11th meeting of the Working Group in the project
"Climate Change and Security in the Dniester River
22 October – Chişinău

“Management and Technical Assistance Support to Moldova Flood Protection Project”

MINISTRY OF ENVIRONMENT OF REPUBLIC OF MOLDOVA

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HR Wallingford
Working with water
Main objectives of the Project

- Identify **flood risk areas** and **measures** to reduce flood risk
- develop a **phased investment programme**
National high level flood risk assessment

FLOOD HAZARD

FLOOD VULNERABILITY

FLOOD RISK

LEGEND
- National boundary
- Districts
- Rivers and lakes
- Flood defences

Flood risk:
- High
- Moderate
- Low
The 3,400 km of rivers to be modelled in detail in Task 2 have been identified, based on the results of the PFRA and together with the stakeholders. This includes the Moldovan part of river Dniester.

Following a request from Zoï Environment Network, we agreed to include in the hydraulic simulation also the Ukrainian part of the lower Dniester.
Data collection: high resolution LIDAR DTM and topographic survey (cross sections survey, dyke survey)

Hydrological and hydraulic analysis carried out for three sizes of flood: 1%; 0.5%; 0.1% using InfoWorks ICM: internationally recognised software package (1D and 2D modelling of rivers and floodplains)

Impacts of dam failures analysed
Impacts of climate change analysed
Lower Dniester model calibration

Flood extent and depth: 2008 flood

Observed and predicted flood hydrographs at Bender
Comparison with previous studies: Dniester

InfoWorks ICM model

Results from Jeleapov et al. 2014
Flood outlines and water levels

Dniester downstream of Dubasari
Dniester downstream of Tiraspol
Dniester flood hydrographs

Lower Nistru WD RP0100

- Nistru-321500_NRL_US-Ichel (Flow (m³/s))
- Nistru-219800_NRL_US-bic (Flow (m³/s))
- Nistru-191900_NRL_DS-Botna (Flow (m³/s))
- Nistru-152000_NRL_US-Turunchuk (Flow (m³/s))
- Nistru-007200_NRL_DS-Turunchuk (Flow (m³/s))
- NRL_FlowToBlackSea (Flow (m³/s))

Flow (m³/s)
Days
Floopenl storage between Hirbovat
Floopenl between Hirbovat and Botna full
Floodwave from the right floodplain
Impact of dykes

Floodplain flow blocked by dyke
TASK 2 – HYDRAULIC MODELLING AND FLOOD HAZARD MAP

Upper Dniester: Longitudinal section

Upstream of Dubasari dam
Climate change: potential impact on flood levels

- A **20% increase in flows** has been used for the climate change analysis. This has been used on the Dniester and Prut in previous literature.

- The impact on flood extent of a 20% increase in flow is small. This is because the 1% flood event fills the river valleys in almost all cases, and the **difference between the 1% and the 0.5% and 0.1% flood extents is small**

- The flood hazard maps can be used to assess the impact of a 20% increase in the 1% flow as a result of climate change. This is because the **0.1% event flow is more than 30% greater than the 1% flow**, and therefore the **0.1% flood extent will be greater than the 1% event flood extent with the climate change allowance**.
Climate change: potential impact on flood levels

- The impacts of a 20% increase in flow is to increase flood levels by 1 m to 1.5 m on the Dniester from Bender upstream. The increase is lower on the Dniester further downstream because the floodplain is very wide.

- An increase in peak flood flow of 20% would reduce the existing standard of protection by a factor of 25% to 50% and the frequency of flooding would increase. The standard of protection has been measured with specific hydraulic modelling.

- Even if the flood extent for the climate change will not increase, the risk on the receptors will increase.
Climate change: potential impact on flood levels

20% increase in flow

Increase in level [m]

Increase in flow [%]

Flood extent for 20% increase in 1% flow lies between the dark blue and light blue flood extents

Flood extent for 0.1% (1 in 1,000-year) flood extent (dark blue)
Flow = (1% flow) x 1.35

1% (1 in 100-year) flood extent (light blue)

Bender

Hrusca

0.1% (1 in 1,000-year)
flow extent (dark blue)
Flow = (1% flow) x 1.52

1% (1 in 100-year)
flow extent (light blue)
Flood hazard mapping delineates flooded areas along rivers using design flood levels established as part of the hydraulic modelling.

The results of the hydraulic modelling have been used to synthesise the flood outlines into 3 different classes according to the 3 size of flood used in the modelling.

A framework of 45 hazard maps has been created in GIS in order to cover all the modelled rivers, with 1:50,000 scale map.
Within each map the flood extension for different modelled probabilities is given with 3 different gradation of blue.
How a flood hazard map looks
Definition of ‘flood risk’

2. ‘flood risk’ means the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event.

Implementation of the procedure

Total risk [€] is calculated
A framework of 45 hazard maps has been created in GIS in order to cover all the modelled rivers, with 1:50,000 scale map.
Reduce flood risk establishing objectives and strategies for sustainable flood risk management through a Multi Criteria Analysis (MCA)

Prepare a list of prioritised measures for flood risk management for all rivers basins in the territory of Moldova

The prioritisation method will be shared and discussed with the Promoter and the stakeholder in order to seek an agreement
Prepare a **phased investment programme** *(2016 - 2035)* for the entire territory of Moldova in order to give a **broad overview** for the **necessary investment to decision makers** and potential financing agencies

- Identify a **list of priority measures** to be implemented within the first investment phase *(2016 - 2020)*
- The **priority of measures** will be **shared and discussed** with the Promoter and the stakeholder in order to **seek an agreement**
Capacity building training has been carried out for:

- theoretical background on river basin management, hydrology, river hydraulics, flood management, appraisal and planning
- use of the hydrological-hydraulic 1-2D model (InfoWorks ICM) and use of the GIS systems both used in the project in the Task 2, 3 and 5

- Provision of 4 licences of the hydraulic model (2 licences already provided to the Promoter)
- NO need of a new GIS. Public availability in electronic format of maps and data collected and created on the Promoter’s Geoportal
Lower Dniester

The Lower Dniester (downstream of Dubasari dam) can be divided into separate flood compartments with an independent system of dykes. The dykes have a significant impact on attenuation of the peak flow. *Flood risk is generally low or medium but it is high near towns and settlements located along the river.*
Lower Dniester

The river valley is quite narrow between Dubasari and Bender with narrow floodplains protected by long lengths of dykes. **Two very high flood risk areas at Mălăiești and Pîrîta.**
Lower Dniester

There are very high flood risk areas at Bender, Tîrnuca, and Tiraspol.
Lower Dniester

Downstream of Bender the river valley is very wide. The river divides into two channels near Talmaza (Dniester on the Moldova side and the Turunciuc on the Transnistria side).
CHARACTERISTICS OF FLOOD RISK

Lower Dniester

Level of flood risk:
- VH: very high
- H: high
- M: medium
- L: low

Chişinău
PROPOSED STRATEGIES

Strategic Options

Lower Dniester

SO9: Different approach

SO3: Rehabilitate and improve dykes in high risk areas
- Length of new dykes = 36 km
- Length of improved dykes = 29 km

SO4: Provide more flood storage: change operation of Novodnistrovsk dam (Ukraine)

SO6: Measures that are compatible WFD

Preferred option
Opțiunea preferată
Measures for flood risk management

The objective of the previous task was to identify, for each basin, the preferred strategic option for flood risk management.

The following and on-going task is to prepare a list of prioritised measures for flood risk management for all rivers basins in the territory of Moldova.

Measures will be designed to:

1. achieve or contribute to the objectives agreed in previous step including economic, social, environmental and health objectives
2. not to significantly increase the flood risk either within or downstream of the river basin. In practice it is difficult to avoid small increases in flood risk at some locations when structural measures are implemented

- Measures will take account of the potential future impacts of climate change and will be designed as far as practicable to be adaptable to future change;
- Measures will be developed in the spirit of the Flood Directive (2007/60/CE), and the Water Framework Directive (2000/60/CE).
The integrated set of measures will be sub-divided into the following categories:

- PREVENTIVE measures
- FLOOD PROTECTION measures
- INSTITUTIONAL measures

PREVENTIVE measures relate to spatial planning and include:
- promotion of building development outside the flood hazard areas;
- developing appropriate building codes to reduce flood damage
- changes in land use, for example reforestation
FLOOD PROTECTION measures include (1/2):
- new dykes and raising of existing dykes
- repair and improvement of existing dykes
- new dams and reservoirs for flood management
- repair and improvement of existing dams

FLOOD PROTECTION measures include (2/2):
- changes to the operation of existing dams
- abandonment of existing dykes and dams
- creation of new flood storage areas or increasing the area of the natural floodplain
- ...

INSTITUTIONAL measures include:
- flood warning including flood detection, flood forecasting and dissemination of flood warnings
- emergency response including actions by those potentially at risk and by civil protection agencies
- public education and awareness raising
POTENTIAL MEASURES FOR FRM (Dniester downstream Dubasari dam)

- Rehabilitate and improve dykes in high risk areas
- Rehabilitate dykes in medium-low risk areas (the flood defenses will be improved only locally; the flows downstream will not decrease)
- Reconnect floodplain with the river
- Change operation of Novodnistrovsk dam (Ukraine) to provide more flood storage
- 20-30 M€ (preliminary appraisal !)
POTENTIAL MEASURES FOR FRM (Dniester downstream Dubasari dam)
POTENTIAL MEASURES FOR FRM (Dniester downstream Dubasari dam)
Financing of measures

- There will be a need to fund **maintenance** of flood protection works. The EIB cannot do this, but without it the assets constructed under the programme will deteriorate → sustainability for Moldova Government of those costs in the future will be considered in the definition of the Short Term Investment Plan.

- The Master Plan will contain structural and **non-structural measures**, EIB can fund only structural measures → other funders are needed.

- EIB can only fund 50% of cost of projects → co-funders are needed.

- The **EIB normally funds projects > 40 M€.** → the cost of single measures is normally less than that: those project can also be a set of different measures.
Thank you for your attention