

*Using historical records to identify long-term  
trends in relation to climate change:  
Myanmar case studies*

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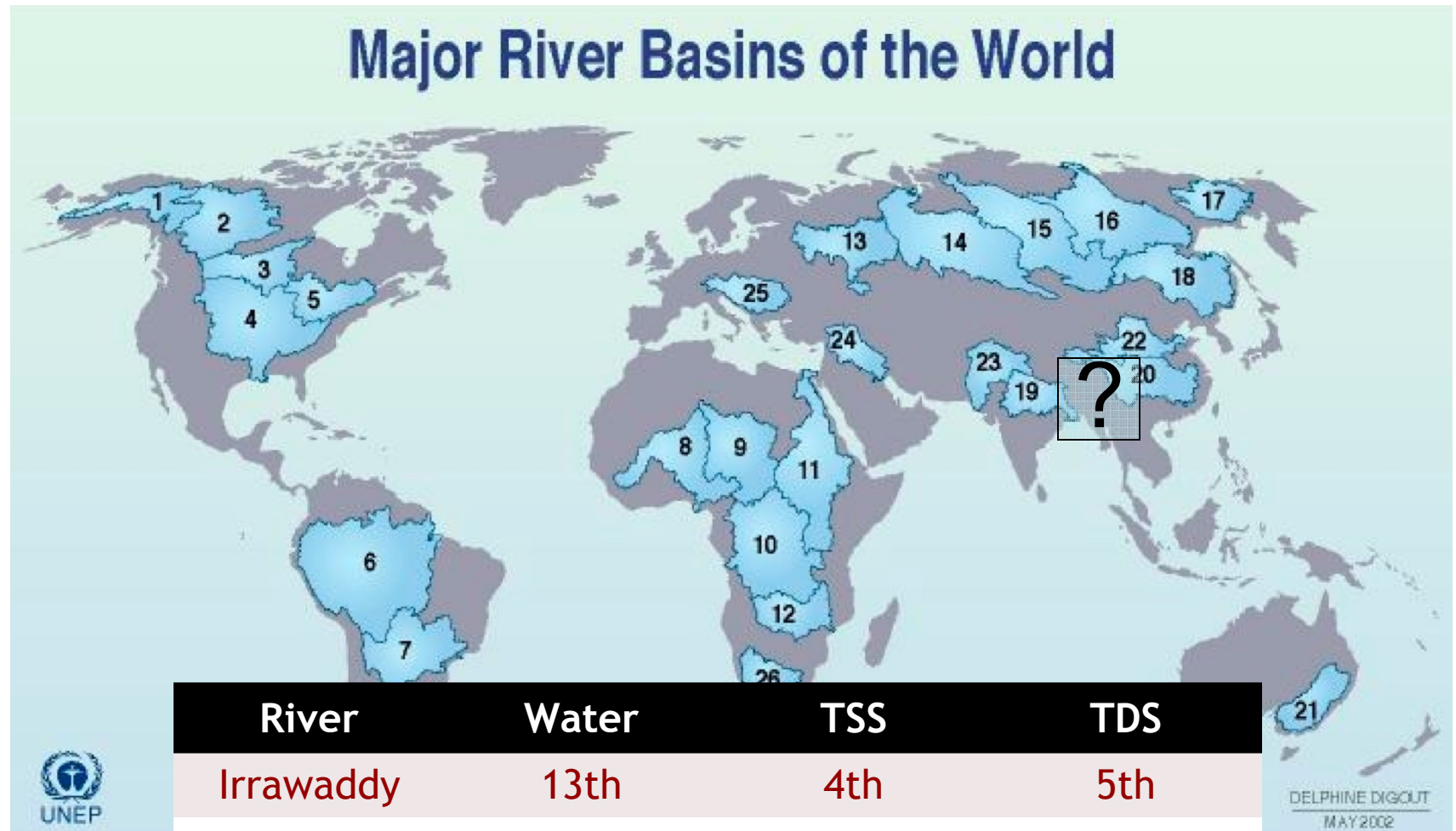
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# Studies in Burma

- Materials flux
  - [REDACTED]
  - [REDACTED]
- Provenance/denudation
  - U/Pb in modern and Tertiary sediments
  - Ar/Ar of detrital micas
  - Trace elements in garnets et al.
- Geomorphology
  - OSL dating of terraces/islands (16ka terrace, Pagan)
  - GIS of channel change from 19th century
  - [REDACTED]
- Climate
  - [REDACTED]
  - Crater lakes in Myanmar dry zone



# Where are the Irrawaddy/Salween?



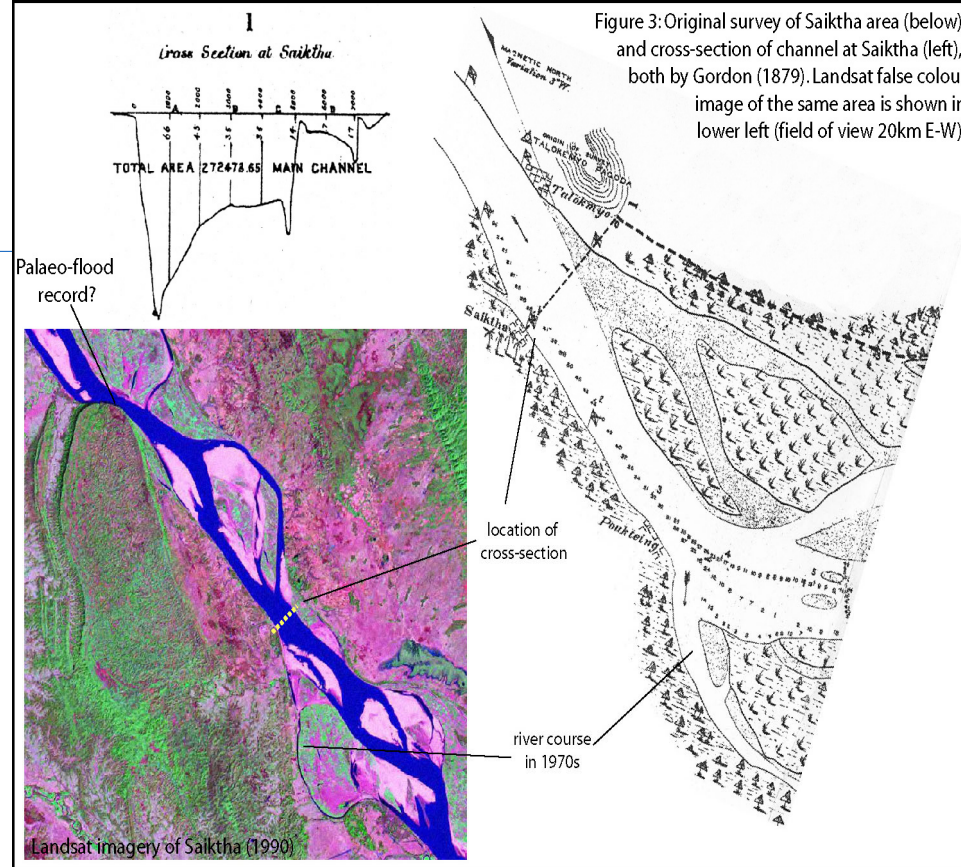
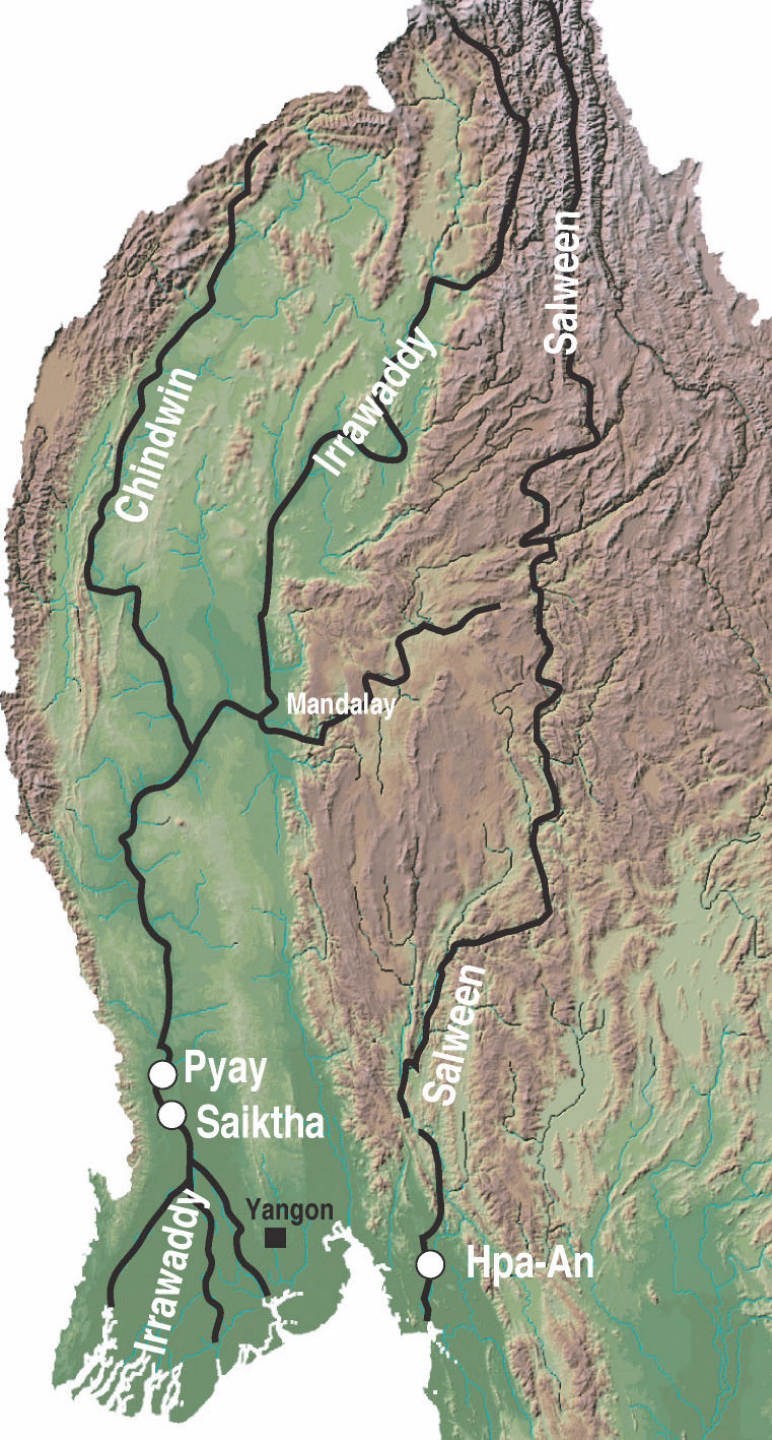


# historical data



- Mandalay - 1000km from mouth during dry season

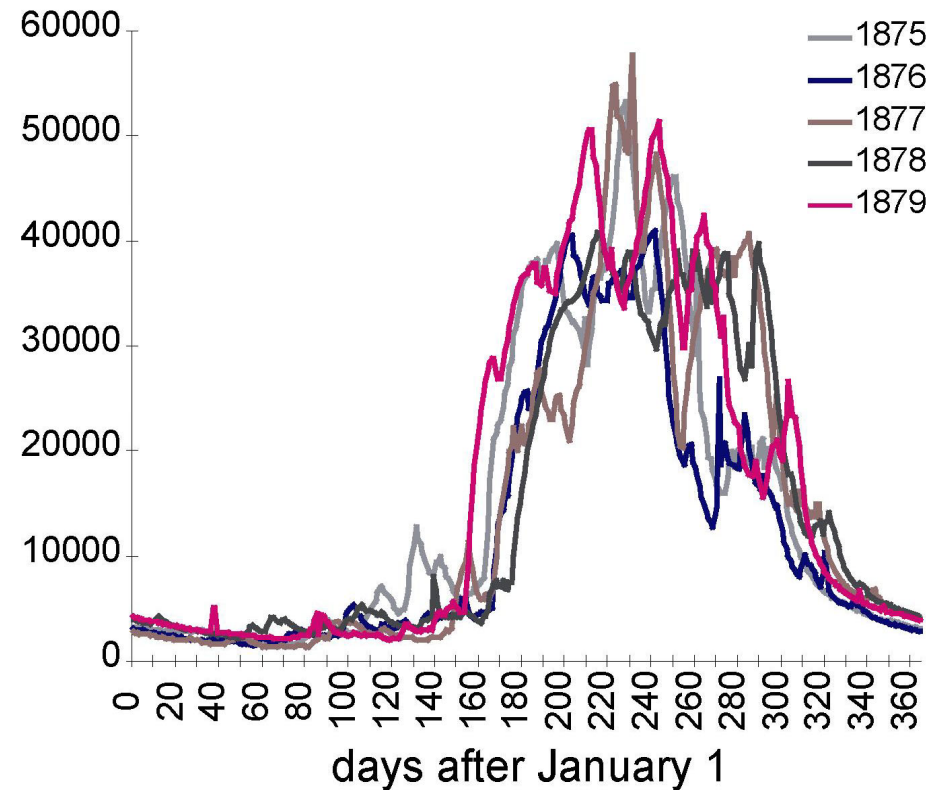
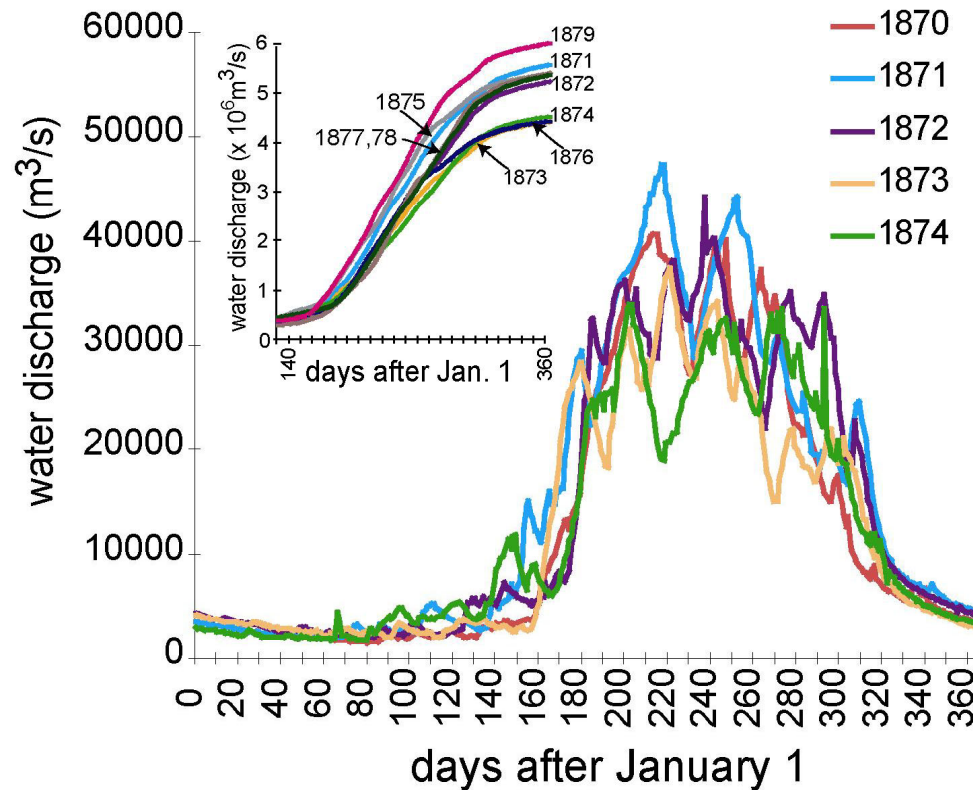




- 19th Century data collected from Saiktha between 1869 and 1879 by engineer Robert Gordon (for the Government of India) with annual water and sediment fluxes based on:
  - 10 years of daily stage records
  - 2 years of daily velocity measurements
  - 1 year of sediment load measurements
- Three modern stations (TSS, TOC)

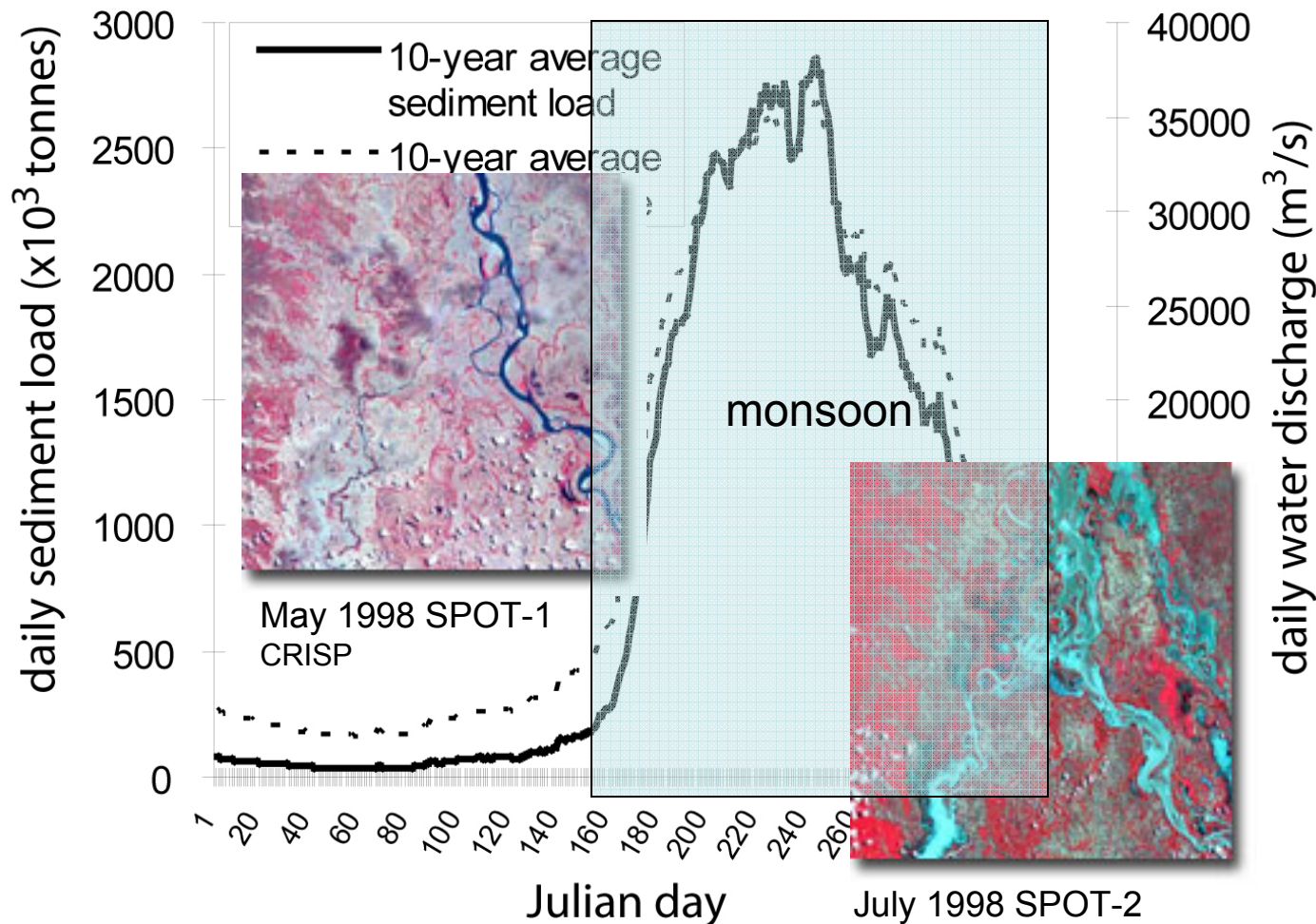
# Historical data for the Ayeyarwady at Seiktha

## The Gordon survey of 1869-1879: water discharge



“Daily” velocity measurements conducted in 1872-73 and again in 1875. Only discharges are presented in Gordon’s 1879 report. Stage was measured daily at Seiktha and Myanaung and the records were merged after 1875 to produce a 10 year record. Gordon published the full dataset in 1885 We have digitized all data from the RGS archives, amounting to several tens of thousands of data points





- Combined Irrawaddy/Salween transports  $605\text{km}^3$  water and 332-583Mt sediment (62% and 31-55% of G/B)
- 82% of water and 92% of sediment flux during 5 month monsoon season from mid-June to mid-November

	Area, Mkm <sup>2</sup>	Qnat, km <sup>3</sup> /yr	TSS, Mt/yr	POC	DOC	TOC	YPOC, t/km <sup>2</sup> /yr	YDOC, t/km <sup>2</sup> /yr	yield
Ayerawady- Thanlwin total	0.68	638	379-576	4.6-7.7	1.1	5.7-8.8	3.8-11.3	1.6	8.4-12.9
Huang He				Huang He was Amazon 6.1			8.4 (3.3 <sup>b</sup> )		G/B 7.9
Amazon				Chang Jiang was 6.0 now 2.2			1.0		Amazon 6.9
Chang Jiang							5.3 (1.2 <sup>a</sup> )		Orinoco 6.0
Mackenzie	1.8	500	124	2.2			1.2		
Zaire/Congo	3.7	1325	31.7	2.0			0.5		
Orinoco	1.1	1135	107	1.7		3.7	1.5	4.5	6.0
Ganges	1.05	493	520	1.7		3.1	1.6	1.3	2.9
Parana	2.8	568	79	1.6		5.1	0.6	1.3	1.9
Amur	1.85	344	24.9	1.4		3.5	0.8	1.1	1.9
Brahmaputra	0.58	510	730	1.6		3	2.2	2.8	5.0
Mississippi	3	580	500	1.9		3	0.4	0.6	1.0
Niger	1.2	192	40	0.6		1.3	0.6	0.5	1.1
Lena	2.5	525	20.7	3.5		4.1	0.2	1.4	1.6
Zambezi	1.3	106	5	0.5		1.1	0.4	0.5	0.9
Nile	2.9	83		0.4		0.7	0.1	0.1	0.2
Ob	2.99	404		0.3		3.1	0.1	1.0	1.1
Yenisey	2.58	620		0.2		4.9	0.1	1.8	1.9
St Lawrence	1.02	337	4	0.2		1.2	0.2	1.2	1.4
Nelson	1.13	89	10	<0.1		0.7	nd	0.6	nd
Murray	1.06	23.6	30	<0.1		0.2	nd	0.2	nd

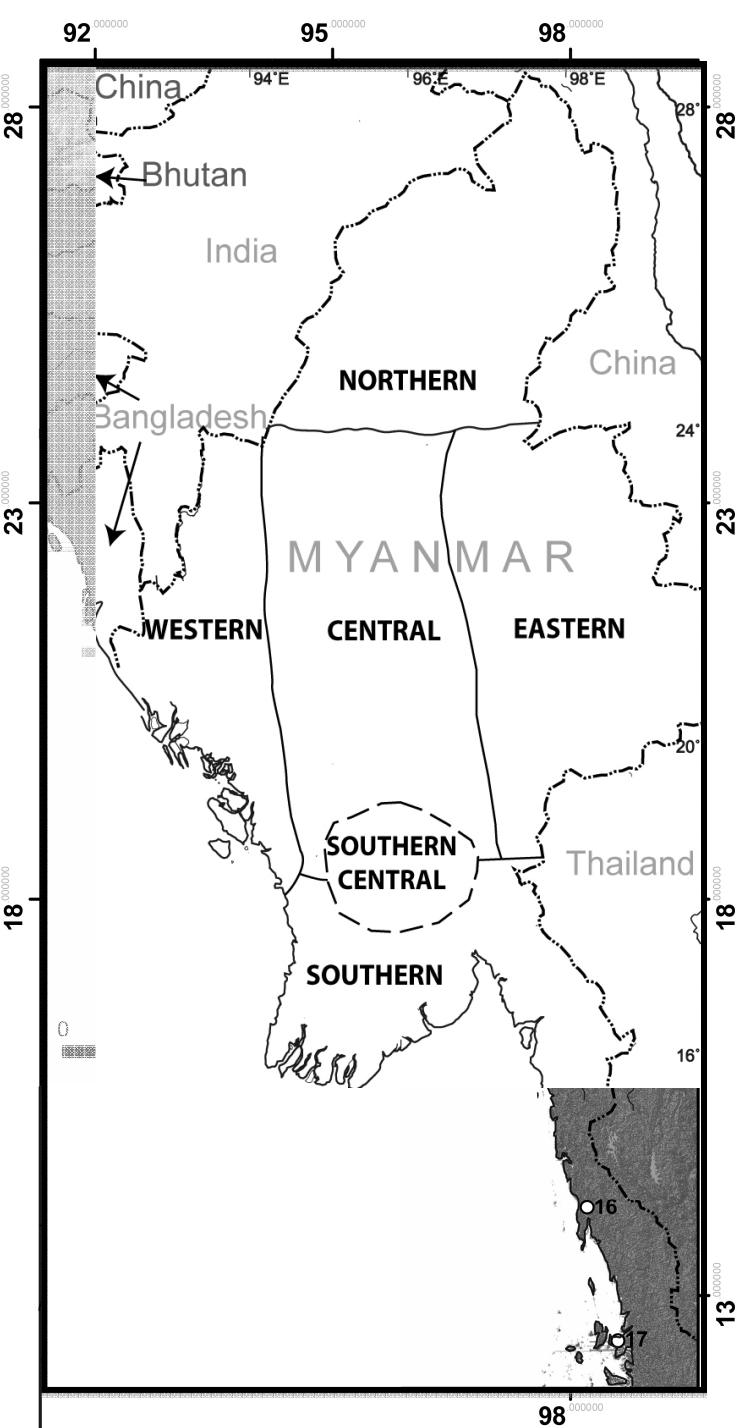
Cost: time, photocopying

- With dammed chinese rivers, I/S may now be the largest source of POC, is very likely to the 3<sup>rd</sup> /4<sup>th</sup> largest source of TOC, highest TOC yields
- Due to (1) much forest on steep, unstable slopes (2) monsoon climate (3) unconsolidated sediments in the 'dry zone' (4) not much 'floodplain'



# Historical climate records



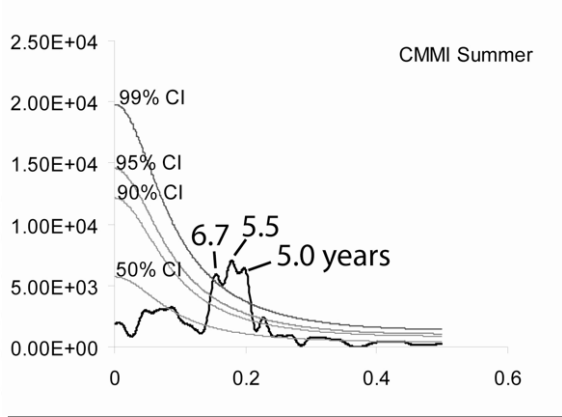


# Monsoon records

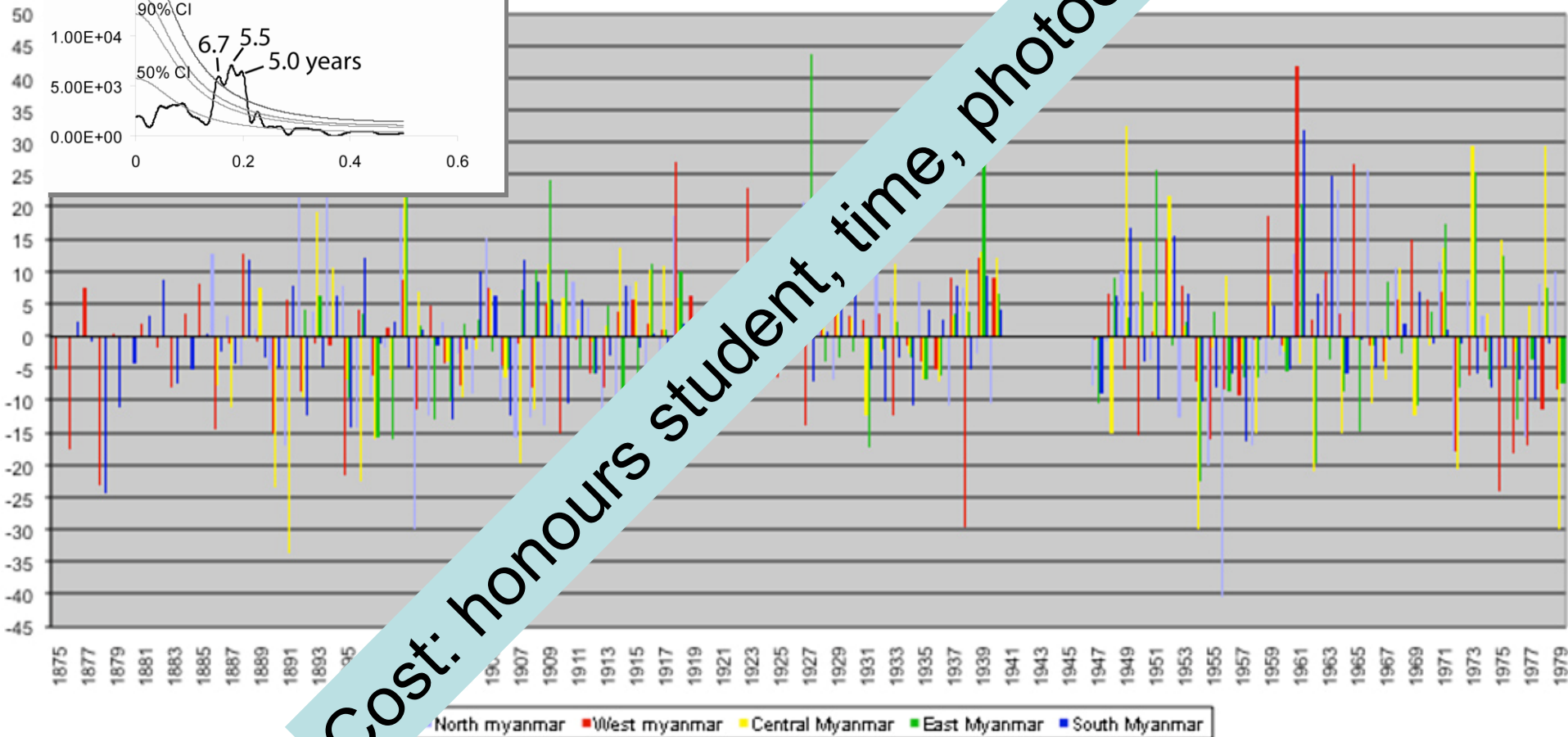
- Myanmese monsoon sandwiched Indian monsoon and Asian monsoon, influenced by both as well as ENSO and ITF
- 56 stations 32,000 monthly records 1875-1939 and 1947-1975
- Digitized from British Library records
- Six regions of similar characteristics identified
- Summer and winter monsoon indices calculated for each



# Summer monsoon index



Complete time series as % deviation from average



Good coherence in sign, but large regional variability in IAV  
Variable coherence with ENSO, IOD and TBO, none with AISMR

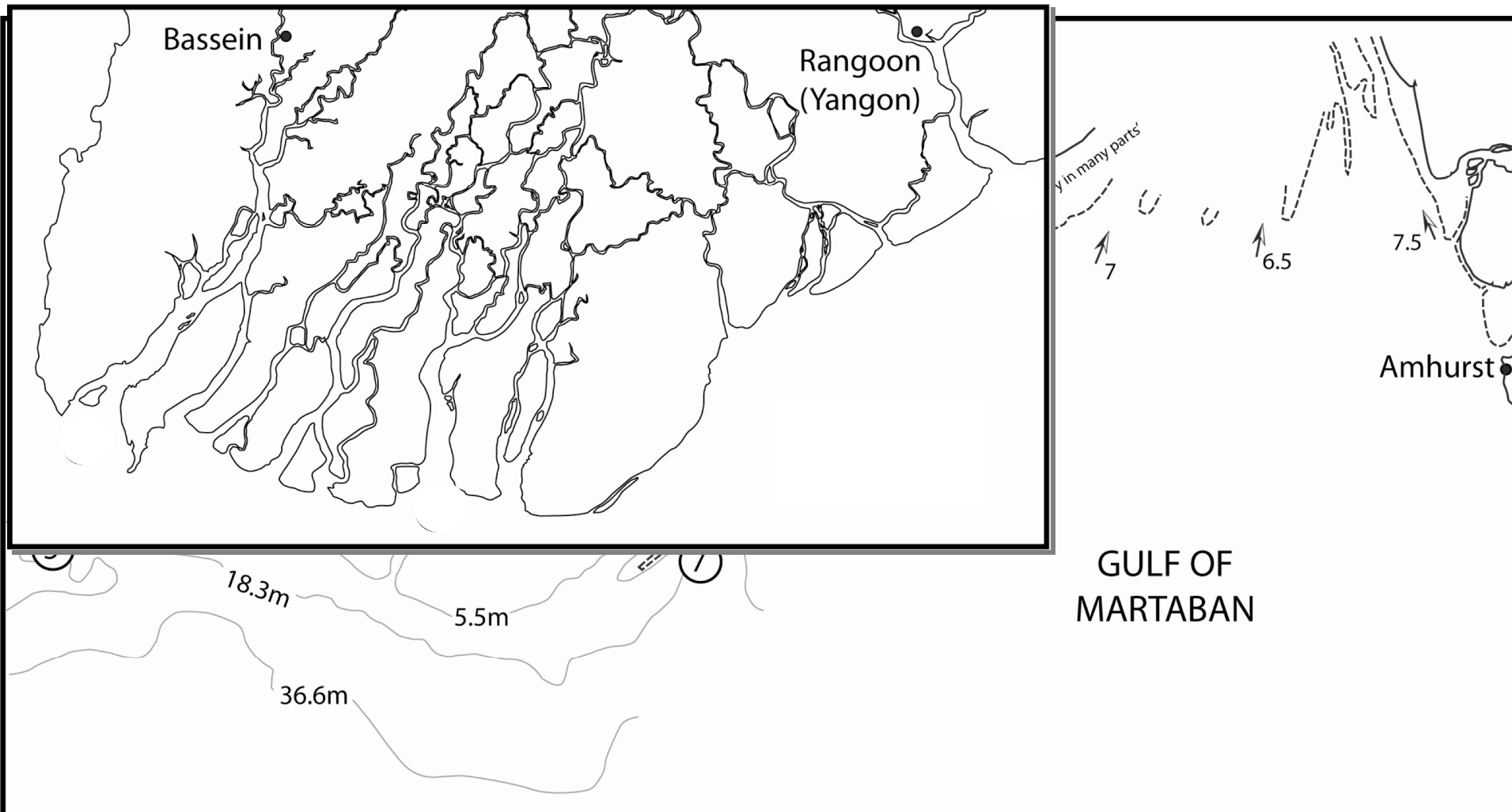




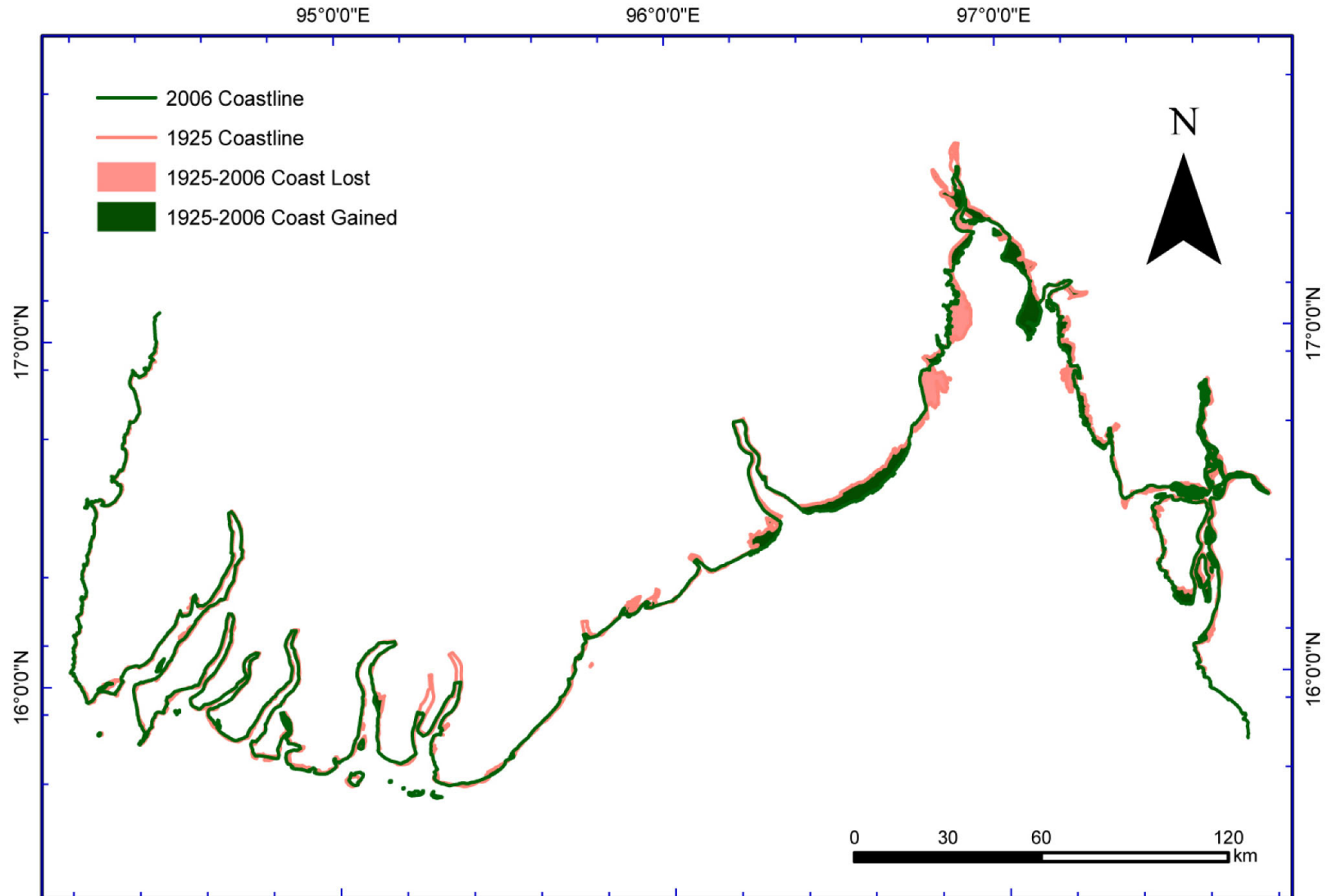
# The delta

- One of the major delta complexes in the world – Burma's rice basket
- Receives 370-600Mt of sediment/year
- Supposed delta is advancing at 25-60m/yr (2.5-6km/century)
- No major dams, but plans to build several on the Salween
- Indian Ocean Tsunami hit the delta in January 2004
- Cyclone Nargis inundated 14,400km<sup>2</sup> in May 2008
- Resources: earliest navigation chart from 1850, a set of topographic maps from 1913 to the 1940s, and satellite imagery from 1973, 1989, 2000, 2006

# Early charts: 1850 versus 1915



# Comparison 1925 to 2006





A satellite image of a coastal delta region, likely the Irrawaddy delta in Myanmar, showing a complex network of river channels and sediment deposition. A diagonal text overlay in a light blue box reads "Cost: honours student, time".

# Delta conclusions

- Irrawaddy delta is thought to be prograding 50m/yr, based on early 20<sup>th</sup> century work
- Andromeda prograding 3-4m/yr, protected by rock highs, but unable to advance due to strong currents
- Most dynamic area is the head of the Gulf of Martaban with both accumulation and erosion
- <9% of the sediment flux has contributed to progradation of the delta front
- Sediments in the Gulf accumulating at 0.7-2.5cm/yr
- May well change due to tsunamis, Nargis, and with plans to dam

- GIS-ready time series of satellite images in in standard, compact (jpg), georeferenced format
- Imagery available free with global coverage
- Free viewer for change analysis, including most basic GIS functions – intuitive interface

