Involvement of stakeholders in the selection and implementation of Nature-Based Solutions for hydro-meteorological risk reduction

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Challenges & Aims

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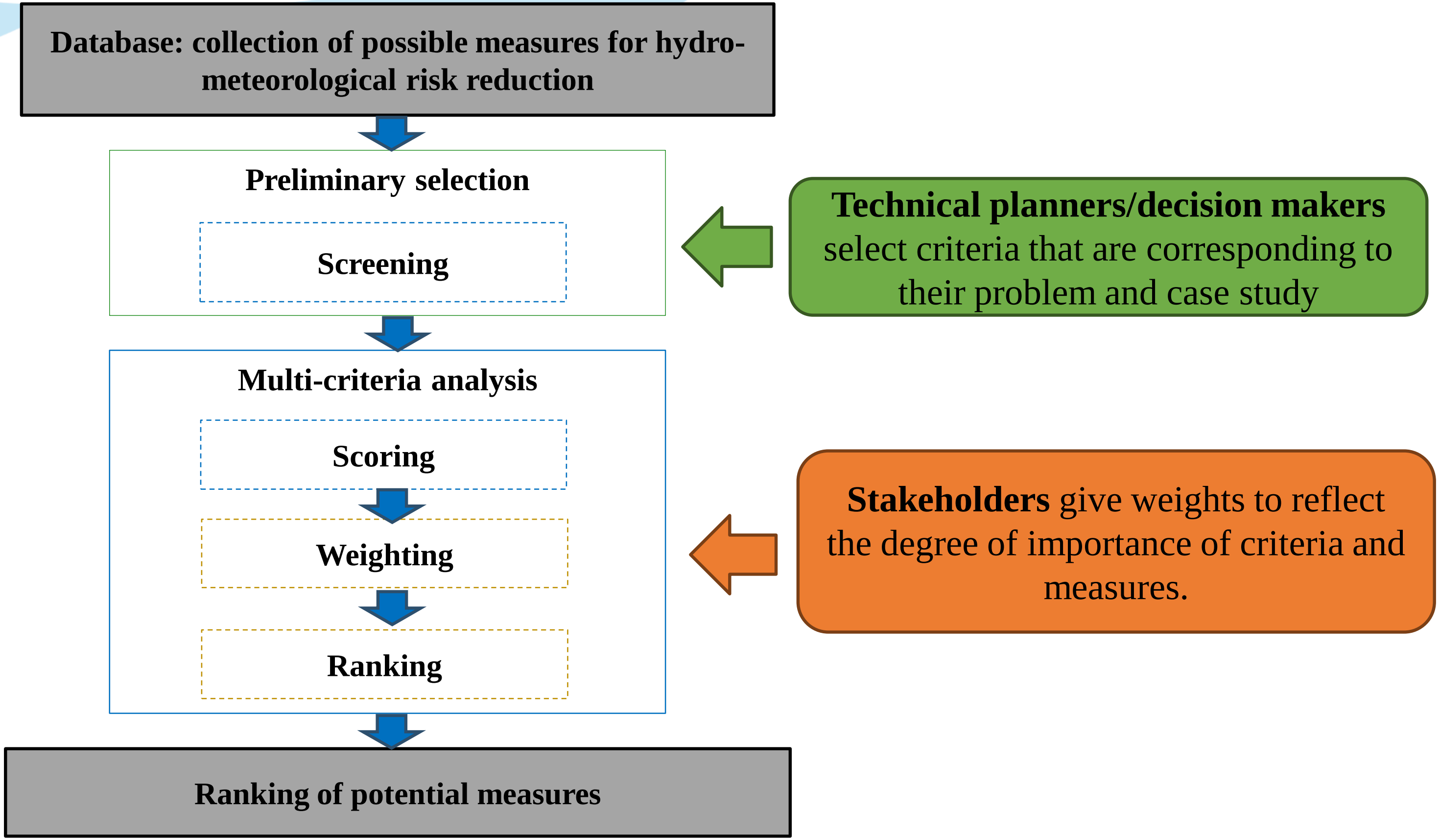
Challenges

- There is a challenge in **selecting suitable NBS measures** based on problems in the area, specific local constraints and social-economic conditions
- No single NBS solution can solve all problems and NBS are **not easy to implement in practice yet**, especially at a river basin scale
- The procedure of efficient **planning and selection** of NBS is a complex process that requires the involvement of multiple stakeholders.

Aims

- Developing and presenting a methodology to select NBS measures for reducing hydro-meteorological risk and increase co-benefits.
- Involving stakeholders' preferences into a multi-criteria analysis framework in planning NBSs.
- Helping **technical planners/decision makers** in defining suitable measures in a systematic way
- Applying this methodology to a case study from the RECONECT project; Tamnava River Basin in Serbia

Methodology for measures selection



Methodology: Preliminary selection

Identify measure type

- Nature-Based solutions
- Grey infrastructure

Identify problems in the area (i.e., type of hazard)

- Fluvial flooding
- Pluvial flooding
- Coastal flooding
- Ground water flooding
- Flash flooding
- Storm surge
- Drought
- Landslide

Identify the affected area

- Urban area
- Non-urban area

Identify potential location for implementing measures

- **Urban area**
- **Non-urban area**
  - Mountainous area
  - Coastal area
  - River basin
    - Upper course
    - Middle course
    - Lower course

Identify Project type

- Implementation of new measures
- Improvement or expansion of existing measures

Identify Land use type

- Artificial surfaces
- Agricultural areas
- Forest and semi natural areas
- Wetlands
- Water bodies

Methodology: Multi-criteria analysis

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General

- MCA is used to select and rank NBS measures by using the **weighted summation method**
- MCA has the potential to integrate and overcome the differences between social and technical approaches and allows the assessment of options along with several criteria that have different units (both quantitative and qualitative)
- We can involve stakeholders' view and preferences in the assessment relative importance of criteria.
- The criteria have a hierarchical structure divided into goals and sub-goals.
- The goals include hydro-meteorological risk reduction, water quality, habitat structure, biodiversity, socio-economics and human well-being. These 6 goals are divided into 19 sub-goals

Methodology: Multi-criteria analysis

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Scoring	Weighting

- Scoring is used to reflect the performance of the sub-goals
- The scoring is based on the collection of quantitative data for different sub-goals and measures through literature review and expert judgement
- Quantification was done by assigning simple score levels based on the qualitative descriptions
- Scoring scale is **from 5 to -5** : **5** (Very high positive impact) to **1** (Very low positive impact); **0** (No impact); and **-1** (Very low negative impact) to **-5** (very high negative impact)
	- Weighting is used to reflect the degree of importance.
	- The weighting was conducted in **three steps** with stakeholders
	  - Weight the importance of 6 main goals
	  - Weight the importance of 19 sub-goals.
	  - Weight the suitability/applicability of measures
	- Weights is given by choosing a value **from 0 to 10,**
	  - a value of **0** represents **not important**
	  - a value of **10** represents **the most important.**

Methodology: Multi-criteria analysis

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Ranking

Step 1: Calculate scores for each goal for each measure

$$\mathrm{Score}_{GOAL}(m_j)=\sum_{i=1}^{N} W_{SUB-GOALS_i} S_{SUB-GOALS_{i,j}}$$

Where N is a number of sub-goals, $W_{subgoal_i}$ is the normalised weight for sub-goal (i) and $S_{subgoal_{i,j}}$ is the score for sub-goal (i) for measure m

Step 2: Calculate criteria score for each measure

$$S_{criteria}(m_j) = \sum_{k=1}^{L} W_{goal_k} S_{goal_{k,j}}$$

$$\sum W_{GOAL} S_{GOAL} = W_{MAIN\ RISK}\ x\ S_{MAIN\ RISK} + W_{WQ}\ x\ S_{WQ} + W_{HS}\ x\ S_{HS} + W_{Bio}\ x\ S_{Bio} + W_{SE}\ x\ S_{SE} + W_{HWB}\ x\ S_{HWB}$$

where L is a number of goals, W_{goal_k} is the normalised weight for goal (k) and $S_{goal_{k,j}}$ is the score for goal (k) for measure $m_{j\ j}$.

Step 3: Calculate final score for each measure

$$\mathrm{Score}_{final}(m_j) = S_{criteria,j}\ W_j$$

where W_j is measure weights

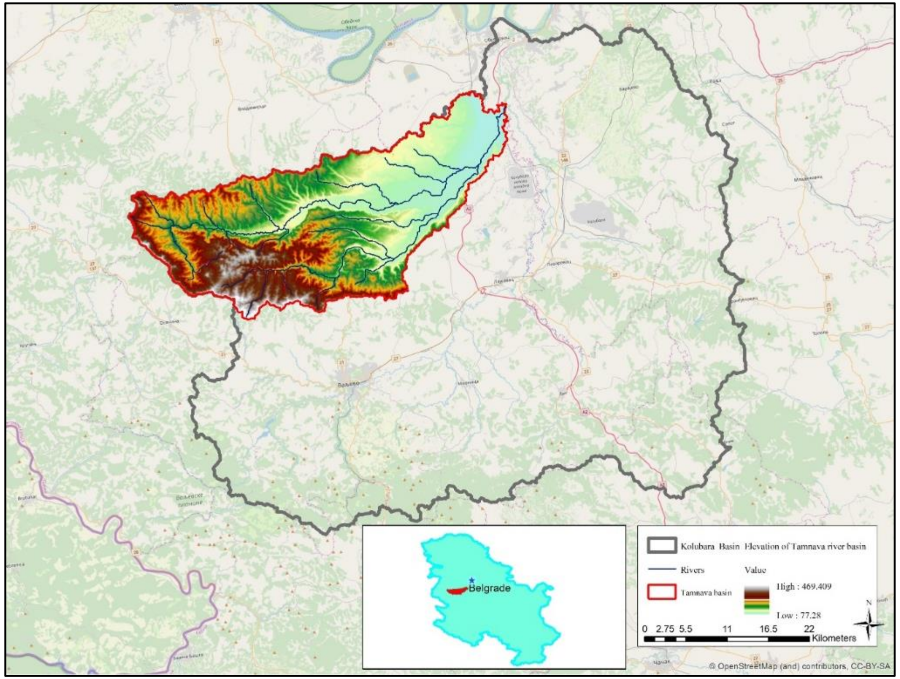
Case study: Tamnava river basin

- The Tamnava catchment is located in western Serbia, which is a sub-catchment of the Kolubara river basin and covers an area of 930 km2

- Significant recent floods occurred in 1999, 2006, 2009, and 2014.

- The most serious problem was pointed out by the last flood in

- The Flood in May 2014 was the most severe in Kolubara and had a high impact on citizens, the economy, infrastructure and natural resources

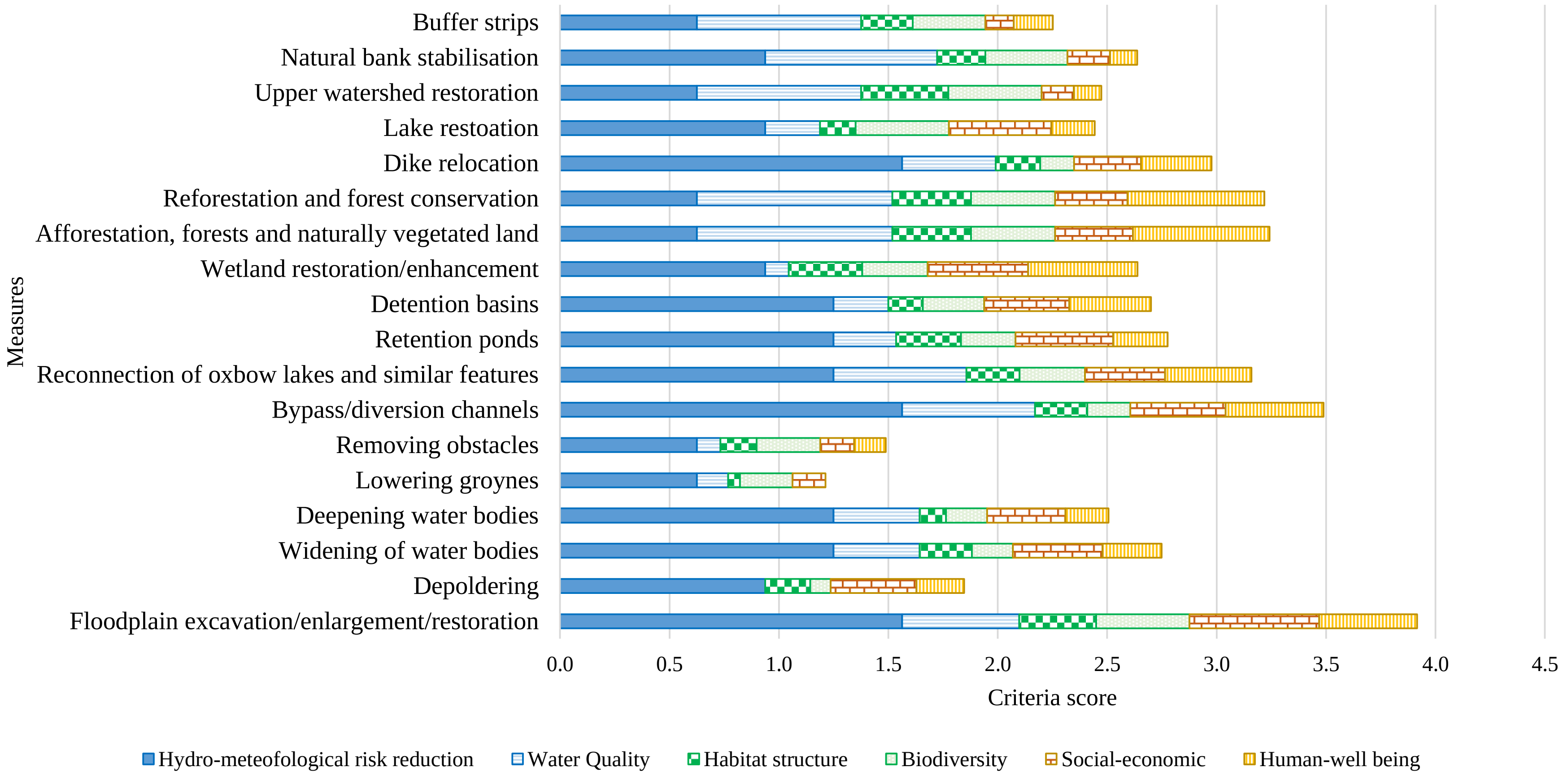


Results: The preliminary selection measures

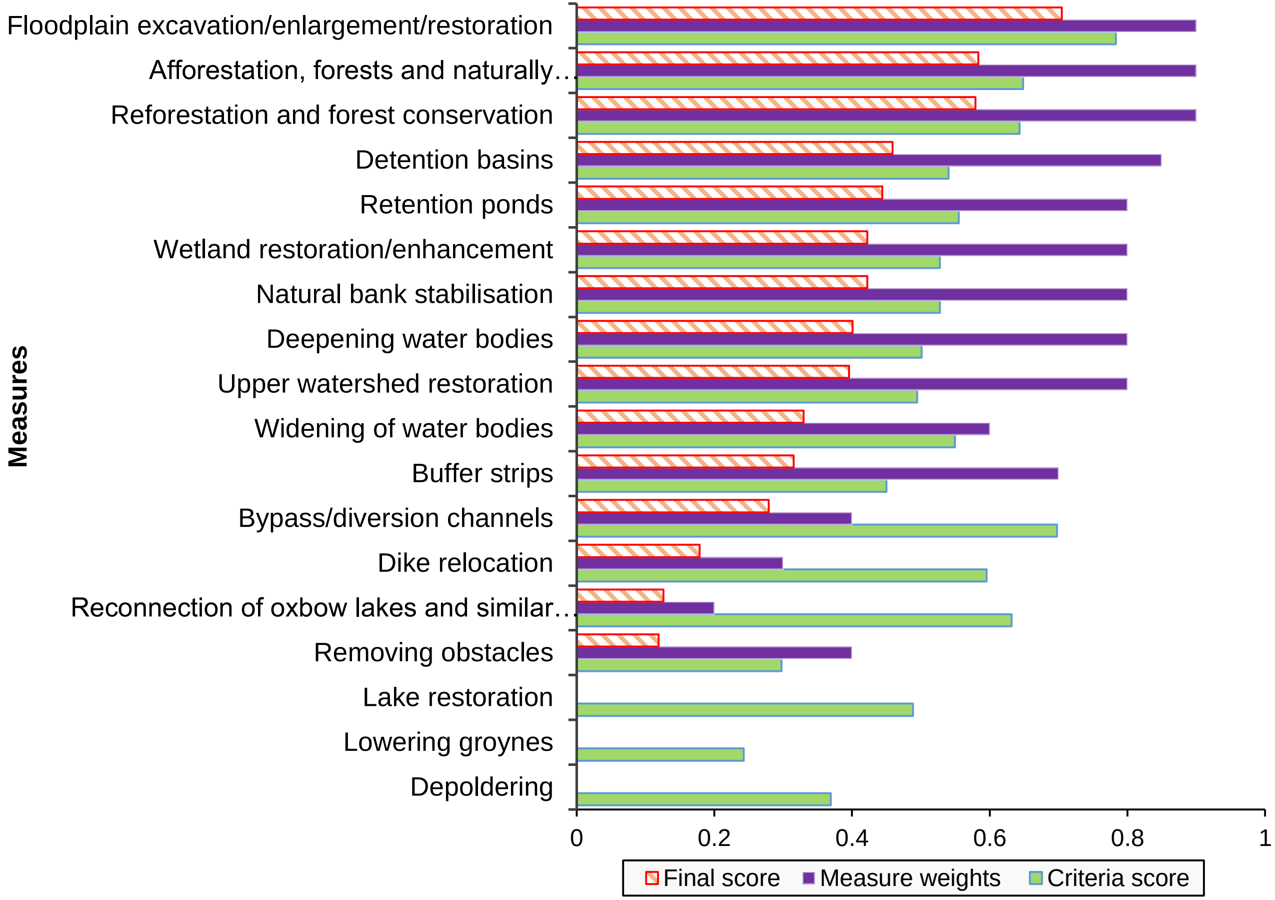
Criteria	Tamnava river basin
Type of measures	Nature-Based Solutions
Hazard type	Fluvial flooding
The affected area	Urban and non-urban area
Potential location	Non-urban area : Upper course and middle course of river basin
Identify Project type	Implementation of new measures Improvement or expansion of existing measures
Land surface	Agriculture areas/Forests/water bodies

Measures
Depoldering
Lowering groynes
Removing obstacles
Reconnection of oxbow lakes
Dike relocation
Afforestation, forests and naturally vegetated land
Reforestation and forest conservation
Bypass/diversion channels
Wetland restoration/enhancement
Widening of water bodies
Buffer strips
Deepening water bodies
Natural bank stabilisation
Upper watershed restoration
Retention ponds
Detention basins
Lake restoation
Floodplain excavation/enlargement/restoration

Results: Criteria Scores



Results: Final Scores and ranks



Criteria Rank	Final Rank
1	1
3	2
4	3
9	4
7	5
10	6
11	7
12	8
13	9
8	10
15	11
2	12
6	13
5	14
17	15
14	16
18	16
16	16

Conclusions

- This method is based on **preliminary selection** and **MCA,** including different types of **hazards** and possible **locations**
- This method comprises **criteria** (impacts) that cover a wide range of aspects (risk, water quantity, habitat structures, biodiversity, socio-economic and human well-being).
- Based on the inputs of local characteristics, it was concluded that **not all selected measures were applicable in the area.** This was possible to see **after local stakeholders were asked** for their opinions on the measure suitability.
- By applying the method, it was possible to prioritise the **measures that have potential in reducing hydro-meteorological risks** and **enhancing co-benefits**
- The methodology can enable a **systematic** and **transparent** NBS planning process.