

Assessment of Landscape Sensitivity of the semiarid Krom Antonies River Catchment, Western Cape, South Africa

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The Krom Antonies Catchment

- It is semiarid ($\bar{x} = 490$ mm) with reliable winter rainfalls.
- The catchment is characterized by agroindustrial fruit and vegetable production – mostly grapes and potatoes.
- The stream's lower course is seasonal, the upstream tributaries are perennial. Round-the-year water availability is granted by excessive groundwater pumping and storage.

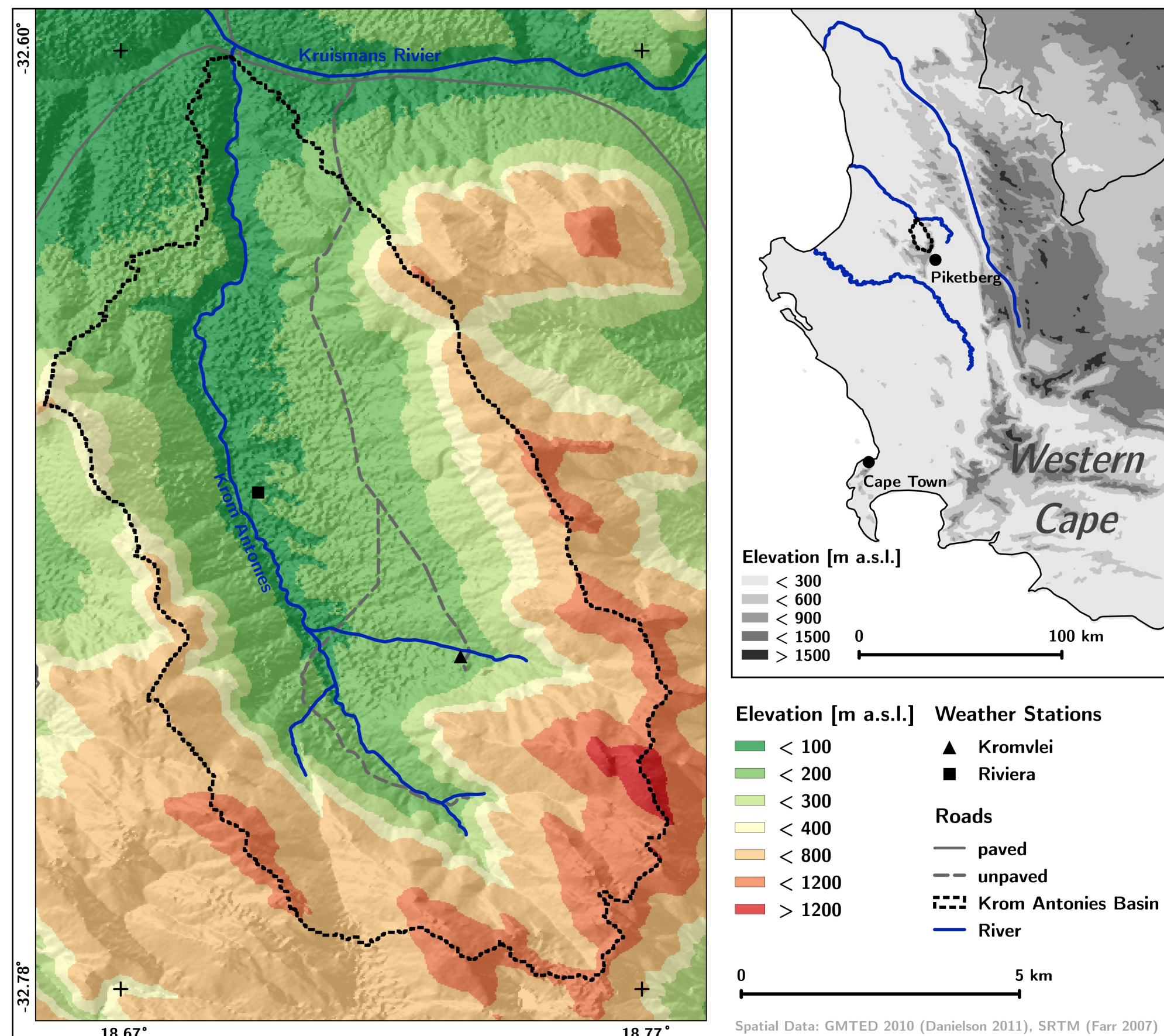


Figure 1: Overview map of Western Cape and the Krom Antonies River Catchment [1, 2].

SPEI

The Standardized Precipitation-Evapotranspiration Index (SPEI) [3] makes use of a simple log-logistic distribution of $D_i = P_i - PET_i$ where D is the difference between precipitation (P) and potential evapotranspiration (PET). The more distant from 0 the more extreme the climate event. Values between 1 and -1 are considered to represent normal conditions.

Droughts & Wet Spells

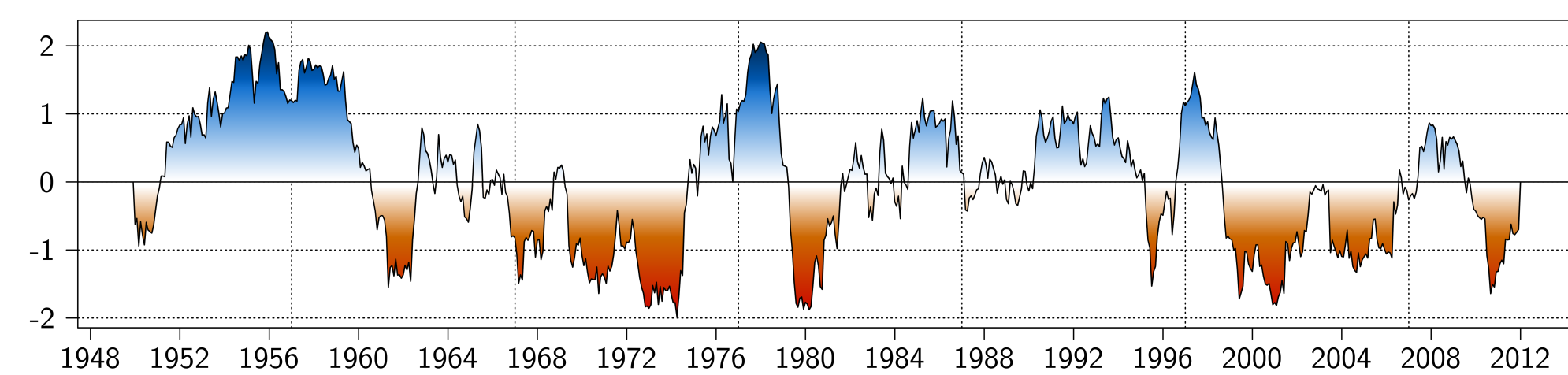


Figure 2: SPEI using a 24 month time scale for a 64 year time series. Data Source: [4]

- Droughts and humid phases occur in cycles.
- The winter months tend to prevalent above normal rainfalls.
- Very humid phases do not occur during winter rain.
- No severe droughts are shown on a two-year time scale.
- Light drought conditions appear in all seasons.

Table 1: Absolute Frequencies.

	Humid		Drought		
	very	light	normal	light	severe
Jan	2	7	43	12	0
Feb	3	6	45	13	0
Mar	2	9	40	13	0
Apr	0	12	40	12	0
May	0	11	41	12	0
Jun	0	10	42	12	0
Jul	0	13	37	14	0
Aug	0	13	39	12	0
Sep	1	9	41	13	0
Oct	1	8	44	11	0
Nov	1	6	46	10	0
Dec	1	7	45	11	0

Landuse & Landcover

- Major fractions ($> \frac{1}{3}$) are not used.
- Intensive agroindustry only in minor shares of the catchment ($< 3\%$).
- As a rule of thumb: »The further away from the stream, the less intensive the water use.«
- Open Water is exclusively from artificial water storage dams.
- Pasture, Barren and Fallow are in parts indistinguishable.
- Wetland classes always related to the stream and/or water storage facilities
- All Forest is man-made.

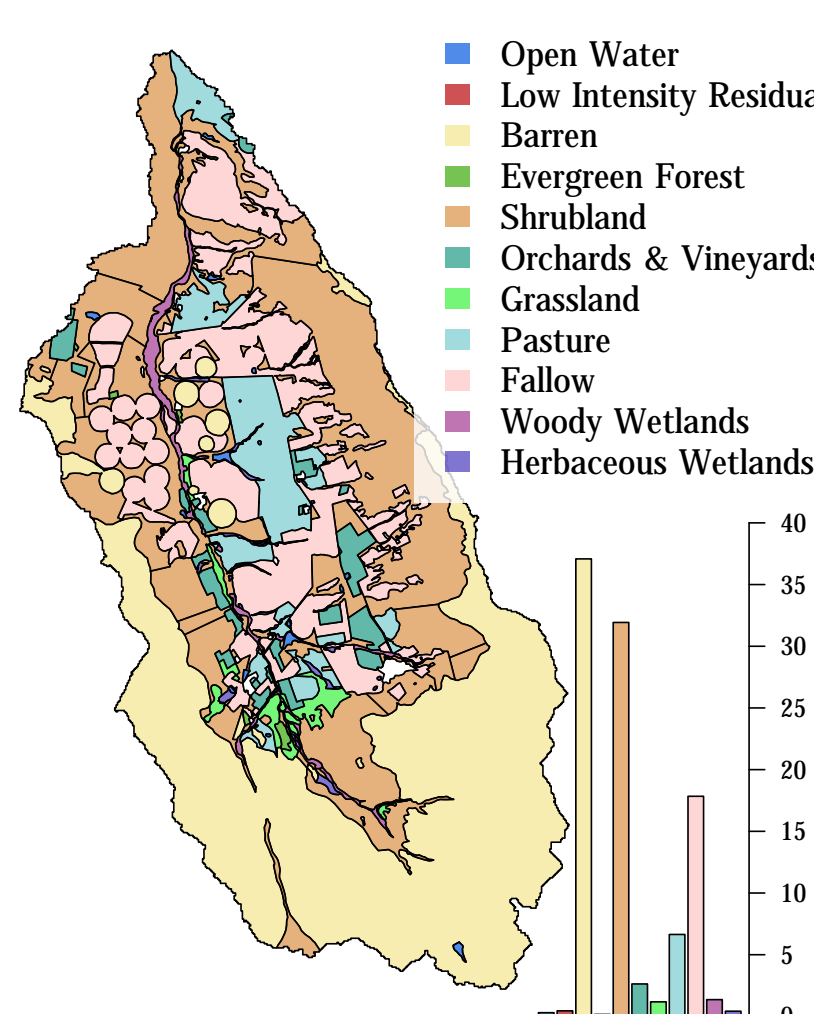


Figure 3: Classes after [5]

Magnitude-Frequency-Analysis

The recurrence interval (RI) of daily rainfall values shows a log-linear relationship of the rainfall values (r) and their descending rang position (N) [6].

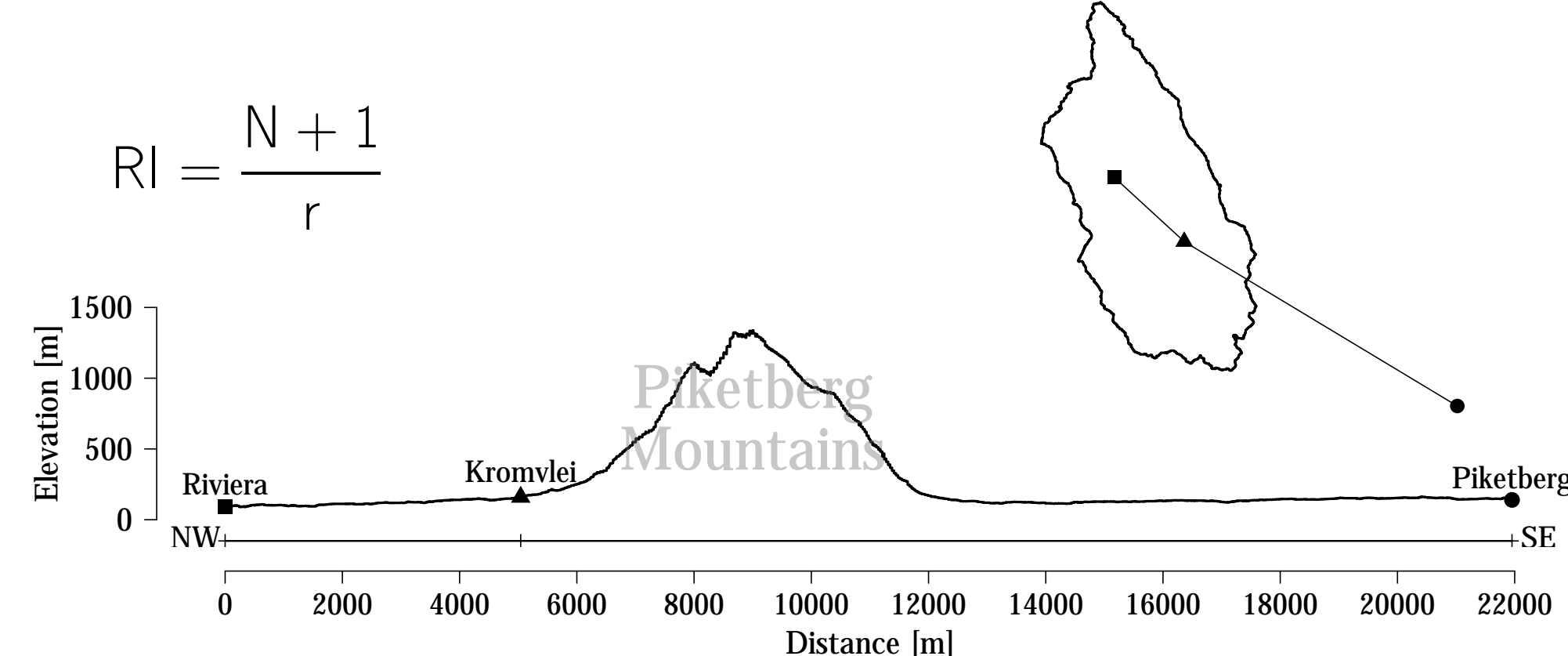


Figure 4: Transect of the weather stations across the mountains.

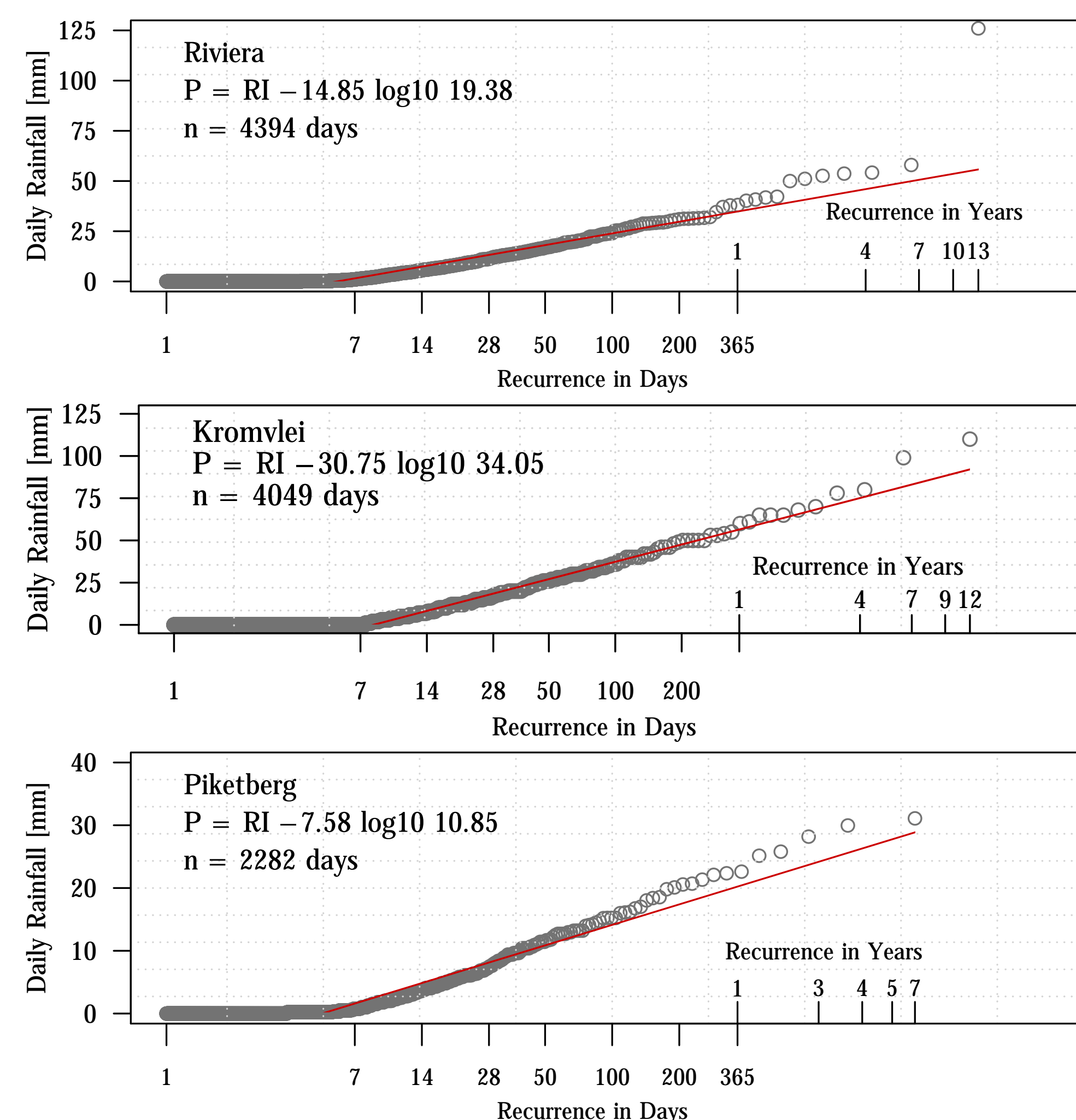


Figure 6: MFA along a Transect. Data Source: [7, 8]

- Piketberg station strongly differs from the others. Rainfall amount is generally lower and less frequently.
- Kromvlei and Riviera show similar scales, but differing slopes and intersects reveal spatially heterogeneous rainfall events.
- The frequencies of rainfalls are much higher than outside the valley, which is interpreted as a result of orographic rainfalls from the Westerlies and the valley's topographic configuration.

Unit Stream Power Erosion Deposition

USPED [9] makes use of the transport capacity (T) limitation of soils and sediments to estimate potential erosion and deposition based on (R)USLE parameters, via $T = LS \times K \times R \times C \times P$.

Spatial Subfactors

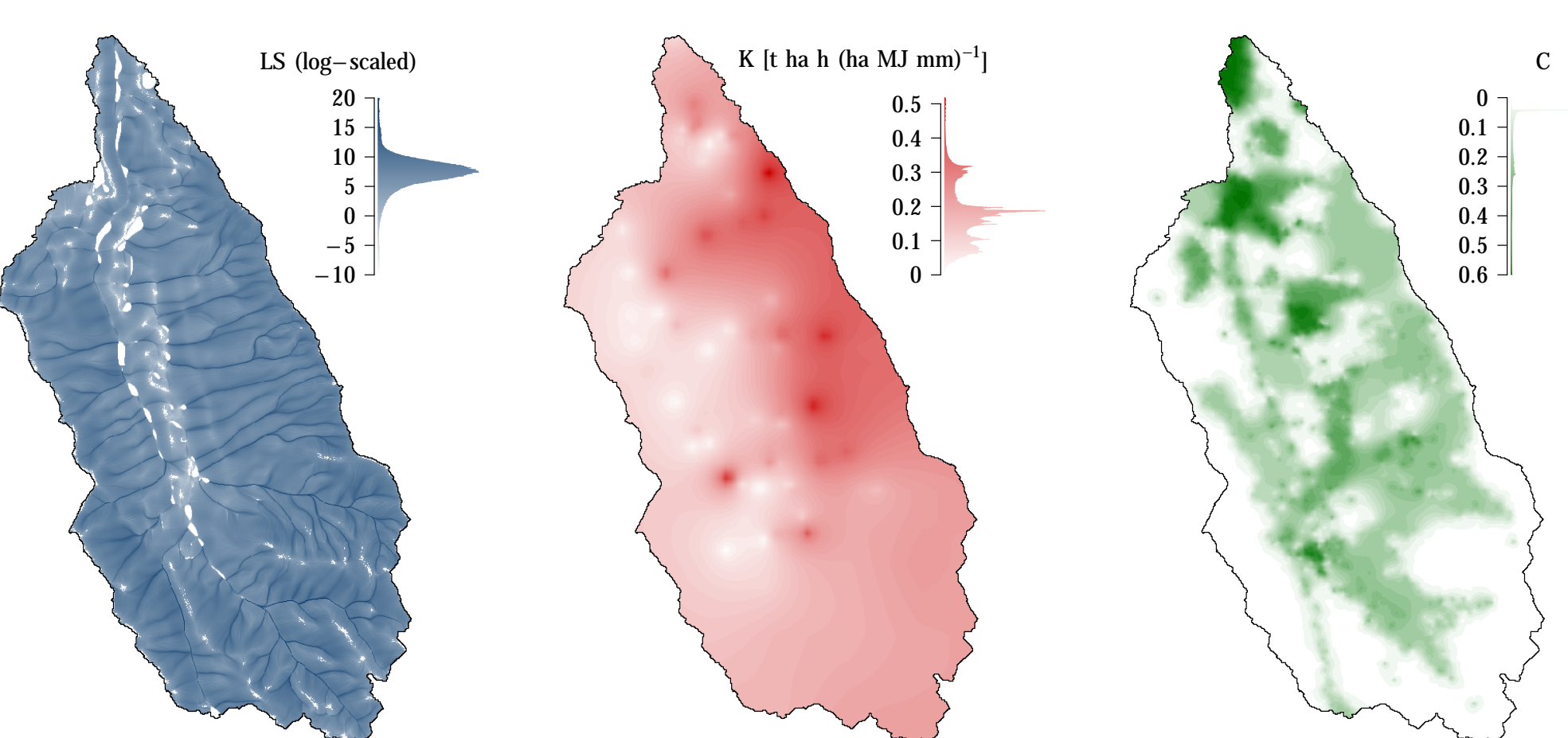


Figure 7: Slope Length & Steepness

Figure 8: Soil Erodibility

Figure 9: Cover-Management Factor

- Most of the LS values are reasonable, only the extreme values – located in v-shaped valleys and (perennial) streams – cause the LS factor to be exaggerated. LS is processed with the upslope contributing area (A) and slope (β) – $LS = A^m(\sin \beta)^n$. Rill-interrill (m) affects the values extraordinarily (Fig. 11).
- The eastern mountain range is geologically older and thus more erodible than the rest. Therefore K values are increased.
- Vast areas are occupied by sparse or patchy vegetation. That leads to a generally low protection against erosive rainfalls. Only some minor regions in the lower course show favorable values.

Rainfall-Runoff Erosivity

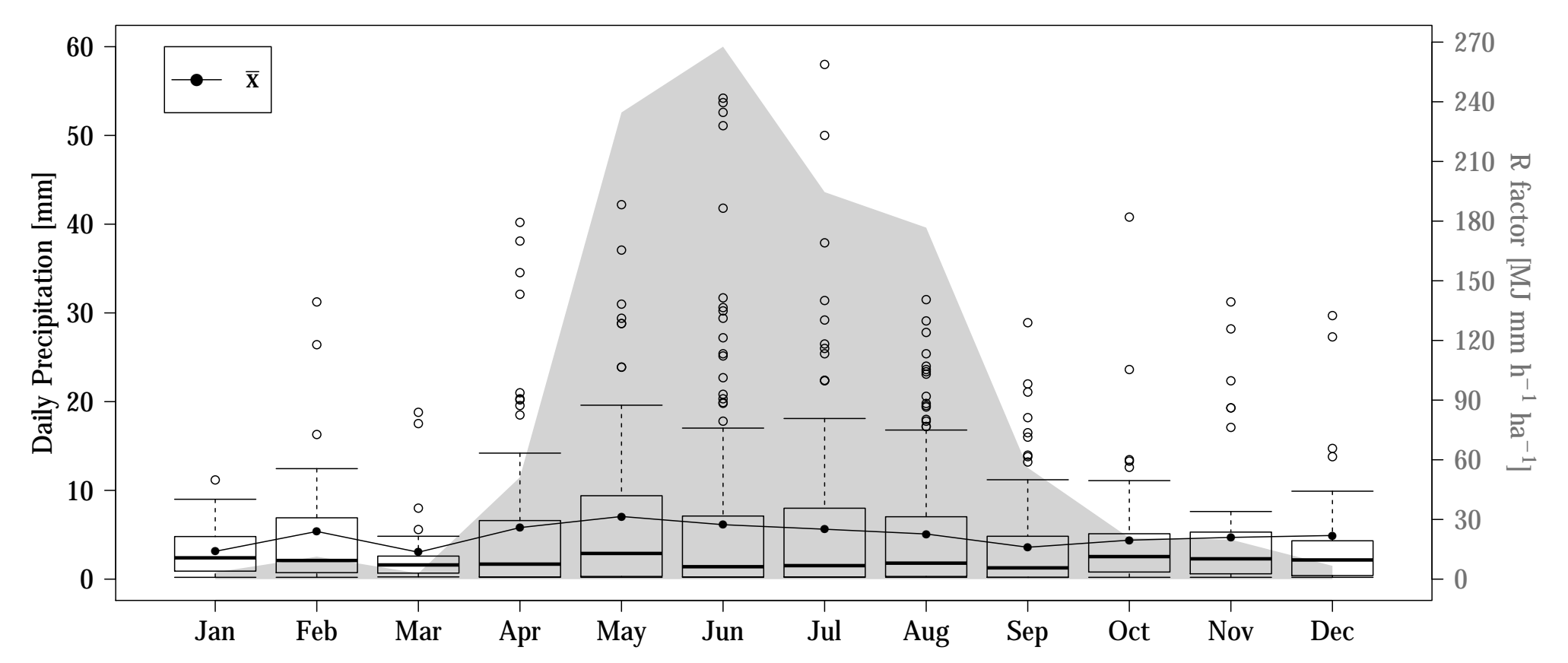


Figure 10: Daily rainfall distribution and the corresponding R factor for Riviera station. Data Source: [7]

Erosion & Deposition

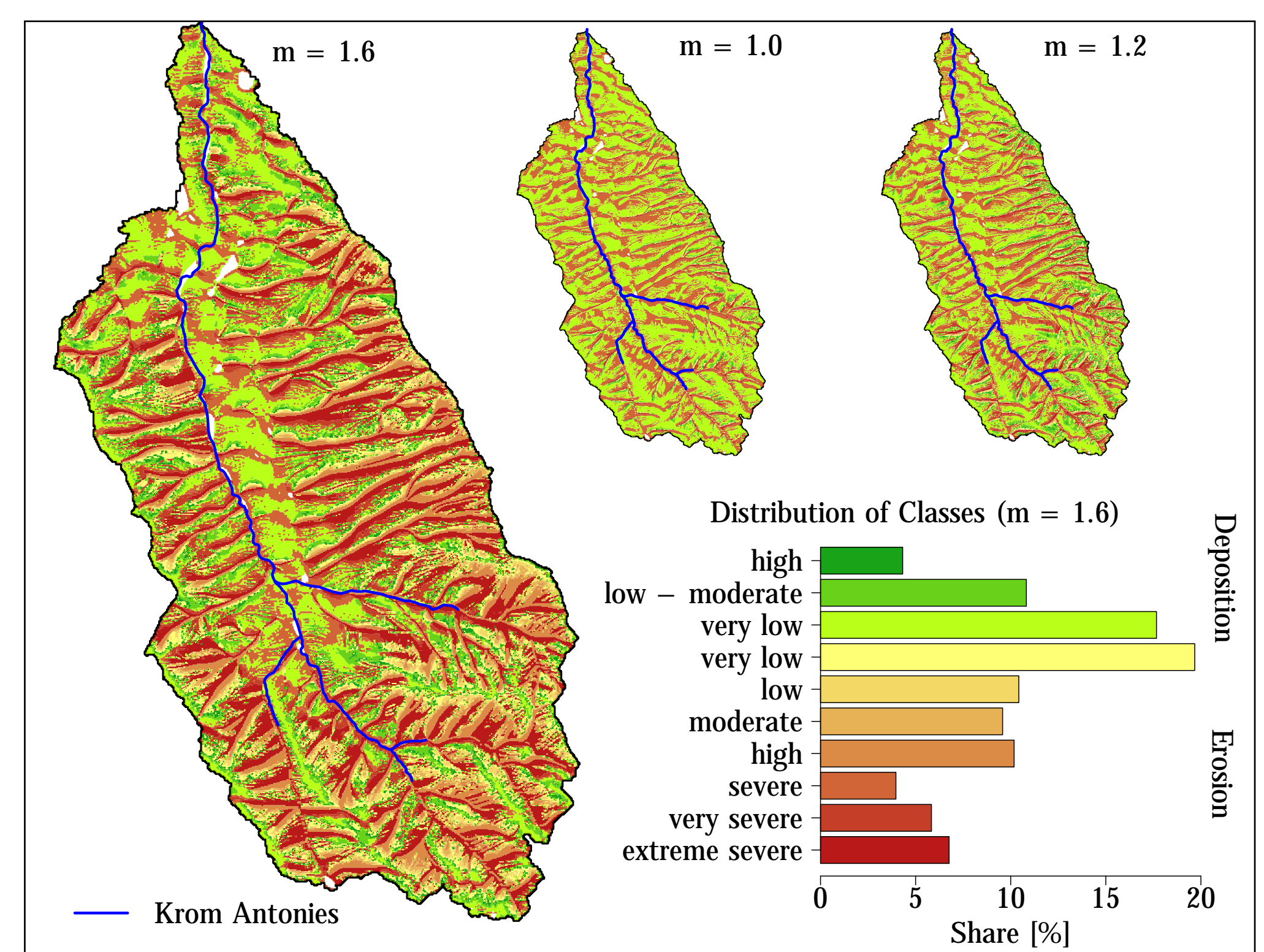


Figure 11: Potential erosion/deposition. Classes after [10, 11]

- The valley bottom is relatively stable.
- The surrounding slopes are very prone to erosive processes.
- Overshooting values – especially upstream – result from highly concentrated streamflow (Fig. 12) and need to be reclassified so these values must be seen as trends.
- The most determining factor is the topography. Landuse and sediment properties are of minor importance.



Figure 12: Stabilized Gully (N. Anselm 2014)

Conclusions

- The valley is blessed with a topographically and thus climatologically favored location.
- Rainfalls occur temporally and spatially highly variable, in parts they fail. Their erosivity is most of the year negligible – only four months per year the values are excessive.
- Climatic stresses (e.g. droughts) are intrinsic part of that environment.
- Only very small fractions of arable land are used (ground-)water intensive. The majority is barren/unused.
- The main trigger for potential erosion and deposition are the topography and rainfalls. Using USPED in this environment reveals LS and the rill-interrill ratio m as extremely sensitive.

References

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