

Hydromorphological Impact Ratios

27/03/2020

Hydromorphological Impact Ratios (HIR) are indices describing departure from natural condition and impact for four hydromorphological indices (CSI, FRI, GAI and CVI) using the following equation:

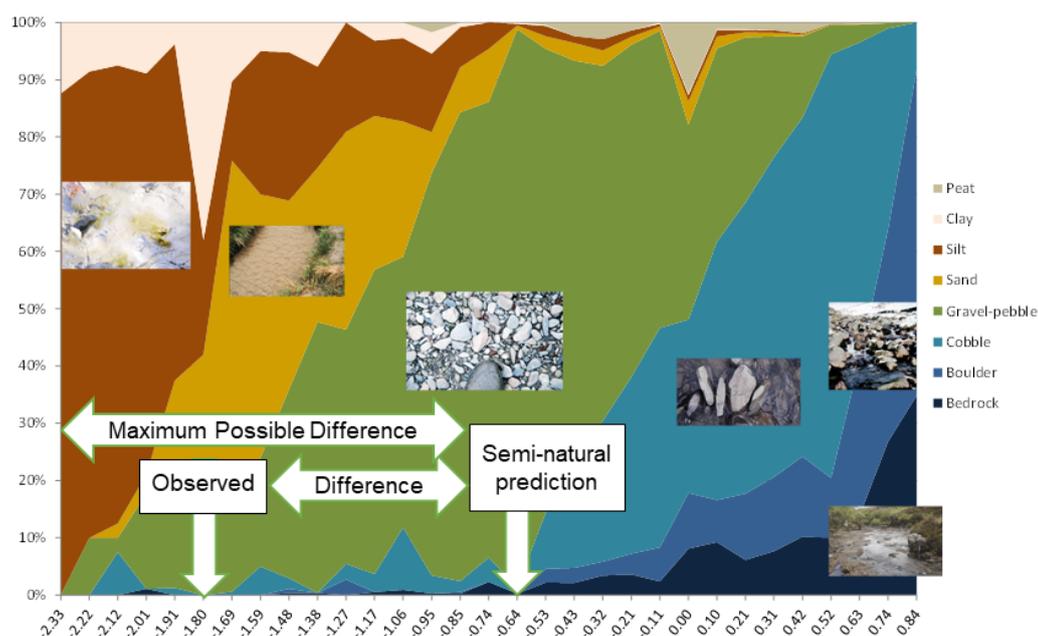
$$HIR_{Index} = \frac{Index_{semi-natural\ prediction} - Index_{observed}}{Index_{semi-natural} - Index_{maximum\ possible\ difference}}$$

Semi-natural index values were predicted using map-derived data on stream power, shear stress, geology, etc for a subset of semi-natural RHS sites (Naura et al, ms).

The HIR is a ratio between **observed** over **maximum possible** departure from natural state/impact. It varies from 0 (no impact/semi-natural condition) to 1 (maximum impact). For example, following a survey, we find that a site is dominated by sand and gravel with a CSI value of -1.8 (Figure A3.1). Using the predictive model, we find that the semi-natural CSI should be -0.64 indicating a gravel-dominated stream. The HIR_{CSI} will be calculated as:

$$\begin{aligned} HIR_{CSI} &= \frac{-0.64 - (-1.8)}{-0.64 - (-2.33)} \\ &= \frac{1.16}{1.69} \\ &= 0.69 \text{ (69\%)} \end{aligned}$$

Figure A3.1: Channel Substrate Index (CSI) and HIR_{CSI} calculation. The chart represents the substrate composition of RHS sites with increasing CSI values (x-axis). The HIR_{CSI} is calculated as the ratio between 'observed' and 'maximum possible' departure from semi-natural state or impact.



1



The calculated HIR_{CSI} value (0.69) means that the observed difference of 1.16 between semi-natural and observed CSI values represents 69% of the maximum possible difference (1.69) for a silt-dominated stream. The site can be considered as heavily impacted.

HIR_{index} values are calculated for FRI (HRI_{FRI}), GAI (HRI_{GAI}) and CVI (HRI_{CVI}). The indices are categorised into five categories representing 'Very Low' (HIR_{index} between 0 and 12.5%), 'Low' (HIR_{index} between 12.5 and 25%), 'Moderate' (HIR_{index} between 25 and 37.5%), 'High' (HIR_{index} between 37.5 and 50%) and 'Very High' impacts (HIR_{index} between 50 and 100%).

A **composite HIR** index can then be derived for each site using the highest impact value amongst all four indices. Thus, a site with a HRI_{CSI} , HRI_{FRI} , HRI_{GAI} and HRI_{CVI} of 2, 3, 3 and 5 would have an overall HIR of 5 (Very High Impact).

Note for HRI_{CSI} calculation: in the case of CSI, some of the channel substrate may have been artificially introduced such as concrete, gabions or boulders from nearby rip-rap. In this case, substrate is recorded as 'ARTificial' in RHS. For the calculation, of CSI, artificial substrate is given the same score as bedrock, which results in higher CSI scores and does not accurately represent the **natural** substrate size.

To calculate a meaningful HRI_{CSI} score, we therefore need to account for the presence of artificial substrate. To do so, we need to:

- recalculate CSI omitting any artificial substrate and we use this value to derive the distance to semi-natural condition;
- include the coverage of artificial substrate in the HIR_{CSI} calculation so that if 80% of the site had concrete as bed material, the HIR_{CSI} would at least be set at 80%.

We do so by applying the following formula:

$$HIR_{CSI} = \%Artificial\ substrate + (1 - \%Artificial\ substrate) * \frac{Index_{semi-natural\ prediction} - Index_{observed}}{Index_{semi-natural\ prediction} - Index_{maximum\ possible\ difference}}$$

Therefore, if the site in Figure A3.1 has 20% of its river bed concreted up and the rest made of gravel/sand/silt, the score would be:

$$\begin{aligned}HIR_{CSI} &= 0.2 + (1 - 0.2) * \frac{-0.64 - (-1.8)}{-0.64 - (-2.33)} \\ &= 0.2 + 0.8 * 0.69 \\ &= 0.2 + 0.55 \\ &= 0.75 (75\%)\end{aligned}$$