European Open Rivers Programme
DAMROS and its use by the programme

1. Summary

The programme makes use of a scoring system called DAMROS – Dam Removal Opportunity Score (Garcia de Leaniz et al, 2021) to support the shortlisting of applications for dam removal grants. DAMROS was developed using publicly available data and it scores European rivers against 10 criteria to help indicate where the merits of barrier (hereafter named dam) removal might be greatest. DAMROS is not used alone to select dam removal projects – it is used alongside the programme's bespoke criteria which considers the strength and viability of individual applications and the local context. This paper introduces DAMROS, explains how it is used by the programme, outlines its limitations, and where opportunities lie for further development.

2. Why develop DAMROS?

There are around 1.2 million dams and other instream barriers in Europe which makes it one of the most fragmented continents in the world (Belletti et al., 2020). Over the last few decades dams have started to be removed as a means of restoring connectivity but they are typically identified based on opportunity rather than as part of a coordinated strategy. Even if we discount dams that cannot be removed because they still provide economic, societal or other benefits, there are still c. 150,000 small dams in European countries that are not in use and are of less interest to society, (Garcia de Leaniz et al, 2021). These are obvious contenders to be removed by the programme, but it will only be possible for it to support a fraction of these. It is therefore essential that the programme has a set of tools at its disposal to assist it to select projects that have the highest potential to restore connectivity and help it to achieve the greatest possible ecological outcomes. The DAMROS methodology was developed to assist the programme to select projects in catchments that offer high potential for restoring biodiversity thus ensuring the best possible return for every Euro spent.

3. What is DAMROS?

The DAMROS methodology provides a mechanism for assigning a score based on the attractiveness of a river catchment for dam removal. It considers 10 metrics that capture four aspects considered to be important for dam removal (see Table 1). Data from these metrics were used to score 211,075 individual Surface Water Bodies (SWBs) which provides the highest spatial resolution. Data was also aggregated into 172 River Basin Districts (RBDs) and then into countries,

which accounts for the three spatial scales that are most relevant for management. The total area covered is 1,699,234 km of river length across 35 countries, which incorporates both natural and heavily modified water bodies.

In order to ensure accuracy and avoid bias, each original metric was scaled from 0 to 1 to ensure that it had an equal weighting on the final score. The quality and completeness of the data, the redundancy and complementary of different metrics, and the robustness of the resulting lists to the influence of individual metrics was explicitly considered. The use of publicly available data helped to ensure that results are transparent and that the score is repeatable.

Table 1: A summary of the DAMROS metrics and the rationale for their inclusion

Metric	Data Source	Rationale for inclusion
Extent of fragmentation		
1. Barrier density	1	Dam removal is more likely to be effective in the least fragmented basins because larger areas of river can be made free flowing. It is likely to be more cost-effective to restore river continuity in areas of lower fragmentation.
2. Extent of barrier under reporting	1	
3. River continuity conditions	2	
Biodiversity and river quality		
4. Chemical status	2	The four metrics combined were considered to provide a strong measure of the ecological value of a river.
5. Ecological status	2	
6. Biodiversity value	2	
7. Included in Protected Area	3	
Governance and support for dam removal		
8. Barriers flagged as pressure in RBMP	2	The two metrics help to provide a broad indication of the degree to which dam removal is recognised and supported.
9. Support for dam removal	4	
Futureproofing		
10. Water stress and future flows	5	Barrier impacts are likely to increase in places where river flows decrease and vice versa. This means that barrier removals will be most beneficial in places where connectivity is most at risk due to droughts and reduced river flows.

4. **How will DAMROS be used by the programme?**
DAMROS will assist the programme to get a better insight into potential dam removal opportunities but only over large spatial scales. It is therefore essential that it is also supplemented by additional criteria to assess the strength and viability of individual applications and the local context e.g the size and type of dam; the impact of dam removal/s on the ecology of a whole catchment; the km of river that will be opened up as a result of the removal; and the ease at which a dam can be removed / absence of community or political objection to a removal.

The programme will allocate a score to every application that incorporates a) DAMROS and b) programme's bespoke criteria. A weighting will be applied to emphasize the most important elements for the programme which will prioritise a) the degree to which a positive ecological outcome is generated b) the time it will take for a dam to be removed c) the strength of due diligence undertaken and the risk of the project being completed successfully and d) DAMROS. If an application is received from any of the 16 countries of Greater Europe where DAMROS has not been applied, only the programme's bespoke criteria will be applied. The weighting will be adjusted so that these applications are not treated unfavourably against applications from countries where DAMROS applies.

5. **Limitations of DAMROS**
DAMROS should be seen as a tool to assist with the identification of dam removal projects but it is not sufficient to be used on its own and it has several limitations.

Firstly, it is based mostly on the European Environment Agency's Water Information System for Europe (WISE database) that was collected for the purposes of assessing ecological status and for monitoring compliance with Water Framework Directive (WFD), not to select rivers for dam removal. WISE data were collected by different people in different countries and over different periods of time, and not always using the same methods, which makes comparisons sometimes challenging.

Secondly, although results indicate that the score is relatively robust to the influence of individual metrics, consideration of other metrics might result in other scores, and therefore conclusions.

Finally, most of the datasets are still incomplete and thus the scores should be treated as indicative and subject to revision as data quality improves.

6. **Opportunities for further development**
The DAMROS tool can be strengthened over time by adding in missing data for the existing metrics and incorporating new metrics. It should also be expanded to cover all of the 51 countries that are eligible to apply to the programme, but this will only be feasible if data becomes available.

List of acronyms

DAMROS Dam Removal Opportunity Score

EEA European Environment Agency

RBD River Basin District

SWB Surface Water Body

WISE Water Information System for Europe **-** a database of information taken from River Basin Management Plans compiled by EU Members States

References

Garcia de Leaniz, C., Jones, J., Börger, L. (2021) Ranking of Europe's River Basins for Dam Removal: an evidence-based approach. Swansea University.

DAMROS data sources

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