

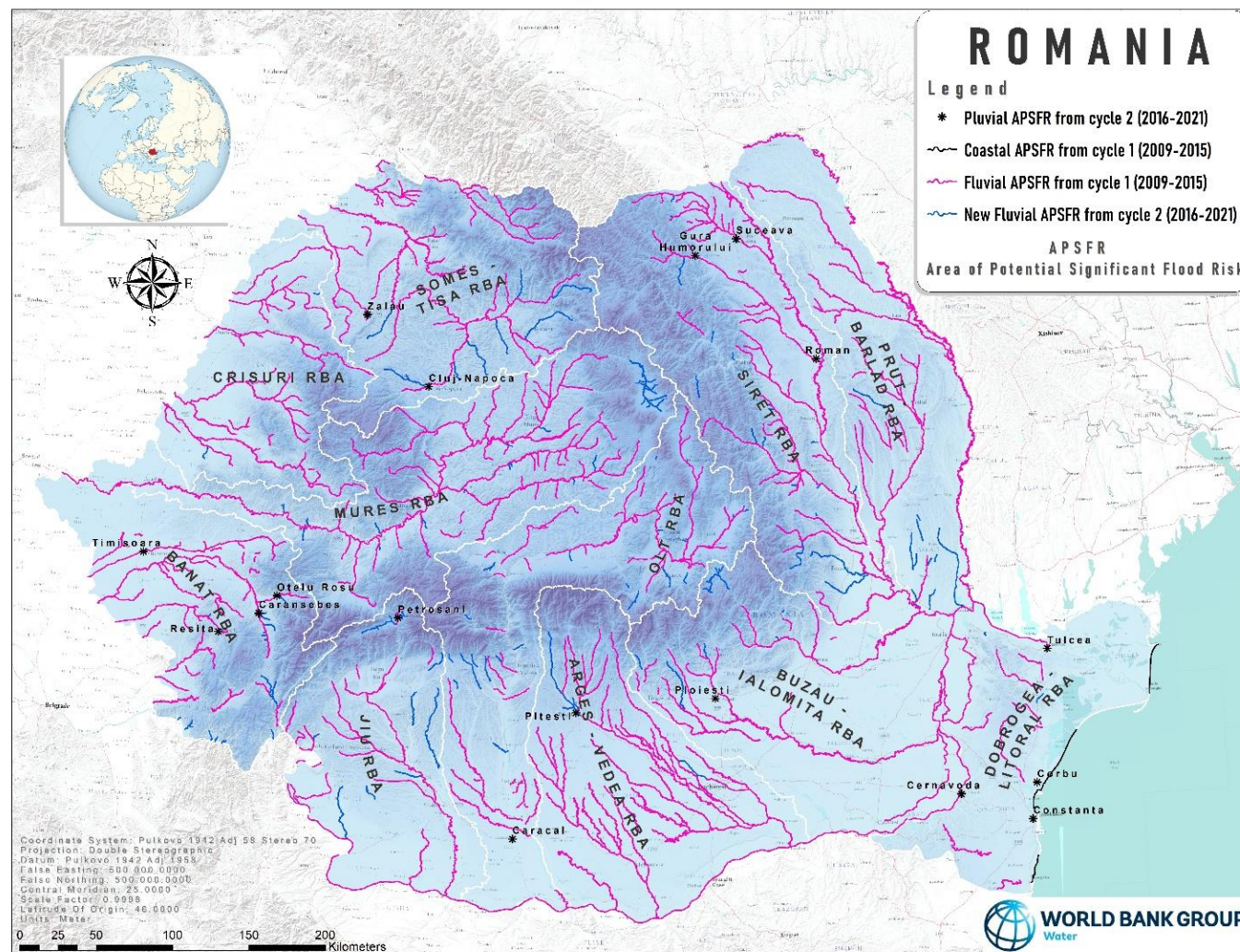
Innovations in Flood Risk Management

Examples from Romania

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May 23, 3023



RO Floods Project



Context

Romania is a flood prone country with an **Annual Expected Damage of EUR 1.72 billion** in over 500 Areas of Potential Significant Flood Risk (APSFR).

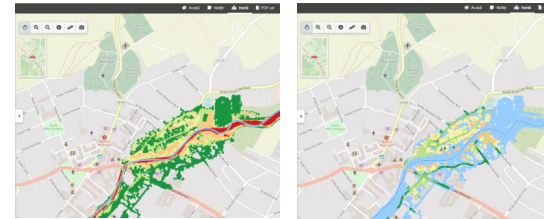
2019-2023 **World Bank Technical Assistance** to strengthen Flood Risk Management and support with the implementation of the EU Floods Directive:

- **New Flood Hazard and Risk Maps**
- **12 New Flood Risk Management Plans**

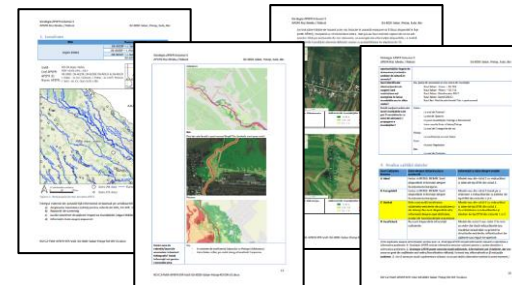
Challenges and Solutions

Together with our Romanian Partner, the World Bank identified **flood risk management challenges** in the following areas:

**Modelling and Flood
Risk Assessment**



**Development of
Programs of Measures**



**Stakeholder Engagement
and Communication**

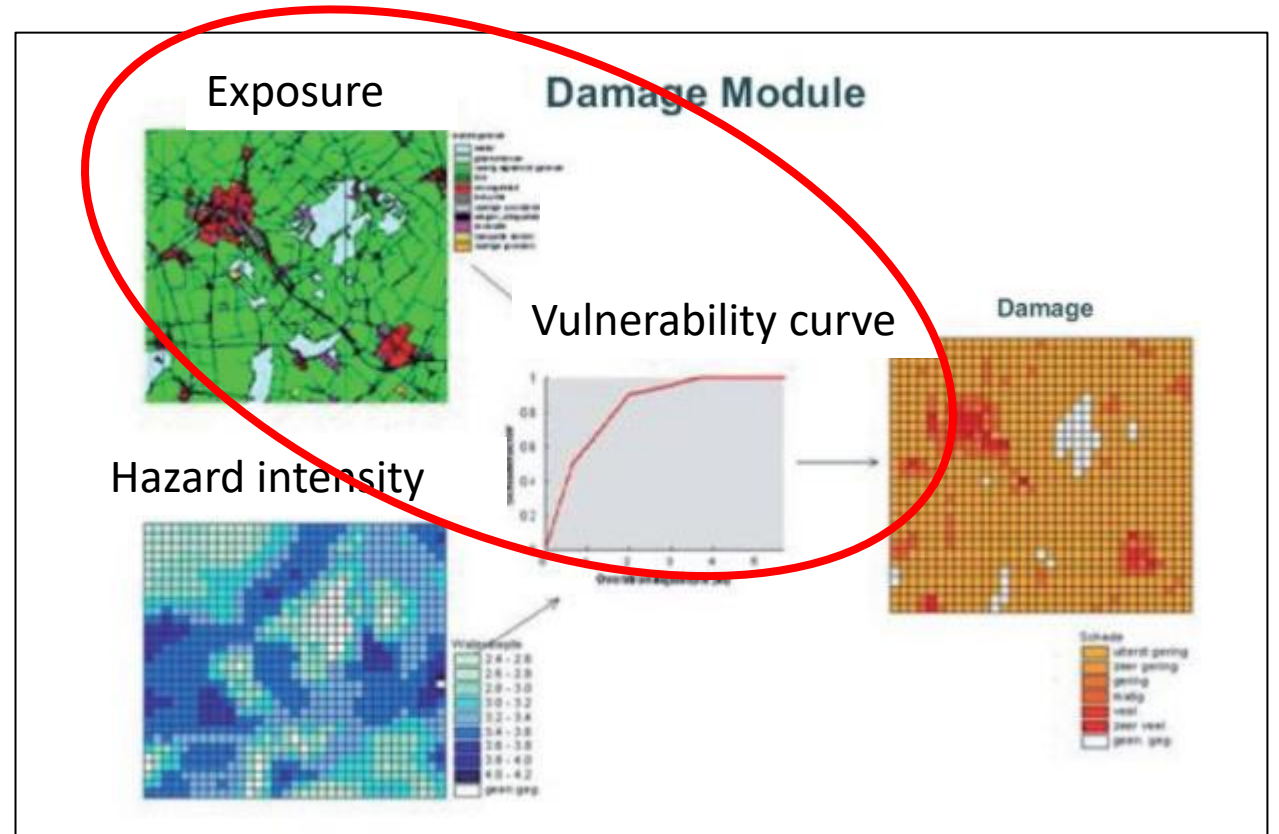


Modelling and Flood Risk Assessment

Introducing quantitative flood risk assessment to monetize damages

Monetized damages are needed for the economic justification of investments in flood risk management.

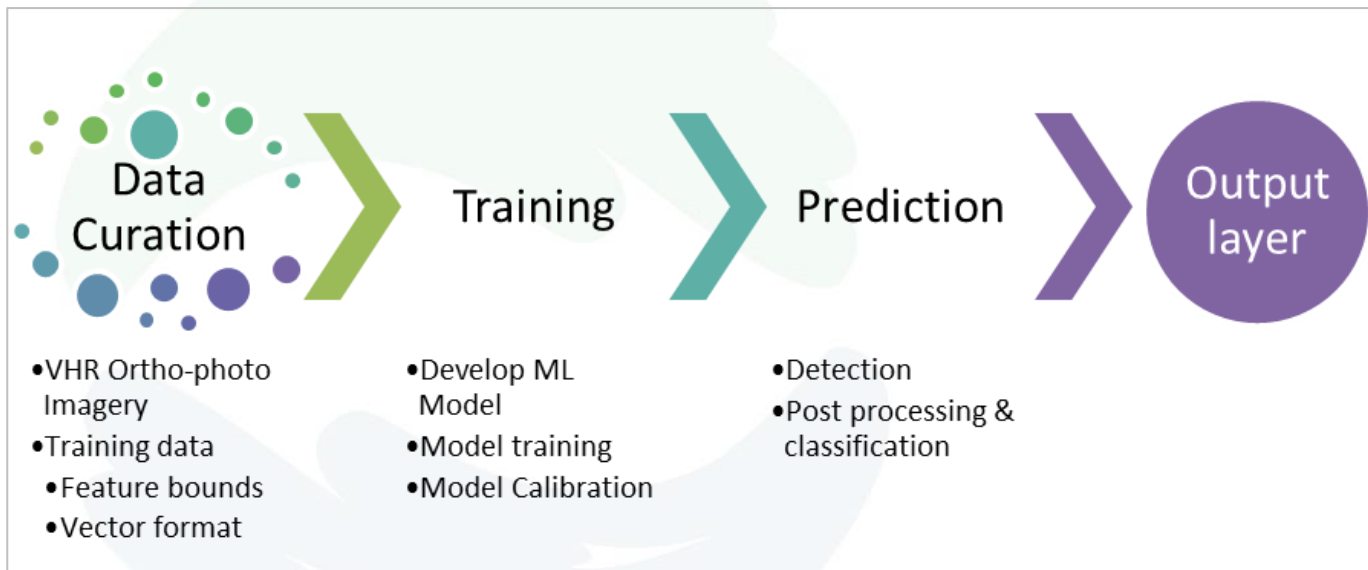
To monetize flood risk, detailed information on exposure and on vulnerability is needed in addition to the flood hazard maps:



Modelling and Flood Risk Assessment

Introducing quantitative flood risk assessment to monetize damages

Creation of risk exposure data using Machine Learning: Feature detection and classification



Machine Learning model for extraction of attributes from ortho-photos (0.5m)

- building footprints,
- social features,
- Transport infrastructure
- utility features, and
- agricultural activity

On site validation / google street view validation (under Covid19 limitations);

Modelling and Flood Risk Assessment

Introducing quantitative flood risk assessment to monetize damages

Resulting data set: Standardized data model with a total of **12,010,156 features** available in the exposure database within a **6 months time frame**.



Sectoral impacts in monetary terms		
Indicator	AED	AED+CC
Sectoral impacts in monetary terms (total direct tangible damages)		
Residential buildings	€488.99 million	€664.23 million
Education	€16.81 million	€22.90 million
Health	€9.59 million	€13.43 million
Agriculture	€126.83 million	€170.68 million
Industry	€322.13 million	€441.88 million
Commercial	€80.18 million	€108.20 million
Infrastructure	€83.69 million	€109.12 million
Cultural	€12.3 million	€16.46 million
Others	€13.61 million	€19.23 million
Total direct tangible damages	€1.15 billion	€1.56 billion

Modelling and Flood Risk Assessment

Modelling pluvial floods in 17 urban areas (pluvial APSFR)

Risk of pluvial flooding in cities is increasing and local authorities struggle with assessing and managing this risk.

Modelling pluvial flooding is challenging:

- Short concentration times
- Complex topography
- Influence of drainage/sewage system
- High concentration of assets and high potential damages



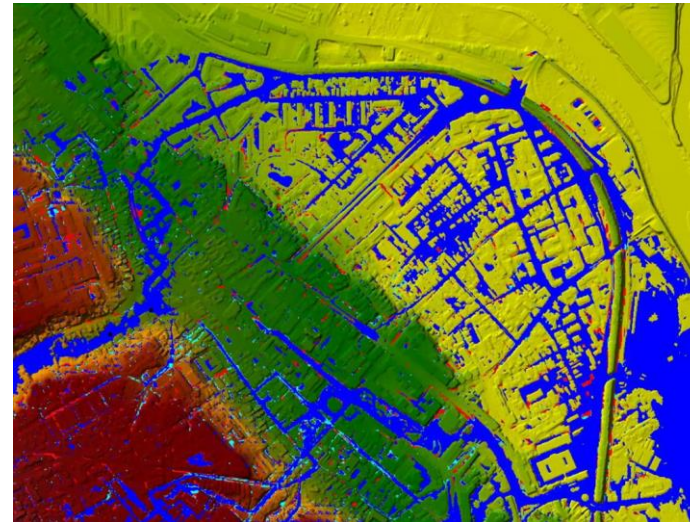
Modelling and Flood Risk Assessment

Modelling pluvial floods in 17 urban areas (pluvial APSFR)

Fully 2D shallow water equations modelling (HEC-RAS 6.0) with optimizations procedures:

- Sub-grid approach to take account for actual topography (presented with 0.5m DTM) in a larger mesh (ranging from 2x2m to 10x10m).
- Capacity of water drainage modelled as equivalent infiltration (in general $T=2-3a$).

Calibration of maps using reports on historical floods, validation with local stakeholder.



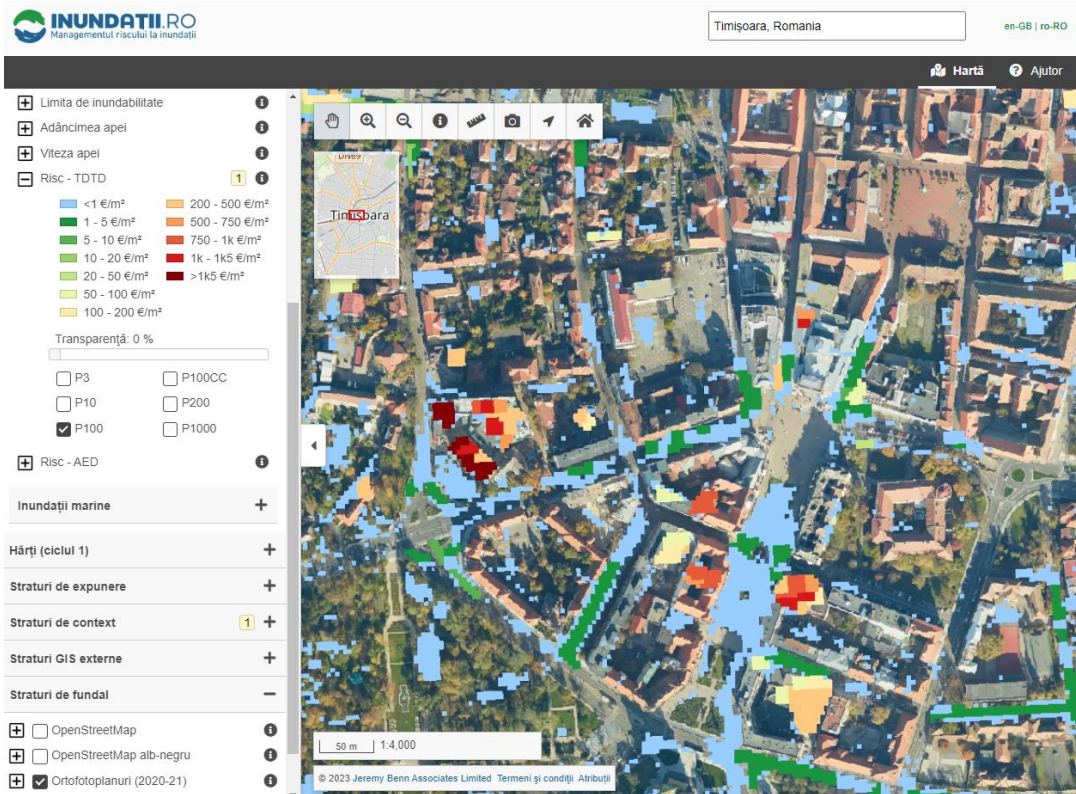
*Results from sub-grid approach.
Flow is restricted to the streets*

Calibration with historical localized flooding for properties between 2006-2020.



Modelling and Flood Risk Assessment

Modelling pluvial floods in 17 urban areas (pluvial APSFR)



Results and their use:

Urban flood maps identify flooding hotspots to:

- Strengthen preparedness and better prepare emergency response.
- Initiate coordination between urban developers and water agency.
- Raise awareness.

Models can be used to test the potential of green measures:

- Permeable pavement
- Green roofs
- Sustainable drainage Systems (SUDS)

Development of Program of Measures

Identifying effective and viable nature-based solutions

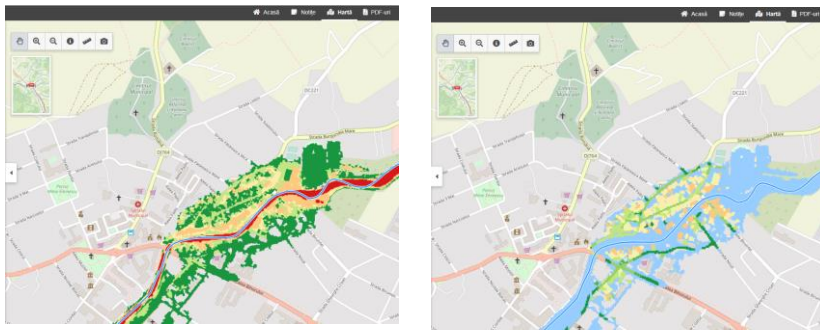
Preliminary Flood Risk Assessment

Input for developing the PoM

Catalogue of Measures

Flood Hazard and Risk Maps

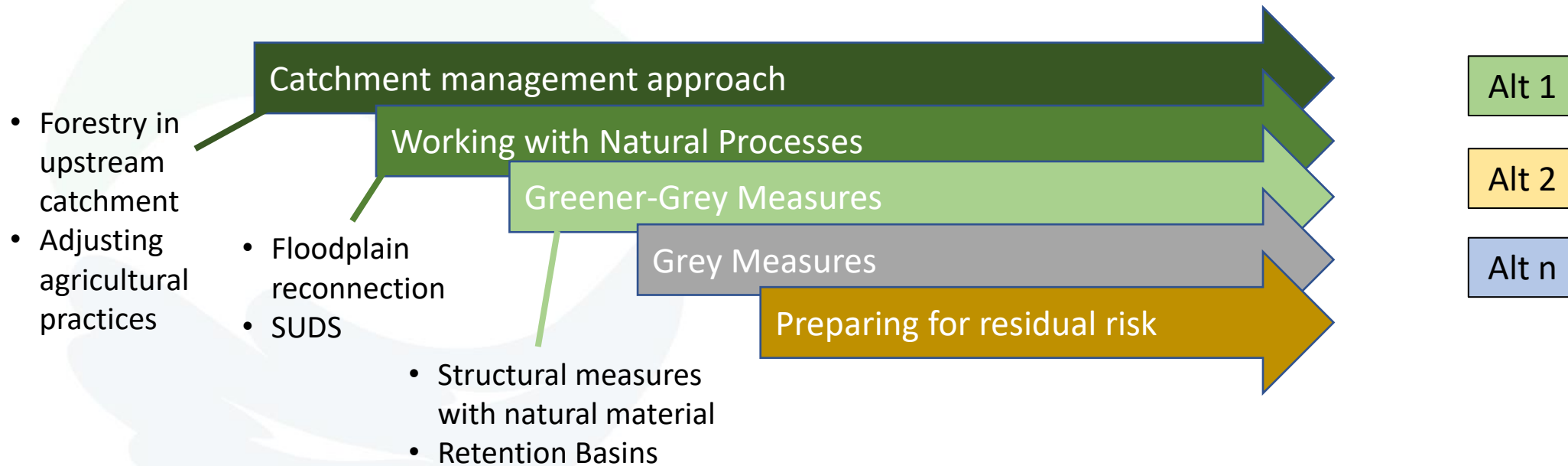
Domain	Code	Description
No action	M01	No Action. No measure to be proposed to reduce the flood risk in the APDR or other defined area.
Prevention	M21	Prevention. Measures to prevent the location of new or additional receptors in flood-prone areas, such as land use planning policies or regulation.
	M22	Removal or relocation. Measures to remove receptors from flood-prone areas, or to relocate receptors to areas of lower probability of flooding and/or of lower hazard.
	M23	Resilience. Measures to adapt receptors to reduce the adverse consequences in the event of flood actions on buildings, public networks, etc.
Protection	M24	Other prevention. Other measures to enhance flood risk prevention (may include, flood risk modelling and assessment, flood vulnerability assessment, maintenance programmes or policies etc.)
	M31	Natural flood management / runoff and catchment management. Measures to reduce the flow into natural or artificial drainage systems, such as overhead flow interception and / or storage, enhancement of infiltration, etc., and including in-channel, floodplain works and the rehabilitation of banks, that restore natural systems to help slow flow and store water.
	M32	Water flow regulation. Measures involving physical interventions to regulate flows, such as the construction, modification or removal of water retaining structures (e.g., dams or other on-flow storage areas or development of existing flow regulation rules), and which have a significant impact on the hydrological regime.
	M33	Channel, Coastal and Floodplain Works. Measures involving physical interventions in freshwater channels, mountain streams, estuaries, coastal waters and flood-prone areas of land, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.
Preparedness	M34	Surface Water Management. Measures involving physical interventions to reduce surface water flooding, typically, but not exclusively, in an urban environment, such as enhancing artificial drainage capacities or through sustainable drainage systems (SuDS).
	M35	Other measures to enhance protection against flooding, which may include flood defence asset maintenance programmes or policies.
	M41	Flood forecasting and warning. Measures to establish or enhance a flood forecasting or warning system.
	M42	Emergency Event Response Planning / Contingency planning. Measures to establish or enhance flood event institutional emergency response planning.
Recovery and Resilience	M43	Public Awareness and Preparedness. Measures to establish or enhance the public awareness or preparedness for flood events.
	M44	Other preparedness. Other measures to establish or enhance preparedness for flood events to reduce adverse consequences.
	M51	Planning for the recovery and resilience phase to provide part of (preparatory) individual and societal recovery. Clean-up and restoration activities (buildings, infrastructure, etc.) in Health and mental health supporting actions, incl. managing stress or Disaster financial assistance (grants, tax), incl. disaster legal assistance, disaster compensation assistance, Temporary or permanent relocation, etc. Other: Environmental recovery, Clean-up and restoration activities (with several sub-topics as removal protection, wall-water safety and FD Reporting Guidance – Final 11.07.2019, 200 recording hazardous materials contained).
	M52	Other recovery and resilience (except a hazard from flood events) (insurance policies, etc.)
M53	Other	



Development of Program of Measures

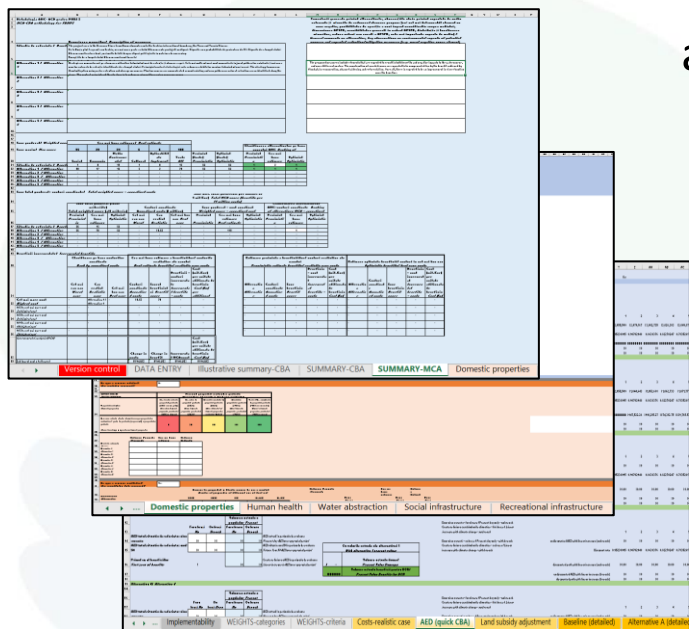
Identifying effective and viable nature-based solutions

Based on the input, building alternative strategies for each APSFR following a **green** guidance

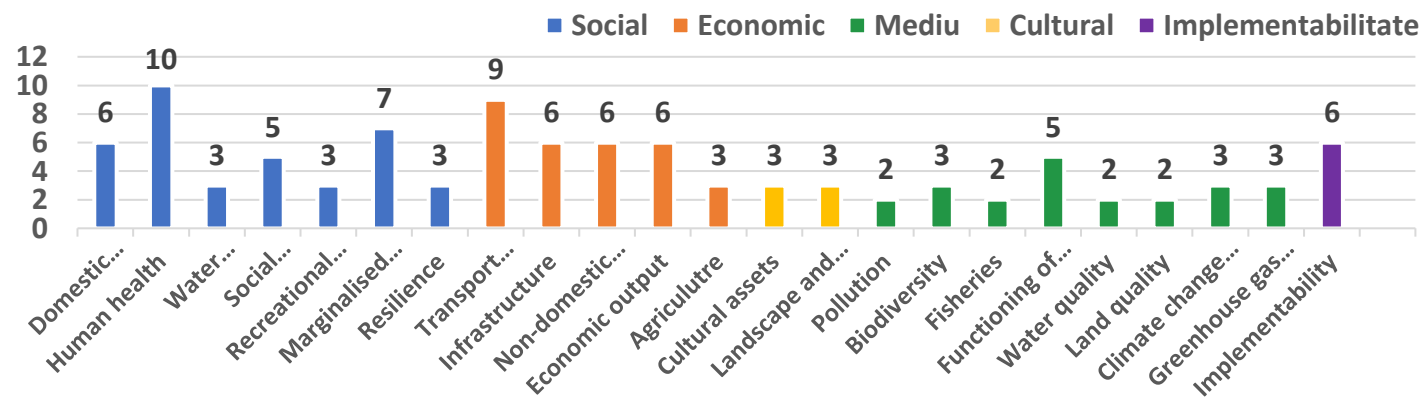
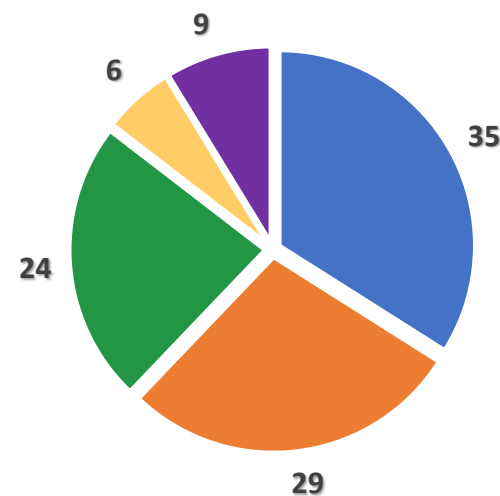


Development of Program of Measures

Systematic appraisal and prioritization of measures

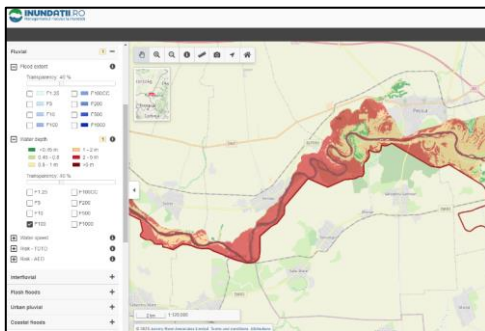


Tools for appraisal and prioritization of alternative strategies in over 500 APSFR:
Appraisal Summary Table (MCA and CBA)

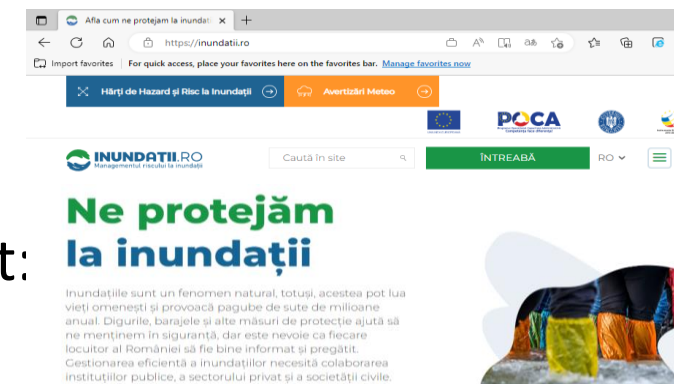


Stakeholder Engagement and Communication

Engaging stakeholders in consultations, building trust and raising awareness



Interactive WebViewer allowing institutional stakeholders to comment and validate the new flood maps.



New website, new *brand* on flood risk management: www.indundatii.ro



Social Media posts and video animations: <https://www.youtube.com/@inundatiiro>



Innovations in Flood Risk Management

Examples for Romania

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