Supplementary information

Figure S1 Component smooth effects (mean ± 95%CI) on dominant female body mass.

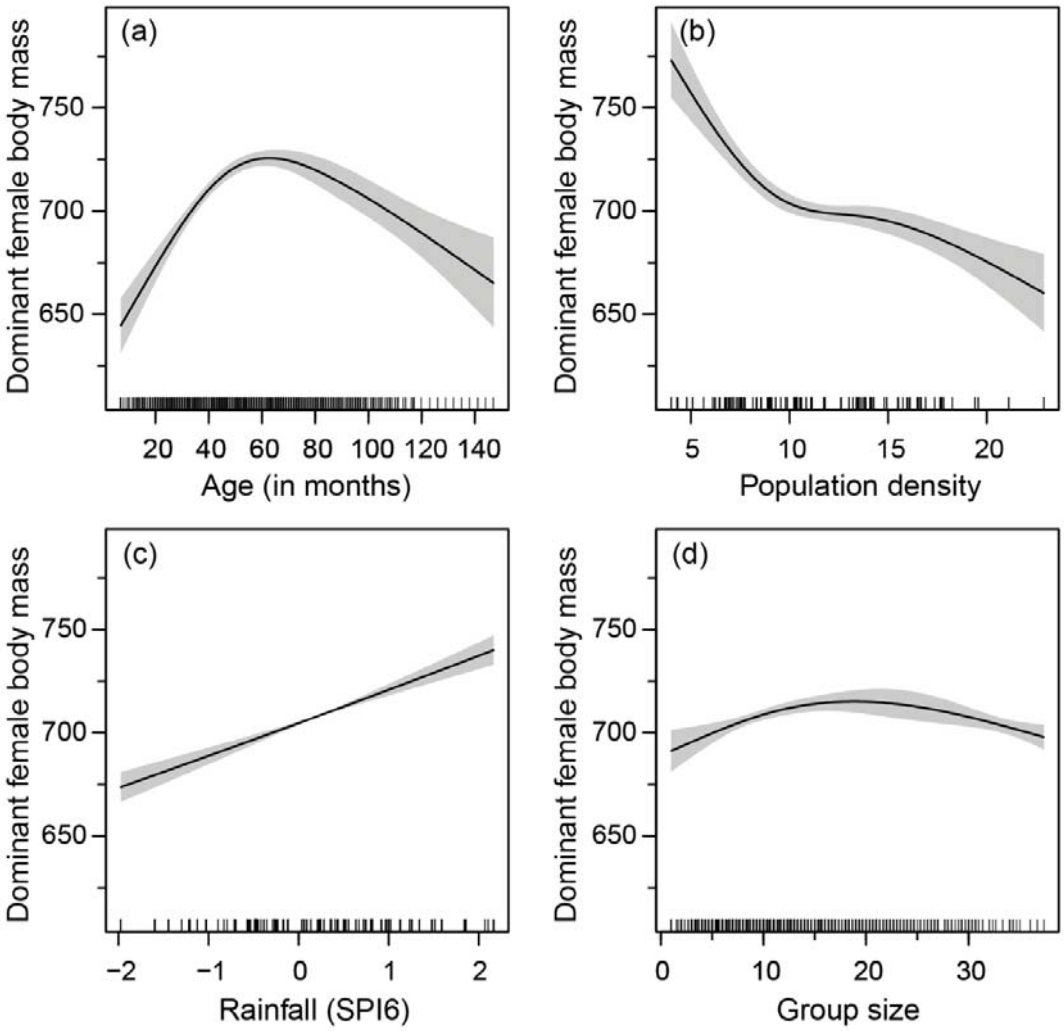


Figure S2 The relationship between the monthly weight gain of dominant female meerkats, standardised rainfall (SPI6) and whether females gave birth to a litter that month (green circles) or not (orange triangles). Lines and shaded areas show model predicted means and 95% CI.

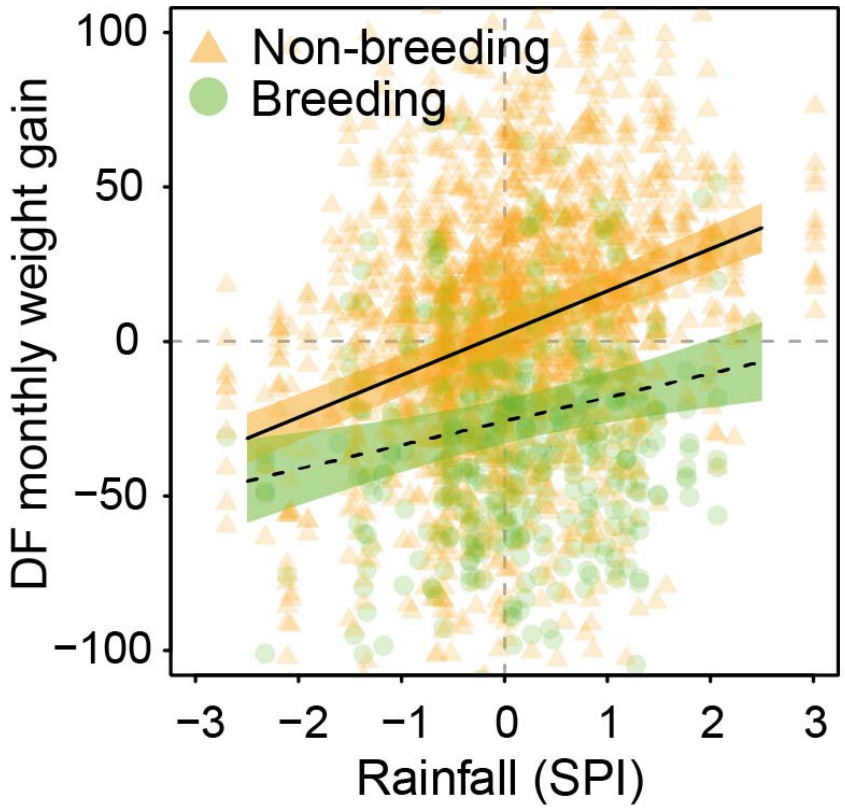


Figure S3 Component smooth effects (mean ± 95%CI) on pup survival on a logit-scale.

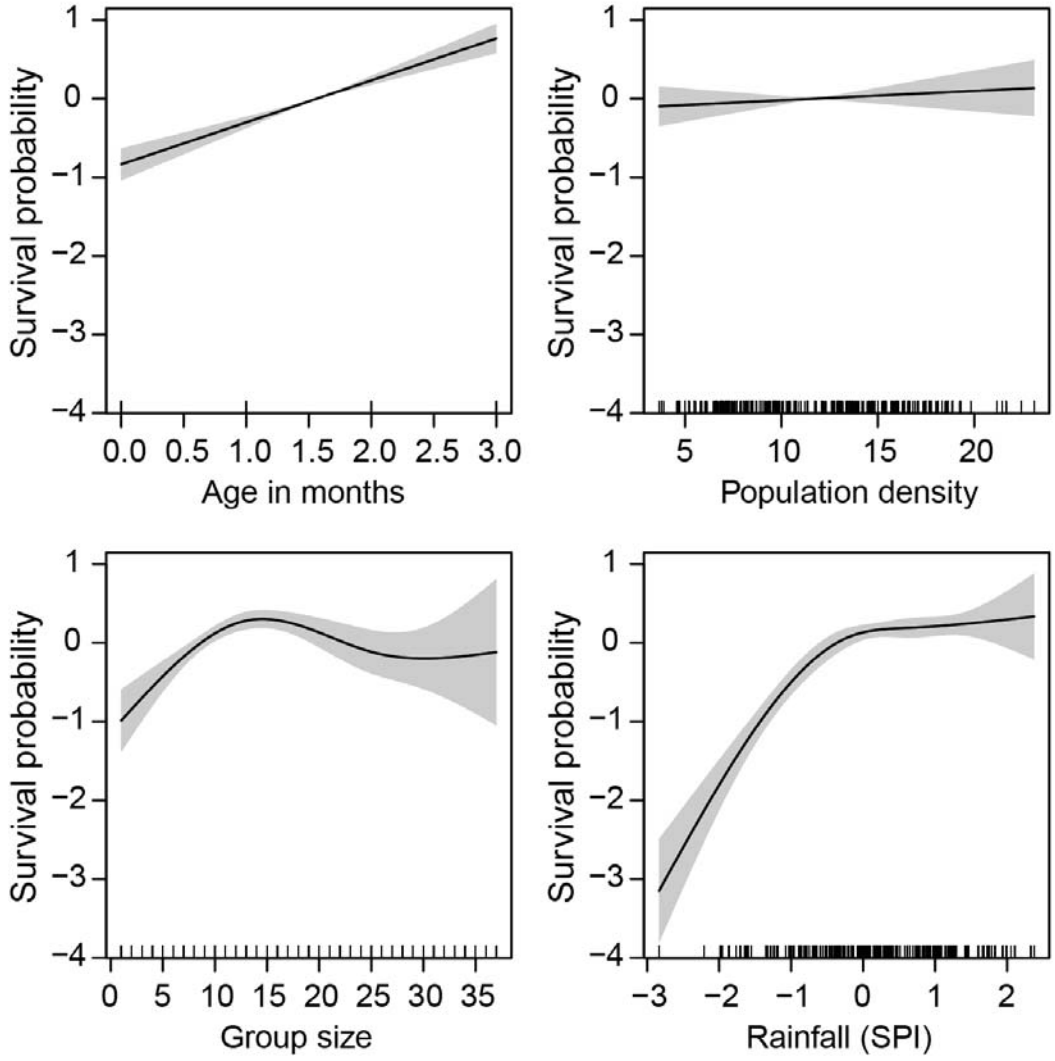
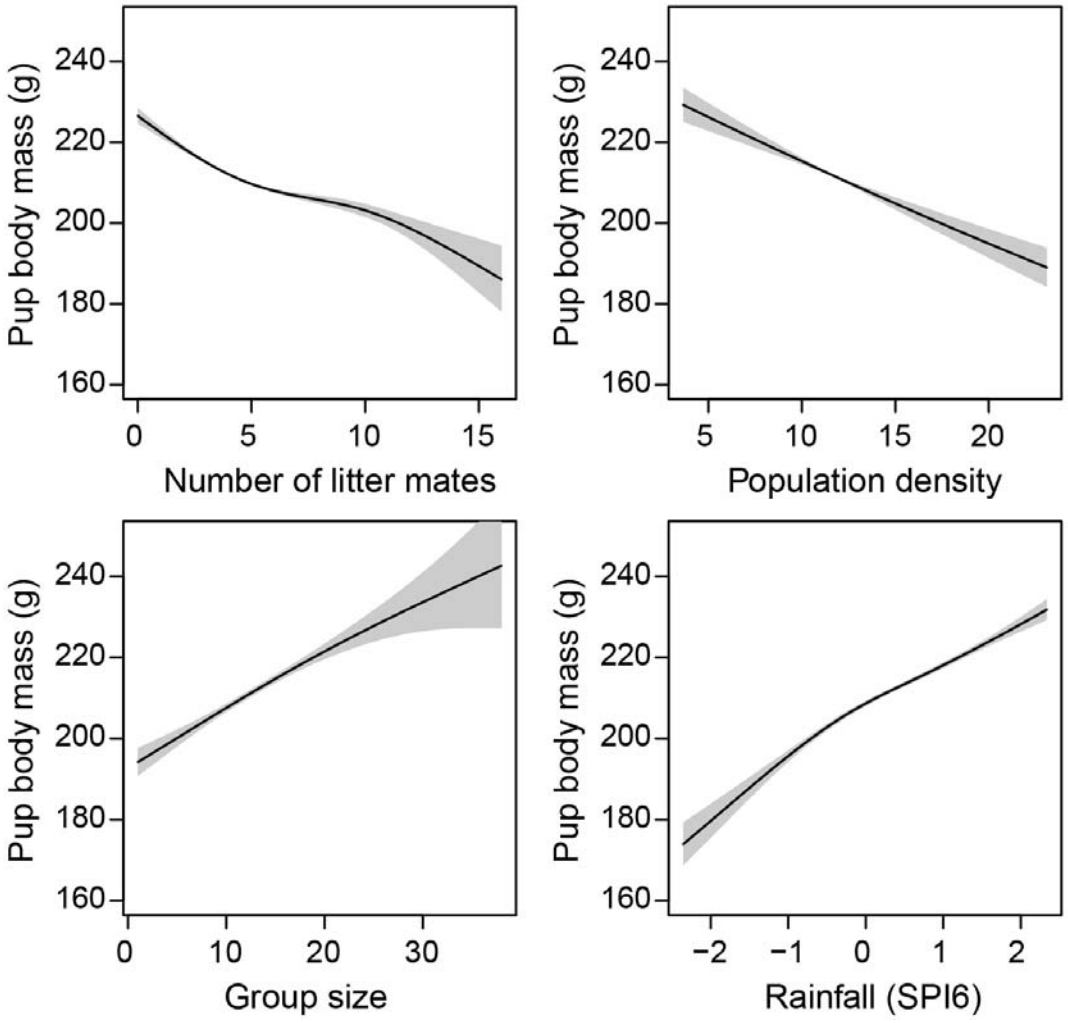


Figure S3 Component smooth effects (mean ± 95%CI) on pup body mass (±95%CI).



Validation of long-term GPCP rainfall data

To validate our long-term records of precipitation obtained from the GPCP (Global Precipitation Climatology Project) we modelled this data and the precipitation data obtained from our local weather station (CR200 datalogger; Campbell Scientific) using three additive models with the following assumptions:

i. The two measures differ in both intercept and trend

ii. The two measures differ only in intercept

iii. The two measures do not differ

We fitted models that included (i) a smooth-by-factor interaction $f(Year, Month, \text{by} = Source)$, where *source* refers to the type of precipitation data used (GPCP vs local) as well as a parametric term for the factor *Source*; (ii) a tensor product interaction $f(Year, Month)$ and a parametric term for the factor *Source; (iii)* a tensor product interaction $f(Year, Month)$ only.

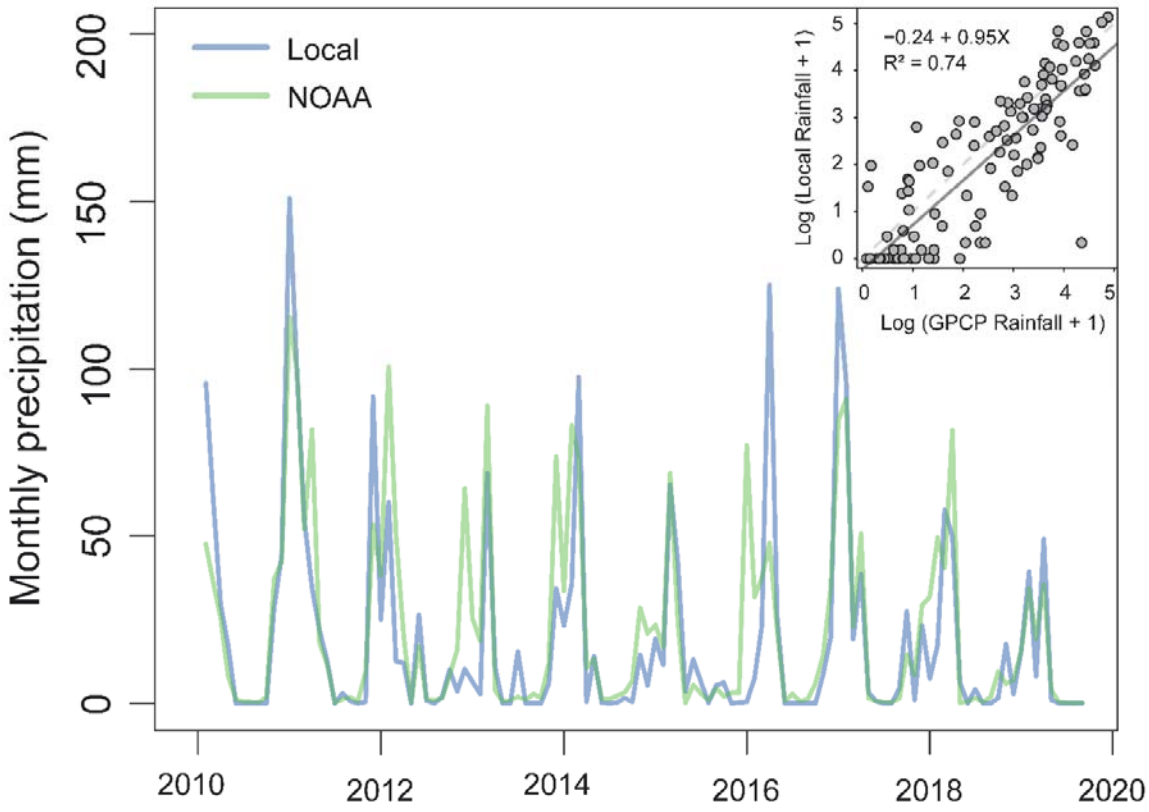
We log(x+1)-transformed rainfall and we calculated and compared AIC's between models to assess out-of-sample deviance. We also compared rainfall between the GPCP and local measures directly by fitting local rainfall as a response and GPCP rainfall as a predictor in a linear model.

Our data show that a model with different intercepts but a single smooth for both measures of rainfall has the best predictive value (see table below), indicating that rainfall trends for both measures are not significantly different. The GPCP data assumes on average 2.9 mm of additional monthly rainfall compared to local rainfall measures.

Model	DF	AIC
i. Source + $f(Year, Month, \text{by} = Source)$	34.00125	662.9
ii. Source + $f(Year, Month)$	36.29363	**643.7**
iii. $f(Year, Month)$	32.17328	653.4

When comparing the two measures of rainfall directly in a linear model, estimates indicated an (non-significant; P = 0.10) average monthly rainfall difference of 1.79 mm between the GPCP and local

rainfall measures, but estimates were relatively consistent for both low and high levels of precipitation as indicated by the regression slope between the local and GPCP rainfall measurements ($\beta_{NOAA} \pm SE = 0.95 \pm 0.053$).



Comparisons between raw and standardized monthly rainfall data

The SPI (standardized precipitation index) is the most widely used index of drought globally and recommended by the World Meteorological Organization due to its many favourable characteristics compared to other precipitation and drought measures (Mckee et al. 1993, Wu et al. 2007, Hayes et al. 2011, Sienz et al. 2012). For instance, the SPI is thought to be a better measure of drought than similarly used Z-scores, particularly at shorter time scales (Wu et al. 2001). Although some care should be taken when SPI's are used in arid conditions (Hayes et al. 2000, Sienz et al. 2012), alternative methods have recently been developed that should result in more accurate SPI estimates (Stagge et al. 2015).

We calculated the SPI in our study area over 1-, 3-, 6- and 12-month timescales by using the package *SCI* (Gudmundsson and Stagge 2016). We used the methods advocated in (Stagge et al. 2015), calculating SPI using a gamma distribution and modeled the probability of zero precipitation with a mixed distribution (p0 = T). Comparisons between calculated SPI's and raw monthly rainfall data rainfall in our study population shows high agreement between the two measures: R^2 between 0.89 and 0.98 for 6-month SPI (Figure S5c). Comparisons between long-term monthly rainfall and SPI at different time scales (Figure S6) also shows clear seasonality in rainfall as well as interannual variation in rainfall and distinct wet and dry periods over the duration of our study (1998 – 2019).

Figure S5. The relationship between 1-, 3-, 6- and 12-month SPI and accumulated measures of rainfall on the same time scale for 40 years of historical rainfall data at our study area in the Southern Kalahari. R^2-values and regression lines are presented for each plot which are based on simple linear regression models between SPI and rainfall for each month.

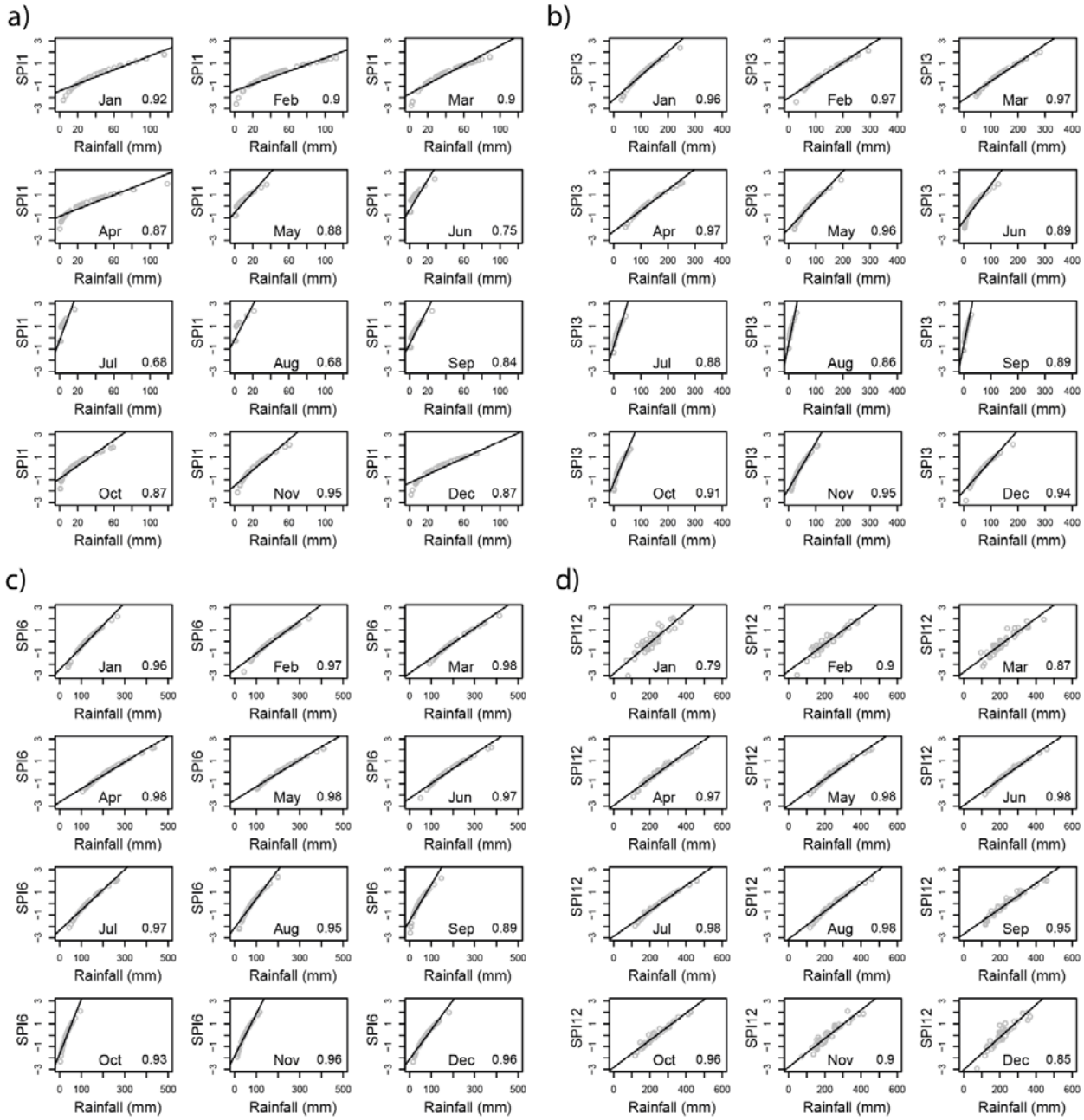
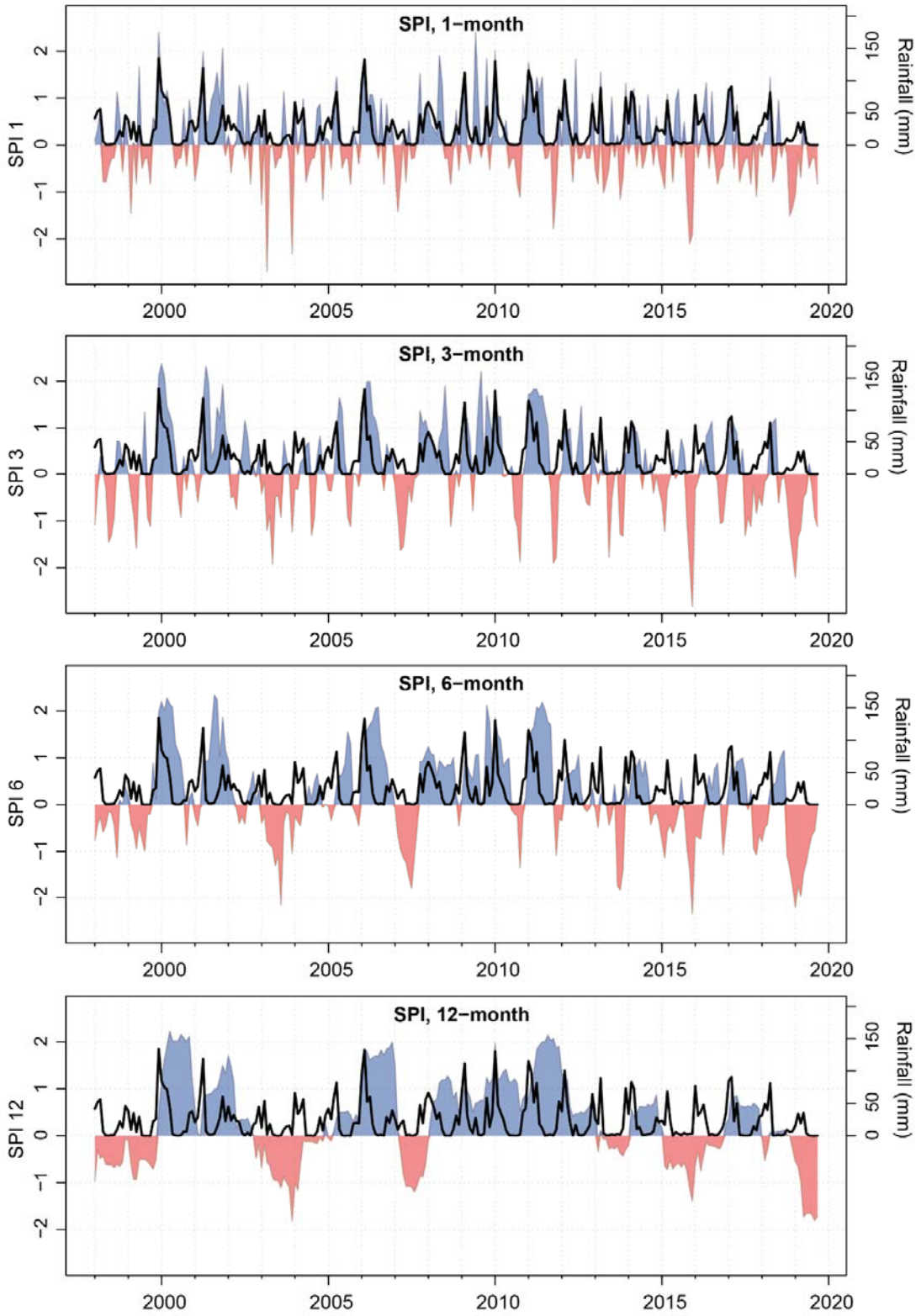


Figure S6. Long term monthly rainfall measures (black lines) and 1-, 3-, 6- and 12-month SPI values (SPI ≥ 0 = blue, SPI < 0 = red) for our study area in the Southern Kalahari from 1998 – 2019.



Supplementary tables

Table 1 Parameter estimates of smooth terms of a generalised additive mixed model (GAMM) investigating the effects of various environmental, individual and social factors on the quarterly body mass of 168 dominant female meerkats. The effective degrees of freedom (EDF) increases as the "wiggliness" of the terms increase; an EDF ~1 or <1 is consistent with a linear effect.

Smooth terms	EDF	Ref DF	χ^2	P
f(Age in months)	2.33	3.00	929.71	**< 0.001**
f(Quarter)	1.91	2.00	33.63	**< 0.001**
f(Group *f*ize)	1.50	3.00	77.52	**< 0.001**
f(Population density)	2.87	3.00	58.08	**< 0.001**
f(Year)	11.00	21.00	227.04	**< 0.001**
f(SPI)	1.00	3.00	58.63	**< 0.001**
f(SPI, Group size)	0.00	9.00	0.00	0.67
f(Group size, Quarter)	0.00	6.00	0.00	0.56
f(SPI, Quarter)	5.52	6.00	18.33	**< 0.001**
f(SPI, Group size, Quarter)	5.97	18.00	4.41	**< 0.001**
f(Individual)	148.60	167.00	14.14	**< 0.001**

Table 2 Parameter estimates of smooth terms of a zero-inflated Poisson (ZiP) GAMM investigating the correlates of quarterly fecundity (likelihood to reproduce and number of offspring) for 168 dominant female meerkats between 1998 – 2019 either including (right) or excluding (left) dominant female body mass as a predictor . The effective degrees of freedom (EDF) increases as the "wiggliness" of the terms increase; an EDF ~1 or <1 is consistent with a linear effect.

Model part	Smooth terms	EDF	Ref DF	χ^2	P	EDF	Ref DF	χ^2	P
Poisson()	*f*(Body mass)					1.00	1.00	4.91	**0.03**
	f(Body mass, Quarter)					1.60	1.96	1.25	0.49
	f(Age in months)	2.24	2.64	5.96	0.08	1.96	2.39	3.22	0.25
	f(Quarter)	1.60	2.00	8.50	**< 0.01**	1.58	2.00	8.13	**0.01**
	f(Group size)	1.90	2.31	2.49	0.33	1.98	2.40	3.02	0.27
	f(SPI)	1.00	1.00	1.39	0.24	1.00	1.00	0.56	0.45
	f(SPI, Group size)	1.42	1.71	0.45	0.64	1.36	1.62	0.33	0.66
	f(SPI, Quarter)	0.95	6.00	1.66	0.17	0.07	6.00	0.07	0.35
	f(Individual)	0.00	110.00	0.00	1.00	0.00	110.00	0.00	1.00
Bernouilli	*f*(Body mass)					2.27	2.65	12.29	**< 0.001**
	f(Body mass, Quarter)					2.59	3.50	10.83	**0.03**
	f(Age in months)	2.69	2.92	35.88	**< 0.001**	2.60	2.88	23.12	**< 0.001**
	f(Quarter)	1.96	2.00	94.93	**< 0.001**	1.96	2.00	88.25	**< 0.001**
	f(Group size)	1.57	1.90	1.10	0.60	1.33	1.57	0.29	0.81
	f(SPI)	2.27	2.62	38.89	**< 0.001**	2.07	2.45	27.11	**< 0.001**
	f(SPI, Group size)	1.91	2.53	0.41	0.83	1.01	1.03	0.04	0.85
	f(Group size, Quarter)	1.56	6.00	6.77	**0.01**	1.61	6.00	7.94	**0.01**
	f(SPI, Quarter)	4.95	6.00	26.98	**< 0.001**	4.80	6.00	23.16	**< 0.001**
	f(SPI, Group size, Quarter)	1.58	18.00	2.94	0.11	1.36	18.00	2.28	0.15
	f(Individual)	20.10	167.00	26.28	**0.03**	22.82	167.00	31.03	**0.01**

Table 3 Parameter estimates of smooth terms of generalised additive mixed models (GAMM) investigating the effects of various environmental, individual and social factors on the growth of 2417 meerkat pups. The effective degrees of freedom (EDF) increases as the "wiggliness" of the terms increase; an EDF ~1 or <1 is consistent with a linear effect.

Smooth terms	EDF	Ref DF	χ^2	P
f(Number of litter mates)	2.85	2.85	125.89	**< 0.001**
f(Age in days)	3.00	3.00	78953.70	**< 0.001**
f(Month)	9.07	10.00	91.88	**< 0.001**
f(Population density)	1.05	1.05	77.90	**< 0.001**
f(Group size)	1.70	1.70	35.21	**< 0.001**
f(Population density, group size)	2.82	2.82	172.41	**< 0.001**
f(SPI)	8.06	8.06	24.18	**< 0.001**
f(SPI, Month)	29.86	30.00	70.62	**< 0.001**
f(Number of litter mates, Age in days)	8.69	8.69	53.51	**< 0.001**
f(Group size, SPI)	8.45	8.45	15.51	**< 0.001**
f(Group size ,Month)	27.90	30.00	38.61	**< 0.001**
f(Group size, Age in days)	7.09	7.09	101.64	**< 0.001**
f(SPI, Age in days)	8.08	8.08	30.30	**< 0.001**
f(Group size, SPI, Age in days)	19.51	19.51	26.30	**< 0.001**
σ^2 LitterID	0.19			
σ^2 Residual	0.10			

Table 4 Parameter estimates of smooth terms of generalised additive mixed models (GAMM) investigating the effects of environmental, individual and social factors on the survival of 2127 meerkat pups between 1998 - 2019. The effective degrees of freedom (EDF) increases as the "wiggliness" of the terms increase; an EDF ~1 or <1 is consistent with a linear effect.

Smooth terms	EDF	Ref df	χ^2	P
f(Age in months)	2.00	3.00	55.90	**< 0.001**
f(Month)	0.00	10.00	0.00	0.50
f(Year)	6.56	19.00	61.33	**< 0.001**
f(Population density)	0.95	3.00	20.04	**< 0.001**
f(Group size)	1.83	4.00	18.21	**< 0.001**
f(SPI)	3.47	4.00	56.41	**< 0.001**
f(SPI, Group size)	2.55	16.00	7.28	**0.03**
f(Age in months, Group size)	1.81	12.00	4.22	**0.05**
f(SPI, Age in months)	4.46	12.00	13.70	**< 0.01**
f(Age in months, SPI, Group size)	3.82	48.00	8.01	**0.02**