flood events due to reduced adaptive capacity, limited mobility, and dependence on critical infrastructure and public services. In addition, small municipalities and local administrations often have limited technical and financial resources to implement comprehensive adaptation measures without external support.

The Key Risk Assessment was conducted through a participatory process involving representatives of the principal organisations responsible for flood risk management and climate adaptation in the basin. Their participation ensured that the assessment reflected both scientific evidence and practical knowledge regarding hazard occurrence, exposure, vulnerability, emergency response capacity, and adaptation needs.

The participatory process also contributed to improving the understanding of risk ownership, highlighting that responsibility for managing priority climate risks is shared among national, regional, and local institutions, while effective adaptation requires coordinated action across multiple sectors, including water management, civil protection, spatial planning, transport infrastructure, environmental protection, and local governance.

Stakeholders acknowledged that strengthening resilience will require continued investment in both structural and non-structural measures, enhanced inter-institutional cooperation, increased community awareness, and targeted support for the most vulnerable groups.

Table 2-1 Summary of key risk assessment results

Priority climate risk	*Resilience capacity (low, medium, substantial, high)*	*Description of the resilience capacity (such as existing knowledge, planned measures, gaps)*	*Stakeholders, experts and priority groups involved in the key risk assessment & modality of engagement*
River flooding affecting population, settlements, built-up areas, transport infrastructure	Medium	Existing knowledge is relatively strong due to previous flood events and national flood risk management frameworks. Hydraulic modelling and hazard maps improve understanding. However, gaps remain in implementation capacity, funding, and local preparedness. Adaptive capacity is limited in smaller rural communities. Transport infrastructure (roads, bridges) has high vulnerability due to exposure and ageing infrastructure, limited redundancy and high dependence on key	Ministry of Environment, Water and Forests, , Siret River Basin Administration (NARW), Water Management Service, NIHWM experts, Emergency Inspectorate, local authorities (municipalities, mayors), Vrancea County Council, National Agency for Environment and Protected Areas. Local communities and vulnerable groups were

		transport routes. Some technical capacity exists, but investment needs are significant. Population and vulnerable groups in flood prone areas have high exposure combined with socio-economic vulnerability (elderly population, rural communities). Limited resources for adaptation and recovery at local level. Awareness is improving but still insufficient.	represented through municipal authorities (which include local social services). Engagement through workshops (Phase 2 and 3), field visits, and questionnaire-based consultations. Stakeholder input during workshops and validation of local data and impacts. -
Heavy rainfall/ Flash floods	Medium	Advanced forecasting tools (e.g. ROFFG system), 24X7 operation of the National Hydrological Forecast Center and institutional expertise provide good coping capacity. However, warning lead time, early warning dissemination, local preparedness, and response coordination can be improved. Climate projections indicate increasing pressure on existing systems.	

2.2 Key implementation mechanisms and policy context for CRM

Climate Risk Management (CRM) in Putna River Basin is shaped by a multi-level policy framework integrating EU, national, regional, and local instruments.
Key Policy Instruments and Frameworks

- EU level
  - EU Floods Directive 2007/60/EC – framework for flood risk assessment and management plans
  - European Green Deal – promotes nature-based solutions and climate resilience
  - CLIMAAX framework – standardized methodology for climate risk assessment
- National level (Romania)
  - National Strategy for Flood Risk Management (NSMFR)
  - Flood Risk Management Plans (Cycles I and II)
  - National Strategy on Adaptation to Climate Change for the Period 2023-2030 with a Perspective to 2050
  - Environmental and water legislation (land use, permitting, protected areas)
  - Reforestation legislation (Forestry Code, legislation related to degraded lands, funding and state aid for national forestation campaigns etc.)
- Regional and local level
  - Spatial planning and zoning regulations (restriction of construction in flood-prone areas)
  - Local development strategies and emergency plans
  - Water management regulations implemented by basin authorities

Key Implementation Mechanisms:

- Implementation of hydraulic infrastructure projects
- Deployment of nature-based solutions (reforestation, floodplain restoration)
- Early warning systems and monitoring
- Land-use planning and zoning restrictions
- Awareness raising and community preparedness

The main policy goals that can influence a successful implementation of the Climate Risk Management (CRM) in Putna River Basin include: reducing flood risk to the population and infrastructure, integrating climate change adaptation into planning processes, protecting biodiversity and develop ecosystem services, promoting sustainable land and water management, and increasing the resilience of vulnerable communities.
The potential implementation of the Climate Risk Management (CRM) is constrained by several key challenges, including limited funding and investment capacity, complex legal and land ownership issues, insufficient enforcement of existing regulations, and the need for stronger integration of policies across sectors.

2.3 Key actors and systems for CRM

The main institutions/stakeholders involved in the development and implementation of Climate Risk Management (CRM) strategies for Putna river basin are:

- National level
  - Ministry of Environment, Water and Forests – policy development and coordination
  - National Administration "Romanian Waters" – water management and flood risk implementation
- Regional level
  - Siret River Basin Administration – implementation of basin-level measures
  - Vrancea Water Management Service – operational management and data provision
- Local level
  - Municipalities and mayors – local planning, community representation, emergency response
  - Vrancea County Council – infrastructure and regional coordination
  - Local communities and vulnerable groups (represented by mayors)
- Emergency and environmental authorities
  - Emergency Inspectorate – response and preparedness
  - National Agency for Environment and Protected Areas – biodiversity and environmental protection

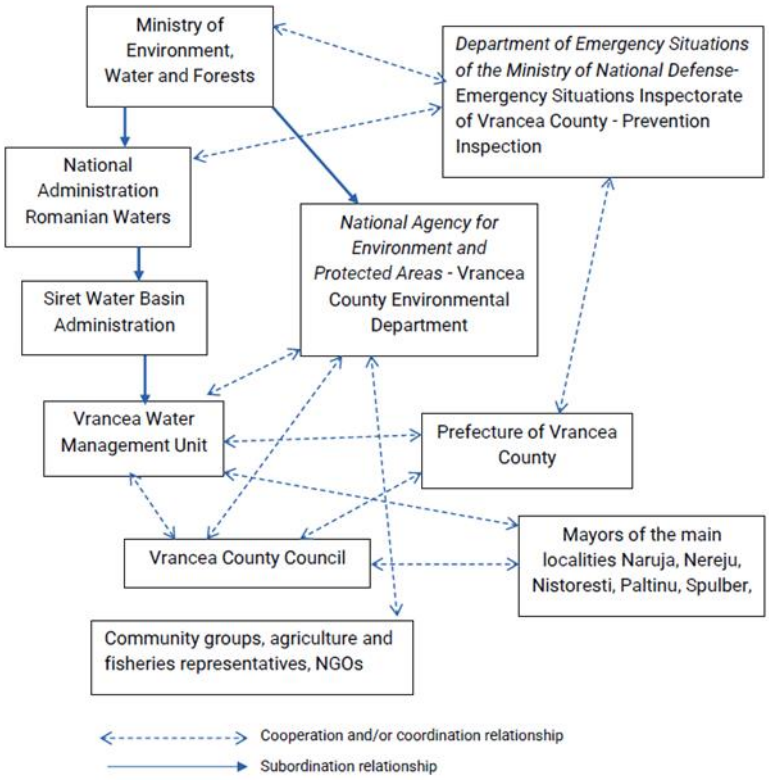


Figure 2-2 The stakeholders interconnection relationship diagram

The main stakeholders (*Figure 2-1*) are motivated by the need to reduce climate and flood risks, comply with European and national policy requirements, and protect local communities. At the same time, local authorities and other actors require adequate financial support, technical guidance, and clearer regulatory frameworks to effectively implement Climate Risk Management (CRM) measures, while communities need increased awareness, preparedness, and support to strengthen their adaptive capacity and facilitate the implementation of adaptation measures.

The potential implementation of Climate Risk Management (CRM) in Putna River Basin benefits from several important opportunities, including the availability of high-resolution climate risk information generated during Phase 2 of the project, a well-established institutional framework aligned with European Union policies and an increasing level of stakeholder awareness and engagement. At the same time, the implementation process faces several barriers, such as financial constraints, legal and land ownership complexities, limited local technical and administrative capacity, and challenges related to public acceptance of certain adaptation measures, particularly those involving land-use restrictions.

Stakeholders engagement - The second stakeholder workshop

Open dialogue with local stakeholders represents a key element in the development of solutions tailored to the local context and community needs, contributing to increased resilience to climate change.

Stakeholders were first engaged during Phase 2 within the Scoping phase (identification of stakeholders and planning engagement) and the Risk analysis phase (first stakeholder workshop - validation of local data and results through workshop and field visit) and then during all the steps of the analysis through the second and the third consultation workshops.

During phase 3 of the project, **the second workshop** dedicated to stakeholder consultation, was organized by NIHWM on 21 April 2026 in the study area (at the Golești Commune City Hall, Vrancea County), in collaboration with the SGA Vrancea and the Siret River Basin Administration.

Active participation in the workshop was ensured by approximately 30 participants, including representatives of Vrancea Emergency Inspectorate, local municipalities (also representing vulnerable communities) from the study area, officials from Vrancea County Council, experts from Vrancea Water Management Service and Siret River Basin Administration (National Administration Romanian Waters), as well as a biodiversity and protected areas expert from the County Environmental Directorate within the National Agency for Environment and Protected Areas.

During the meeting, the results of the climate risk analysis carried out in the second phase of the project were presented, providing a detailed overview of flood risk in the Putna River Basin through the integration of higher-resolution local data (hazard, exposure, and vulnerability).

In the second part of the workshop, participants engaged in discussions on measures for the prevention and reduction of flood risk in the Putna River Basin.

During the discussions, the results of the climate risk analysis carried out in Phase 2 of the project were validated by the participants, confirming their relevance and consistency with local conditions and stakeholder experience. The analysis provided a solid basis for informed dialogue, supporting a shared understanding of flood risk drivers within the Putna River Basin.

Participants engaged in detailed exchanges on the types of flood risk reduction measures considered necessary and of high priority, taking into account the specific characteristics of different sectors of the hydrographic network. Both structural and nature-based solutions, as well as non-structural measures, were discussed in relation to their feasibility, effectiveness, and suitability to local conditions.

The discussions also focused on identifying the main challenges and barriers to the implementation of such measures. Key issues highlighted included limited public acceptance, legislative and regulatory constraints, insufficient financial resources, and legal aspects related in particular to land ownership and land use.

Furthermore, stakeholders shared practical insights and lessons learned from past flood events, reflecting on the effectiveness of previously implemented measures and the difficulties encountered during emergency response and recovery phases. Particular attention was given to the most recent flood event on the Putna River, which occurred on 30 March 2026, with participants analyzing the impacts, response actions, and remaining gaps in risk management.

Overall, the discussions contributed to a comprehensive understanding of both the opportunities and constraints associated with flood risk reduction in the basin, supporting the identification of realistic and locally adapted solutions.

Following the discussions, the participating stakeholders completed the prepared questionnaire, designed as a key consultation tool within the CARE-ROPutna project workshop, aimed at engaging local stakeholders. Its primary purpose was to collect expert opinions, local knowledge, and institutional perspectives in order to support the identification and prioritization of effective flood risk reduction measures.

The survey targets representatives of local and regional institutions and explores their views on different categories of measures, including structural (grey), nature-based (green), combined (grey-green), and non-structural approaches. Respondents are invited to indicate the most suitable types of interventions for their areas, identify specific locations where such measures should be implemented, and highlight potential constraints such as legal, financial, or social barriers.

In addition, the questionnaire gathers information on existing flood protection works and their perceived effectiveness, as well as suggestions for additional measures. A significant component of the survey involves the evaluation of a range of proposed measures—such as riverbank protection, reforestation, floodplain restoration, early warning systems, and land-use regulations—using a ranking system to assess their importance in reducing flood risk.

Participants were also asked to identify priority actions and express their level of agreement with strategies such as allocating more land for natural river expansion. Finally, the questionnaire encourages stakeholders to select and rank the top five optimal measures for flood risk reduction in their respective localities.

The stakeholder consultation questionnaire provided important insights into local perceptions regarding flood risk reduction priorities, preferred adaptation measures, and implementation barriers within the Putna River Basin.

The results showed a clear preference for integrated climate risk management approaches. Most respondents (approximately 61%) considered that a combination of structural, nature-based, and non-structural measures represents the most suitable solution for reducing flood risk in the study area (Figure 2-3). Structural measures alone were selected by around 33% of participants, while only a limited number of respondents considered exclusively non-structural or green measures sufficient on their own.

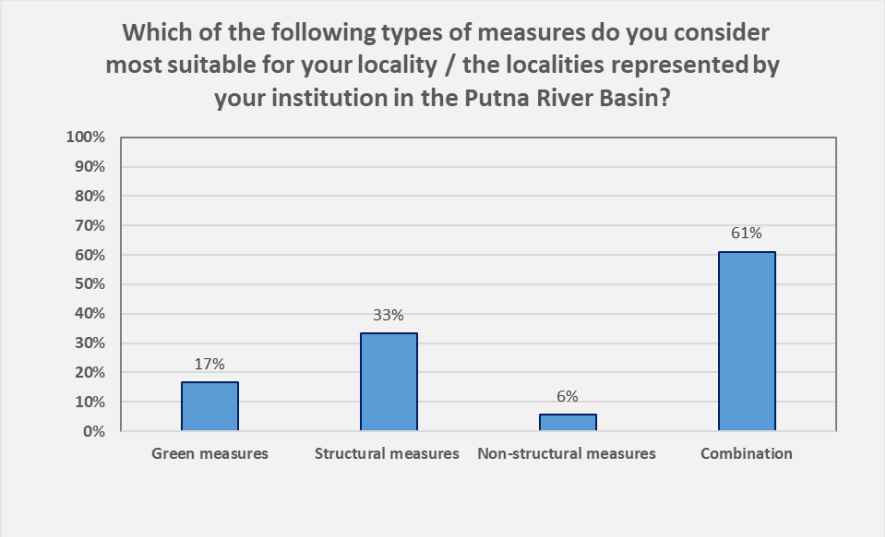


Figure 2-3 Most suitable types of measures highlighted by respondents for Putna river basin

Regarding implementation barriers, the questionnaire highlighted lack of funding as the most significant constraint, identified by more than 80% of respondents (Figure 2-4). Other frequently mentioned challenges included legal issues related to land ownership, public acceptance of certain interventions, high implementation costs, and difficulties related to regulatory enforcement.

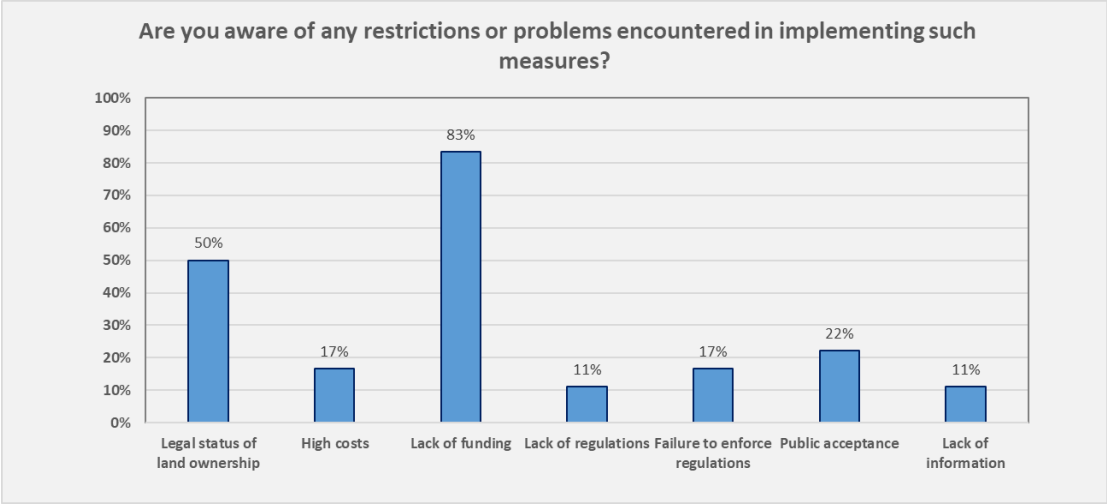


Figure 2-4 Implementation barriers mentioned by respondents for Putna river basin

Among the structural measures, stakeholders considered the following interventions as having the highest importance for flood risk reduction:

- construction of new dikes and levees;
- riverbank stabilization and protection works;
- riverbed regulation and maintenance works.

Nature-based solutions were also evaluated positively by respondents. Afforestation and riverbank renaturalization received some of the highest scores among green measures, followed by natural water retention measures and floodplain restoration (Figure 2-5). Stakeholders recognized the important role of ecosystem-based approaches in reducing runoff, limiting erosion processes, and improving long-term resilience.

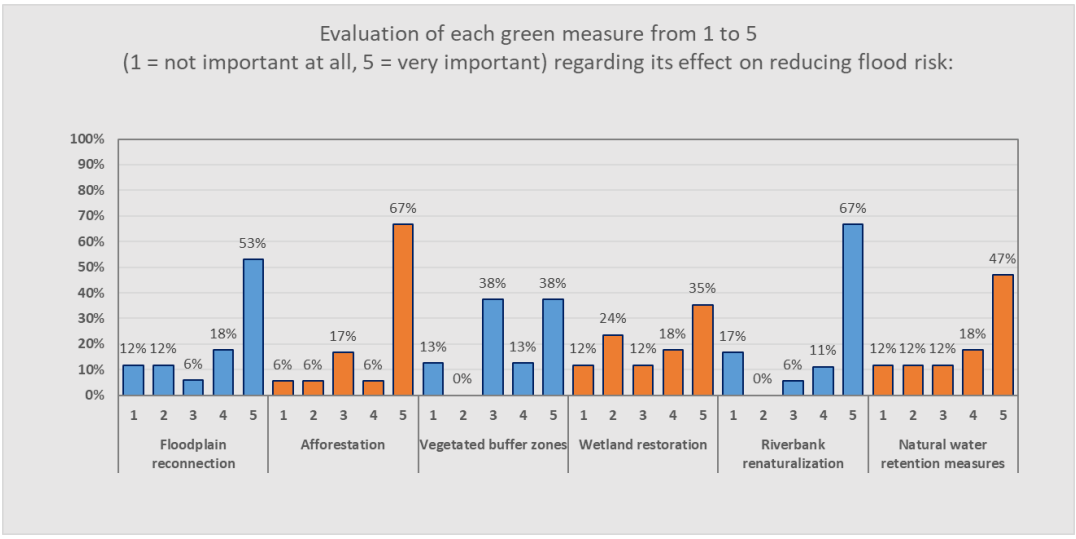


Figure 2-5 Evaluation of green measures by the respondents

The questionnaire results also highlighted strong support for non-structural measures (Figure 2-6). Risk monitoring systems, public information and awareness campaigns, early warning systems, local emergency response plans, and stricter spatial planning regulations received very high importance scores from respondents. In particular, stakeholders emphasized the importance of improving community awareness and preparedness, especially in vulnerable rural areas exposed to recurrent flood events.

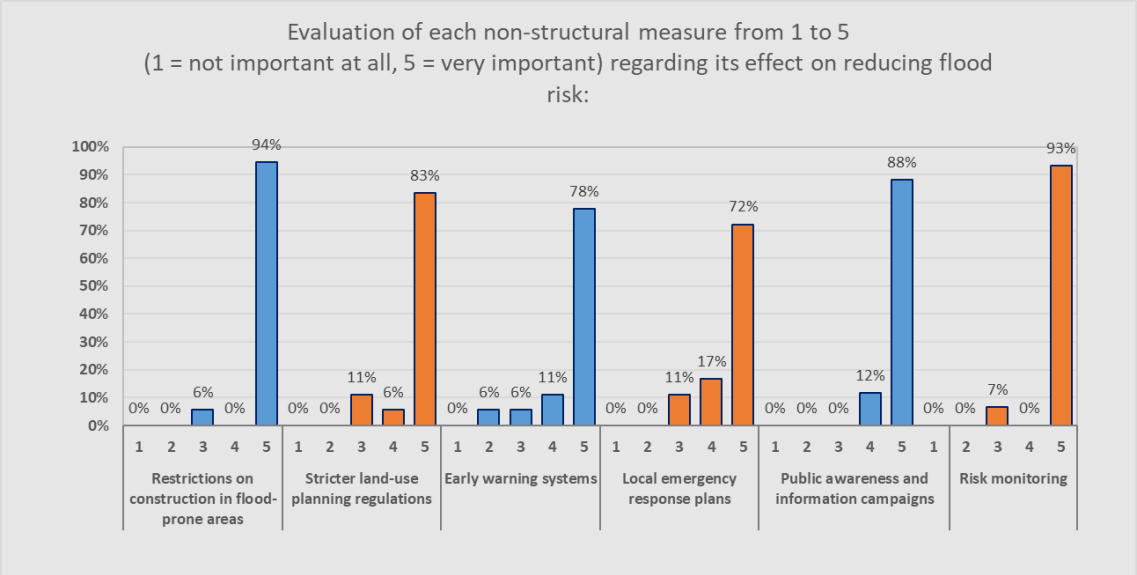


Figure 2-6 Evaluation of non-structural measures by the respondents

The consultation process confirmed that stakeholders support a balanced and integrated flood risk management strategy combining grey infrastructure, nature-based solutions, preparedness measures, and improved governance mechanisms. The questionnaire results also demonstrated the relevance of participatory approaches in identifying locally adapted and socially acceptable climate risk management solutions.

The third stakeholder workshop was organised on 17 June 2026 in Vrancea County as the concluding consultation activity of the project. The workshop brought together representatives of national, regional and local authorities, water management institutions, emergency management authorities, municipalities, environmental agencies, research organisations and other relevant stakeholders with responsibilities related to flood risk management and climate change adaptation. The event aimed to present the proposed Climate Risk Management (CRM) measures developed during the project, validate the results with stakeholders, and collect additional feedback to support the prioritisation of the proposed adaptation measures.

To encourage active participation, an interactive Mentimeter session was organised, allowing stakeholders to express their opinions through real-time polls and open-ended questions. The consultation focused on perceptions of flood risk, priority adaptation measures, implementation challenges, community preparedness and future policy needs.

The responses highlighted a strong consensus that awareness raising and investments are among the most important aspects requiring improvement to reduce the impacts of flooding. Participants also emphasised the importance of cooperation between institutions, improved flood hazard mapping, appropriate legislation, and better integration of adaptation measures into local decision-making processes.

When asked which measure should be implemented immediately to reduce flood risk, stakeholders proposed a combination of structural and non-structural interventions (Figure 2-7). Frequently mentioned actions included torrent control works, river channel maintenance and vegetation management, reinforcement and construction of flood protection infrastructure, afforestation, implementation of green infrastructure combined with traditional engineering solutions, improved early warning systems, restrictions on construction in flood-prone areas, and awareness and

education campaigns. Several participants explicitly stressed that no single measure would be sufficient and that an integrated portfolio of complementary measures is required.

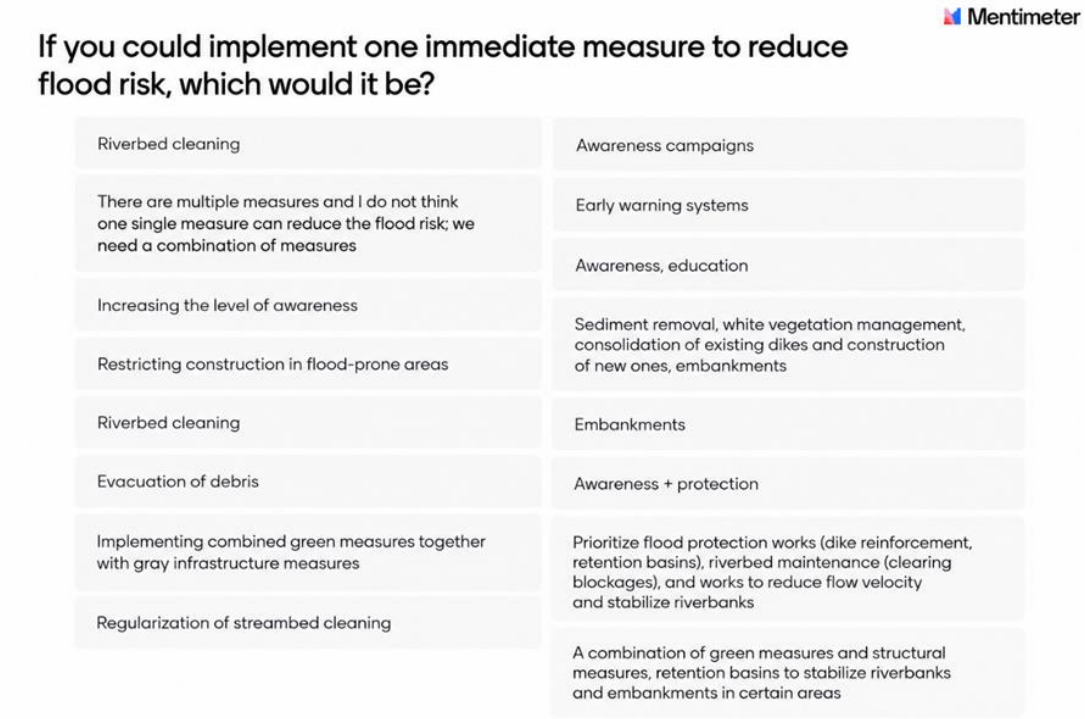


Figure 2-7 Priority measures highlighted by respondents

Regarding the main challenges associated with flooding in the Putna River Basin, stakeholders most frequently identified the need for intervention and the lack of financial resources (Figure 2-8). Other responses referred to erosion, transport disruptions, insufficient response capacity, insecurity, and the need for continued research and effective emergency interventions. These results indicate that stakeholders perceive implementation capacity and funding as major constraints for increasing regional resilience.



Figure 2-8 flood-related challenges mentioned by respondents

Related to erosion, more speakers highlighted the fact that Putna river basin has one of the largest sediment transports in Romania, especially during flooding events. Therefore, there are sectors where erosion (deepening of the riverbed) is dominant, but also sectors characterized by alluvium. Examples of hydrotechnical works that remained suspended following erosion during floods were

given. All these elements led to the conclusion that in this river basin the impact of sediments must be carefully analyzed in the studies that will form the basis for the design of measures.
Other experts emphasized the importance of reducing runoff on slopes and in torrential basins, in the runoff formation area, before it reaches the main watercourses.
The importance of non-permanent reservoirs and the possibility of proposing such measures in Putna river basin were also discussed. However, local factors stated that the local landforms does not allow such works.
The consultation also revealed concerns regarding the preparedness of local communities for major flood events (Figure 2-9). Most respondents considered that communities are poorly prepared, while only a small number assessed preparedness as moderate or good. This finding confirms the need for continued investments in preparedness planning, public awareness, emergency response capacity and community engagement.

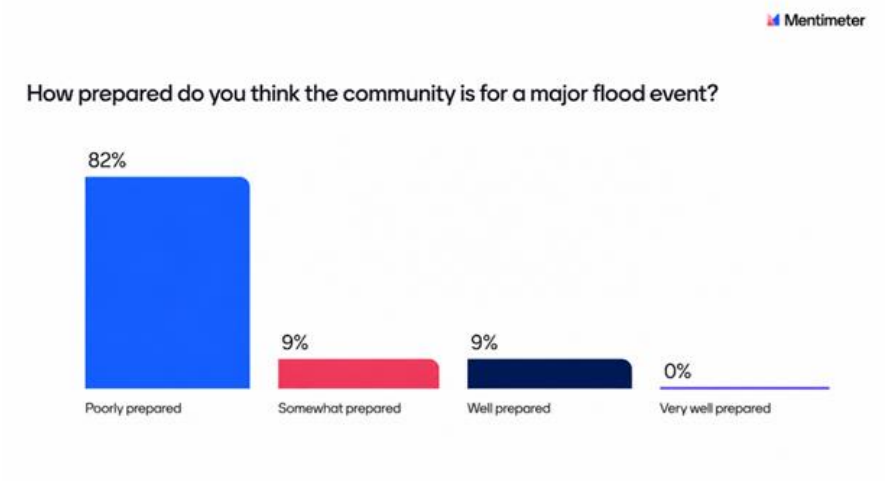


Figure 2-9 Respondents opinion on preparedness of local communities for major flood events

When stakeholders were asked to prioritise measures for the next five years, the preferred option was a combination of adaptation measures, followed by nature-based solutions, grey infrastructure measures, education and communication activities, and early warning systems (Figure 2-10). These responses demonstrate broad recognition that effective climate adaptation requires integrated approaches combining structural protection measures with ecosystem-based solutions and enhanced public awareness.

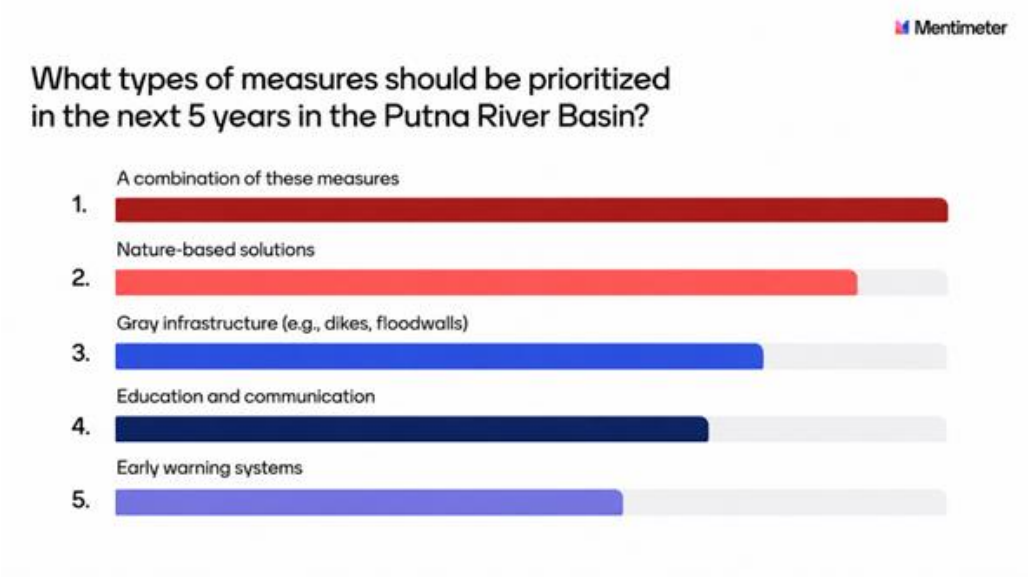


Figure 2-10 Priority measures for the next 5 years, according to the respondents

Overall, the final workshop confirmed the high level of stakeholder engagement achieved throughout the CARE-ROPutna project. The interactive consultation validated the project's proposed Climate Risk Management measures while providing additional qualitative information on local priorities, implementation barriers and opportunities. The results further reinforced the need for integrated adaptation strategies combining structural and nature-based measures, strengthened institutional cooperation, increased financial support, improved public awareness and enhanced preparedness of local communities to address future climate-related flood risks.

To support dissemination and awareness-raising activities, promotional materials and project brochures were prepared and distributed during the stakeholder workshops organized within the study area, as well as among relevant national institutions involved in flood risk management, water management, and climate change adaptation.

Table 2-2 Key actors and systems for CRM

Key actors	*Role and responsibility*	*Motivation and needs*	*Opportunities related to the their active involvement in CRM*	*Barriers related to the their active involvement in CRM*	*Type of engagement*
Ministry of Environment, Water and Forests	• Develop national climate adaptation and flood risk policies • Coordinate implementation of EU legislation	• Compliance with EU directives • Reduce climate and flood risks • Improve national resilience	• National policy mandate • Alignment with EU climate policies	• Funding limitations • Need for stronger cross-sector coordination	Consultation and participatory engagement during all steps of the analysis, through 3 dedicated workshops
National Administration Romanian Waters	Water resources management • Flood risk management planning • Implementation of flood protection measures	Reduce flood impacts • Improve water management	Technical expertise • Monitoring network • Access to national and EU programmes	•Financial constraints • Complex implementation procedures	
Siret River Basin Administration	• Implement basin-scale CRM measures • Coordinate river basin management • Provide technical expertise	• Improve flood protection • Increase basin resilience	• Detailed local knowledge • High-resolution risk data	• Budget limitations • Land ownership constraints	
Vrancea Water Management Service	• Operational water management • Hydrological monitoring	• Improve operational flood management	• Local monitoring experience	• Limited local resources	
Municipalities and mayors (including municipal social services representing local communities)	• Local planning •Local knowledge • Community representation • Emergency response • Representation of vulnerable groups	• Protect communities • Strengthen local resilience • Financial and technical support	• Direct contact with communities • Integration into local planning • Participatory consultation	• Limited administrative capacity • Financial constraints • Regulatory and land ownership issues	

		• Awareness and preparedness		• Low preparedness of local communities • Financial limitations	
Vrancea County Council	• Regional infrastructure planning • Regional coordination	• Protect critical infrastructure	• Coordination across municipalities	• Funding constraints • Cross-sector coordination	
Emergency Inspectorate	• Emergency preparedness • Flood response • Civil protection	• Protect population • Improve emergency response	• Established emergency procedures	• Resource limitations	
National Agency for Environment and Protected Areas	• Biodiversity conservation • Environmental protection • Nature-based solutions	• Ecosystem protection	• Ecosystem-based adaptation expertise	• Land-use conflicts • Regulatory constraints	

2.4 Lessons learned from past events

Past flood events in the Putna River Basin have highlighted the high vulnerability of local communities, transport infrastructure, and economic activities to river floods and flash floods generated by intense rainfall. Historical flood events recorded in the basin caused significant damage to residential areas, roads, bridges, agricultural land, and public utilities, while also disrupting local economic and social activities.

Several major flood events triggered by intense rainfall, particularly in 2005, 2012, 2016, 2021 and 2022, causing significant socio-economic damage and, in some cases, loss of life.

The 2005 flood was the largest event ever recorded in the basin, reaching a peak discharge of approximately 1,500 m³/s, corresponding to an exceedance probability of about 2.5% (1951–2022 reference period).

These recurrent events confirmed the high vulnerability of the basin to heavy rainfall, flash floods and river flooding, reinforcing the need for improved climate risk assessment and adaptation planning.

Previous flood events demonstrated the importance of timely hydrometeorological forecasting, effective communication between institutions, and rapid emergency response. At the same time, they revealed several recurring weaknesses, including insufficient local preparedness, limited maintenance capacity for flood protection infrastructure, inadequate drainage systems, and the continued exposure of settlements and infrastructure located in flood-prone areas.

Particular lessons learned from historical events include:

- the need to improve coordination between local authorities, emergency services, and water management institutions;
- the importance of integrating local knowledge into flood risk assessment and emergency planning;
- the necessity of increasing public awareness and preparedness, especially in vulnerable rural communities;
- the need for investments in both structural measures and nature-based solutions to reduce flood impacts;
- the importance of upgrading monitoring, forecasting, and early warning systems.

The most recent flood event affecting the Putna River Basin occurred in March 2026 and was discussed extensively during the stakeholder consultation workshop organized within Phase 3 of the project. Participants reported significant impacts on local roads, bridges, riverbanks, and agricultural areas, as well as temporary isolation of some communities.

Stakeholders also highlighted difficulties related to emergency intervention access, insufficient local resources, and the rapid response required during flash flood conditions. Representatives of the Emergency Inspectorate also reported that a significant number of residents refused evacuation during the March 2026 flood event, despite the existing warnings and emergency interventions. This aspect underlines the need to strengthen risk awareness, community education, and preparedness activities, particularly within vulnerable rural communities exposed to recurrent flood hazards.The March 2026 event confirmed the increasing pressure generated by extreme rainfall events under climate change conditions and emphasized the necessity of strengthening local resilience capacities. The event also reinforced the importance of improving flood risk communication, updating local emergency plans, and accelerating the implementation of prevention and adaptation measures identified through the Climate Risk Assessment.

3 Climate risk management – phase 3

3.1 CRM objectives

Clearly defined objectives are essential for supporting strategic planning and the implementation of effective flood risk management measures. These objectives aim to reduce the adverse impacts of flooding on human health, economic activities, the environment, and cultural heritage, while contributing to the protection, conservation, and, where appropriate, the improvement of the ecological and quantitative status of water bodies and associated natural habitats.

The objectives have been established in accordance with the following policy and regulatory framework:

- the requirements stipulated in Article 7.2 of the Floods Directive,
- taking into account the objectives related to the Romanian Flood Risk Management Plans,
- Flood Risk National Strategy for Medium and Long-term 2025-2035,
- Sustainable Development of Romania National Strategy for Horizons 2013–2020–2030,
- Romanian Climate Change Adaptation National Strategy 2024-2030,
- in accordance with other relevant European directives and strategies.

Considerations of justice and equity principles in defining CRM objectives referred to:

- Prioritizing vulnerable communities and areas at risk,
- Ensuring the participation of vulnerable groups (elderly population, low-income households),
- Accessible communication for vulnerable groups.

For each CRM objective, specific indicators were defined. These indicators are used to assess the extent to which each measure could contribute to the achievement of the corresponding objective. By linking the expected outcomes of the measures to the CRM objectives, the indicators provide a consistent framework for evaluating their potential effectiveness. The assessment indicators values represent the difference between the baseline and the post-implementation period for the proposed measures.

The CRM objectives that correspond to local priority climate risks are listed in the following table.

Table 3-1 CRM objectives

Primary objectives	*Assessment indicators*
Decrease risk to floods	*Number of people exposed* *Annual flood damage (€)*
Increasing the resilience of infrastructure	*Infrastructure length (km)*
Enhance the level of awareness and resilience	*Number of properties where resilience to flooding is improved* *Number of people at risk covered by insurance*
Increase the capacity for early warning, alarm and intervention, and response in case of emergency	*Number of rapid response units* *Number of people receiving flood warnings* *Early warning lead time (hours)*

Improve the involvement of stakeholders	*Number of stakeholders involved in proposing measures* *Number of stakeholders' workshops / initiatives* *Number of measures implemented in partnership*

Additional objectives	*Assessment indicators*
Integrating climate risks into urban planning	*Number of plans that include climate risks* *Number of localities with adaptation plans*
Increasing awareness and preparation	*Informed population (%)* *Coverage of warning systems (%)*
Strengthening natural barriers	*Reforestation (ha)*

3.2 Supportive elements for effective CRM

An efficient management of CRM is based on a strategic combination of structural defenses, land-use planning, early warning systems, community preparedness, and financial mechanisms. Together, these elements shift the approach from merely reacting to disasters to proactively minimizing vulnerability.

Table 3-2 Supportive elements for effective CRM

Supportive elements for effective CRM	*Description*
Knowledge and data	*Institutional capacity* - The primary authority responsible for flood risk management in Romania is the Ministry of Environment, Waters and Forests (M.E.W.F.) who acts through National Administration "Romanian Waters" (NARW) and its constituent bodies—specifically the 11 River Basin Administrations (RBAs: Banat, Jiu, Argeș-Vedea, Olt, Buzău-Ialomița, Dobrogea-Litoral, Mureș, Crișuri, Someș-Tisa, Siret, Prut-Bârlad) and National Institute of Hydrology and Water Management (N.I.H.W.M.). - RBA Siret comprise 4 Water Management Systems (W.M.S.), the Putna river basin is under the jurisdiction of WMS Vrancea. - NIHWM support NARW and RBAs with studies and data on maximum flows with different probability of exceeding, flood-waves elements, other hydrological parameters necessary in the design of measures.
Tech and infrastructure	*Flood protection infrastructure* - 0,9 km of flood protection dikes that are mainly located in the area of the confluence between the Putna River and the Siret River; *Hydrometeorological warning and alarm system* - The hydrometeorological information system comprises the observation, measurement, collection, recording, processing, and dissemination of meteorological and hydrological data. It supports the generation of forecasts, alerts, and warnings, which are communicated to the competent authorities and other entities involved in emergency management. This enables the timely implementation of appropriate decisions and response measures to address hydrometeorological hazards and mitigate their potential impacts. The overall structure of the hydrometeorological information system, including the authorities responsible for its operation and for flood risk management, is presented below:

- National Meteorological Administration (N.M.A.) including Regional Meteorological Centers from which the initial meteorological information/warnings are issued,
- NIHWM – responsible for hydrological information/warning/alerts generation
- Central public institutions/authorities at the national level (N.A.R.W., County/Local Committees for Emergency Situations, County Inspectorate for Emergency Situations).
- At the NARW level, the information system is based on a four-tiered National Water Management Data Transmission Network, extending from the base of the organizational structure; this network facilitates the transmission of both operational information—via a fast data flow (hydrological data, data on accidental pollution, incidents at hydraulic structures, etc.)—and information via a slow data flow (forecasts, diagnoses, general information, summaries, databases, etc.)
- Data collection is carried out via a monitoring network consisting of:
  - hydrometric and rainfall monitoring stations,
  - permanent and non-permanent reservoirs,
  - rainfall monitoring stations within the NARW. network
  - water intakes, conduits, etc.
  - data provided by the NMA. network:
    - meteorological and rainfall monitoring stations,
    - weather forecasts and warnings,
    - synoptic and radar maps.
  - data obtained from hydrological forecasting activities:
    - hydrological forecasts produced at the National Hydrological Forecasting Center within NIHWM,
    - detailed forecasts produced at the Basin Forecasting Centers within the RBSs.
- For Putna river basin quantitative monitoring of water resources is carried out using dedicated systems (hydrometric stations managed by WMS Vrancea); the data is validated at the RBA. Siret dispatch center and subsequently at the NARW central dispatch center.
- Data and information processing takes place at the hydrological stations, with all information transmitted to the RBA. Siret headquarters.
- Data and information storage is handled at the hydrological stations and at RBA. Siret.
- -Data transmission is facilitated by the infrastructure existing at the headquarters of each river basin administration, consist:
  - radio communication network,
  - fixed and mobile telephony network, scanner and fax,
  - the existing computer network and connections to water management systems at the level of each county within the basin;
  - Virtual Private Network (VPN.) between RBA. and NARW.
- The response structures consist of:
  - WMS./Independent Hydro-technical Systems, which have established operational response units (response forces and resources) at the county level,
  - County Inspectorates for Emergency Situations, with personnel specialized in responding to flood-related emergencies,

	○ Local Committees for Emergency Situations, under which Voluntary Emergency Services have been established (utilizing their own response forces and resources). *Monitoring platforms* - Web GIS Viewers: Interactive online platforms (www.inundatii.ro)
Citizen engagement	- the documents are made available to the interested public for consultation at the national level (on the MEWF website), as well as at the regional and local levels, - information campaigns, - information guides and brochures.
Finances & resources	Potential resources are: - National Recovery and Resilience Plan, - Territorial Cooperation Programme (2021-2027), - Danube Region Programme (2021-2027) - Investment Programme for Transport Infrastructure Development (2021–2030), - "Connecting Europe" Facility, - Transport Operational Programme (2021–2027) - Post-2020 National Strategic Programme – Common Alerting Protocol, - Sustainable Development Operational Programme (European Regional Development Fund) - National Budget, - European Green Deal, - European Union's "Horizon Europe" framework programme (2021–2027) – Cluster 5: Climate, Energy and Mobility, - Loans contracted from the European Investment Bank (EIB), the World Bank (WB), or other financial institutions identified by the Government of Romania, - Blended financing involving a loan and a request for its reimbursement from the Cohesion Fund (via Sustainable Development Operational Programme), - General Consolidated State Budget (including dedicated budget lines within the budgets of responsible or competent ministries) - NARW budget.
Governance arrangements & political leadership	- Flood risk management involves a wide range of actors operating at national, regional and local levels, including ministries, public authorities, specialised institutions and other relevant organisations. These actors collaborate to reduce flood risk through coordinated planning, water resources management, emergency preparedness and disaster risk reduction. They include competent public authorities responsible for flood risk management, institutions and commercial entities involved in water resources management, as well as inter-institutional bodies with decision-making or advisory responsibilities in emergency management and civil protection. - While the Ministry of Environment, Waters and Forests (MEWF) and the National Administration "Romanian Waters" (NARW) are the primary authorities responsible for coordinating the implementation and reporting requirements of the Floods Directive, effective flood risk management relies on close cooperation among a broader range of institutional and inter-institutional stakeholders. These include: ○ The national working group, composed of experts designated by the MEWF. as responsible for the implementation of the Floods Directive. ○ The Interministerial Water Council, at the national level, plays a primary role in coordinating and monitoring policies and strategies regarding water resources and flood risk management, as well as in setting priorities and formulating proposals for the allocation and mobilization of available financial resources to achieve those priorities. It approves and monitors various plans. The structure of the

	Interministerial Water Council is established by Government Decision no. 1095/2013, with 18 members. ○ Regional River Basin Committees review regional plans concerning water resources and flood risk management, as well as outputs related to the implementation of the Flood Directive; they facilitate collaboration on the development and updating of plans, monitor the implementation of proposed measures, and ensure public information and consultation. Information regarding the activities of the River Basin Committees is disseminated to the public at least 30 days prior to consultations. In the water management decision-making process, the Committees ensure consultation with water users, riparian populations, and the general public, actively encouraging their participation. For all matters proposed for approval, they organize public debates and hearings, ensuring public access to these meetings and the associated official documents. The structure of the River Basin Committees is established by Government Decision no. 270/2012, and they consist of a maximum of 21 members serving a four-year term. - Emergency situation management is carried out by the components of the National Emergency Situation Management System, in accordance with the provisions of Emergency Ordinance no. 1/2014, Law no. 15/2005, and the Joint Order of the Minister of Waters and Forests and the Minister of Internal Affairs no. 459/78/2019, - In accordance with applicable legislation—specifically Joint Order MAP/MAI No. 459/78/2019—"defense plans" are drawn up (by local and county committees, as well as by Water Management Systems and Hydrological Stations, etc.) to establish the regulatory framework for managing emergency situations arising from specific risk types. Plans are also prepared by other institutions that own hydraulic structures serving a flood defense function, as well as by operators of reservoirs falling under importance categories C and D. - County plans, system plans, and the river basin plan are updated every four years, while the Local Emergency Committee plans are updated by the Local Committee for Emergency Situations under the guidance of the SGA (Water Management System). The information presented in the local plans for the Putna river basin is also included in the Vrancea County Flood Defense Plan and the Siret River Basin Flood Defense Plan. - Various national and international projects play a major role in developing the warning and alert system; their implementation contributes to flood risk prevention (e.g., WATMAN – Integrated Water Management Information System – Phase I; RO-ALERT – public emergency warning system; DAREFFORT – Danube River Basin Enhanced Flood Forecasting Cooperation; Development of the national monitoring and warning system for hazardous weather phenomena to ensure the protection of life and property – SMIS code 2014+ 127994; Infrastructure for the European Earth System Modelling Network – IS-ENES2; etc.). - Joint Order of the Ministry of Waters and Forests and the Ministry of Internal Affairs No. 459/78/2019 regarding the meteorological and hydrological information system.

3.3 Potential CRM measures

Table 3-3 Potential CRM measures

Key climate risk	*CRM measure*	*Effectiveness /Risk reduction (high, medium, low)*	*Contribution to CRM objectives*	*Possible co-benefits*	*Timeline (short, medium, long term)*	*Responsible organization*	*Possible adaptation limits*
River Floods/ Heavy Rainfall-Flash Floods	*Local dikes*	*High*	*Territorial stability (clearly defines watercourses, preventing major and unpredictable changes to riverbeds), Erosion prevention (protects riverbanks against the destructive action of waves and strong currents), flood protection (ensures direct protection of homes, agricultural land, and critical infrastructure against periodic floods)*	*The crest of the levees can be used to create facilities such as bicycle paths or promenade areas for the community.*	*Long*	*Local municipality / RBA*	*Financial Constraints*
River Floods	*Raising of dikes*	*High*	*Increases the level of protection for communities, reduces damage, ensures the safe operation of the levee, and increases the hydraulic capacity of the watercourse*	*Allows for the retention of a larger volume of water during periods of high flow, adapting existing structures to new climate changes*	*Long*	*Local municipality / RBA*	*Financial Constraints*
River floods	*Improving river channel transport capacity*	*High*	*Reducing water level during the floods*	*Protect against bank erosion, reducing sediment transport during floods*	*Short*	*Local municipality / RBA*	*Future floods may cancel out their effect*
Heavy Rainfall-Flash Floods	*Management of torrential basins*	*Medium*	*Upstream flow control*	*Protects the environment, ensures soil stability and prevents soil erosion*	*Long*	*Local municipality / ROMSILVA*	*Institutional and Governance Barriers*

Key climate risk	CRM measure	Effectiveness /Risk reduction (high, medium, low)	Contribution to CRM objectives	Possible co-benefits	Timeline (short, medium, long term)	Responsible organization	Possible adaptation limits
Heavy Rainfall-Flash Floods	Afforestation	Medium	Reduce runoff rate, retain water in the soil	Protects the environment, ensures soil stability and prevents soil erosion, restores ecological balance, reduces the risk of desertification, creates new habitats for flora and fauna	Long	Local municipality / ROMSILVA	Institutional and Governance Barriers
River Floods	Stabilization and vegetative bank protection	Medium	Ensures anti-erosion stability Safety and civil protection	Create habitats, filter pollutants, landscape integration, air quality	Medium	Local municipality / RBA	None
River Floods Heavy Rainfall-Flash Floods	Awareness campaign	Medium	Enhanced community resilience & preparedness	Training and education empower local stakeholders to take part in participatory decision-making making solutions more tailored to local needs	Short	Local municipality	None
River Floods Heavy Rainfall-Flash Floods	Communication and educational campaigns	Low	Ensures long-term visibility and increases awareness. Ensuring community involvement Raising local community awareness regarding flood risk management Increasing public action and reducing economic losses and loss of life	Increases the level of trust in authorities and transparency	Short	Local municipality / ISU	None
River Floods Heavy Rainfall-Flash Floods	Organizing initiatives/workshops	Low	Increase the engagement and utilization of proposals from stakeholders	Ensuring access to information, providing local expertise, and understanding the capabilities and needs of stakeholders	Short	Local municipality / RBA	None

Key climate risk	CRM measure	Effectiveness /Risk reduction (high, medium, low)	Contribution to CRM objectives	Possible co-benefits	Timeline (short, medium, long term)	Responsible organization	Possible adaptation limits
River Floods Heavy Rainfall-Flash Floods	Development of the hydrological forecasting system	Medium	Increasing the coverage of the warning, alarm, intervention, and response system Increasing the percentage of people warned/alerted in an emergency situation	Supporting and enhancing the capacity of communities to engage in early action activities following the issuance of a warning. Increases administrative and economic capacity as well as resilience by automating processes, reducing crisis response times, optimizing resources, and improving citizens' access to essential public services	Long	NIHWM / NARW / RBA	Financial Constraints
River Floods Heavy Rainfall-Flash Floods	Review and adaptation of existing regulations and technical standards	Medium	Better covers flood risk areas Prevents future damage to transport infrastructure	European conformity	Long	Ministry of Development, Public Works and Administration, Ministry of Agriculture and Rural Development, MEWF. .	Institutional and Governance Barriers

Climate change is expected to significantly influence flood risk in Romania and is therefore a key factor in shaping future flood hazard and risk patterns, as well as flood risk management strategies. In line with the requirements of the EU Floods Directive, climate change considerations are incorporated into the Flood Risk Management Plans through flood hazard and flood risk maps and the associated Programme of Measures.

A general comprehensive program of measures has been developed at national level to meet CRM objectives. This program comprises three distinct categories of measures:

- Policies, guidelines, decision-support tools, and capacity-building activities at the national level;
- Prevention and protection measures, including both structural and non-structural interventions;
- Preparedness, response, and recovery measures, covering early warning, emergency response, rescue, relief, and post-event recovery activities.

Within the framework of this project, Phase 3 focused on the analysis and integration of the results obtained during the first two phases. This assessment provided the basis for identifying a portfolio of proposed measures tailored to the specific hydrological and flood risk characteristics of the Putna River basin, intended to support the next update of the Flood Risk Management Programme of Measures.

From a hydrological perspective, the Putna River basin is highly susceptible to intense precipitation events. In recent years, rainfall has become increasingly localized and unevenly distributed, resulting in rapid runoff generation and high peak discharges. Consequently, the implementation of measures in the upper parts of the basin, upstream of vulnerable settlements, could contribute to reducing flood peaks and mitigating downstream flood impacts.

The analysis indicates that there is potential for the development of flood mitigation infrastructure in the upper catchment. However, the feasibility of large-scale structural measures, such as flood retention reservoirs, requires further technical, environmental, and socio-economic assessment in collaboration with the competent authorities before their inclusion in future planning documents.

The assessment also highlights the need to shift from the predominantly structural (grey) approach historically adopted for flood protection towards a more integrated flood risk management strategy that combines structural and nature-based solutions. While existing flood defence infrastructure plays an essential role in protecting exposed areas, the implementation of upstream preventive measures capable of increasing water retention and reducing runoff generation could decrease downstream flood peaks and, consequently, reduce the need for additional structural interventions.

Torrent catchments have been identified as one of the main contributors to flash flood generation within the basin. Therefore, improved management of these areas, including slope stabilization and runoff control measures, should be considered. In addition, areas affected by inadequate land management following deforestation have been identified, where gully and torrent development has increased erosion and runoff, indicating the need for appropriate restoration and soil conservation measures.

The assessment also identified additional aspects that should be considered to further reduce flood risk:

- maintenance and rehabilitation of existing flood protection infrastructure;

- regular maintenance of watercourses, including vegetation management to maintain conveyance capacity;
- riverbed works adapted to local conditions (thalweg stabilization, restoration of bed sills, cross-section recalibration),
- systematic assessment and monitoring of bridge hydraulic capacity to identify structures that may increase flood risk;
- identification of agricultural areas protected by flood defence structures that could potentially be used as controlled flood retention areas during extreme events.

The development of proposed measures for adapting transport and hydraulic infrastructure to increasing flood risks associated with climate change was guided by the following principles:

- Ensuring compliance with current protection standards while incorporating appropriate design tolerances and climate change allowances;
- Promoting no-regret adaptation measures that remain effective under a wide range of future climate scenarios;
- Maximising the potential reduction in future average annual flood damages;
- Prioritising solutions that are robust, flexible, and readily adaptable to changing climatic conditions.

The proposed measures have been selected to support an integrated approach to flood risk management, prioritising effective flood risk reduction solutions, with particular emphasis on green measures where feasible, while maintaining an appropriate balance between structural and non-structural interventions.

3.4 Integration into planning and decision making

Flood management demands an integrated approach — including within the Putna basin — as handling these phenomena goes beyond the remit of any single entity and necessitates the collaboration of multiple authorities and institutions. Where monitoring systems are lacking (data and research are needed), local administrations must step in — either by employing specialists or organizing volunteer services — yet they often lack the necessary financial and human resources. Consequently, strengthening the capacity of the authorities involved in flood management is essential, requiring an increase in financial resources, human capital, and institutional competencies. Furthermore, public awareness and education regarding flood risks remain low, and trust in authorities is similarly limited.

In Romania, the monitoring and reporting of the implementation status of measures and structural/non-structural works outlined in the Flood Risk Management Plan (FRMP) are conducted on an annual basis. All institutional stakeholders involved in flood risk governance populate standardized tabular templates aggregated at the level of each River Basin Administration RBA. These matrices centralize critical operational metrics regarding the proposed interventions, including monitoring and validation threshold indicators, execution milestones, the typological nature of the measures, and the specific leading implementation authorities.

This dataset will be collected, analyzed, and disseminated systematically via a dedicated monitoring and reporting platform, ensuring multi-stakeholder accessibility and data interoperability.

A national flood database operates is a vital decision-support system (DSS) for evidence-based policymaking. By systematically logging flood extents (spatial perimeters) and post-disaster damage assessments of exposed assets following each hydrological event, this repository provides the empirical foundation required to substantiate optimized mitigation strategies and enhance flood resilience.

To underpin development plans and the decision-making process, the following aspects will be considered also:

- Comprehensive analysis of the entire river basin by urban planners, even when work is effectively carried out at a smaller scale and for a more limited territory.
- Cooperation across various territorial levels and scales.
- Clarification regarding the ownership of land exposed to flood risk and land designated for the implementation of flood risk management measures, as well as the initiation of expropriation procedures, where appropriate, to ensure the implementation of said measures.
- Use of urban planning documentation as a tool for allocating the land required to implement future measures.
- Collaboration between urban planners and professionals from other fields (flood management, water management engineering, soil science, landscape architecture, sustainable development, environmental science, etc.) and with other relevant stakeholders.
- Informing the authorities responsible for integrating risk management into spatial and urban planning regarding the implementation of measures from the Flood Risk Management Plan (FRMP).
- Incorporation of an assessment regarding the probable impact of climate change on flood-related risks.
- Review and re-adoption of spatial and urban planning documentation with regard to flood risk aspects whenever Flood Hazard and Risk Maps and associated measures are modified or updated in accordance with the requirements of the Floods Directive 2007/60/EC (at least every six years).
- Coordination with other strategic development plans (climate change adaptation, spatial planning, flood defense, etc.).
- Implementation of pilot projects utilizing nature-based solutions or green infrastructure to reduce flood impacts and enhance resilience.
- Use of the national flood hazard map in the background studies for spatial planning and urban planning documentation.

The above considerations constitute the basis for an integrated flood risk management approach in the Putna River basin and have informed the identification of a portfolio of proposed measures intended to support the future update of the Flood Risk Management Programme of Measures, while enhancing the basin's long-term resilience to climate change.

4 Project Evaluation

4.1 Usability of the results

The CARE-ROPutna project has significantly improved the knowledge base available for flood risk management in the Putna River basin and has provided practical support for climate change adaptation at both regional and national levels. While Phase 1 established the initial climate risk assessment using the CLIMAAX framework and European-scale datasets, and Phase 2 refined the assessment through the integration of local high-resolution data and hydraulic modelling, Phase 3 translated these scientific results into a portfolio of climate risk management measures tailored to the specific characteristics of the basin.

The project generated new knowledge by combining a high-resolution terrain model, locally calibrated hydrological simulations, updated exposure and vulnerability datasets, climate change scenarios, and stakeholder knowledge. This integrated approach enabled a more detailed understanding of flood hazards, exposure and potential impacts than previously available and allowed the identification of priority intervention areas and adaptation needs.

One of the main outcomes of Phase 3 is the development of a portfolio of proposed structural, non-structural and nature-based measures intended to support the future update of the Flood Risk Management Programme of Measures. The proposed measures were identified through the integration of technical analyses, existing policy frameworks and stakeholder consultation, ensuring that they are both scientifically justified and aligned with local priorities. The stakeholder consultation confirmed strong support for integrated flood risk management approaches combining grey infrastructure, nature-based solutions, improved early warning systems, public awareness and institutional cooperation.

The project further demonstrates the importance of integrating flood hazard information into land-use planning and infrastructure development in order to avoid increasing future exposure to flood risk.

Beyond the regional scale, the methodology developed within CARE-ROPutna provides a transferable approach that can be replicated in other Romanian river basins facing similar climate-related flood risks. The preparation and dissemination of two Policy Notes further strengthened the transfer of knowledge towards decision-makers by translating the technical findings into practical recommendations for regional and national authorities. These communication products contribute to the wider uptake of project results and support evidence-based decision-making for climate adaptation and flood risk reduction.

Overall, the project has created a robust scientific and technical basis for improving flood resilience in the Putna River basin while strengthening cooperation between river basin authorities, emergency management institutions, local administrations and other stakeholders involved in climate risk management.

4.2 Lessons learned

The third phase of the CARE-ROPutna project demonstrated the importance of translating scientific climate risk assessments into practical and implementable climate risk management solutions. While the previous phases focused on understanding hazards, exposure and vulnerability, Phase 3 emphasized the identification, prioritization and validation of adaptation measures capable of reducing future flood risk under changing climatic conditions.

One of the main lessons learned is that effective flood risk management requires an integrated and participatory approach. The technical analyses alone were not sufficient to identify the most appropriate adaptation measures. The active involvement of stakeholders through workshops, questionnaires and structured consultations provided valuable local knowledge, validated the technical findings and ensured that the proposed measures reflected both scientific evidence and practical implementation needs. The consultation process also highlighted the importance of combining structural measures with nature-based solutions, early warning systems, public awareness campaigns and institutional capacity building rather than relying on individual interventions.

Another important lesson concerns the value of high-resolution local data. The detailed analyses performed during the previous phases substantially improved the identification of flood-prone areas and vulnerable assets, allowing adaptation measures to be better targeted and prioritized. This confirmed that local datasets and locally calibrated models provide a much stronger basis for decision-making than assessments relying solely on continental-scale information.

The main challenge encountered during Phase 3 was the prioritization of adaptation measures under conditions of uncertainty associated with future climate scenarios, available financial resources and implementation responsibilities. Identifying measures that are technically effective, economically feasible, environmentally sustainable and socially acceptable required balancing multiple objectives and considering different stakeholder perspectives. In addition, the diversity of institutions involved in flood risk management highlighted the need for stronger coordination mechanisms and clearer responsibilities for implementing future measures.

The project also demonstrated that flood resilience cannot be achieved exclusively through engineering solutions. Institutional cooperation, continuous monitoring, public participation, risk communication and integration of flood risk considerations into spatial planning are equally important components of long-term climate adaptation.

Overall, Phase 3 successfully transformed the climate risk assessment developed during the previous project phases into a coherent portfolio of proposed adaptation measures supported by stakeholder engagement and policy recommendations. The experience gained provides a valuable methodological framework that can be applied in future updates of the Flood Risk Management Programme of Measures and replicated in other Romanian river basins facing similar climate change challenges.

Stakeholders played a key role throughout Phase 3 of the CARE-ROPutna project, contributing to the validation of the Climate Risk Assessment results and to the identification, evaluation, and prioritization of climate risk management (CRM) measures. Their involvement ensured that the proposed recommendations reflect local conditions, institutional responsibilities, operational experience, and community needs.

The participatory process included stakeholder workshops, technical discussions, field visits, and questionnaire-based consultations involving representatives of local municipalities, water management authorities, emergency services, environmental institutions, and vulnerable communities. This process supported the integration of scientific results with local knowledge and practical experience from past flood events.

The questionnaire results highlighted a strong preference for integrated flood risk management approaches. Most participants considered that a combination of structural, nature-based, and non-

structural measures represents the most suitable solution for the Putna River Basin, rather than relying exclusively on a single category of interventions. Stakeholders identified riverbank stabilization works, riverbed maintenance, reforestation measures, floodplain restoration, early warning systems, and awareness-raising activities among the most important priorities for reducing flood risk.

The consultation process also helped identify priority areas where measures are considered necessary, particularly in vulnerable sectors from the upper and middle basin, including Năruja, Nistorești, Vânători, Vetrești-Herăstrău, and other exposed localities.

Stakeholders generally expressed positive feedback regarding the proposed CRM recommendations, especially those related to:

- improvement of early warning and preparedness systems;
- implementation of integrated grey-green infrastructure measures;
- strengthening protection of transport infrastructure and settlements;
- increasing public awareness and community preparedness;
- improving coordination between institutions involved in flood risk management.

At the same time, participants emphasized several implementation challenges, including limited financial resources, land ownership constraints, legislative barriers, and difficulties related to public acceptance of certain measures, particularly land-use restrictions or river restoration interventions.

The stakeholder involvement process also contributed to strengthening institutional dialogue and supported the alignment of the proposed measures with existing planning and policy frameworks, including Flood Risk Management Plans, local development strategies, spatial planning instruments, and climate adaptation objectives.

Learning and knowledge exchange were ensured through a continuous participatory process implemented during the project. Stakeholder workshops, technical discussions, field visits, and consultation questionnaires facilitated mutual learning between scientific experts, authorities, and local stakeholders.

The project contributed to increasing the understanding of climate-related flood risks and adaptation needs by combining scientific analysis with local knowledge and operational experience. In particular, discussions related to recent flood events, including the March 2026 flood event, provided valuable practical insights regarding emergency response, community preparedness, and the effectiveness of existing protection measures.

In addition, the dissemination of project materials, technical presentations, and awareness-raising activities supported the transfer of knowledge toward local authorities, technical institutions, and vulnerable communities. The participatory approach adopted within the project created the basis for continued learning and future collaboration among stakeholders involved in climate risk management.

The final outcomes of the CARE-ROPutna project were communicated through several dissemination and stakeholder engagement activities organized at local and national level.

The project results were presented during stakeholder workshops organized in the study area, involving representatives of local administrations, emergency authorities, water management

institutions, environmental authorities, and vulnerable communities. These meetings facilitated discussion of the Climate Risk Assessment results, proposed CRM measures, and implementation challenges.

In addition, promotional materials and brochures describing the project objectives, methodology, and results were developed and distributed both during the stakeholder workshops and within relevant national institutions involved in water management, flood risk management, and climate adaptation activities.

The dissemination activities also included:

- policy-oriented communication materials;
- dissemination posts on the NIHWM website and social media channels;
- technical presentations and discussions with institutional stakeholders;
- electronic distribution of project materials and outputs.

These communication activities contributed to increasing awareness of climate-related flood risks and promoting the integration of climate adaptation considerations into local and regional planning and decision-making processes.

To support the uptake of the project results by decision-makers, two Policy Notes were prepared and disseminated to key institutional stakeholders at both regional and national levels.

- The first Policy Note, addressed to county-level authorities, translates the project's scientific findings into practical recommendations for strengthening flood resilience in the Putna River basin. It highlights the added value of high-resolution flood hazard and risk assessments for supporting spatial planning, prioritising investments in critical infrastructure, enhancing inter-institutional cooperation, improving early warning systems, and promoting nature-based solutions and public awareness initiatives.
- The second Policy Note targets national policy-makers and focuses on the strategic implications of the CARE-ROPutna methodology for climate adaptation and flood risk management at the national scale. It demonstrates the benefits of integrating high-resolution local datasets into future Flood Risk Management Plans, supports the implementation of the National Climate Change Adaptation Strategy and the Floods Directive, and promotes the replication of the project's methodology in other Romanian river basins.

Both Policy Notes were designed as concise, evidence-based communication products that translate the technical outcomes of the project into actionable policy recommendations. Their objective is to facilitate the integration of the project's results into future flood risk management planning, climate adaptation policies, and investment priorities at both regional and national levels.

Several aspects of the third phase proved particularly successful. First, the integration of the scientific results obtained during Phases 1 and 2 into a practical climate risk management framework enabled the identification of a coherent portfolio of adaptation measures specifically tailored to the characteristics of the Putna River basin. The use of high-resolution local datasets and locally calibrated hydrological and hydraulic models significantly increased the confidence in the proposed interventions and facilitated their acceptance by stakeholders.

Stakeholder engagement also represented one of the strongest elements of the project. The workshops, Mentimeter consultation, questionnaires and bilateral discussions provided valuable

local knowledge that complemented the technical analyses and helped validate the proposed measures. The consultation process demonstrated broad agreement among stakeholders regarding the need for integrated flood risk management based on a balanced combination of structural measures, nature-based solutions, improved monitoring, early warning systems and public awareness initiatives.

The preparation of Policy Notes further contributed to translating scientific results into practical recommendations for regional and national decision-makers, increasing the potential uptake of the project outcomes.

The main difficulties were related to the uncertainty associated with future climate projections and the prioritization of adaptation measures under limited financial resources and multiple institutional responsibilities. Another challenge was balancing different stakeholder expectations while maintaining technical consistency with the analytical results. As with many adaptation planning exercises, some proposed measures require additional technical studies, feasibility assessments or detailed cost-benefit analyses before implementation can be considered.

The project resources were used efficiently by progressively building each project phase upon the results of the previous one. The methodologies, datasets and modelling framework developed during Phases 1 and 2 provided a solid technical basis for Phase 3, allowing the project team to focus primarily on the evaluation, prioritization and validation of climate risk management measures rather than repeating analytical work.

The multidisciplinary expertise available within the project team ensured efficient integration of hydrological modelling, flood risk assessment, GIS analyses and climate adaptation planning. Existing institutional datasets, national flood risk management documentation and stakeholder knowledge were effectively combined, maximizing the value of available information while minimizing additional data collection efforts.

Stakeholder consultations were organised using cost-effective participatory approaches, including interactive workshops and online questionnaires, enabling broad participation without significant additional financial resources. This approach increased the quality and acceptance of the proposed measures while ensuring efficient use of both project time and available funding.

The Climate Risk Management phase has substantially improved the understanding of flood risk within the Putna River basin by translating complex scientific analyses into practical decision-support information that can be used by public authorities, emergency management institutions and local stakeholders.

The participatory process contributed to raising awareness of the increasing flood risks associated with climate change and highlighted the importance of combining engineering measures with ecosystem-based approaches, improved preparedness and institutional cooperation. The consultation results also demonstrated an increased recognition among stakeholders of the need for integrated flood risk management rather than isolated structural interventions.

Institutionally, the project strengthened cooperation between river basin authorities, local administrations, emergency services and other relevant organisations by providing a common technical basis for discussing future adaptation priorities. The proposed portfolio of measures and the accompanying Policy Notes support evidence-based decision-making and can facilitate the

future revision of Flood Risk Management Plans, climate adaptation strategies and spatial planning documents.

Although the project does not directly finance the implementation of adaptation measures, it creates the technical and strategic foundation required for accessing future national and European funding opportunities. By identifying priority intervention areas and well-supported adaptation options, the project contributes to increasing the readiness of regional and local authorities to develop mature investment projects aimed at enhancing flood resilience under future climate conditions.

5 Conclusions Phase 3

Phase 3 of the CARE-ROPutna project successfully translated the climate risk assessment results obtained during the previous project phases into a practical climate risk management framework for the Putna River basin. Building upon the high-resolution hazard, exposure and risk analyses developed in Phases 1 and 2, this phase focused on identifying, evaluating and prioritising a portfolio of proposed adaptation measures capable of reducing future flood risk under changing climatic conditions.

A key achievement of this phase was the development of an integrated portfolio of proposed measures combining structural interventions, nature-based solutions and non-structural actions. Rather than promoting individual engineering solutions, the project adopted an integrated flood risk management approach that considers prevention, preparedness, protection, response and long-term climate adaptation. The proposed measures were designed as technical recommendations to support the future update of the Flood Risk Management Programme of Measures and do not represent formally adopted interventions.

The project also demonstrated the added value of stakeholder participation in climate risk management. Through workshops, questionnaires and interactive consultations, representatives of public authorities, river basin management institutions, emergency services and local administrations contributed to validating the proposed measures and identifying implementation priorities. Stakeholder feedback consistently highlighted the importance of combining grey infrastructure with nature-based solutions, improving early warning systems, strengthening institutional cooperation and increasing public awareness of flood risks.

Another important outcome was the successful integration of scientific evidence into policy support. The preparation of Policy Notes for regional and national decision-makers transformed the technical project results into practical recommendations aimed at supporting future planning processes, climate adaptation policies and investment decisions.

Despite these achievements, several challenges remain. The implementation of many proposed measures will require detailed feasibility studies, environmental assessments, sustainable financing mechanisms and continued institutional coordination. Climate change uncertainty, competing land-use demands and limited financial and administrative resources continue to influence the prioritisation and implementation of flood risk reduction measures. These aspects underline the need for adaptive management approaches that can be updated as new information and climate projections become available.

Overall, Phase 3 has established a robust basis for climate-resilient flood risk management in the Putna River basin. By combining scientific evidence, stakeholder knowledge and policy-oriented

recommendations, the project has strengthened the capacity of regional authorities to integrate climate change considerations into flood risk management and spatial planning. The methodological approach developed within CARE-ROPutna is transferable to other Romanian river basins and can contribute to the future implementation of the Floods Directive, the National Climate Change Adaptation Strategy and broader climate resilience initiatives.

6 Progress evaluation

6.1 Project outputs

Table 6-1 Overview key performance indicators

Key performance indicators	*Progress*
2 communication actions taken to consult and share results with stakeholders;	The second workshop within the CARE-ROPutna project, dedicated to stakeholder consultation, was organized by NIHWM on 21 April 2026 in the study area (at the Golești Commune City Hall, Vrancea County. The third stakeholder workshop (final) was held on 17 June 2026 in Livezile village. Both workshops brought together representatives of key institutions involved in flood risk management to present the project results, discuss the proposed climate risk management measures, and collect stakeholder feedback for the validation and prioritisation of the proposed portfolio of measures. Project dissemination materials were distributed, including a brochure presenting the main project results and a set of promotional materials branded with the CLIMAAX visual identity .
at least 7 stakeholders involved in the activities of the project during the foreseen consultation and dissemination workshops	Stakeholders engagement was ensured by the active participation in the workshops of about **25 participants** per event from **12 involved institutions**: Vrancea Emergency Inspectorate, 6 local municipalities also representing vulnerable communities (Nistoresti, Naruja, Spulber, Nereju, Golesti, Paltin), Vrancea County Prefecture, Vrancea County Council, Vrancea Water Management Service, Siret River Basin Administration (National Administration Romanian Waters), as well as County Environmental Directorate within the National Agency for Environment and Protected Areas.
2 notes for policy makers.	Two Policy Notes were developed: one addressed to county and regional authorities involved in flood risk management and spatial planning, and a second addressed to national authorities responsible for water management, flood risk management and climate

Key performance indicators	*Progress*
	change adaptation, to support the uptake of the project's recommendations in future policies and planning processes.
2 dissemination posts in social media (NIHWM FB page)	More than two dissemination posts were published through the official NIHWM Facebook page and website and disseminated further by other institutions. the second workshop post post on NIHWM website the final workshop post
1 brochure distributed electronically/in paper to inform and raise awareness in local communities;	A brochure in the national language was developed to present the project's main results and raise awareness of flood risk reduction and climate adaptation in the Putna River basin. The brochure was distributed to stakeholders during the project workshops and shared also with interested parties to support wider dissemination of the project's outcomes.

Table 6-2 Overview milestones

Milestones	*Progress*
M7: Potential new measures to address the risk and vulnerabilities identified from the multi-risk analysis carried out in Phases 1 and 2 proposed	Measures to address the risks and vulnerabilities identified in the detailed CRA were selected and prepared to be presented and discussed with local stakeholders.
M8: The second stakeholders consultation meeting	The second stakeholder consultation workshop was successfully held in the study area, during which the proposed measures were presented and discussed with stakeholders, and feedback was collected.
M9: Measures for supporting the updating of the program of measures for the study area in the Flood Risk Management Plan of the 3rd implementation Cycle of the Floods Directive proposed (Month 22);	A portfolio of proposed climate risk management measures was developed to support the future update of the Programme of Measures within the Flood Risk Management Plan for the third implementation cycle of the Floods Directive. The proposed measures were developed based on technical analyses and stakeholder feedback.
M10: The third stakeholders meeting for the presentation of the results done (Month 22)	The final stakeholder workshop was successfully organised, during which the project results and the proposed portfolio of climate risk management measures were presented, discussed and validated with representatives of the relevant authorities and other key stakeholders.

Milestones	*Progress*
M11: Attend the CLIMAAX workshop held in Brussels	Attendance at the upcoming workshop in Brussels is ensured.

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7 Supporting documentation

Zenodo structure

- Main Report
- Outputs of the second stakeholder consultation workshop (results of the surveys, charts)
- Outputs of the third stakeholder consultation workshop (results of the surveys, charts)
- Notes to policy makers
- Media posts and dissemination materials

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