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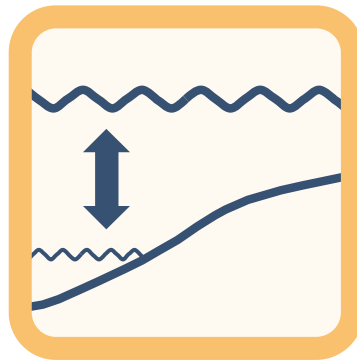Water Division

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Technical Sheet: Indicator Set 2 Dynamics

Indicators:	• 2.1 River bed structure dynamics (Woolsey et al. 2005, no. 33)
	• 2.2 River bank structure dynamics (Woolsey et al. 2005, no. 43)
	• 2.3 Change in river bed elevation (in accordance with Hunzinger et al. 2018)

Publication details

This Indicator Set forms part of the Swiss STANDARD outcome evaluation and is to be used in conjunction with the practice documentation "Evaluating the outcome of restoration projects – collaborative learning for the future" (FOEN 2019). The indicators included in the Indicator Set derive from various sources (e.g. Woolsey et al. 2005; Modular Stepwise Procedure) and, where appropriate, have been updated or adapted for the practice documentation. An overview of the most important modifications made can be found in Factsheet 7.

Principle

In natural watercourses, the morphological bed and bank structures are continuously reshaped by floods, as solids are stirred up and gravel or wood is washed away or deposited. Structural changes over time are an indicator of the morphological dynamics of the watercourse and of the regenerative capacity of the ecosystem. Indicator Set 2 is based on the data collected in Indicator Set 1. It is determined how and to what extent the morphological bed and bank structures have changed, as well as the river bed elevation.

Parameters	Proportion of the bed area with altered bed structures (%) Proportion of the non-human-modified shoreline length with altered bank structures (%) Mean bed elevation (m asl)
Applicability	For the project sizes large and individual project.
Special considerations	In connection with Indicator Set 1, bed and bank structures are surveyed once before and twice after restoration; for Indicator Set 2, an additional "before" survey is conducted with the aid of aerial photography/cross-section surveying. The magnitude of flood discharges between two data collection points must be taken into account in the evaluation.
Survey site	Restored section (see Fig. 2.1)
Timing	One "before" survey and two "after" surveys of bed and bank structures are already conducted in connection with Indicator Set 1. For Indicator Set, 2 an additional "before" survey using aerial photography or cross-section surveying is required in order to determine the dynamics prior to restoration. Aerial photography or cross-section surveying should take place 5–10 years earlier – an interval corresponding to that between the two "after" surveys. Data is to be collected during low-water conditions. Between two data collection points, a discharge of at least HQ_2 must have occurred.
Material	Field map from Indicator Set 1. Aerial photographs or cross-section data from 5–10 years prior to restoration. Indicator 2.3 – Change in river bed elevation: equipment for geodetic survey.

Figure 2.1: Survey site for indicators from Indicator Set 2.
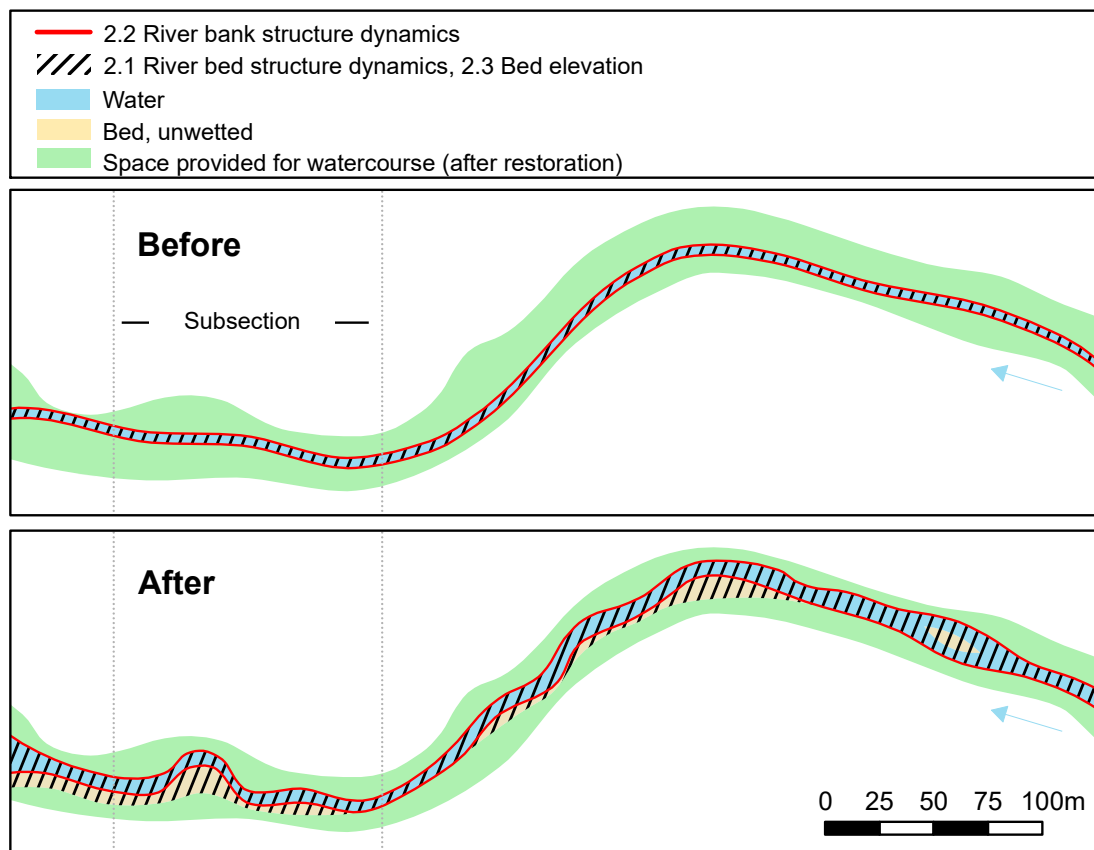
Survey

The individual steps involved in the survey are explained below, in chronological order.

Step	Description	Indicator
Survey of structures	• Identification of bed structures (Table 1.1, Set 1) and bank structures (Table 1.2, Set 1) based on a large-scale aerial photograph and/or cross-section data collected 5–10 years prior to restoration. • Mapping of the position and size of structures	2.1, 2.2
Evaluation of structures	• Overlay/comparison of the bed structures and bank structures from two sets of data collected at different times. The choice of methodology is left to the user. • Determination of the areas where different bed structures were observed at the two time points. • Determination of the sections where different bank structures were observed at the two time points or where the shoreline has shifted. The extent of shoreline shifting is determined.	2.1, 2.2
Measurement of cross sections	• Geodetic survey of 12 cross sections along the entire restored section. The distance between two cross sections should be >1 bed width. • Cross sections are measured from the upper limit of one riparian zone to the upper limit of the other. The shape of the bed is recorded using at least 5 points. • In addition, 2 cross sections are surveyed upstream and 2 downstream of the restored section, at the same distance apart as in the restored section.	2.3
Determination of longitudinal profile	• For each cross section, the mean bed elevation is determined. • Representation of the longitudinal profile of the mean bed elevation. • Comparison of the longitudinal profile with the longitudinal profile in the reference condition. This is determined in accordance with Hunzinger et al. (2018), Section 3.2.3.	2.3

Evaluation

The evaluation approaches given below are taken from the original indicator method sheets in the "Handbook for evaluating rehabilitation projects in rivers and streams" (Woolsey et al. 2005). They serve as a guide and will be revised in the coming years on the basis of the experience accumulated in the STANDARD and EXTENDED outcome evaluations.

Indicator	Description
2.1 Bed structure dynamics	The sum of the areas with altered bed structures is divided by the total bed area: $$p = \frac{Area\ with\ altered\ bed\ structures\ (m^2)}{Total\ bed\ area\ (m^2)}$$ This value (p) is normalised as shown in Figure 2.2.
2.2 Bank structure dynamics	The sum of the shoreline length with altered bank structures or shoreline shifting is divided by the total length of the non-human-modified shoreline, and this value (p) is normalised as shown in Figure 2.3.

$$p = \frac{Shoreline\ length\ with\ altered\ bank\ structures\ (m) + \sum k_i \times shoreline\ length_i\ with\ shifting\ (m)}{Total\ length\ of\ shoreline\ without\ embankment\ (m)}$$

Extent of shoreline shifting:

k = 1	limited shoreline shifting	$\Delta Y \leq h$
k = 2	moderate shoreline shifting	$h < \Delta Y \leq 10\ h$
k = 3	channel displacement	$10\ h < \Delta Y$

ΔY = amount of shoreline shifting [m] along the cross-section axis, i.e. perpendicular to the river axis.
h = mean water depth across cross-sections at HQ_2 [m]

2.3 Change in bed elevation	Indicator 2.3 is normalised as follows:	
	Normalised value	*Longitudinal profile of mean bed elevation in restored section*
	1	≈ Longitudinal gradient in reference condition
	0.5	< Longitudinal gradient in reference condition
	0	<< Longitudinal gradient in reference condition

Figure 2.2: Normalisation of the bed structure dynamics indicator (2.1).

Figure 2.3: Normalisation of the bank structure dynamics indicator (2.2).
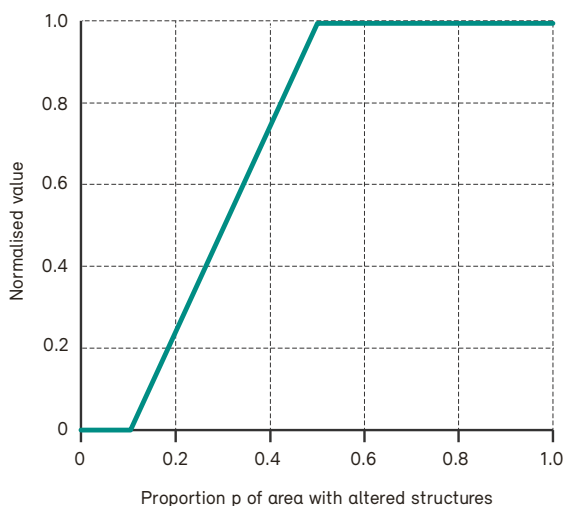
p	*normalised value*
≤ 0.1 (within measurement accuracy)	0
0.1 < p < 0.50	2.5 p − 0.25
> 0.50	1
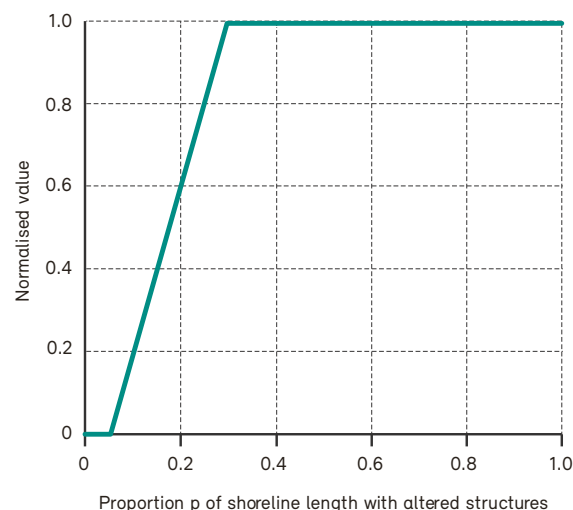
p	*normalised value*
≤ 0.05 (within measurement accuracy)	0
0.05 < p < 0.30	4 p − 0.2
> 0.30	1.0

Time required

Table 2.1: Summary of time required in person-hours for the determination and evaluation of Indicator Set 2. General items (e.g. travel time) are not taken into account. A rough cost estimate can be found in Table 2.1 of Factsheet 2.

Step	Specialists		Assistants	
	Persons	Time per person (h)	Persons	Time per person (h)
Preparation (acquisition of aerial photographs, earlier cross-section data)			1	2–4
Determination of bank and bed structures from aerial photographs/cross-section data	1	8		
Overlay of site maps			1	8
Determination of mean bed elevation, evaluation of cross-section survey			1	8
Determination of reference bed elevation, evaluation	1	4		
Total person-hours		12		18–20

Notes: The costs for a geodetic cross-section survey amount to approx. CHF 200/cross section in a stream up to 5 m wide, and approx. CHF 400/cross section in a larger watercourse. The periodic FOEN cross-section surveys may also be used.

Further information

Data arising	• Data entry form for Indicator Set 2: KT_ProCode_ERHEBUNG_Set2_V#.xls • River bed structures at 5–10 years before restoration as polygon shapefile: KT_ProCode_ERHEBUNG_Set2_Ind2_1.shp • River bank structures at 5–10 years before restoration as line shapefile: KT_ProCode_ERHEBUNG_Set2_Ind2_2.shp Elements of the file naming scheme (see Factsheet 5) • KT = two-capital-letter cantonal abbreviation (e.g. BE) • ProCode = project code • ERHEBUNG = survey time point, i.e. VORHER (= before), NACHHER1 (= after 1), NACHHER2 (= after 2), or VERTIEFT (= EXTENDED) • V# = version number of the data entry form
Attachments	The field protocol, data entry form and other useful documents are available at: https://www.bafu.admin.ch/wirkungskontrolle-revit