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Supplementary material

Spatial and temporal dynamics of suspended sediment causing persistent turbidity in a large reservoir: Lake Dalrymple, Queensland, Australia

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Introduction

Table S1. Distance from sampling locations to the dam wall, river inflow point (boundary of the gazetted reservoir at 100% capacity) and water monitoring gauges

Sample Site	Distance from dam (km)	Distance from inflowing river(s) (km)	Distance from water monitoring station(s) (km)
Burdekin	26	18 (Burdekin River)	113 (Burdekin Sellheim)
Suttor	25	56 (Suttor River)	76 (Suttor St Anns)
		35 (Cape River)	92 (Cape Taemas)
Dam 2	10	34 (Burdekin River)	129 (Burdekin Sellheim)
		71 (Suttor River)	90 (Suttor St Anns)
		50 (Cape River)	107 (Cape Taemas)
Dam 1	0.8	44 (Burdekin River)	139 (Burdekin Sellheim)
		80 (Suttor River)	100 (Suttor St Anns)
		59 (Cape River)	116 (Cape Taemas)

Table S2. Sample collection details for each site

Sample site	Date	Time (24-h clock)	Latitude (decimal degrees)	Longitude (decimal degrees)
Burdekin	29-Jun-04	12:05	146.96826	-20.52081
	16-Dec-04	15:30	146.96834	-20.52124
	3-Aug-05	08:39	146.96863	-20.52106
	11-Oct-06	09:57	146.96849	-20.52130
	6-Sep-11	11:57	146.96807	-20.52100
Suttor	29-Jun-04	11:13	146.97418	-20.67348
	16-Dec-04	17:43	146.97321	-20.67375
	3-Aug-05	11:33	146.97336	-20.67402
	11-Oct-06	12:00	146.97343	-20.67386
	6-Sep-11	15:26	146.97310	-20.67409
Dam 2	29-Jun-04	10:00	147.04939	-20.62979
	17-Dec-04	07:15	147.04921	-20.62994
	3-Aug-05	15:46	147.04910	-20.62986
	11-Oct-06	14:23	147.04909	-20.62988
	7-Sep-11	12:41	147.04930	-20.62989
Dam 1	29-Jun-04	08:42	147.13251	-20.64054
	17-Dec-04	08:27	147.13242	-20.64065
	4-Aug-05	07:50	147.13231	-20.64058
	11-Oct-06	15:57	147.13222	-20.64083
	7-Sep-11	09:33	147.13291	-20.64064

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Additional methods

Rainfall and hydrological data

Rainfall records for the following meteorological stations were downloaded from the Bureau of Meteorology (BOM) website (http://www.bom.gov.au/climate/data/):

• 34085 – Sellheim (equivalent to the Burdekin River water monitoring station);

• 34022 – Mount Douglas (Suttor; 32 km south of the St Anns water monitoring station);

• 34094 – Taemas (equivalent to the Cape River gauging station); and

• 34029 – Burdekin Falls Dam (located at the dam, 5 km upstream of the Burdekin hydro monitoring station).

Additional results and discussion

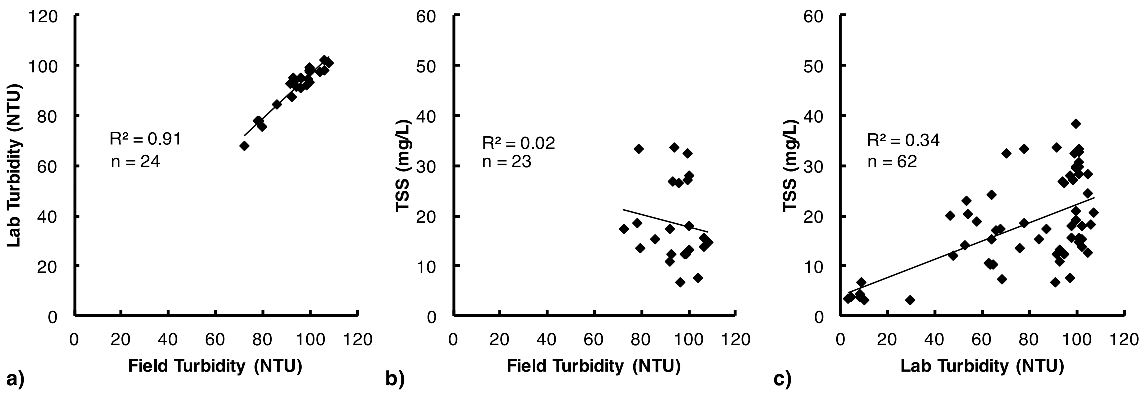

Fig. S1. (equiv. to Fig. 4 in the paper). (*a*) Turbidity data collected *in situ* and in the laboratory; (*b*) *in situ* turbidity data *v*. total suspended solids; c) laboratory turbidity data *v*. total suspended solids. The line $y = mx + c$ was estimated from the available data. Estimates were: (*a*) $m = 0.877$ (s.e. = 0.059, null hypothesis that slope = 1 has a *P*-value of 0.048) and $c = 8.706$ (s.e. = 5.556, null hypothesis that intercept = 0 has *P*-value of 0.131); (*b*) $m = –0.125$ (s.e. = 0.183, null hypothesis that slope = 0 has a *P*-value of 0.502) and $c = 30.316$ (s.e. = 17.315, null hypothesis that intercept = 0 has *P*-value of 0.095); (*c*) $m = 0.181$ (s.e. = 0.033, null hypothesis that slope = 1 has a *P*-value of <0.0001) and $c = 4.130$ (s.e. = 2.720, null hypothesis that intercept = 0 has *P*-value of 0.134).

Regression statistics for the turbidity and TSS relationships have been calculated and are presented above. For figure a, Field *v*. laboratory turbidity, modelling a null hypothesis of a slope = 1, the *P* = value is <0.05 (statistically significant at the 5% level of significance) indicating that there is not a 1 : 1 relationship between laboratory and field turbidity. However, the *P*-value for the null hypothesis intercept = 0 was >0.05 which indicates that there is no evidence to suggest that the intercept is not zero. When the model was run again assuming an intercept of zero, a Pearson's R^2 value of 0.999 was produced however the p-value was still <0.05. This indicates that the slope is still significantly statistically different from 1, but that the difference is not very large. So although there is not a 1 : 1

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relationship between laboratory and field turbidity (even if intercept was zero), the relationship is still very close to one.

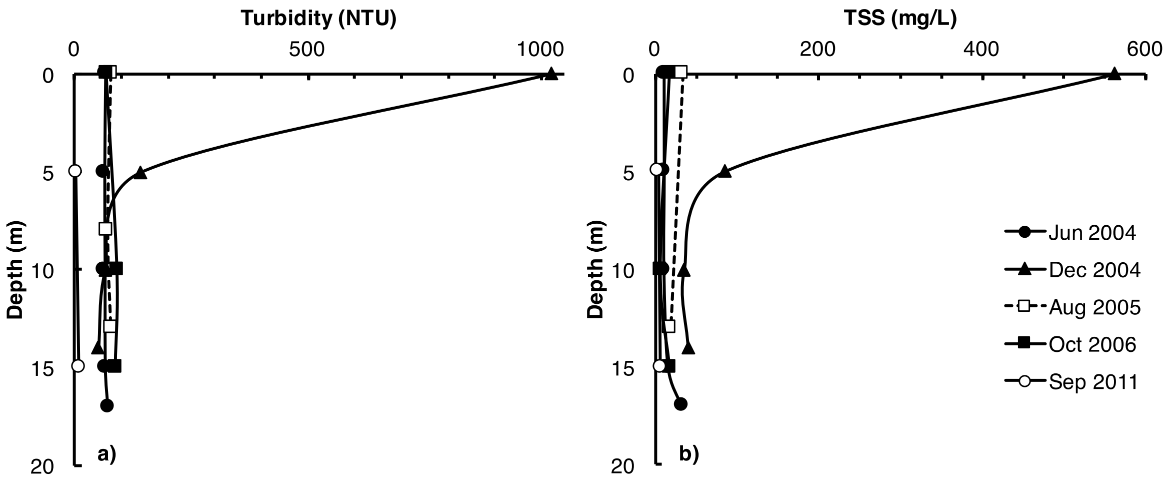

Fig. S2. (*a*) Dry season turbidity and (*b*) TSS with depth at the Burdekin site. These graphs include the samples excluded from Fig. 5 in the paper as turbidity was extremely high in these samples because of localised rainfall in the days before sampling.

High turbidity (1020 NTU in surface water) was observed at the Burdekin Site in December 2004. The turbidity was most likely due to inflow caused by localised rainfall in the days before sampling. In total, 68 mm, equivalent to the monthly median rainfall for December (67.8 mm; Bureau of Meteorology, climate data online, see http://www.bom.gov.au/climate/data/index.shtml Sellheim = Station number 034085, accessed 11 July 2016; Tables S3, S4) was recorded at Sellheim, 113 km upstream of the Burdekin sampling site in the 10 days before sampling in the reservoir.

Although rainfall in the catchments has the ability to cause turbid inflow, the effects of rainfall as measured at upstream gauges on turbidity in the reservoir is not straightforward. The Mount Douglas gauge, 108 km from the Suttor site also recorded 46 mm of rain in the 6–31 days before sampling in December 2004 (Table S3) but no corresponding increase in turbidity was observed at the Suttor site. In the 15 days before sampling in August 2005, 82 and 56 mm of rain were recorded at the Sellheim and Burdekin Falls Dam gauges respectively (Table S3); however, no corresponding increase in turbidity was observed at the Burdekin site.

Rainfall in the vicinity of most sampling sites was not recorded. The closest rainfall gauge to all sites is at the dam wall, 26 km from the Burdekin Site. Prior to the December 2004 sampling 18 mm of rain was received at the dam wall in the 2–27 days before sampling. Although the two Dam sites are closer to the wall and rainfall was also recorded at the Suttor River gauge (Mount Douglas) no increase in turbidity was observed.

We acknowledge that localised rainfall events during the dry season may temporarily elevate turbidity in isolated areas of the reservoir but this study does not have the data to quantify how long turbidity may be elevated nor where it may be located (e.g. proximal to the reservoir's banks).

Table S3. Rainfall in the 2 weeks before sampling at each location (Bureau of Meteorology, climate data online, see http://www.bom.gov.au/climate/data/index.shtml, accessed 11 July 2016)

Sampled date	Sellheim (Burdekin)		Mount Douglas (Suttor)		Taemas (Cape)		Burdekin Falls Dam	
	Rainfall (mm)	Number of days before	Rainfall (mm)	Number of days before	Rainfall (mm)	Number of days before	Rainfall (mm)	Number of days before
29 Jun 04	0	-	0	-	0	-	0	-
16 Dec 04	68.1	4–23	46.4	6–31	18	2–24	18	2–27
3 Aug 05	82.2	0–15	38	1–15	49	0–15	56	0–15
11 Oct 06	0	-	0	-	0	-	0	-
6 Sep 11	0	-	0	-	18	8–9	1.5	7–8

Table S4. Monthly median rainfall in millimetres for each location (Bureau of Meteorology, climate data online, see http://www.bom.gov.au/climate/data/index.shtml, accessed 11 July 2016)

Gauge	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sellheim (Burdekin)	114.8	114.1	84.8	18.9	9.5	11.4	0	0	0	9.4	30.0	67.8
Mount Douglas (Suttor and Belyando)	93.5	92.4	49.4	10.9	12.2	16.0	2.2	5.0	1.9	15.7	44.6	64.0
Taemas (Cape)	112.1	103.4	52.4	11.0	6.3	8.2	0	5.8	0	5.5	27.7	42.0
Burdekin Falls Dam	123.5	97.0	48.2	21.0	18.0	11.5	2.0	1.2	2.5	9.5	34.0	78.2

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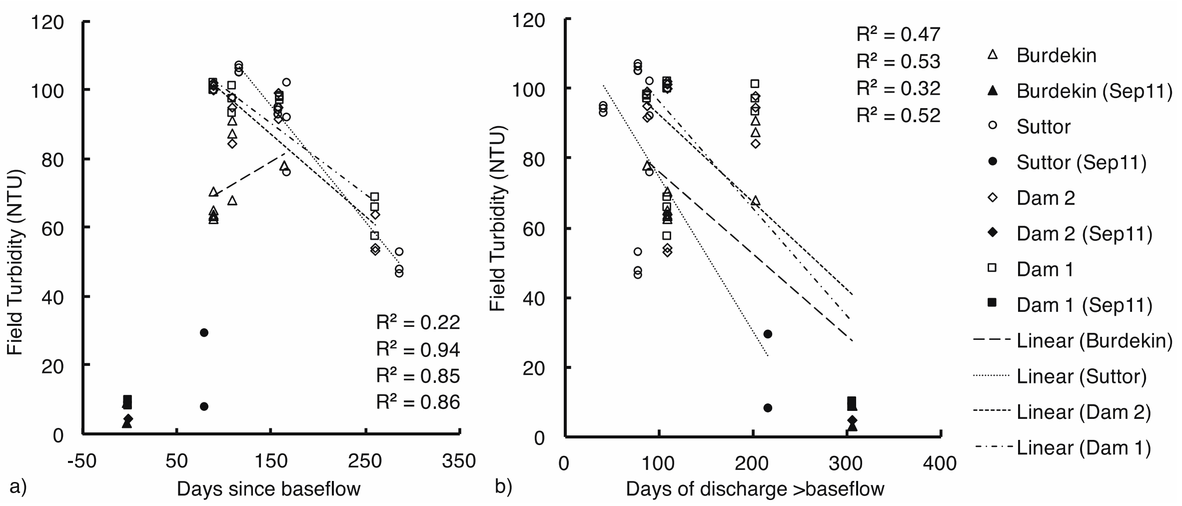

Fig. S3. (equiv. to Fig. 8 in the paper). (*a*) Plot of the number of days since baseflow was last reached *v*. turbidity at each location. September 2011 samples were excluded from the regression calculations as outliers whose turbidity values are greatly affected by the above-average discharge and low flow duration of that water year. The line $y = mx + c$ was estimated from the available data for each set of samples from each location. Burdekin: m = 0.163 (s.e. = 0.108, hypothesis that slope = 0 has a *P*-value of 0.168) and c = 54.791 (s.e. = 12.196, hypothesis that intercept = 0 has *P*-value of 0.002). Note that Burdekin site samples from December 2004 have not been included as discussed above. Suttor: m = –0.335 (s.e. = 0.024, hypothesis that slope = 0 has a *P*-value of <0.0001) and c = 145.386 (s.e. = 4.467, hypothesis that intercept = 0 has *P*-value of <0.0001). Dam 2: m = –0.240 (s.e. = 0.028, hypothesis that slope = 0 has a *P*-value of <0.0001) and c = 122.910 (s.e. = 4.293, hypothesis that intercept = 0 has *P*-value of <0.0001). Dam 1: m = –0.204 (s.e. = 0.022, hypothesis that slope = 0 has a *P*-value of <0.0001) and c = 120.784 (s.e. = 3.312, hypothesis that intercept = 0 has *P*-value of <0.0001). (*b*) Plot of the duration of discharge recorded that was above baseflow *v*. turbidity at each location. The line $y = mx + c$ was estimated from the available data for each set of samples from each location. Burdekin: m = –0.235 (s.e. = 0.079, hypothesis that slope = 0 has a *P*-value of 0.014) and c = 99.581 (s.e. = 0.113, hypothesis that intercept = 0 has *P*-value of <0.0001). Suttor: m = –0.448 (s.e. = 0.024, hypothesis that slope = 0 has a *P*-value of 0.002) and c = 119.711 (s.e. = 11.760, hypothesis that intercept = 0 has *P*-value of <0.0001). Dam 2: m = –0.251 (s.e. = 0.098, hypothesis that slope = 0 has a *P*-value of 0.022) and c = 117.714 (s.e. = 14.389, hypothesis that intercept = 0 has *P*-value of <0.0001). Dam 1: m = –0.310 (s.e. = 0.074, hypothesis that slope = 0 has a *P*-value of 0.001) and c = 127.786 (s.e. = 11.723, hypothesis that intercept = 0 has *P*-value of <0.0001).