WATER AND WASTEWATER MONITORING

Sediment Measurement

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Chapter Description

- Aims
  - Student describe the sediment material
  - Student design sampling sites that address the minimum disturbance
  - Student examine the sediment quality
- Expected Outcomes
  - Student should be able to describe the sediment material
  - Student should be able to design sampling sites that address the minimum disturbance
  - Student should be able to examine the sediment quality
- Other related Information
  - Environmental Protection Agency
  - Natural Resources Conservation Service
- References

  - Burden, Foerstner, McKelvie, and Guenther (2002) **Environmental Monitoring Handbook**, The McGraw-Hill Companies, Inc.
  - Jamie Bartram and Richard Balance. 1996. **Water Quality Monitoring: A Practical Guide to Design and Implementation of Freshwater Quality Studies and Monitoring Programmes**, CRC Press.

SEDIMENT TRANSPORT

Sediment transport is the mass of sedimentary material, both particulate and dissolved, that passes across a given flow-transverse cross section of a given flow in unit time.

SEDIMENT CYCLE

Weathering
- Make particle

Erosion
- Put particle in motion

Transport
- Move particle

Deposition
- Stop particle motion
- Not necessarily continuous (rest stops)

SEDIMENTARY STRUCTURES

Sedimentary structures occur at very different scales, from less than a mm (thin section) to 100s–1000s of meters (large outcrops); most attention is traditionally focused on the bedform-scale

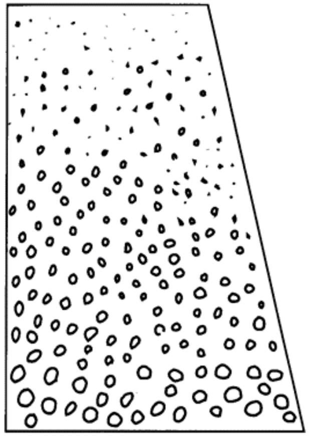
- Microforms (e.g., ripples)
- Mesoforms (e.g., dunes)
- Macroforms (e.g., bars)

SEDIMENTARY STRUCTURES

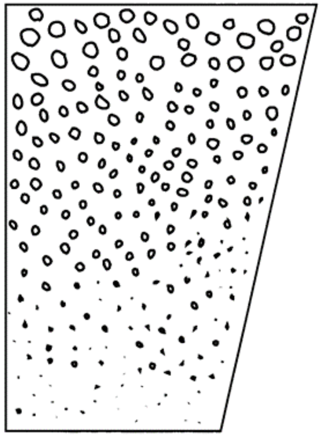
Laminae and **beds** are the basic sedimentary units that produce stratification; the transition between the two is arbitrarily set at 10 mm

Normal grading is an upward decreasing grain size within a single lamina or bed (associated with a decrease in flow velocity), as opposed to **reverse grading**

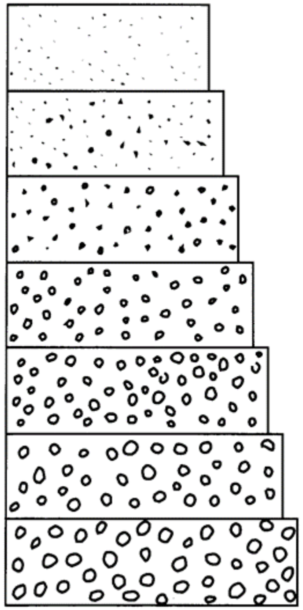
Fining-upward successions and **coarsening-upward successions** are the products of vertically stacked individual beds



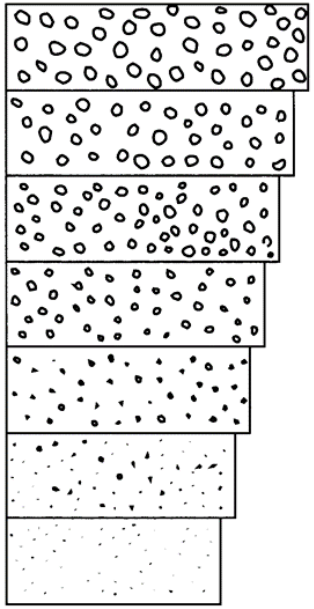
Normal grading in a bed



Reverse grading in a bed



Fining-up of a series of beds



Coarsening-up of a series of beds

Source: Jamie Bartram and Richard Balance, 1996

Table 13.1 Issues associated with sediment transport in rivers

Sediment size	Environmental issues	Associated engineering issues
Silts and clays	Erosion, especially loss of topsoil in agricultural areas; gullying	
	High sediment loads to reservoirs	Reservoir siltation
	Chemical transport of nutrients, metals, and chlorinated organic compounds	Drinking-water supply
	Accumulation of contaminants in organisms at the bottom of the food chain (particulate feeders)	
	Silting of fish spawning beds and disturbance of habitats (by erosion or siltation) for benthic organisms	
Sand	River bed and bank erosion	River channel deposition: navigation problems Instability of river cross-sections
	High sediment loads to reservoirs	Sedimentation in reservoirs
	Habitat disturbance	
Gravel	Channel instability when dredged for aggregate	Instability of river channel leads to problems of navigation and flood-control
	Habitat disturbance	

Source: Jamie Bartram and Richard Balance, 1996

TYPES OF SEDIMENT TRANSPORT

- Suspended load

  Sand+silt+clay–sized particles that are held in suspension because of the turbulence of the water

  < 62 m in particle diameter

  Known as fine-grained sediment

  Mainly originates from erosion of the bed and banks of the river

  Forms most of the transported load

TYPE OF SEDIMENT TRANSPORT

- Bedload

  Stony material, such as gravel and cobbles that moves by rolling along the bed of river because it is too heavy to be lifted into suspension by the current of the river

  Important in high discharge and in landscapes of large topographical relief

- Saltation load

  Transitional between bedload and suspended load.

  Particles that light enough to be picked off the river by the turbulence but too heavy to remain in suspension and sink back to the river bed

SEDIMENT MEASUREMENT

Particle size

Table 13.2 Particle size classification by the Wentworth Grade Scale

Particle description	Particle size (mm)	Cohesive properties
Cobble	256–64	Non-cohesive sediment
Gravel	64–2	
Very coarse sand	2–1	Non-cohesive sediment
Coarse sand	1–0.5	
Medium sand	0.5–0.25	
Fine sand	0.25–0.125	
Very fine sand	0.125–0.063	
Silt	0.062–0.004	Cohesive sediment
Clay	0.004–0.00024	

Source: Jamie Bartram and Richard Balance, 1996

SUSPENDED SEDIMENT CONCENTRATION

Equal discharge-increment method

$$SS_c = \frac{\sum_{i=1}^{n} C_i}{n}$$

SSL in tonnes/day

$$SS_L = \sum_{i=1}^{n} (C_i Q_i) \times 0.0864$$

Where:

SSc = discharge-weighted suspended solid concentration

C = the average of the concentration values

N = number of increment

SSL = suspended sediment load

C = the concentration (ppm)

Q = discharge (m3/s)

I = equal-discharge increment

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SUSPENDED SEDIMENT CONCENTRATION

$$\text{Concentration of sand (mg l}^{-1}\text{)}=(W_{\text{Sand}}/V_{\text{sample}})\times 10^6$$
$$\text{Concentration of clay+silt (mg l}^{-1}\text{)}=(W_{\text{clay+silt}}/V_{\text{sample}})\times 10^6$$
$$\text{Total suspended load (mg l}^{-1}\text{)}=[(W_{\text{Sand}}+W_{\text{clay+silt}})/V_{\text{sample}}]\times 10^6$$

Estimating suspended sediment load ton per year can be calculated by following equation:

$$SS_L=Q_{\text{observed}}\times C_{\text{estimated}}\times 0.0864$$

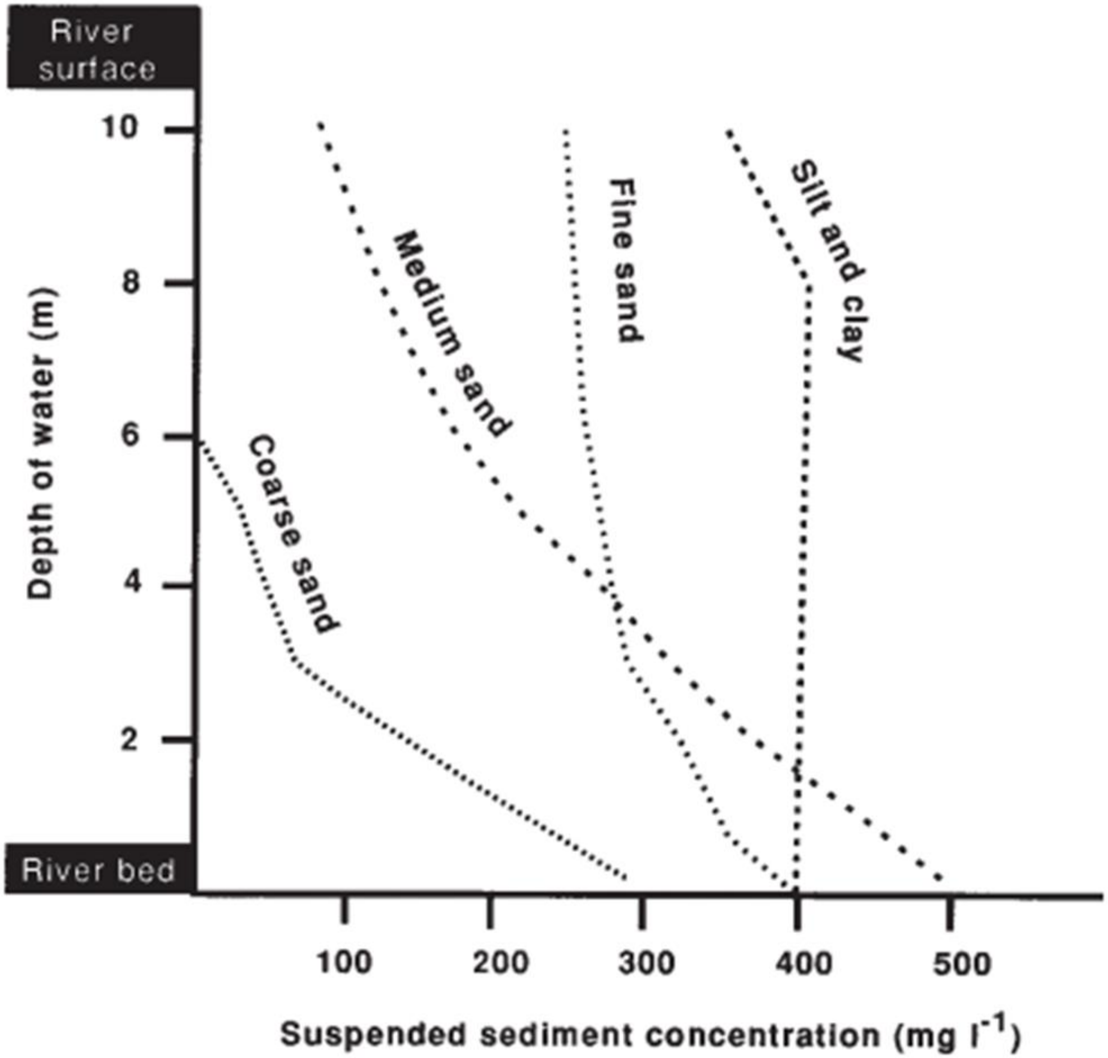

Figure 13.1 Variations in concentration of suspended sediment with water depth for sand, silt and clay as measured at one field site

Source: Jamie Bartram and Richard Balance, 1996

SAMPLING FOR SEDIMENT

- Integrated samplers
- Instantaneous grab samplers
- Pump samplers
- Sedimentation traps

Conclusion of The Chapter

– Sediment measurement is the mass of sedimentary material, that passes across a given flow-transverse cross section of a given flow in unit time.

References

Jamie Bartram and Richard Balance. 1996. **Water Quality Monitoring: A Practical Guide to Design and Implementation of Freshwater Quality Studies and Monitoring Programmes**, CRC Press.