**Error assessment of $\chi$-values**

Predicting the elevation at the divide can be separated in a term representing the $\chi$-calculation with the term in the squared brackets being the elevation error $z_\varepsilon$ (see Fig. 7).

$$BRR_1 + ARR_1 = BRR_2 + ARR_2$$

$$k_{s,b}\chi_{b1} = k_{s,b}(\chi_{b2} + \chi_{a2} - \chi_{a1}) - \left[(k_{s,b} - k_{s,a})(\chi_{a2} - \chi_{a1})\right]$$

$$z_\varepsilon = (\chi_{a2} - \chi_{a1})(k_{s,b} - k_{s,a})$$

With elevated base level we have $\chi_{a1}, = 0$ and we can redefine $\chi_{a2} - \chi_{a1} = \chi_a$ as the remaining alluvial reach in the analysis (see Fig. 7). The mismatch is the error. The error can also be read as an $\chi$-error, $\chi_\varepsilon$.

$$z_\varepsilon = \chi_a(k_{s,b} - k_{s,a})$$

$$\chi_\varepsilon = \frac{z_t}{(k_{s,b} - k_{s,a})}$$

The $\chi$-values in this study have a base level of 250 m above sea level. To compare the $\chi$-values from this study with the base level of 0 m a.s.l. we list here $\chi_d$ . The $\chi_a$-quantity is taken from Giachetta and Willett (2018).

$$\chi_d = \int_{x_b=0}^{x=250} \left(\frac{A_0}{A(x)}\right)^{\frac{m}{n}} dx$$

ESM 1 Table 1: Elevation of the Alpine front, maximum $\chi_{max}$ of the catchments and assessed error $\chi_\varepsilon$ at the transition (negative $\chi_\varepsilon$ values refer to an overestimation of $\chi$ and negative to an underestimation). The $\chi_d$-quantity for the large rivers and indication of a nearby location to the 250 m a.s.l. line.

| River | $z_{mountain\ front}$ | $\chi_{\varepsilon,trans.}$ | $\chi_{max}$ | $\chi_d$ | 250 m a.s.l. location (nearby city) |
|---|---|---|---|---|---|
| Rhine | 400 | -1.9 | 29.8 | 10.6 | Basel |
| Aare | 550 | -3.8 | 35.1 | 10.6 | Basel |
| Neckar | none | none | 30.6 | 13.6 | Esslingen |
| Danube | none | none | 38.7 | 16.4 | Linz |
| Inn | 450 | -2.5 | 36.0 | 16.4 | Linz |
| Traun | 424 | -2.2 | 28.2 | 16.4 | Linz |
| Enns | 300 | -0.6 | 27.3 | 16.5 | Enns |
| Drava | 250 | 0.0 | 29.5 | 15.9 | Maribor |
| Mur | 350 | -1.3 | 29.8 | 16.6 | Leibnitz |
| Rhône | 370 | -1.5 | 41.7 | 7.6 | Bellegarde-sur-Valserine |
| Doubs | none | none | 35.9 | 13.4 | Deluz (Besancon) |
| Isère | 190 | 0.8 | 21.5 | 6.9 | Montmélian (Chambéry) |
| Durance | 80 | 2.1 | 25.2 | 3.7 | Manosque (Aix-en-Provence) |
| Po | 350 | -1.3 | 21.0 | 12.0 | Saluzzo |
| Dora Riparia | 300 | -0.6 | 20.8 | 10.0 | Collegno (Torino) |
| Tanaro | 600 | -4.4 | 22.1 | 12.5 | Fossano (Cuneo) |
| Ticino | 193 | 0.7 | 19.1 | 12.6 | Bellinzona |
| Toce | 193 | 0.7 | 16.1 | 12.3 | Domodossola |
| Adda | 199 | 0.6 | 30.2 | 11.6 | Sondrio |
| Adige / Etsch | 50 | 2.5 | 17.0 | 10.5 | Meran |
| Eisack | 50 | 2.5 | 20.0 | 9.6 | Bozen |