Variations in suspended sediment dynamics of catchments of differing land-use history in the upper Brantian and Kalabakan catchments of the SAFE Project, Sabah (North Borneo)

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Introduction

- The SAFE Project hydrology component aims to understand the effects different land use as well as different treatment of catchments on suspended sediment load, solutes and water quality in tropical streams
- Today’s focus: Different land use history

Background

- Stream water quality is inextricably linked to land use of the catchment
- The export of suspended sediment (terrestrial or aquatic) has important impacts on water quality – aquatic ecosystems, health and economic activity

Background

Adverse effects of high suspended sediment

- Limit penetration of sunlight – limiting aquatic plants
- Killing of aquatic animals – clogging of gills
- Prevent spawning of aquatic animals
- Unfit for human consumption
- Economic activity – industrial or commercial
- Limit of less than 1 NTU for drinking water (WHO, 2011)

Aim

- To compare

(i) **peak suspended sediment concentration**

(ii) **duration of high suspended sediment concentration**

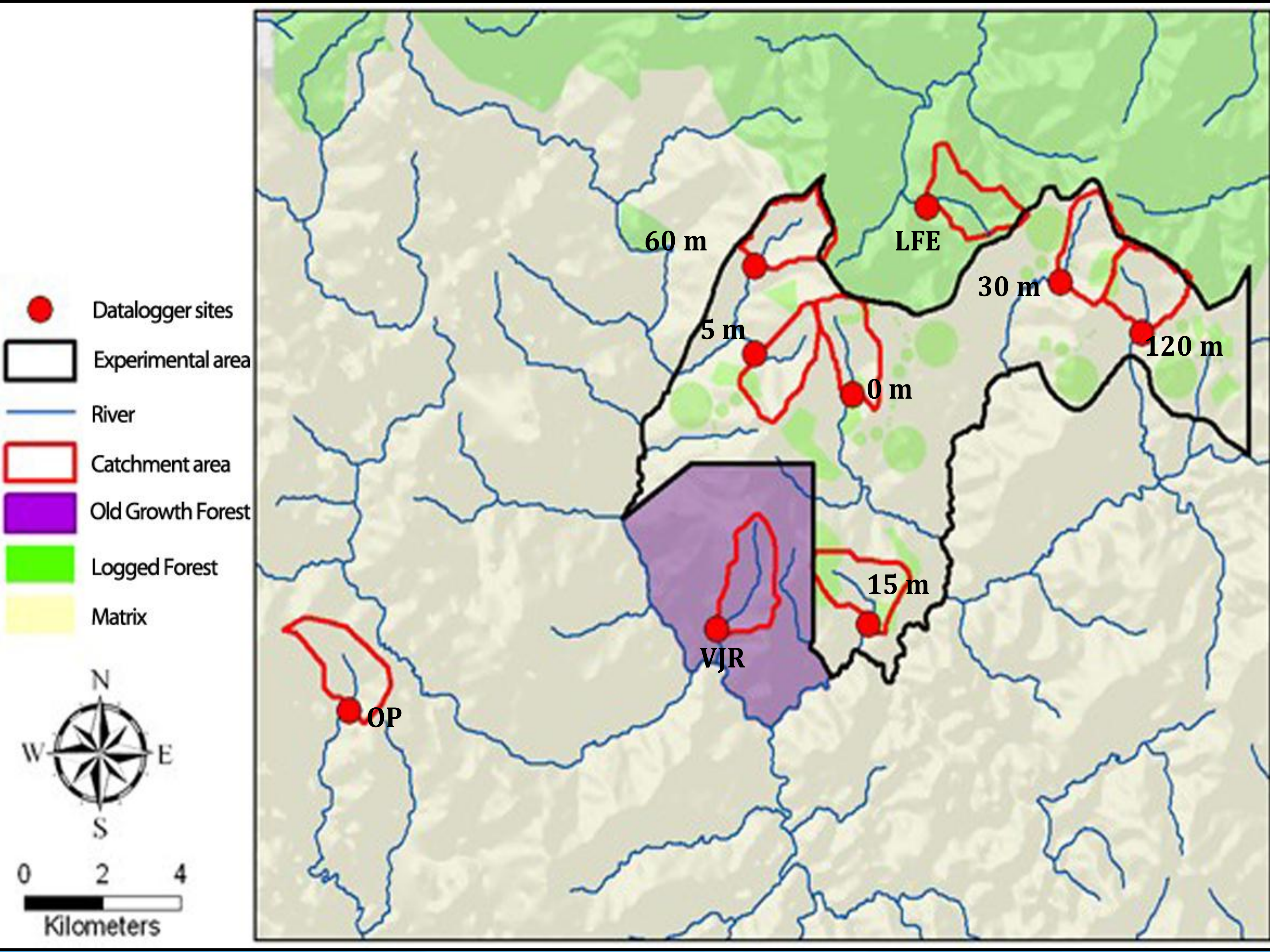
between streams of repeatedly logged forest (5 m), logged forest (LFE), virgin jungle reserve (VJR) and the oil palm (OP).

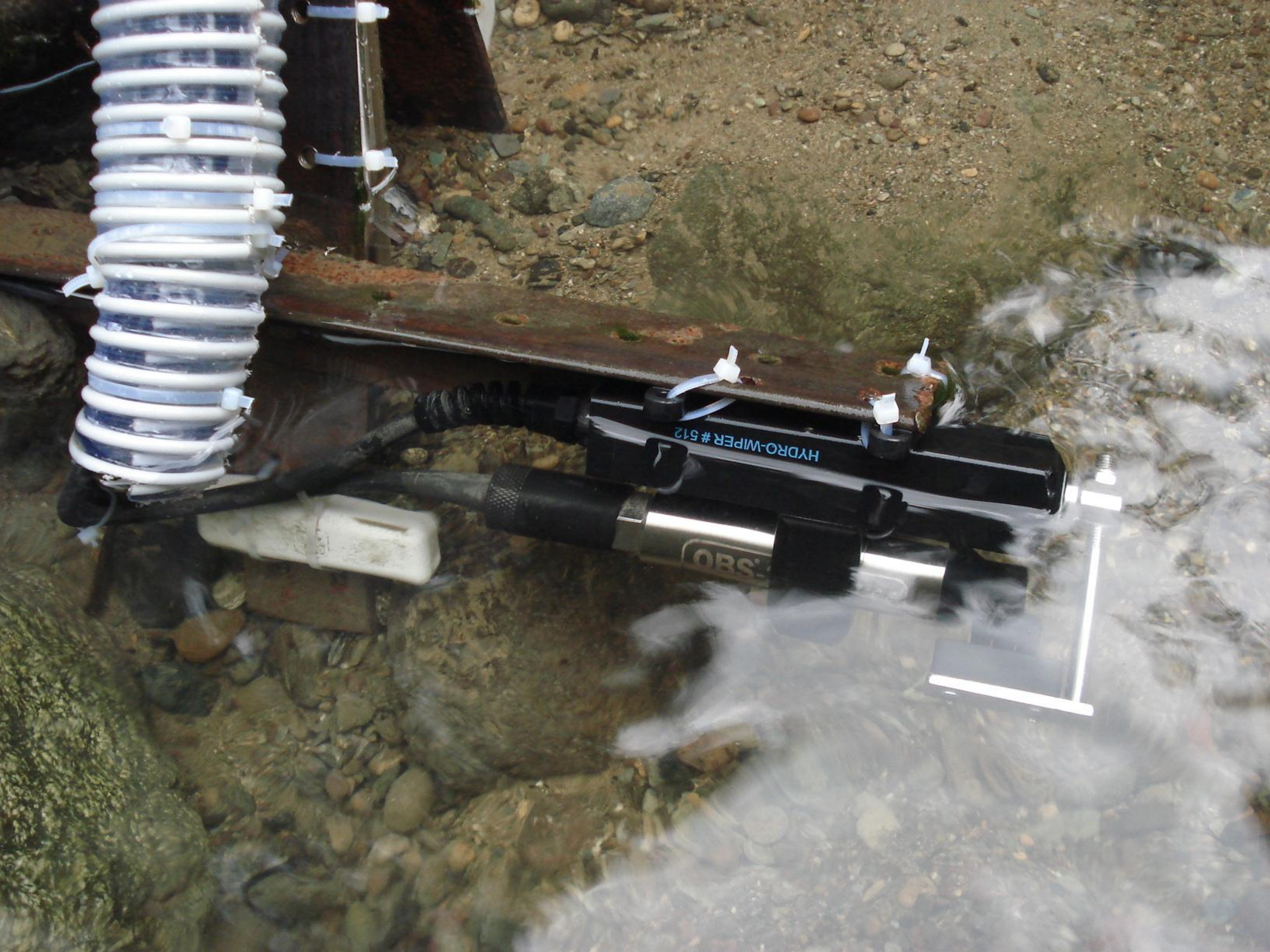
Experimental Design

- 4 catchments of differing land use history
  - 5 m (repeatedly logged)
  - LFE (Logged Forest Experiment – logged)
  - VJR (Virgin Jungle Reserve – Old Growth)
  - OP (Oil Palm)
- Catchment area of 2.6 km^2 and gradient of 16°.
- Data collected via depth sensor, turbidity sensor, conductivity sensor and a tipping bucket raingauge all connected to solar-powered datalogger in each catchment

Experimental Design

- Two sizes of storms from each stream – one for small storm (< 100 L/s) and one large (~ 400 L/s)

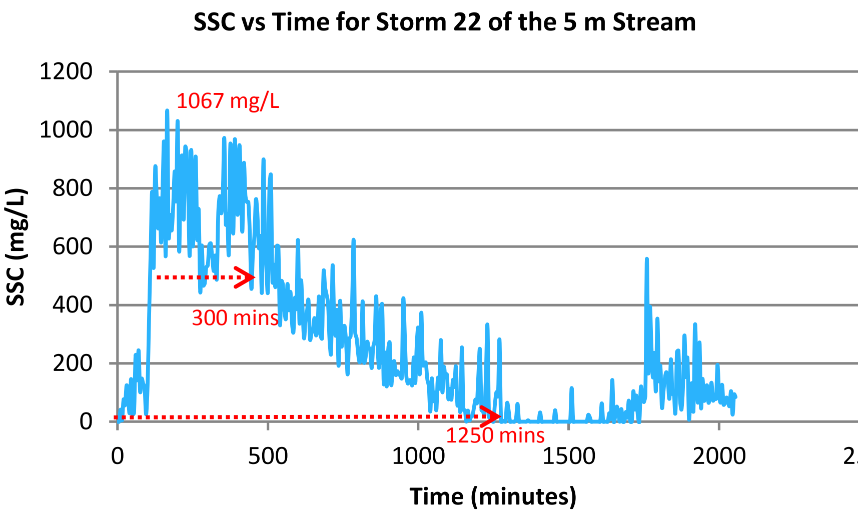

Datalogger sites
Experimental area
River
Catchment area
Old Growth Forest
Logged Forest
Matrix
N
S
W
E
0
2
4
Kilometers
60 m
LFE
30 m
5 m
120 m
0 m
15 m
VJR
OP

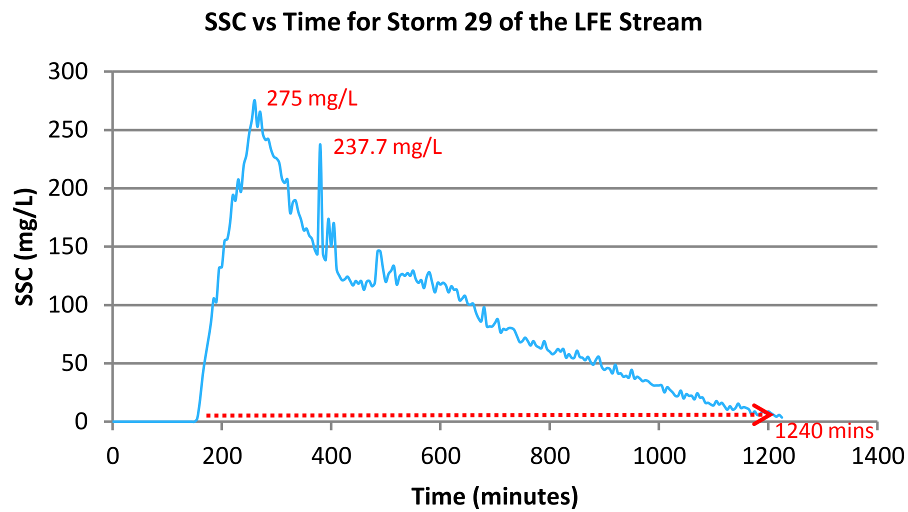

HYDRO-WIPER # 512
OBS

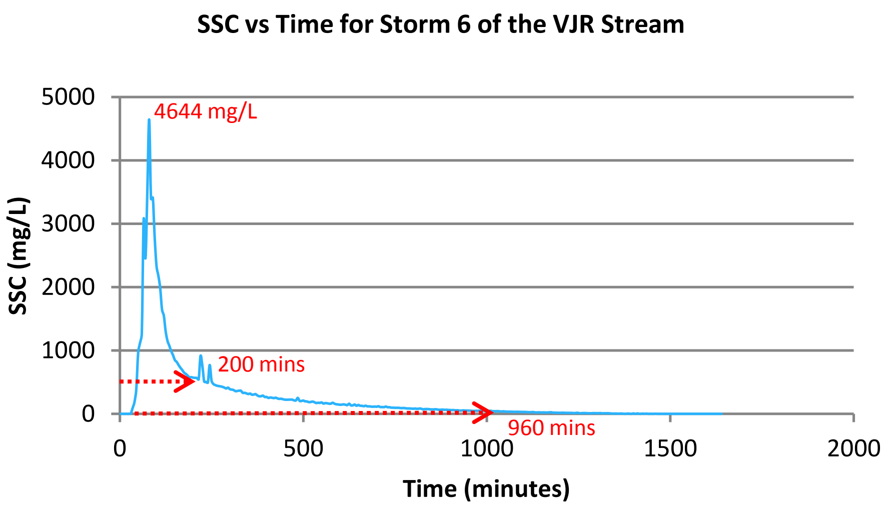
Results

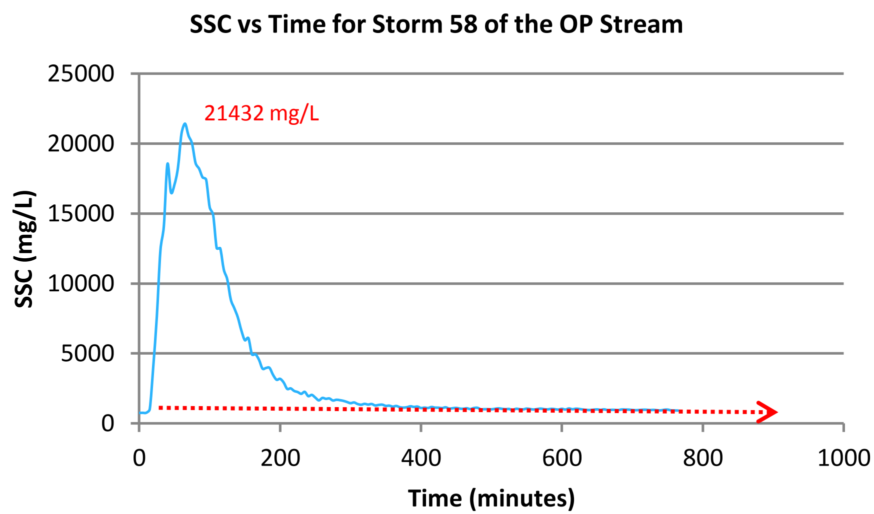
Suspended sediment concentration at baseflow and peak flow

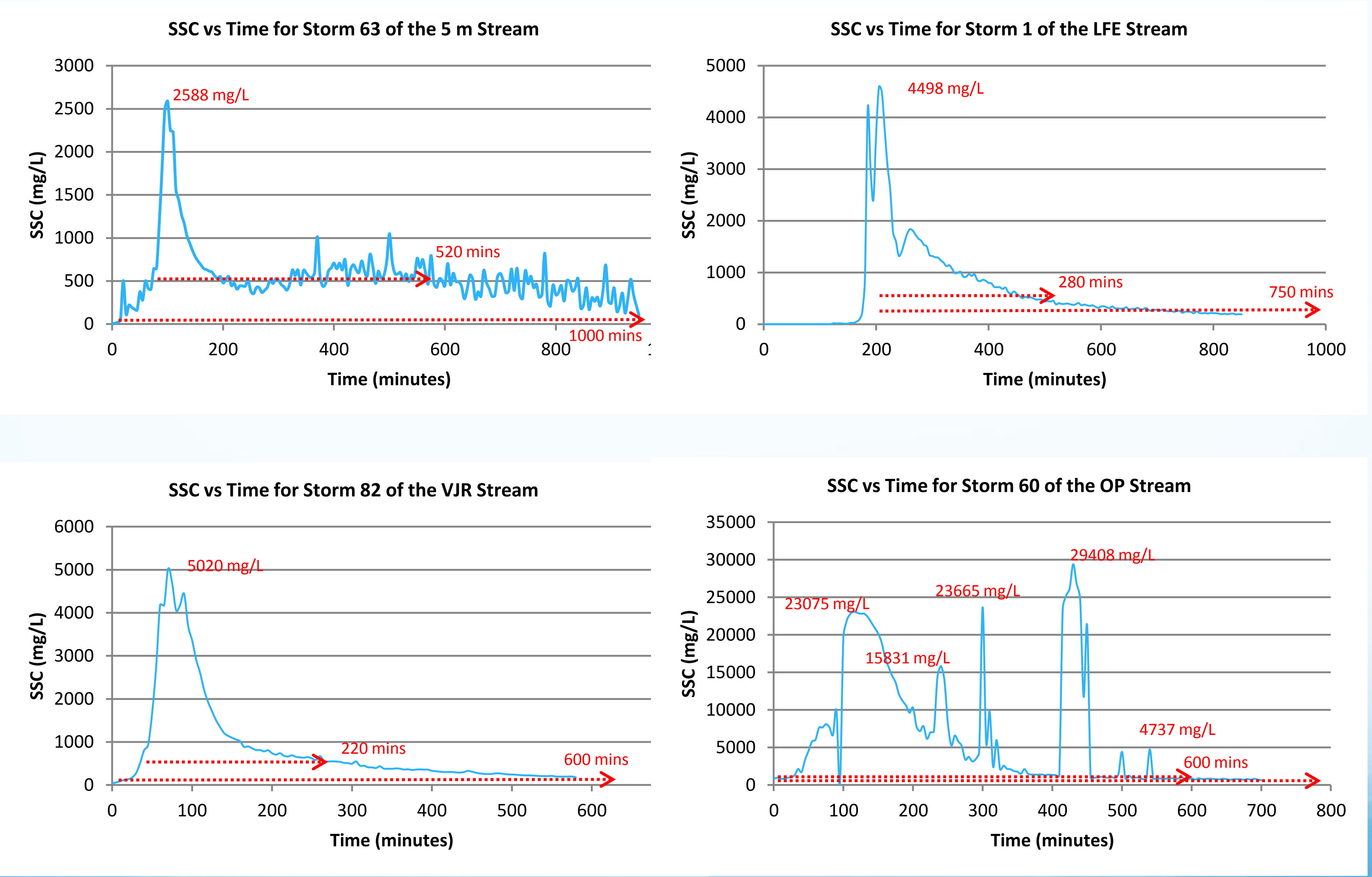
Stream	Baseline Discharge (L/s)	Peak Discharge (L/s)	Baseline SSC (mg/L)	Peak SSC (mg/L)
5 m (repeatedly logged)	15 - 35	1250	0 - 70	32107
LFE (logged; regenerating)	100 - 250	2005	0 - 189	35402
VJR (virgin jungle reserve)	3 - 10	440	0 - 101	25856
OP (oil palm)	3 - 10	443	86 - 414	30926


SSC vs Time for Storm 22 of the 5 m Stream
1067 mg/L
300 mins
1250 mins
SSC (mg/L)
Time (minutes)

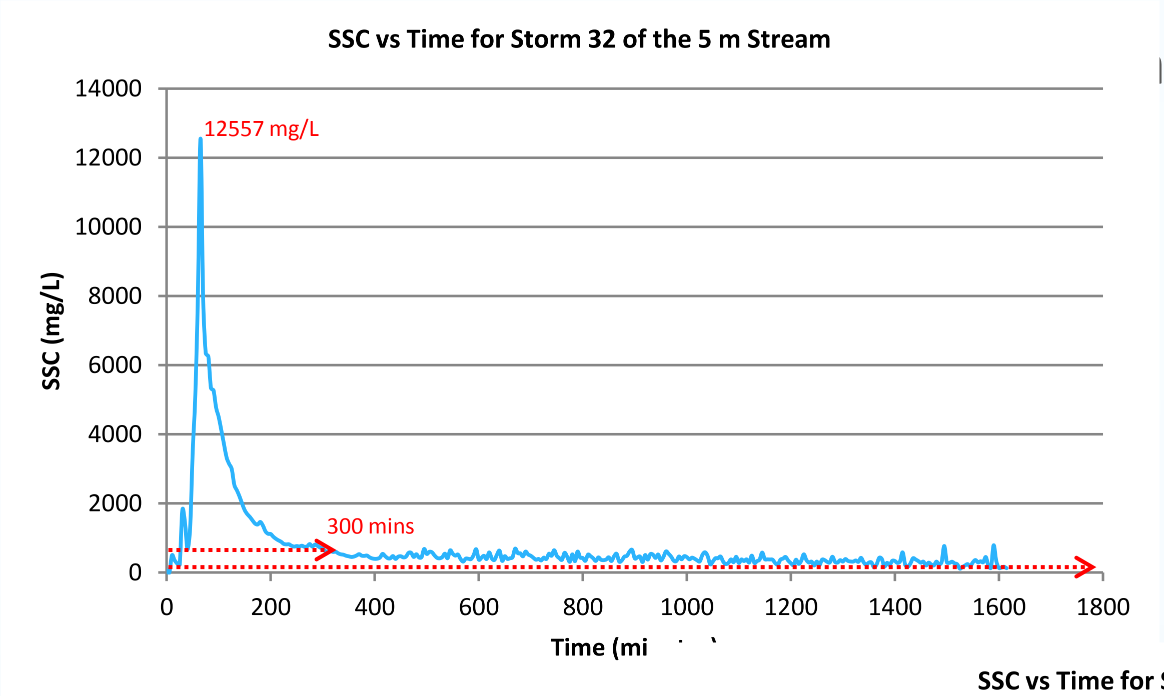

SSC vs Time for Storm 29 of the LFE Stream
275 mg/L
237.7 mg/L
1240 mins
SSC (mg/L)
Time (minutes)

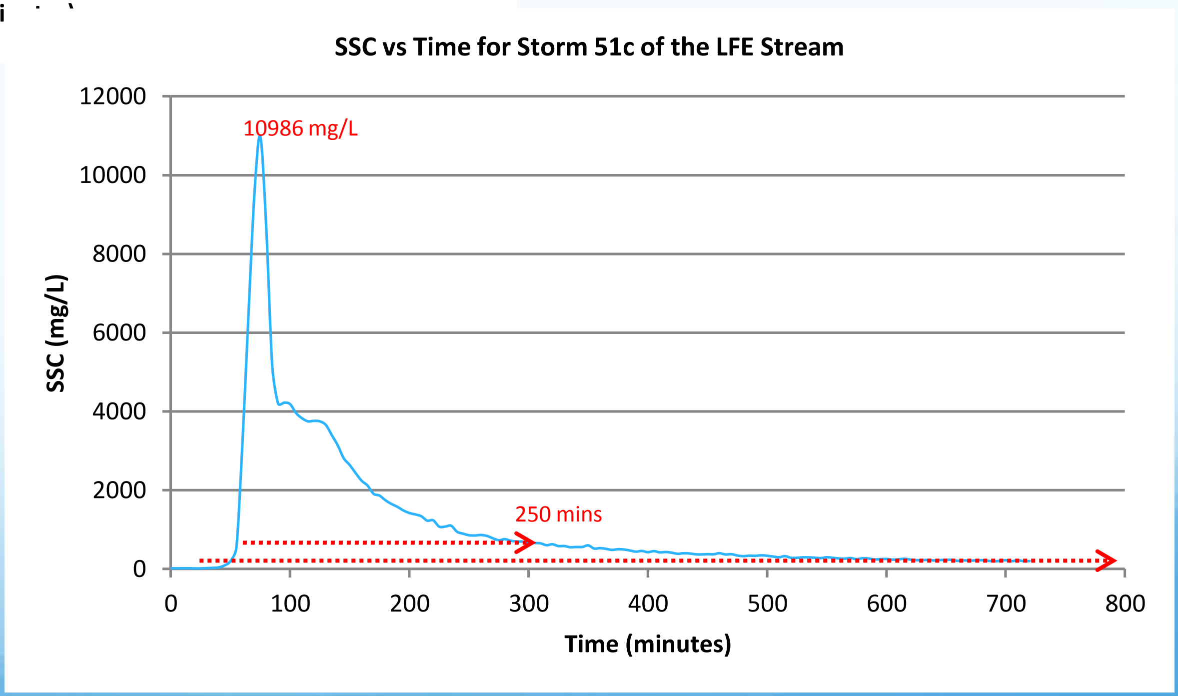

SSC vs Time for Storm 6 of the VJR Stream
4644 mg/L
200 mins
960 mins
SSC (mg/L)
Time (minutes)

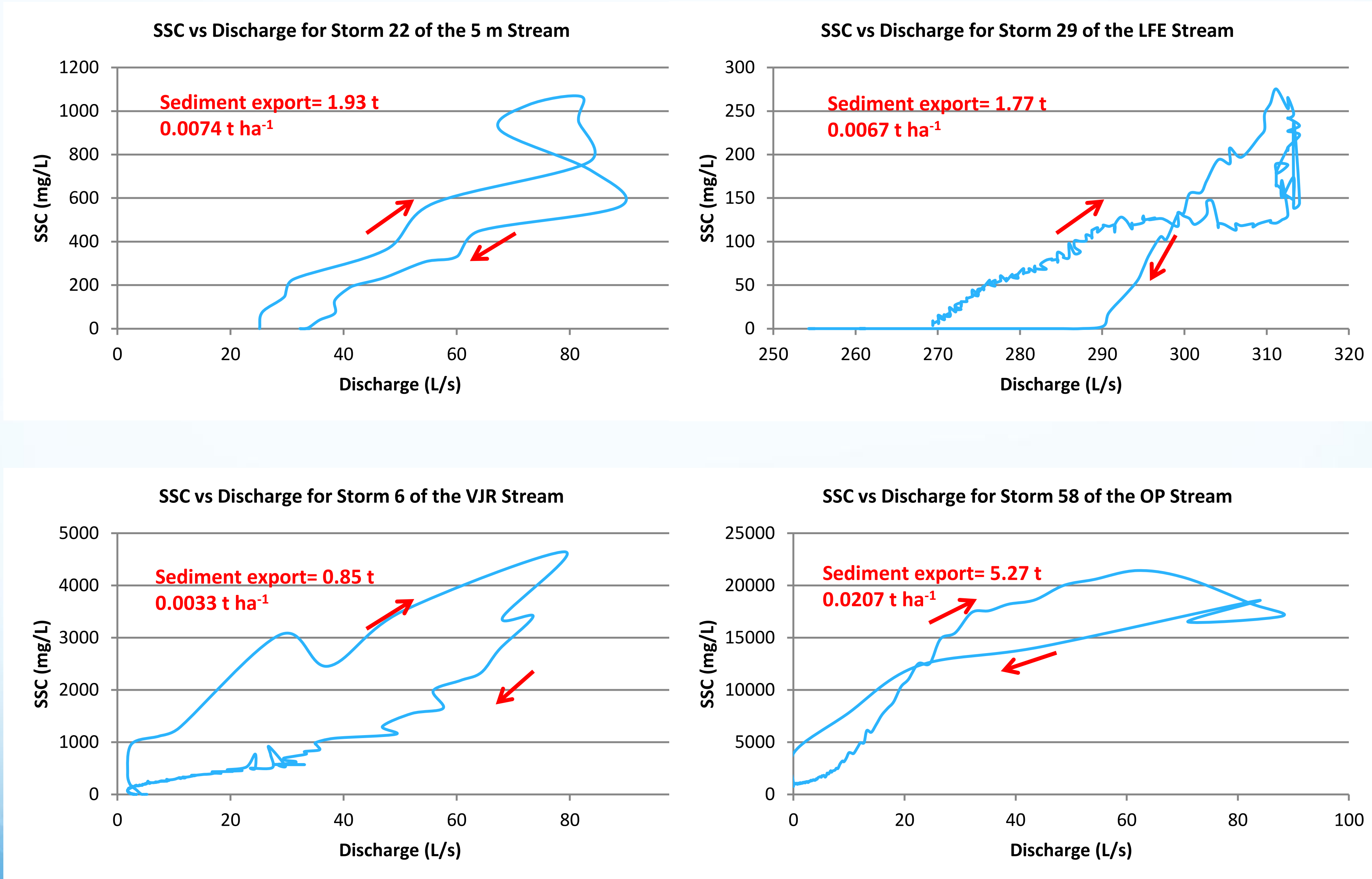

SSC vs Time for Storm 58 of the OP Stream
21432 mg/L
SSC (mg/L)
Time (minutes)

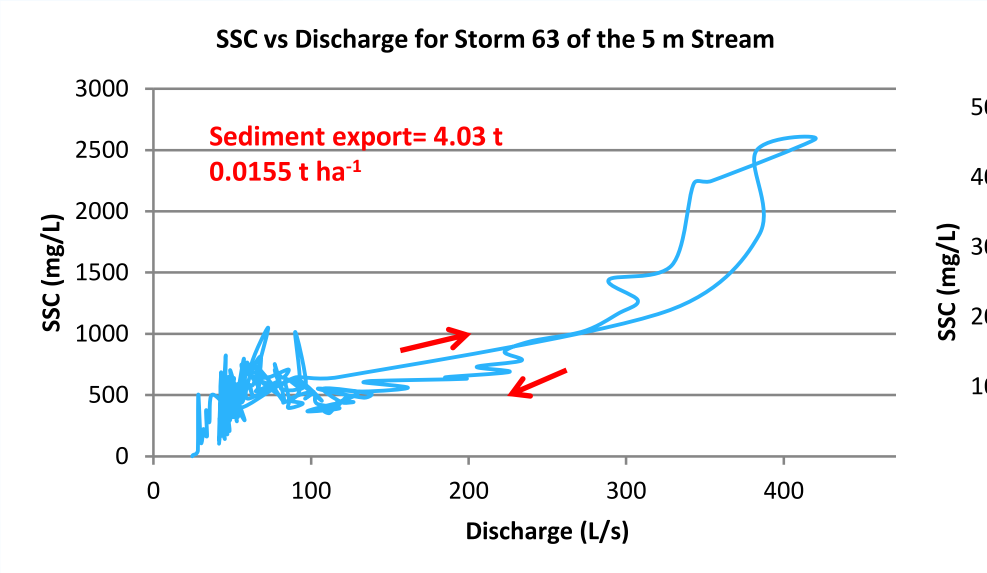

SSC vs Time for Storm 63 of the 5 m Stream
SSC (mg/L)
Time (minutes)
2588 mg/L
520 mins
1000 mins
SSC vs Time for Storm 1 of the LFE Stream
SSC (mg/L)
Time (minutes)
4498 mg/L
280 mins
750 mins
SSC vs Time for Storm 82 of the VJR Stream
SSC (mg/L)
Time (minutes)
5020 mg/L
220 mins
600 mins
SSC vs Time for Storm 60 of the OP Stream
SSC (mg/L)
Time (minutes)
23075 mg/L
23665 mg/L
29408 mg/L
15831 mg/L
4737 mg/L
600 mins

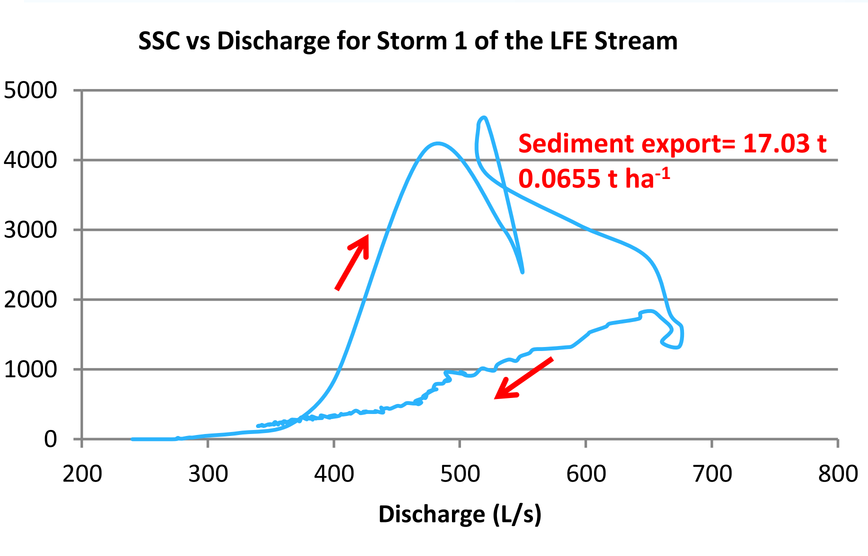
centration (discharge

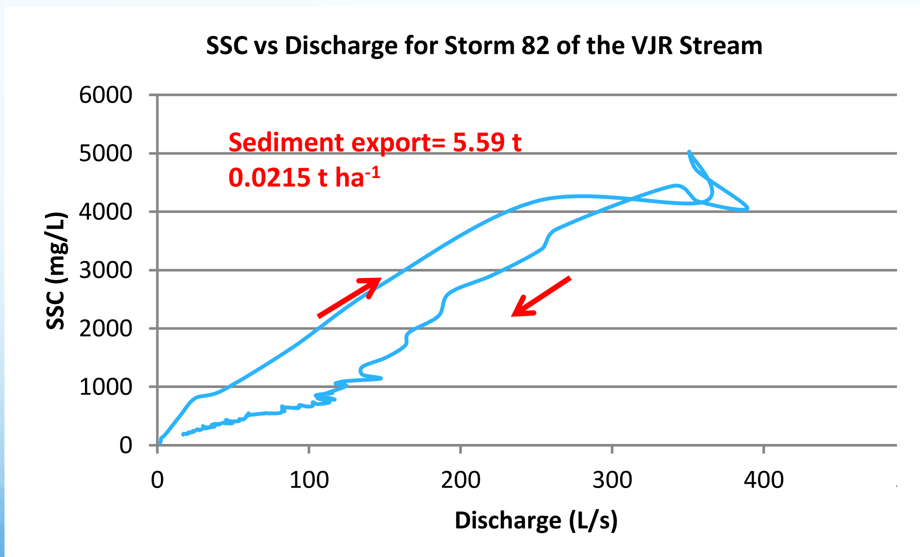


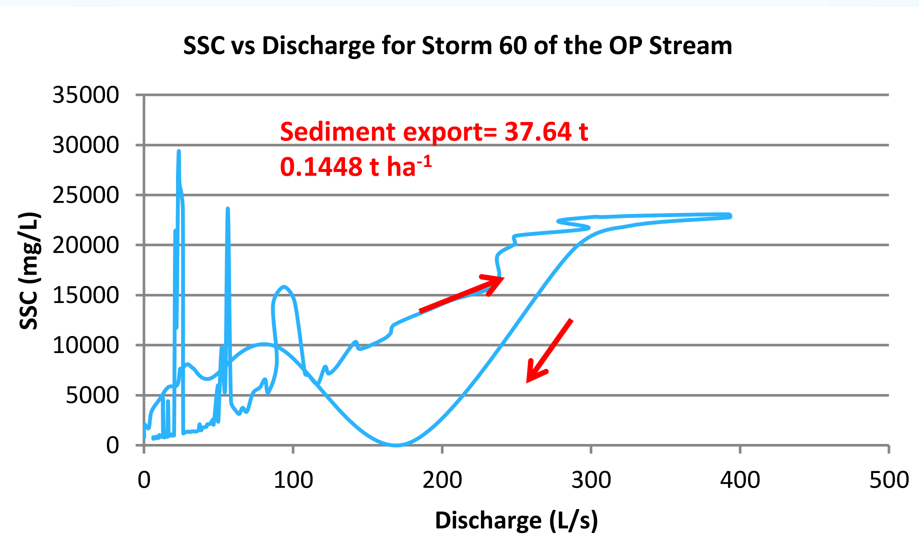



SSC vs Discharge for Storm 22 of the 5 m Stream
Sediment export= 1.93 t
0.0074 t ha-1
SSC (mg/L)
Discharge (L/s)
SSC vs Discharge for Storm 29 of the LFE Stream
Sediment export= 1.77 t
0.0067 t ha-1
SSC (mg/L)
Discharge (L/s)
SSC vs Discharge for Storm 6 of the VJR Stream
Sediment export= 0.85 t
0.0033 t ha-1
SSC (mg/L)
Discharge (L/s)
SSC vs Discharge for Storm 58 of the OP Stream
Sediment export= 5.27 t
0.0207 t ha-1
SSC (mg/L)
Discharge (L/s)

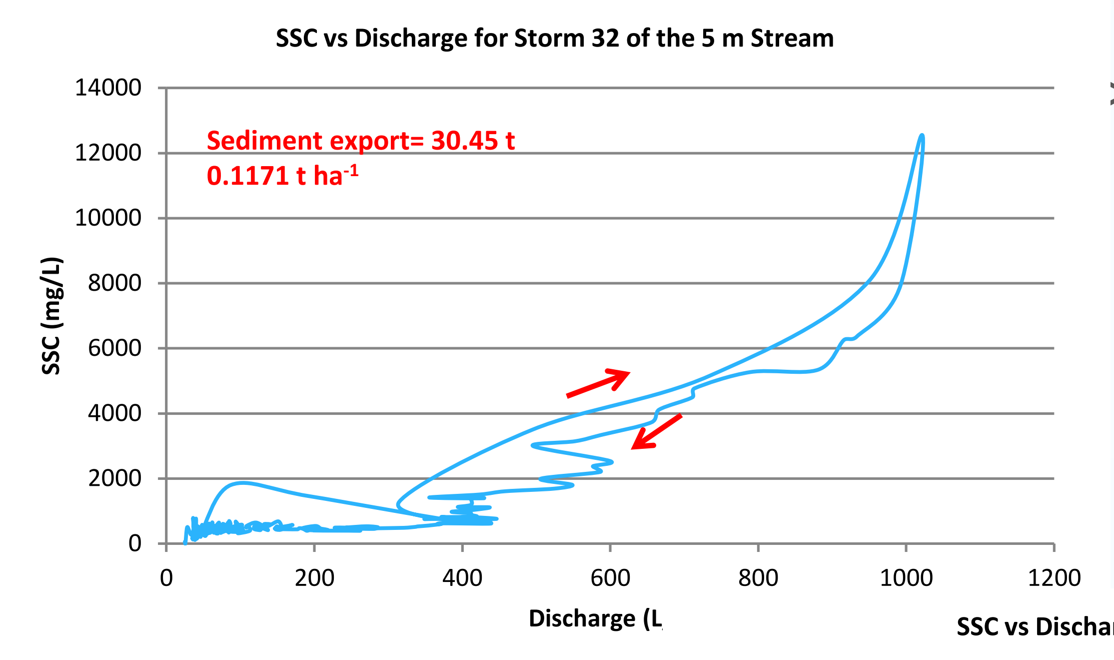

SSC vs Discharge for Storm 63 of the 5 m Stream
Sediment export= 4.03 t
0.0155 t ha-1
SSC (mg/L)
Discharge (L/s)
0
500
1000
1500
2000
2500
3000
0
100
200
300
400


SSC vs Discharge for Storm 1 of the LFE Stream
Sediment export= 17.03 t
0.0655 t ha-1
SSC (mg/L)
Discharge (L/s)
0
1000
2000
3000
4000
5000
200
300
400
500
600
700
800

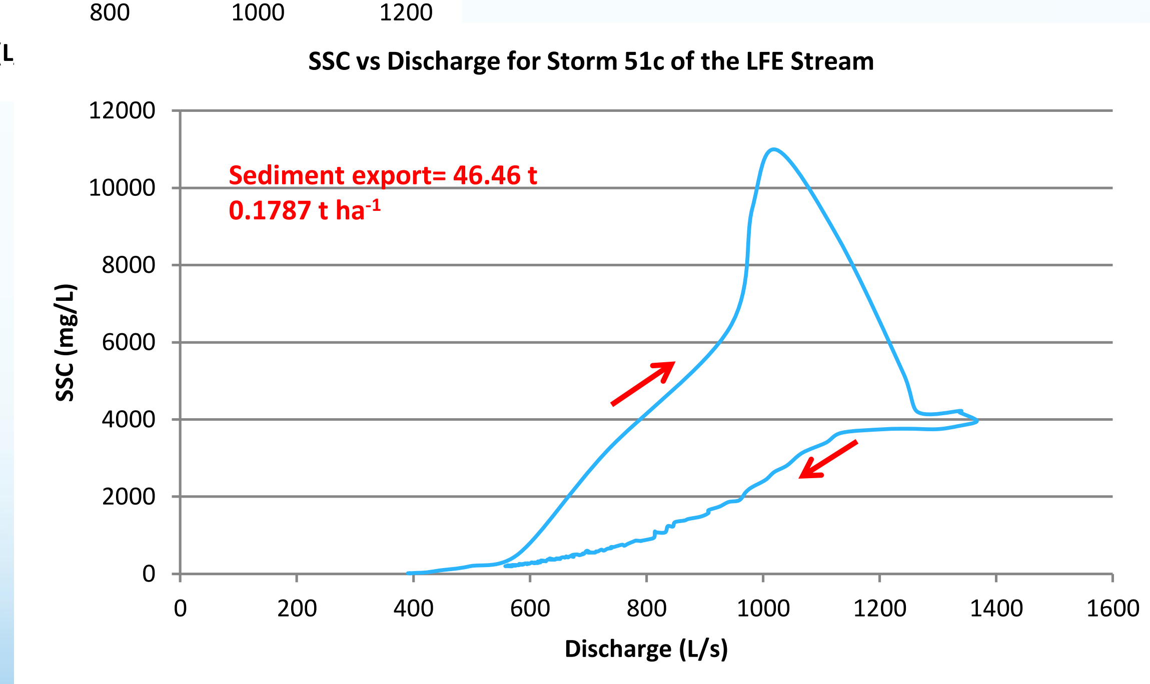

SSC vs Discharge for Storm 82 of the VJR Stream
Sediment export= 5.59 t
0.0215 t ha-1
SSC (mg/L)
Discharge (L/s)
0
1000
2000
3000
4000
5000
6000
0
100
200
300
400


SSC vs Discharge for Storm 60 of the OP Stream
Sediment export= 37.64 t
0.1448 t ha-1
SSC (mg/L)
Discharge (L/s)
0
5000
10000
15000
20000
25000
30000
35000
0
100
200
300
400
500

> 900 L/s)



SSC vs Discharge for Storm 32 of the 5 m Stream
Sediment export= 30.45 t
0.1171 t ha-1
SSC (mg/L)
14000
12000
10000
8000
6000
4000
2000
0
0
200
400
600
800
1000
1200
Discharge (L



SSC vs Discharge for Storm 51c of the LFE Stream
Sediment export= 46.46 t
0.1787 t ha-1
SSC (mg/L)
12000
10000
8000
6000
4000
2000
0
0
200
400
600
800
1000
1200
1400
1600
Discharge (L/s)

Early Conclusions

- In the largest storms, peak SSC recorded is similar for the 5 m, LFE and OP streams (**30000 – 35000** mg/L). The VJR stream has lower peak SSC (**25000** mg/L)
- For the OP stream, SSC is never as low as other streams even at baseflow.

Early Conclusions

- SSC declines much faster in the LFE stream compared to the 5 m stream
- The VJR has higher peak SSC, but SSC recovery time is shorter than the 5m and LFE
- The oil palm has much higher SSC. SSC declines rapidly to bout 1000 mg/L, but recovery time from then is the longest. Baseline is never as low as other streams
- For extreme events, the LFE stream has lower peak SSC than the 5 m stream; and takes less time to return to baseline levels.

Early Conclusions

- Sediment export is highest for the OP stream for small and large storms
- Sediment export is lowest for the VJR stream for small storms, but equals to that of logged streams for larger storms

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Thank you

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Stability of Altered Forest Ecosystems