ture of these drainages from east directed to west directed. Consequently, some escarpment-draining basins may have gained drainage area from the plateau, and we distinguish between rivers that have a headwater divide that coincides with the escarpment edge from those that include drainage area from the plateau (e.g., basin A and basin B in Fig. 2).

Escarpment rivers in the SWG are bedrock rivers cutting into the Precambrian metamorphic basement. The morphology of the rivers draining the escarpment differs primarily due to their initiation on the escarpment or landward of the escarpment on the plateau (Fig. 3). Rivers initiating on the escarpment are characterized by a long, low-slope reach on the coastal plain and abrupt steepening at the escarpment front (Fig. 3a). This is particularly evident in transformed χ–elevation river profiles, which normalize the river profiles for drainage area (Perron and Royden, 2013). A typical χ–elevation profile of these escarpment front-initiated rivers is composed of two near-linear segments: the coastal plain reach and the short and steeper escarpment-draining reach (Fig. 3b). This characteristic χ–elevation profile indicates the transient state of the escarpment topography and is consistent with the model of a moving escarpment with all erosion focused on the escarpment face (Willett et al., 2018). For plateau-initiated rivers, the channel profile and χ profile have an additional low-slope "tail" at low drainage area, representing the reach on the plateau (Fig. 3c and d).

2.2.2 Methods of river profile analysis

In order to calculate a scaled river profile, it is necessary to assume or estimate the concavity of the profile (Perron and Royden, 2013). We evaluated the slope–area scaling of escarpment-draining rivers (Fig. 4). The channel slope and drainage area data were extracted with the MATLAB-based software TopoToolBox 2 (Schwanghart and Scherler, 2014). We calculated the average slope and drainage area over predefined river segments. River segments were defined with a length of 1 km but break at confluences and were limited by both a threshold slope and drainage area. Recognizing that there were two sets of data, corresponding to the escarpment and the coastal plain, we searched for an optimal break point in slope–area space, searching within the red-dashed-line box in Fig. 4b.

We found concavities of 0.3 to 0.6 for the SWG rivers from a slope–area plot with a mean value of 0.42, which is typical for bedrock rivers (Snyder et al., 2000). Conventionally, normalized steepness index is taken as a proxy for erosion rate (Kirby and Whipple, 2012). However, for an escarpment, uplift rate is likely to be limited to the isostatic response to erosion, and the erosion rate should be reflective rather of the erosion associated with the escarpment retreat. Willett et al. (2018) analyzed this problem and demonstrated that the slope–area scaling for a river retreating in a direction opposite to its flow should scale according to

$$S_{\text{river}} = -\left(\frac{v}{K}\right)^{\frac{1}{n-1}} A_{\text{d}}^{-\frac{m}{n-1}} \quad n > 1, \tag{1}$$

where v is the retreat rate, S_{river} is the local channel slope, A_{d} is the upstream drainage area, K is the erodibility constant, and m and n are positive empirical constants. The steepness of a channel following this scaling would be

$$k_{\text{s}} = \left(\frac{v}{K}\right)^{\frac{1}{n-1}} \quad n > 1. \tag{2}$$

This relationship implies a lower concavity $(m/n-1)$ than rivers in equilibrium with vertical uplift, so it is interesting that the concavities we find are close to global averages. This suggests that the assumptions made by Willett et al. (2018) of a steady 1-D river normal to the escarpment with continuous area gain at the channel head might not be appropriate. Sinuous, branching rivers in a transient state due to discrete area capture might fit such a model on average but not for individual escarpment-draining rivers. The slope–area relationship (Fig. 4c) also shows a segmented form as in the channel profiles (Fig. 4b).

2.2.3 Escarpment retreat from river profile analysis

The segmented form of the escarpment-draining rivers is consistent with models of escarpment retreat with a lower reach on the coastal plain, where the gradient is sufficient to transport eroded sediment, but is not incising bedrock. On the upper reach, incision rates are high but have a pattern that results in horizontal retreat of the escarpment as well as the drainage divide. The normalized steepness indices derived from slope–drainage area plots or from the normalized channel profiles show a constant value for the escarpment reaches, consistent with a constant rate of erosion but also consistent with a constant horizontal retreat rate (Willett et al., 2018). Furthermore, river profiles have the same form, but the lengths of the various reaches are highly variable, even scaled into χ space. This suggests that the kinked profile form is not the result of a temporal change in uplift rate common to all rivers, in which case the χ scaling would collapse the profiles onto a common form. Rather the profiles are consistent with an escarpment retreat model in which the lower reach is graded to a low slope sufficient to transport sediment from the eroding escarpment reach, and the steep segment is adjusted to erode the escarpment (Willett et al., 2018).

Rivers that include plateau reaches (Fig. 3c and d) are scattered throughout the study area, intermixed with the escarpment rivers. This suggests that they are not the response to temporal variations in uplift rate; i.e., they are not moving knickpoints in response to base-level changes, or they would be clustered together spatially and have common chi profiles, at least within single drainage basins. Rather they appear to