

# **Assessment of trace element concentrations in sediment and vegetation of mesic and arid**

## **African savannahs as indicators of ecosystem health**

**Running title: Trace elements in protected African savannahs**

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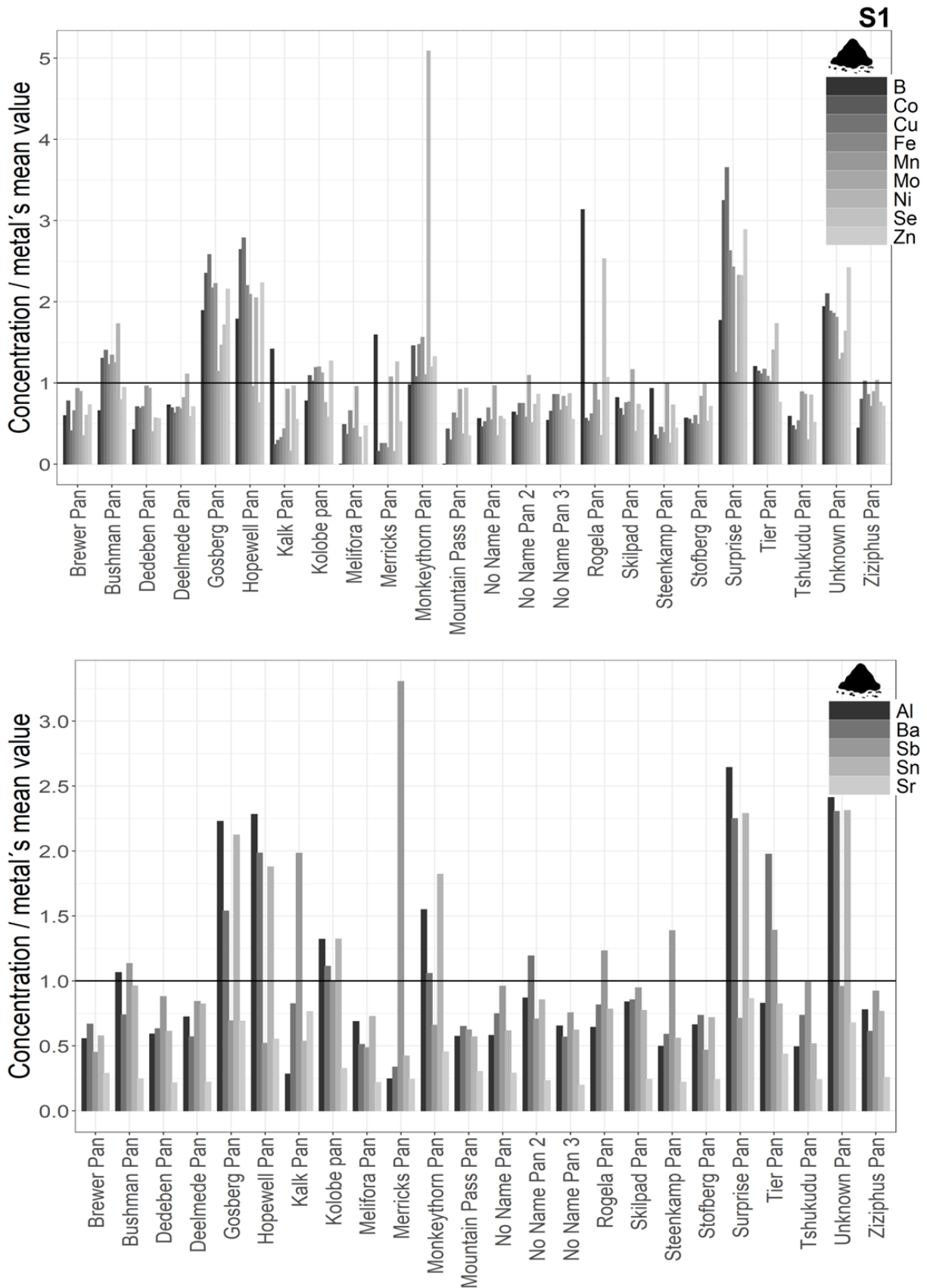
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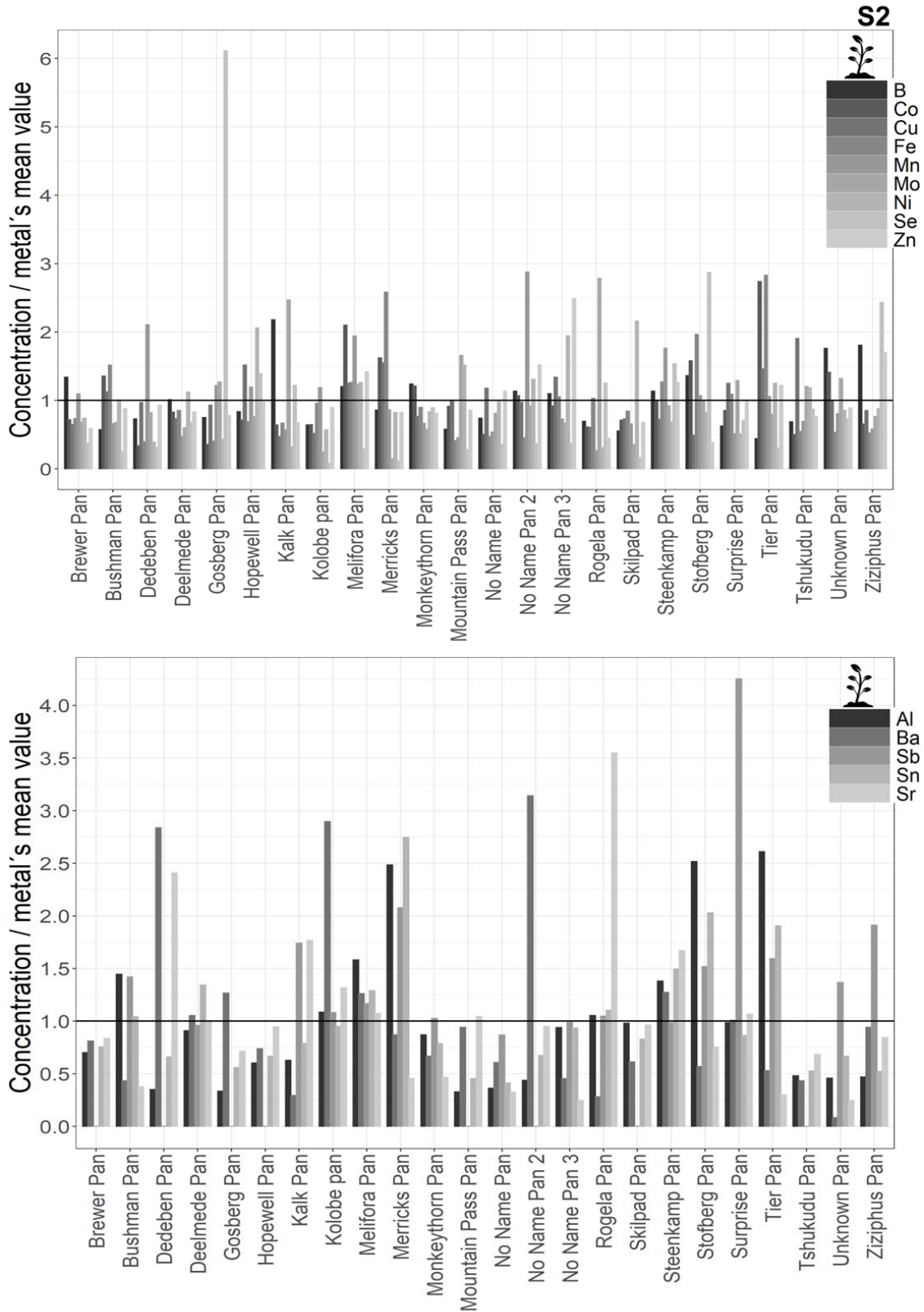
**Table S1.** Student t-test (t) (normality assumed) and Approximate Two-Sample Fisher-Pitman Permutation test (Z) (normality not assumed) results when trace elements in sediment and vegetation were compared between TKR and MNR study sites. Outliers from both sites were removed before comparison. \* TKR and \* MNR superscript denote site with significantly higher concentrations.

Trace element	Sediment – test statistics	Vegetation – test statistics
<b>Group A</b>	<b>Essential elements for plant physiology and function</b>	
<b>B</b>	Z= -2.24; p= 0.010; $\eta$ = 0.33 *TKR	Z= -3.89; p< 1e-04; $\eta$ = 0.7 *TKR
<b>Co</b>	Z= 3.61; p< 1e-04; $\eta$ = 0.62 *MNR	t= 6.60; df= 23.03; n= 19, 23; p= 0; $\eta$ = 0.81 *MNR
<b>Cu</b>	Z= 2.99; p= 2e-04; $\eta$ = 0.53 *MNR	t= 0.028; df= 35.83; n= 21, 24; p= 0.489; $\eta$ = 0
<b>Fe</b>	Z= 3.04; p= 3e-04; $\eta$ = 0.51 *MNR	Z= 0.82; p= 0.209; $\eta$ = 0.13
<b>Mn</b>	Z= 3.25; p= 0.0007; $\eta$ = 0.49 *MNR	Z= 1.94; p= 0.026; $\eta$ = 0.34 *MNR
<b>Mo</b>	t= -9.02; df= 44; p= 0; $\eta$ = 0.81 *TKR	t= -6.57; df= 27.66; n= 22, 22; p= 0; $\eta$ = 0.78 *TKR
<b>Ni</b>	Z= 2.56; p= 0.004; $\eta$ = 0.38 *MNR	Z= -0.47; p= 0.323; $\eta$ = 0.07
<b>Se</b>	Z= -1.03; p= 0.149; $\eta$ = 0.16	Z= -1.69; p= 0.042; $\eta$ = 0.27 *TKR
<b>Zn</b>	Z= 2.58; p= 0.002; $\eta$ = 0.48 *MNR	t= -7.32; df= 25.65822; n= 21, 23; p= 0; $\eta$ = 0.82 *TKR
<b>Group B</b>	<b>Potentially Toxic Elements</b>	
<b>As</b>	Z= -4.02; p< 1e-04; $\eta$ = 0.61 *TKR	t= -5.72; df= 27.04; n= 20, 22; p= 0; $\eta$ = 0.74 *TKR
<b>Cd</b>	t= -2.64; df= 27.66; p= 0.007; $\eta$ = 0.45*TKR	Z= -3.73; p< 1e-04; $\eta$ = 0.72 *TKR
<b>Cr</b>	Z= 3.69; p< 1e-04; $\eta$ = 0.65 *MNR	Z= 3.64; p< 1e-04; $\eta$ = 0.66 *MNR
<b>Hg</b>	Z= 0.17; p= 0.432; $\eta$ = 0.03	Z= 4.32; p< 1e-04; $\eta$ = 0.07*MNR
<b>Pb</b>	Z= -2.30; p= 0.011; $\eta$ = 0.35 *TKR	Z= -0.22; p= 0.421; $\eta$ = 0.04
<b>V</b>	Z= 1.62, p= 0.053; $\eta$ = 0.24 (sig at p=0.06) *MNR	Z= -0.57; p= 0.285; $\eta$ = 0.09
<b>Group C</b>	<b>Additional Elements</b>	
<b>Al</b>	t= 2.45; df= 30.79; p= 0.01; $\eta$ = 0.4 *MNR	Z= 2.01; p= 0.018; $\eta$ = 0.31 *MNR
<b>Ba</b>	t= 0.71; df= 41; p= 0.24; $\eta$ = 0.11	t= 0.179; df= 40; n= 21, 21; p= 0.429; $\eta$ = 0.03
<b>Sb</b>	Z= -5.81; p< 1e-04; $\eta$ = 0.95 *TKR	Z= 3.66; p< 1e-04; $\eta$ = 0.57 *MNR
<b>Sn</b>	Z= 0.91; p= 0.18; $\eta$ = 0.15	Z= 2.85; p= 0.001; $\eta$ = 0.45 *MNR
<b>Sr</b>	Z= 4.72; p< 1e-04; $\eta$ = 0.77 *MNR	t= 4.36; df= 41; n= 21, 22; p= 0; $\eta$ = 0.56 *MNR

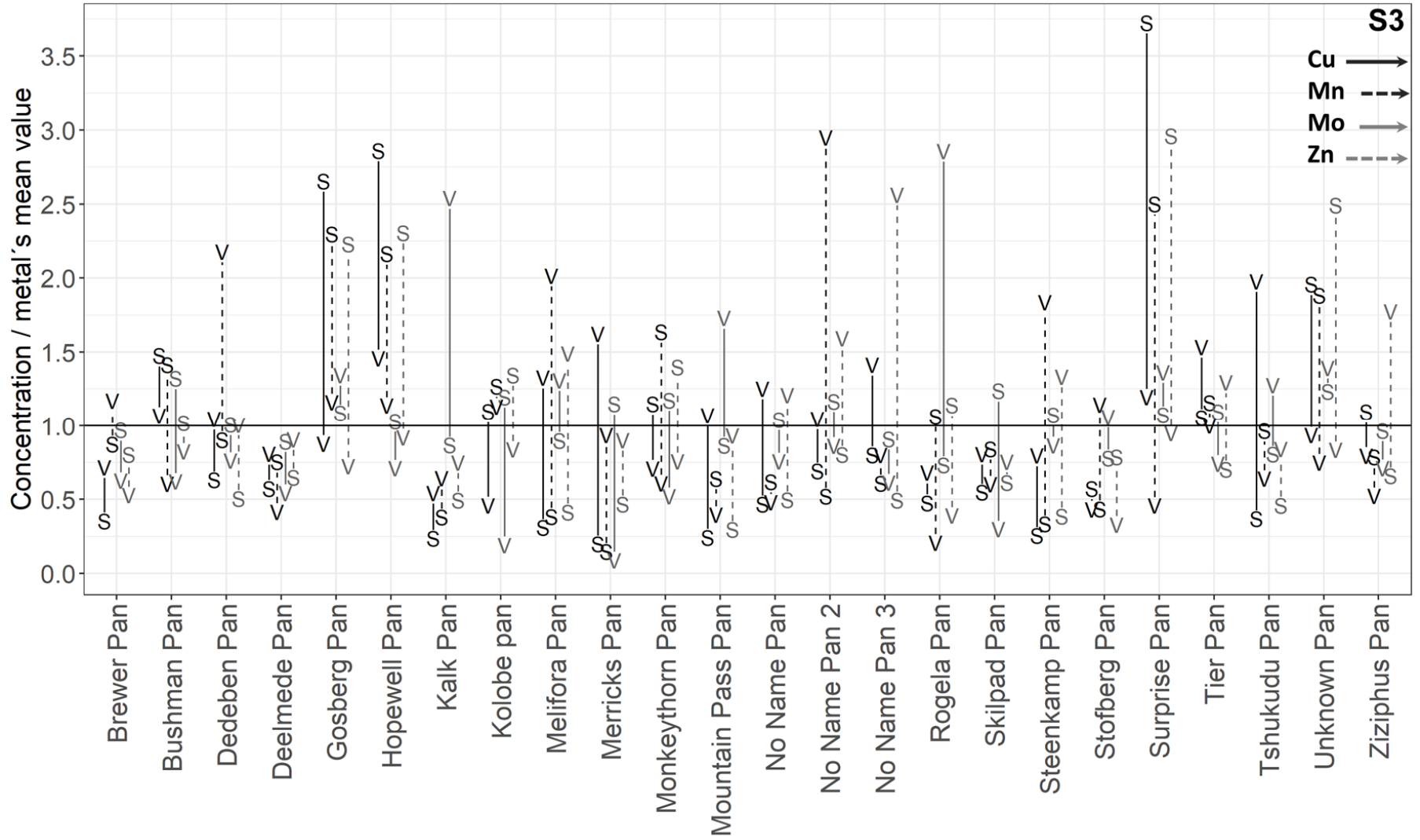
**Figure S1.** Transformed data for Group A: essential elements *B, Co, Cu, Fe, Mn, Mo, Ni, Se* and *Zn* (top) and Group C additional elements *Al, Ba, Sb, Sn* and *Sr* (bottom) against the property mean at sampled points in sediment show spatial variability within the TKR sampling site.



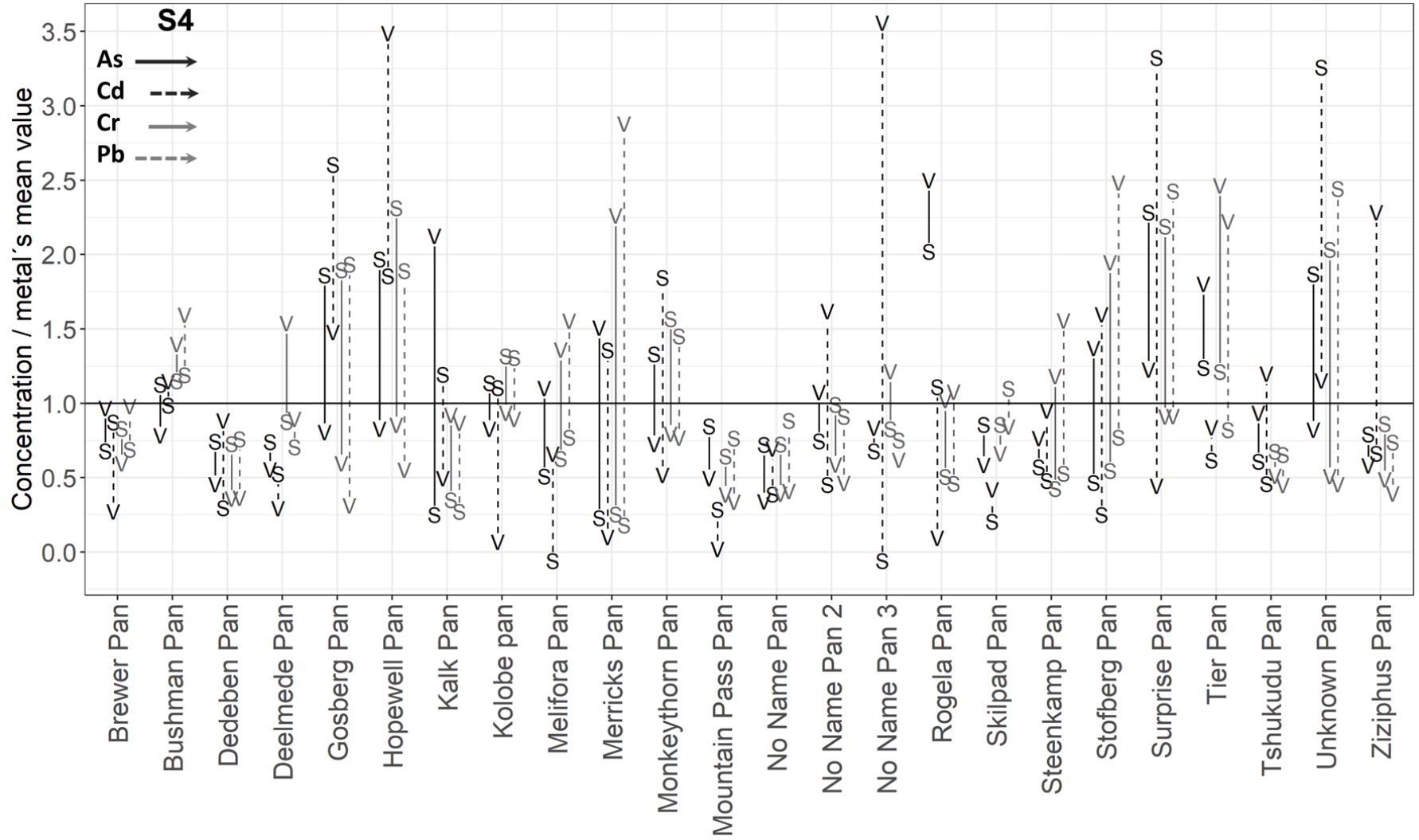
**Figure S2.** Transformed data for Group A: essential elements *B, Co, Cu, Fe, Mn, Mo Ni, Se* and *Zn* (top) and Group C additional elements *Al, Ba, Sb, Sn* and *Sr* (bottom) against the property mean at sampled points in vegetation show spatial variability within the TKR sampling site.



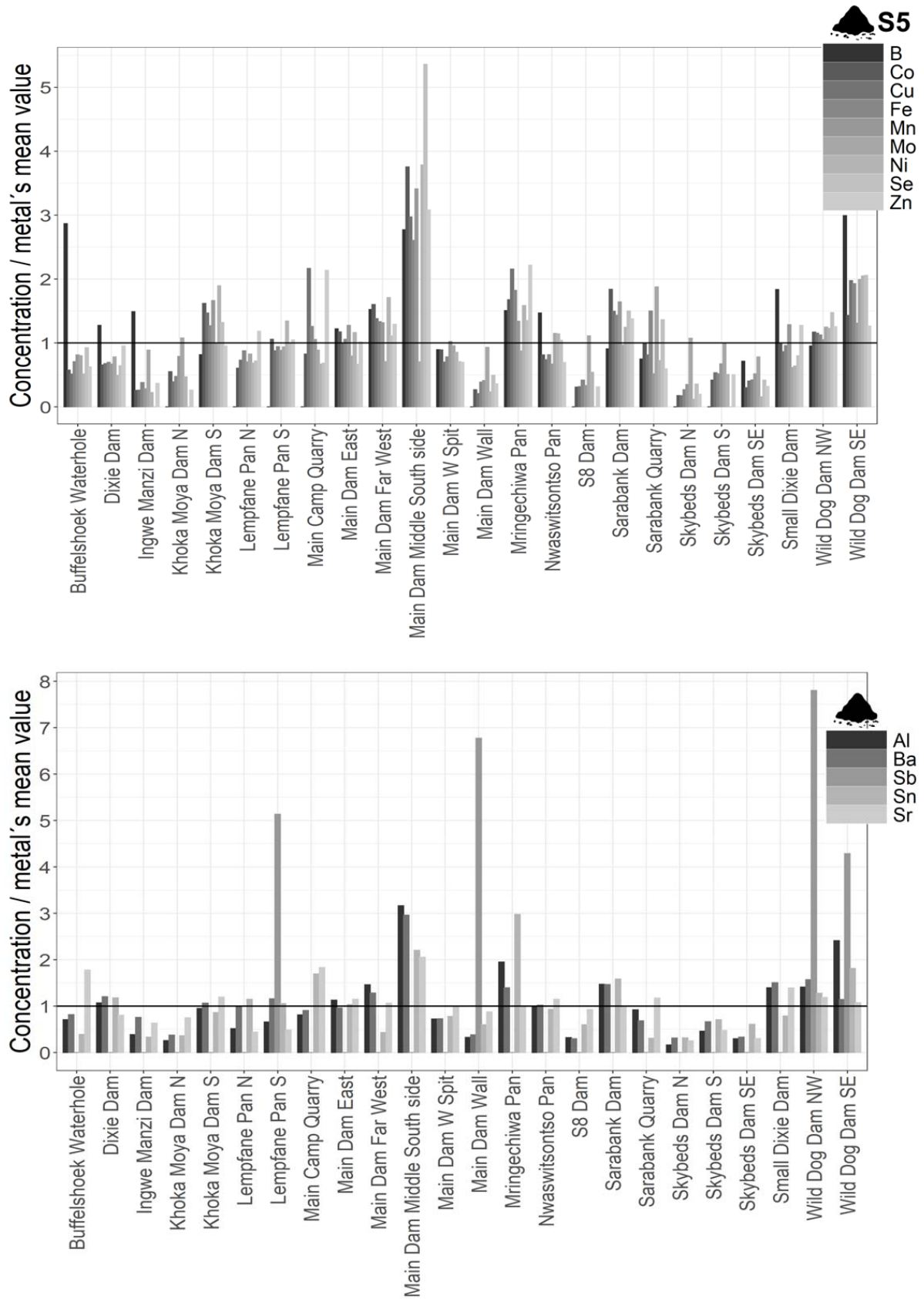
**Figure S3.** Variability of significant essential trace elements *Cu*, *Mn*, *Mo* and *Zn* in sediment (S) and vegetation (V) across the TKR site relative to the property mean. A clear pattern of bioaccumulation from sediment to vegetation does not appear to be evident across sites.



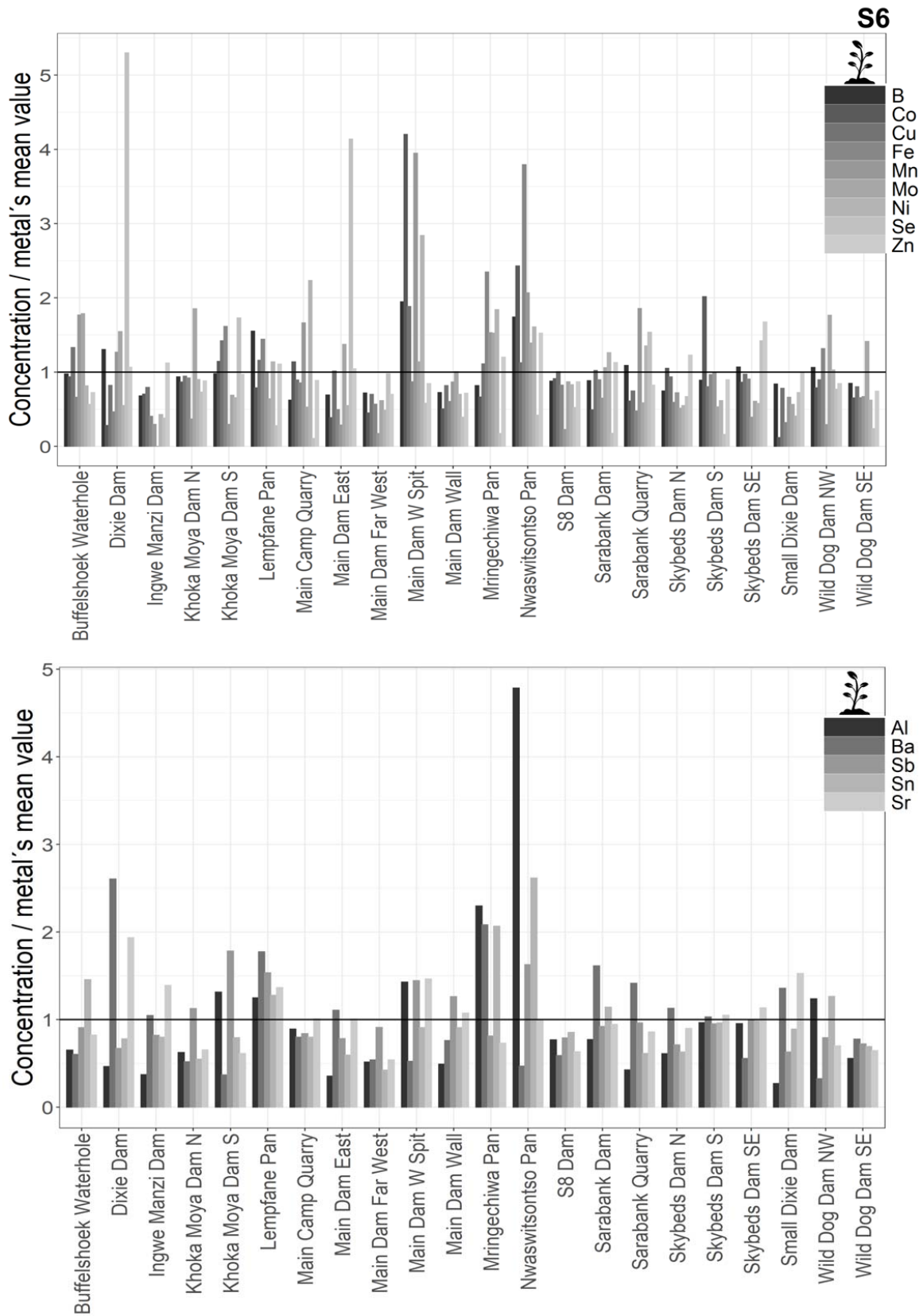
**Figure S4.** Variability of significant toxic trace elements *As*, *Cd*, *Cr* and *Pb* in sediment (S) and vegetation (V) across the TKR site relative to the property mean. A clear pattern of bioaccumulation from sediment to vegetation does not appear to be evident across sites.



**Figure S5.** Transformed data for Group A: essential elements *B, Co, Cu, Fe, Mn, Mo, Ni, Se* and *Zn* (top) and Group C additional elements *Al, Ba, Sb, Sn* and *Sr* (bottom) against the property mean at sampled points in sediment show spatial variability within the MNR sampling site.

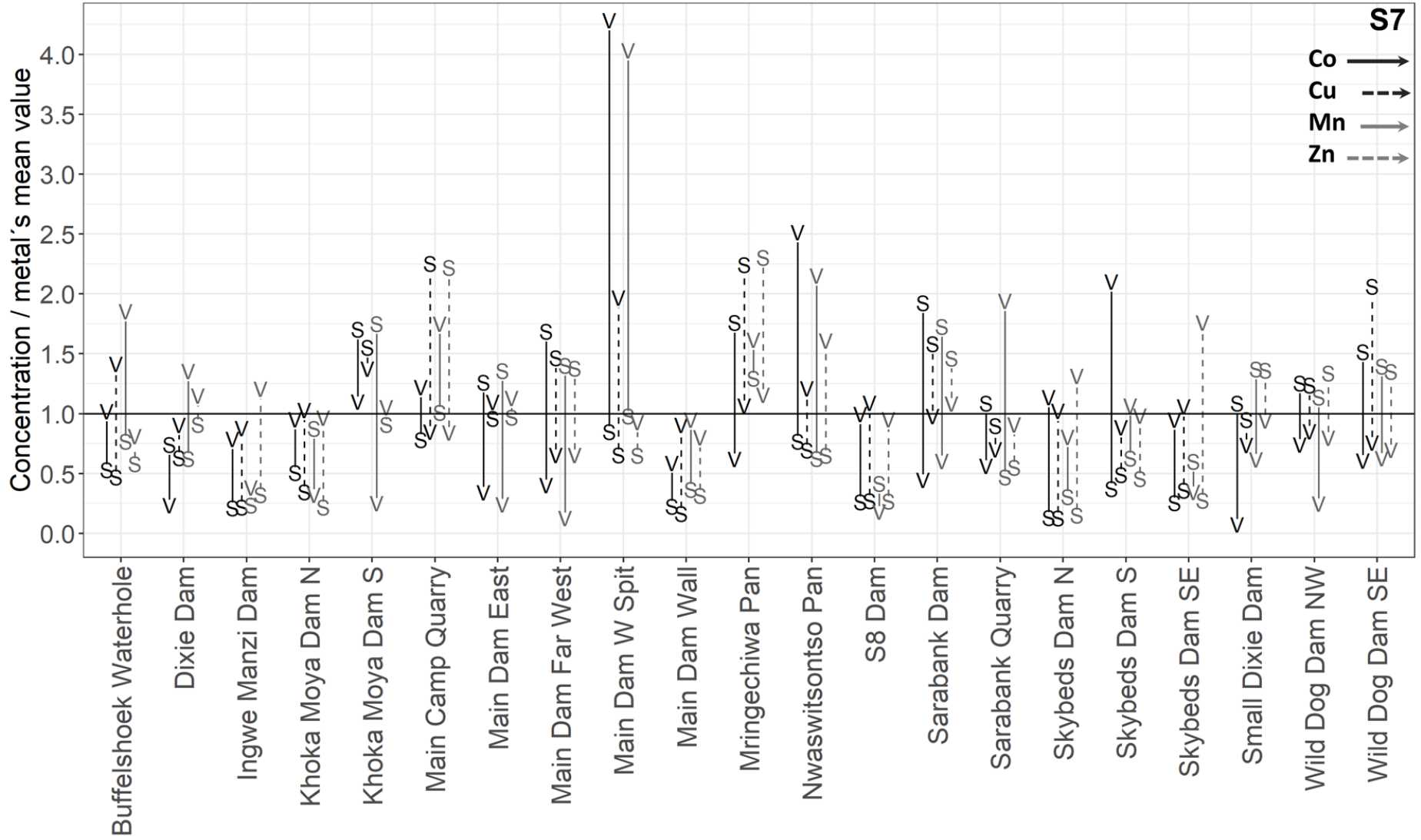


**Figure S6.** Transformed data for Group A: essential elements *B, Co, Cu, Fe, Mn, Mo, Ni, Se* and *Zn* (top) and Group C additional elements *Al, Ba, Sb, Sn* and *Sr* (bottom) against the property mean at sampled points in vegetation show spatial variability within the MNR sampling site.



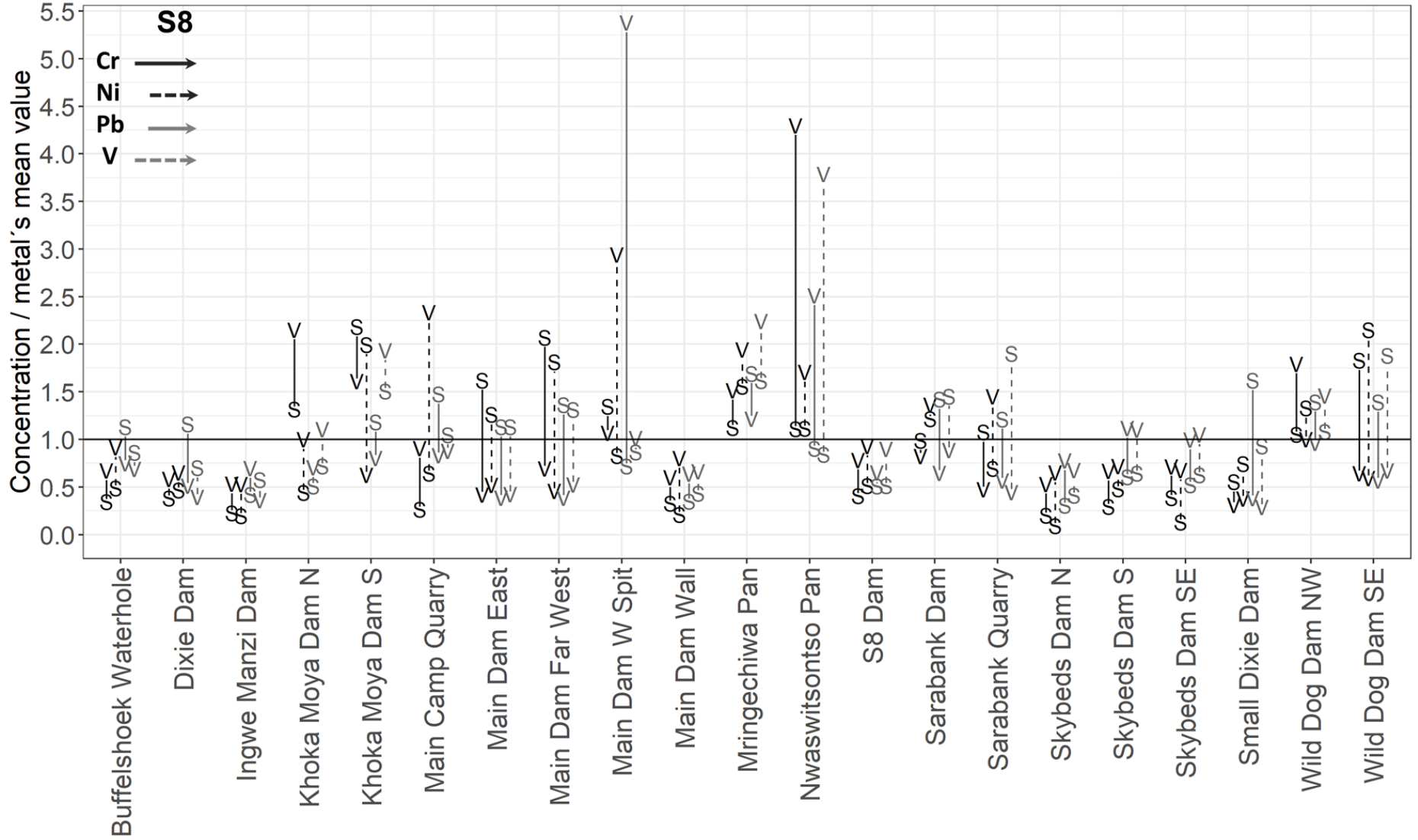


**Figure S7.** Variability of significant essential trace elements *Cu*, *Mn*, *Mo* and *Zn* in sediment (S) and vegetation (V) across the TKR site relative to the property mean. A clear pattern of bioaccumulation from sediment to vegetation does not appear to be evident across sites.



**Figure S8.** Variability of significant potentially toxic trace elements *Cr*, *Ni*, *Pb* and *V*, in sediment (S) and vegetation (V) across the TKR site relative to the property mean.

A clear pattern of bioaccumulation from sediment to vegetation does not appear to be evident across sites.



**Table S2.** Overall summary of key results, elements of potential concern given concentrations and hypothetical source. Summary does not include distinctions between elevated levels in sediment and vegetation

Tswalu Kalahari Reserve (TKR)			Manyeleti Nature Reserve (MNR)		
Sampled location	Element	Hypothetical source	Sampled location	Element	Hypothetical source
Across site	Al, As, Cd, Co, Cu, Cr, Pb, Mn, V and Zn	Geological	Across site	Cr, Co and Ni and Zn	Geological
Rogela Pan	Sr	Kalahari East Pipeline	Wild dog Dam, Main Dam, Nwaswitsontso Pan, Mringechiwa Pan	Cr and Ni	Geological and external anthropogenic
Rogela Pan Kalk Pan	Mo and Sb	Coal combustion/fertilizers	Main Dam W Spit Main Dam Middle	Co, Cu, Mn, Ni, As, Cd, Hg and Pb	Accumulation hotspot from anthropogenic sources
Unknown Pan Surprise Pan Tshukudu Pan	Hg	Aircraft associated with landing strip	Sarabank Dam S8 Dam Dixie Dam	Hg	Unknown anthropogenic
Merricks Pan, Stofberg Pan, Bushmans Pan	Cd	Atmospheric pollution/fertilizers	Skybeds Dam	Zn	Unknown source