

Supplementary Materials A

Table S1. Correlations between the proportion of land use in the buffer area around wells and the average nitrate concentration in groundwater

Watershed (Buffer radius m)	Land use	Pearson correlation coefficient
Dangishta (100)	Rainfed Agriculture	0.32*
	Residential	0.82**
	Grassland	-0.38*
	Eucalyptus	-0.41*
Robit Bata (50)	Rainfed Agriculture	-0.05
	Irrigation	0.06
	Grassland	-0.34*
	Natural Forest	-0.07

Table S2. Correlations between nitrogen fertilizer applications rate in a sphere around each well and the annually averaged nitrate concentration in the well

		<i>N per Buffer area in sphere</i>	<i>[N-NO3]</i>
Dangishta	N per Buffer area in sphere	1	
	[N-NO3]	0.676	1
Robit Bata	N per Buffer area in sphere	1	
	[N-NO3]	-0.005	1

Table S3. Averaged nitrate concentration over the study period and N-fertilizer input in in buffer area around groundwater wells

Dangishta			Robit Bata		
Well ID	N per Buffer area sphere	[N-NO3]	Well ID	N per Buffer area in sphere	[N-NO3]
W31	16.3	7.6	1.1	7.0	4.2
W32	0.0	2.2	1.2	0.0	5.1
W33	0.0	2.2	1.6	6.8	2.7
W35	8.5	3.9	2.1	0.0	3.7
W36	22.8	7.1	2.3	14.5	5.6
W37	0.2	2.7	2.4	8.3	5.0
W38	10.2	4.8	2.5	30.5	4.5
W39	0.0	4.3	2.6	0.0	4.0
W40	4.0	5.9	3.1	7.1	5.2
W41	0.0	3.0	3.2	0.0	4.5
W43	14.3	6.7	3.3	0.0	4.3
W2	6.6	5.2	3.4	8.5	4.9
W3	11.6	7.3	3.6	4.0	5.6
W4	5.1	8.0	3.8	4.4	3.7
W5	0.0	2.5	4.1	2.4	3.2
W6	0.5	2.7	4.3	13.0	4.0
W8	4.9	3.6	4.4	7.3	4.2
W9	20.2	9.4	4.5	13.4	5.0
W12	3.0	3.0	4.6	9.7	2.3
W13	0.0	2.4	5.2	7.0	4.4
W16	10.8	3.0	7.2	15.0	2.5
W17	10.3	2.2	7.3	13.3	2.2
W19	0.0	3.9	7.4	40.9	3.6
W20	12.2	4.2	8.1	11.3	3.4
W23	22.8	7.0	9.1	0.0	3.7
W24	20.2	4.3	9.4	36.6	4.6
W25	3.8	4.5	9.5	0.0	3.5
			11.2	11.4	3.4
			11.3	5.7	3.9
			11.4	8.6	2.7
			12.2	0.0	3.6
			12.3	7.6	5.1
			12.4	8.0	4.5

Table S4. Threshold concentrations for identifying redox processes in groundwater adopted from McMahon et al. (2009).

General redox category	Predominant redox process	Water-chemistry criteria (mg/L)				Comment
		O ₂	N-NO ₃ ⁻	Mn ²⁺	Fe ²⁺	
Oxic	O ₂ reduction	≥0.5	—	<0.05	<0.1	
Suboxic	—	<0.5	<0.5	<0.05	<0.1	
Anoxic	N-NO ₃ ⁻ - reduction	<0.5	≥0.5	<0.05	<0.1	
	Mn (IV) reduction	<0.5	<0.5	≥0.05	<0.1	
	Fe(III)	<0.5	<0.5	—	≥0.1	
Mixed	—	—	—	—	—	(1)

¹Criteria for more than one redox process are met

Table S5 Monthly and annual precipitation in Dangishta and Robit Bata watersheds from 2017 to 2018.

Watershed	Years	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Dangishta	2017	0	42	8	256	312	265	369	387	345	91	0	0	2075
	2018	0	0	0	34	148	172	389	304	259	150	0	0	1456
Robit Bata	2017	0	26	3	42	148	82	482	469	235	119	20	0	1626
	2018	0	0	18	0	64	194	360	288	164	46	11	0	1145

Land Use Land Cover Map

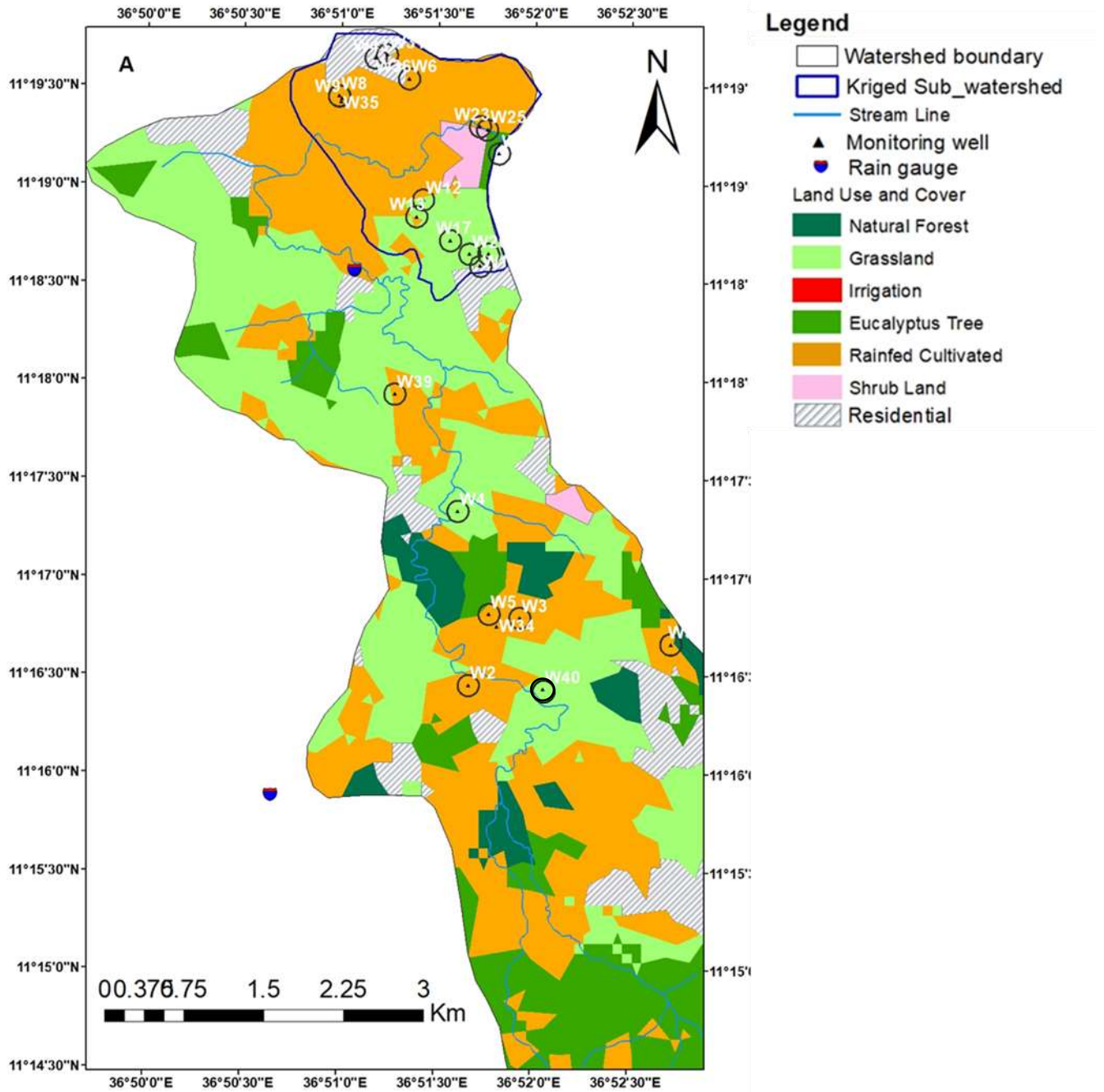


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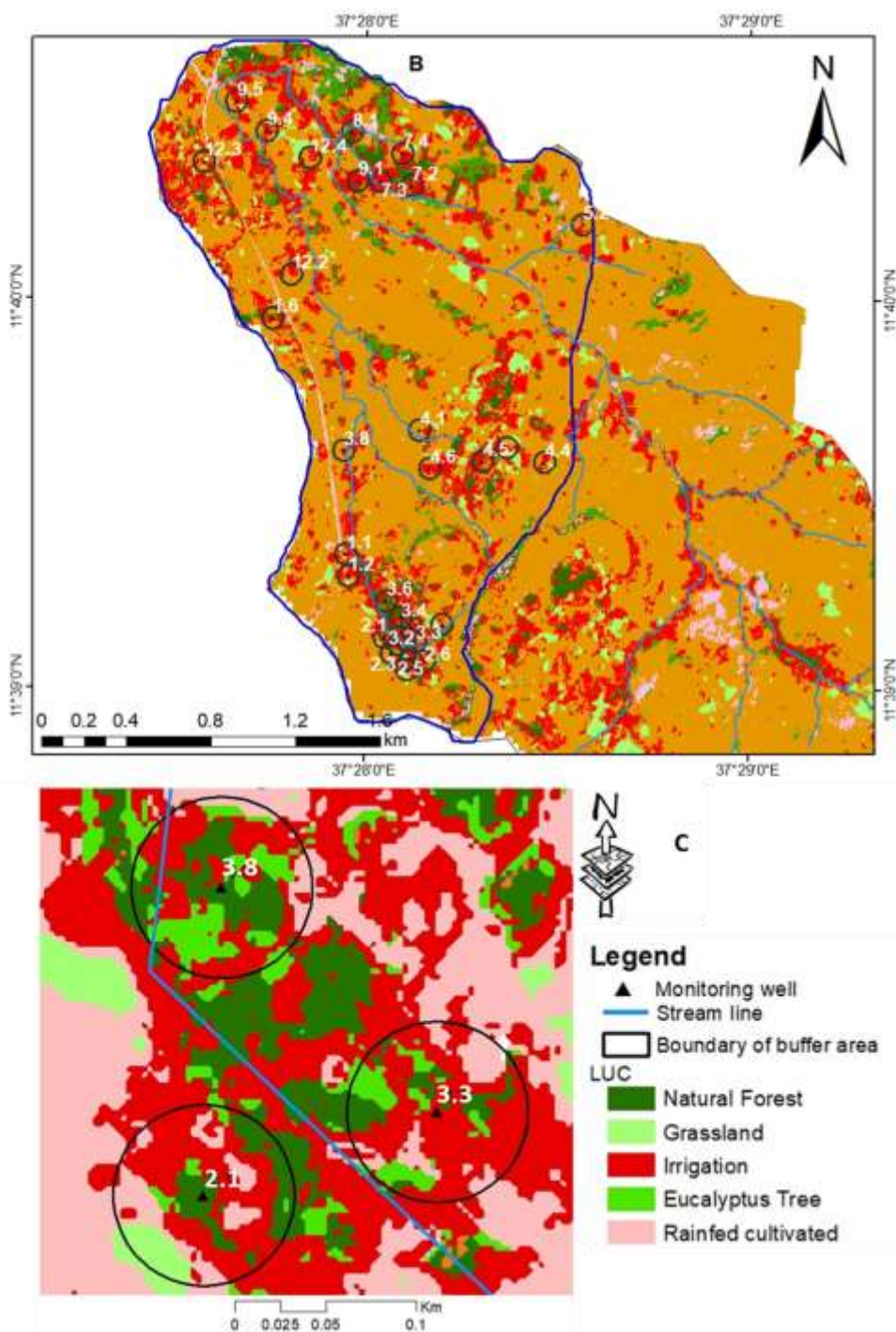


Figure S1. The land use maps with wells names corresponding to nomenclature in supplemental materials S2 and S3. The black triangle is the well point in the center of the delineated circle (100 m radius for Dangishta and 50 m radius for Robit Bata). The nitrogen applied to the various land uses within the sphere is regressed with the nitrate measured in the well. A) Dangishta watershed and B) Robit Bata watershed C) Detail of land-use analysis near wells for Robit Bata.

Multiple Regression Models Assumptions Check: Normality, Equal Variance, and Linearity

Normality: Model residuals are normally distributed. A quantile-quantile (Q-Q plot) was used to assess whether the residuals are normally distributed (Figure S2, b). Our model residuals (y) fit with theoretical quantiles (x), $y = x$.

Linearity: This assumption indicates zero mean values of the residuals indicated by a red line in Figure S2 a. The residuals have a mean closer to zero for every value of the fitted values and predictors. It means that relevant variables and interactions are included in the model, and the functional form of the relationship between the predictors and the outcome is correct.

Homoscedasticity: This assumption implies the residuals have equal variance (homoscedasticity) for every value of the fitted values and the predictors. If the residuals have equal variance, the scale-location plot is close to the flat line, which is shown by a red line in Figure S2,c. No Outlier Effects: This assumption shows the effect of outliers, which are observations whose values greatly differ from those of other observations. Leverage is a measure of the distance between individual values of a predictor and other values of the predictor (Figure S2, d). Leverage values range from 0 to 1..

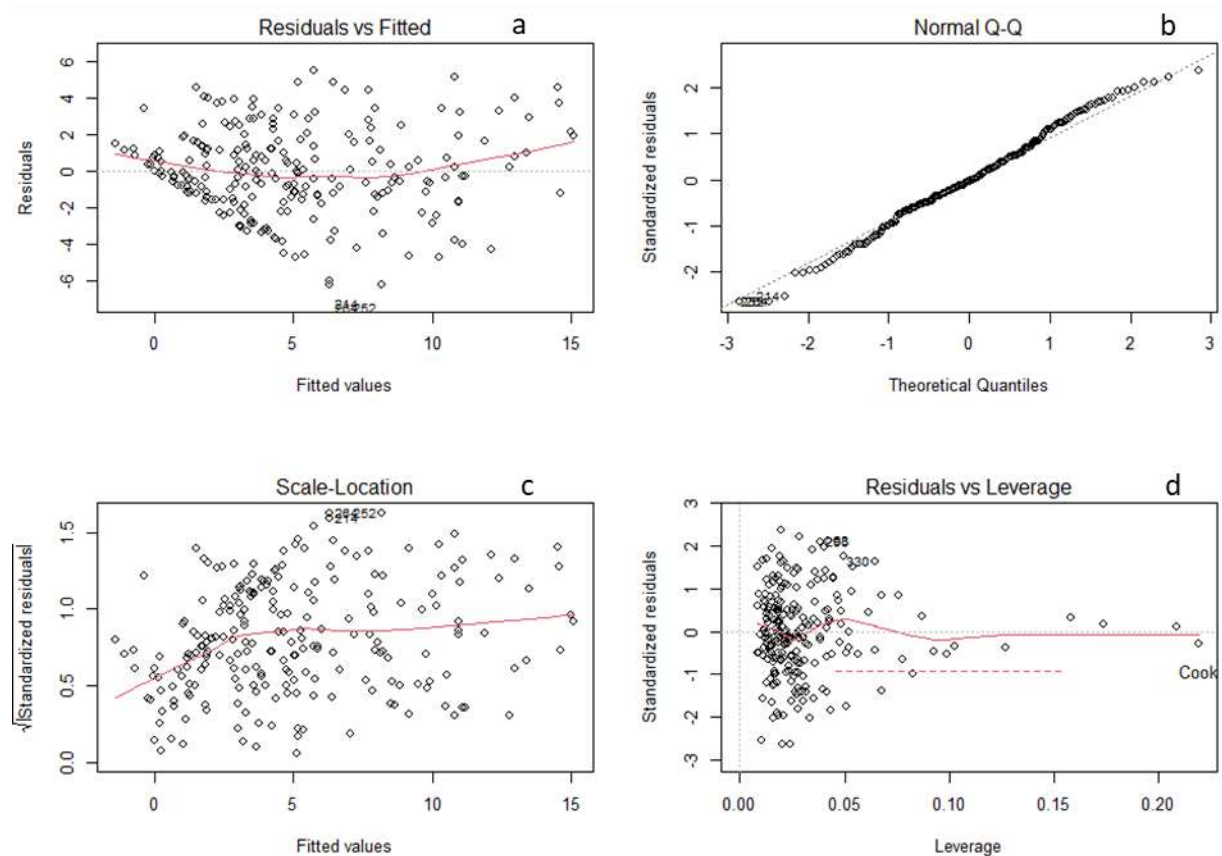


Figure S2A –Plots indicating assumption validations (i.e., linearity, normality constant variance and cook distance) for multiple linear regression model of nitrate monthly concentration in the Dangishta watershed

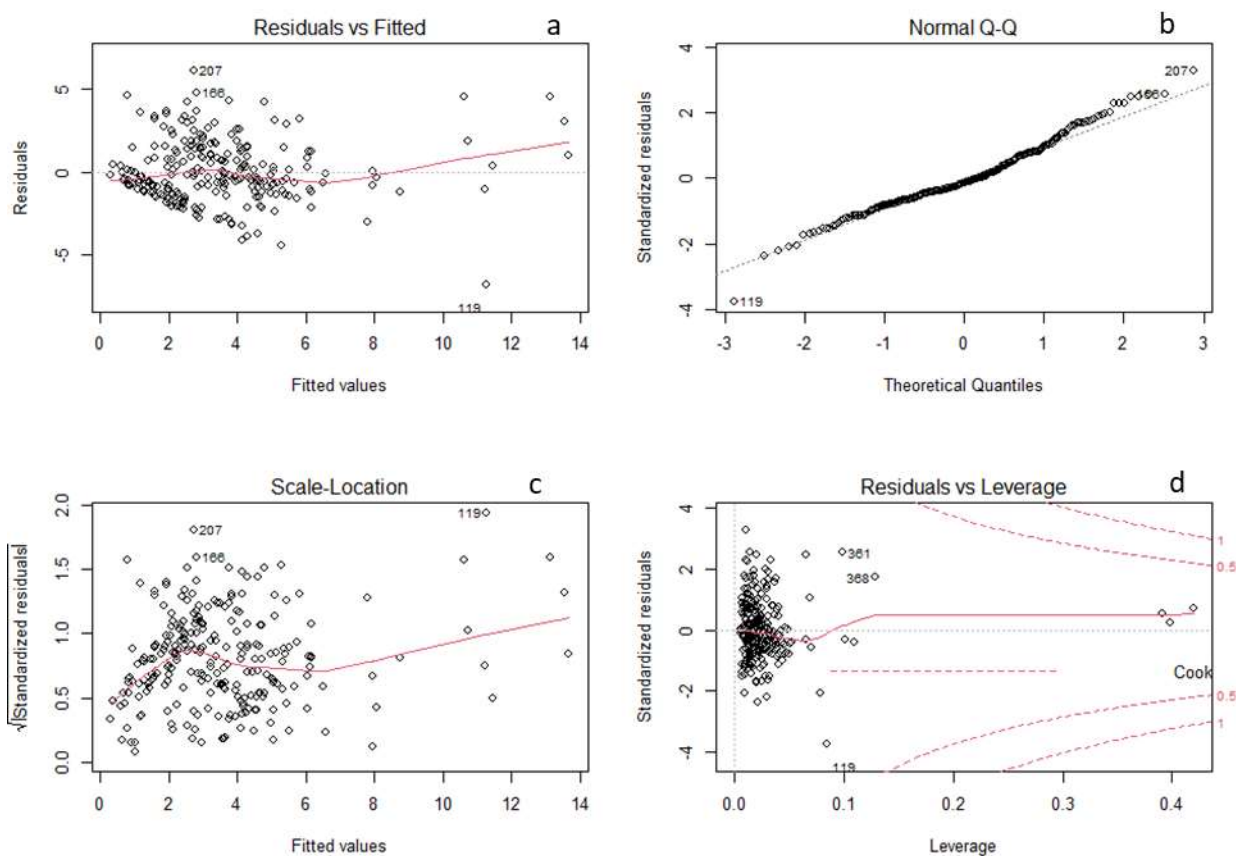


Figure S2B– A plots indicating assumption validations (i.e., linearity, normality constant variance, and cook distance) for multiple linear regression model of nitrate monthly concentration in the Dangishta watershed