

## Interpretation

The indicator identifies the opportunities provided by a river landscape for water-related activities (bathing, non-motorized boating, motorized boating, angling). It can be supplemented by extension options (see next section). The availability of sand and sandbars reflects a feature supporting the activity "swimming". Further variables (e.g., sanitary water quality, flow velocity, depth of visibility) can be added in case regional data on those are available. Stream width is a variable that determines potential navigability by (motor) boat.

For a more detailed representation of individual management areas, the grid cells can be wither-formatted to a relative rating scale ranging between 0-100. In order to enable direct comparison with other ES, assessment scores were transferred to the 5-level RESI scale (Podschun et al., 2018).

Extension possibilities for regional quantifications with the inclusion of regionally produced data

Hygienic water quality via assessment of intestinal enterococci (cfu/100 ml) and Escherichia coli (cfu/100 ml) concentrations (EU Bathing Water Directive (Directive 76/160/EEC) (cf. Paracchini et al. 2014).

Quantification of riparian vegetation from hydromorphological (river structure) mapping data: expert-based assessment of riparian vegetation between 0-100 against the background of performing water-related activities (e.g. bathing).

Water transparency: indirectly via suspended sediment concentration  $\text{g/m}^3$  (interpolate and classify if median May-September record is less than  $10 \text{ g/m}^3$ ) (Morrison n.d.).

Minimum water depth of 60 cm, as calculated from 5 year averaged water levels. Because of possible extreme events, a five-year observation period is suggested (for example, from 2011-2015): relevant for non-motorized boating.

Varied curvature of the water course: quantification using data from hydromorphological (river structure) quality assessment ( $100 \triangleq$  meandering and  $0 \triangleq$  straight).

Flow velocity: relevant for whitewater canoeing or rafting.

Min. depth of 90 cm, as calculated from a 5-year averaged water levels: relevant for motorized boating.

Hydromorphological (river structure) quality rating as a parameter for anglers' preference to fish in near-natural or natural water bodies (Arlinghaus 2004; Hunt 2005): normalize structure quality rating 1-7, with 7 reflecting the lowest and 1 the best hydromorphological status.

## References

- Arlinghaus, R. (2004). Angelfischerei in Deutschland - eine soziale und ökonomische Analyse. Hg. v. Leibniz-Institut für Gewässerökologie und Binnenfischerei (IGB) im Forschungsverbund Berlin e. V. Berlin (Berichte des IGB, 18/2004).
- Hunt, L. M. (2005). Recreational Fishing Site Choice Models. Insights and Future Opportunities. Human Dimensions of Wildlife 10, S. 153–172.
- Morrison, W. Water transparency in Willamette River at Portland. Data from U.S. Geological Survey. Online verfügbar unter [http://or.water.usgs.gov/will\\_morrison/images/secd\\_tbdy\\_linear\\_graph.png](http://or.water.usgs.gov/will_morrison/images/secd_tbdy_linear_graph.png), zuletzt geprüft am 19.12.2016.
- Richtlinie 76/160/EEC vom 15. Februar 2006 über die Qualität der Badegewässer und deren Bewirtschaftung und zur Aufhebung der Richtlinie 76/160/EWG
- Paracchini, M. L., Zulian, G., Kopperoinen, L., Maes, J., Schägner, J. P., Termansen, M., Zandersen, M., Perez-Soba, M., Scholefield, P.A. & Bidoglio, D. (2014). Mapping cultural ecosystem services. A framework to assess the potential for outdoor recreation across the EU. Ecological Indicators 45, S. 371–385.
- Rabe, S.-E., Gantenbein, R., Richter, K.-F. & Grêt-Regamey, A. (2018). Increasing the credibility of expert-based models with preference surveys – Mapping recreation in the riverine zone. Ecosystem Services.
- Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., Kumar, R. & Davidson, N. (2013). The Economics of Ecosystems and Biodiversity for Water and Wetlands. IEEP, London and Brussels, Ramsar Secretariat, Gland.

■ Original approach according to River Ecosystem Service Index (RESI) (Podschun et al., 2018)

Class	Abbr.	Description		Spatial reference		
Cultural	WA	Specific water-related activities for recreational purposes (recreational fishing, swimming, non-motorized boating, motorized boating)		Floodplain segment or compartment <input checked="" type="checkbox"/> former floodplain <input checked="" type="checkbox"/> active floodplain <input checked="" type="checkbox"/> river		
Variable	Abbr.	Unit	Variable description		Data basis	Comment
Normalized density of sand/sandbanks	DSB <sub>danube</sub>	1-100	Normalization of the nationwide density calculation between 1 and 100		Land cover model	
Minimum width of 5m (for non-motorized boating)	MW5 <sub>danube</sub>	100≐yes 0≐no	Section of water with at least 5m width as prerequisite for non-motorized boating		Land cover model	
minimum width of 12m (for motorized boating)	MW12 <sub>danube</sub>	100≐yes 0≐no	Section of water with at least 12m width as prerequisite for motorized boating		Land cover model	
Calculation						
Calculation steps			Indicator			
<b>Nationwide:</b> Calculation of the variables DSB <sub>danube</sub> , MW5 <sub>danube</sub> and MW12 <sub>danube</sub> in grid cells with 100m resolution. Calculation of the indicator (see column on the right) with a normalization between 0-100 <b>Floodplain compartment level:</b> Calculation of the area-weighted mean for the floodplain compartments river, active floodplain and former floodplain (right and left bank respectively). <b>For scaling:</b> Classification into the five-level rating scale via the calculation of quintiles for the all model regions.			$f(WA) = \sum DSB_{danube}, MW5_{danube}, MW12_{danube}$ → normalize raster between 0-100 (Rabe et al. 2018): $\frac{max_{new} - min_{new}}{max_{old} - min_{old}} \cdot (v - max_{old}) + max_{new}$ v is the resulting raster generated by $f_{(WA)}$			
Scaling <input checked="" type="checkbox"/> national <input type="checkbox"/> local	Quintiles	> 2.6 – 68.9	> 1.1 – 2.6	> 0.4 – 1.1	> 0.02 – 0.44	0 – 0.02
Evaluation Class		5	4	3	2	1
Qualitative Evaluation		Very high provision	High provision	Moderate provision	Low provision	Very low provision

■ Adaption for Danube-wide application

Class	Abbr.	Description		Spatial reference		
Cultural	WA	Specific water-related activities for recreational purposes (recreational fishing, swimming, non-motorized boating, motorized boating)		Floodplain segment or compartment <input checked="" type="checkbox"/> former floodplain <input checked="" type="checkbox"/> active floodplain <input checked="" type="checkbox"/> river		
Variable	Abbr.	Unit	Variable description		Data basis	Comm ent
Normalized density of sand/sand bars	DSB <sub>danube</sub>	m²	Area of sand/sand banks per area of segment		Land cover model	
Minimum width of 5m (for non-motorized boating)	MW5 <sub>danube</sub>	100△yes 0△no	Section of water with at least 5m width as prerequisite for non-motorized boating		Land cover model	
minimum width of 12m (for motorized boating)	MW12 <sub>danube</sub>	100△yes 0△no	Section of water with at least 12m width as prerequisite for motorized boating		Land cover model	
Calculation						
Calculation steps			Indicator			
<b>Nationwide:</b> Calculation of the variables DSB <sub>danube</sub> , MW5 <sub>danube</sub> and MW12 <sub>danube</sub> in grid cells with 100m resolution. Calculation of the indicator (see column on the right) with a normalization between 0-100 <b>Floodplain compartment level:</b> Calculation of the area-weighted mean for the floodplain compartments river, active floodplain and former floodplain (right and left bank respectively). <b>For scaling:</b> Classification into the five-level rating scale via the calculation of quintiles for the all model regions.			$f(WA) = \sum DSB_{danube}, MW5_{danube}, MW12_{danube}$  → normalize raster between 0-100 (Rabe et al. 2018):  $\frac{max_{new} - min_{new}}{max_{old} - min_{old}} \cdot (v - max_{old}) + max_{new}$  v is the resulting raster generated by $f_{(WA)}$			
Scaling <input checked="" type="checkbox"/> national <input type="checkbox"/> local	Quintiles	0.8 - 1	0.6 - 0.8	0.4 - 0.6	0.2 - 0.4	0 - 0.2
Evaluation Class		5	4	3	2	1
Qualitative Evaluation		Very high provision	High provision	Moderate provision	Low provision	Very low provision

■ Data sources

Data set	Data type	Spatial reference	Spatial resolution	Source	Creation date	Comments
BWA, EoT Copernicus riparian zones LCLU (MAES_4)	Polygon	International / Active FP	Minimum Mapping Unit: 0.5 ha Minimum Mapping Width: 10 m	<a href="https://land.copernicus.eu/local/riparian-zones/land-cover-land-use-lclu-image">https://land.copernicus.eu/local/riparian-zones/land-cover-land-use-lclu-image</a>	2012	