

Sediment transport and grain size variability



AeoLiS short course
Coastal Sediments 2023

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- Physical geographer
- PhD in Coastal Engineering

Grain size



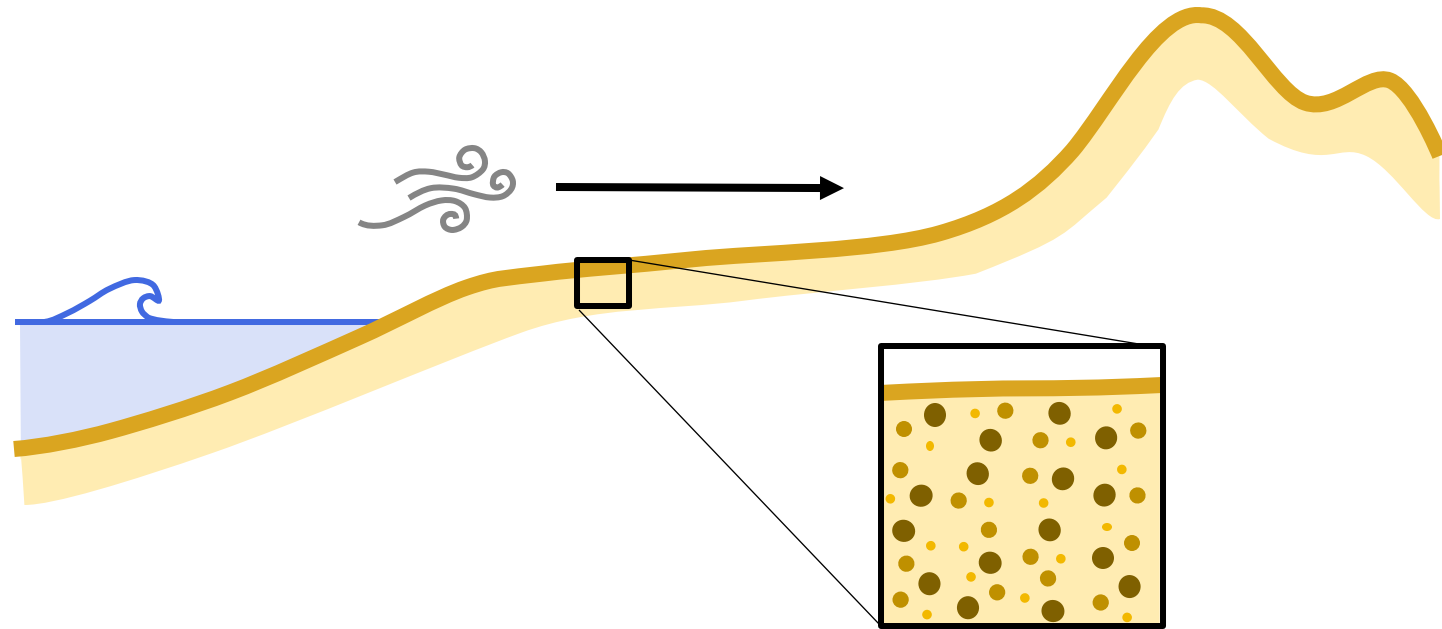
Coastal dune development



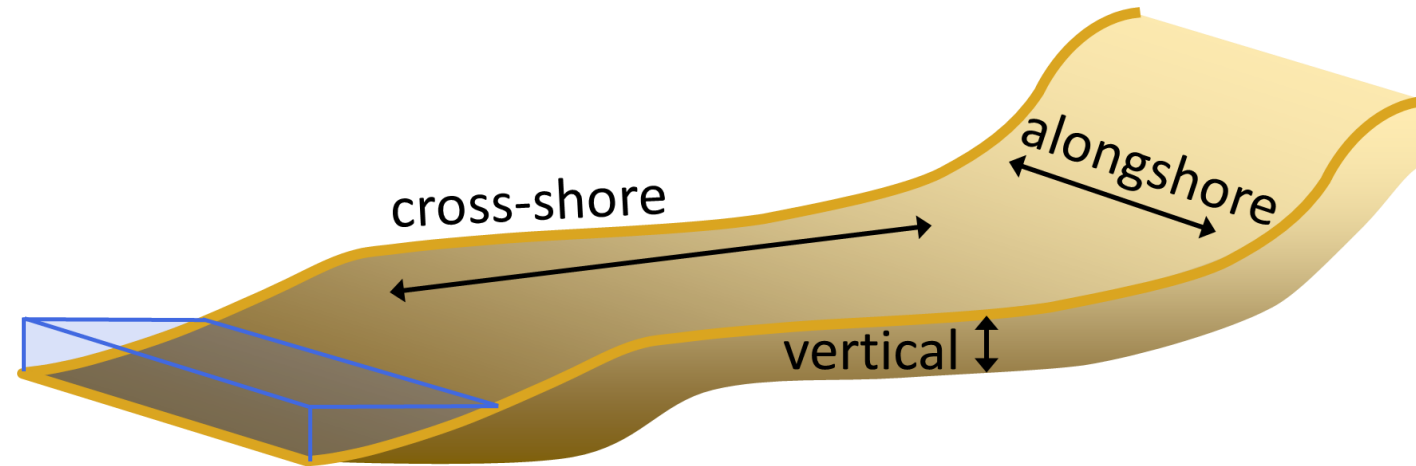
Aeolian sediment transport



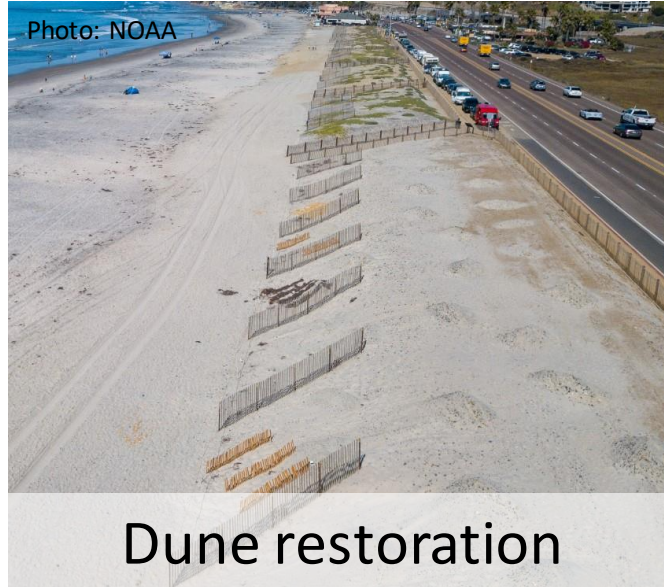
Impact of grain size



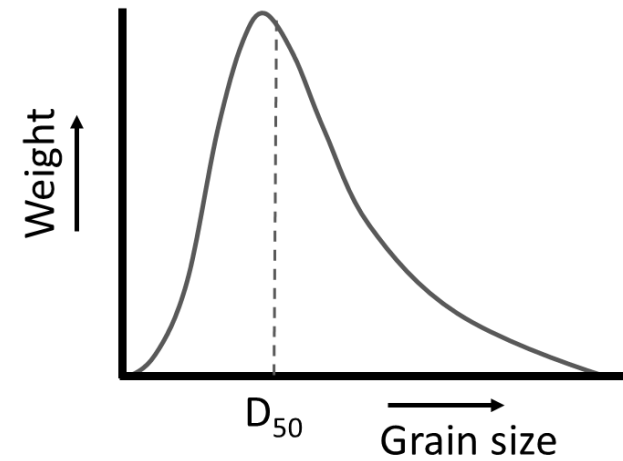
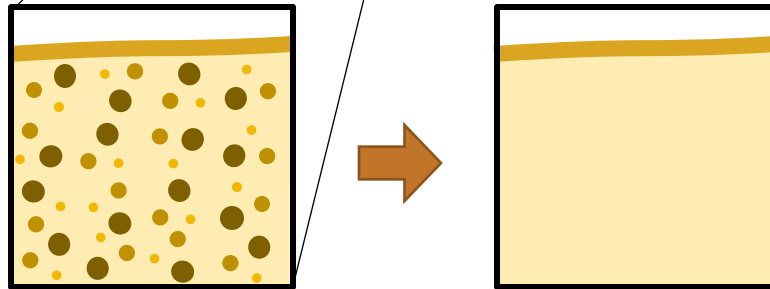
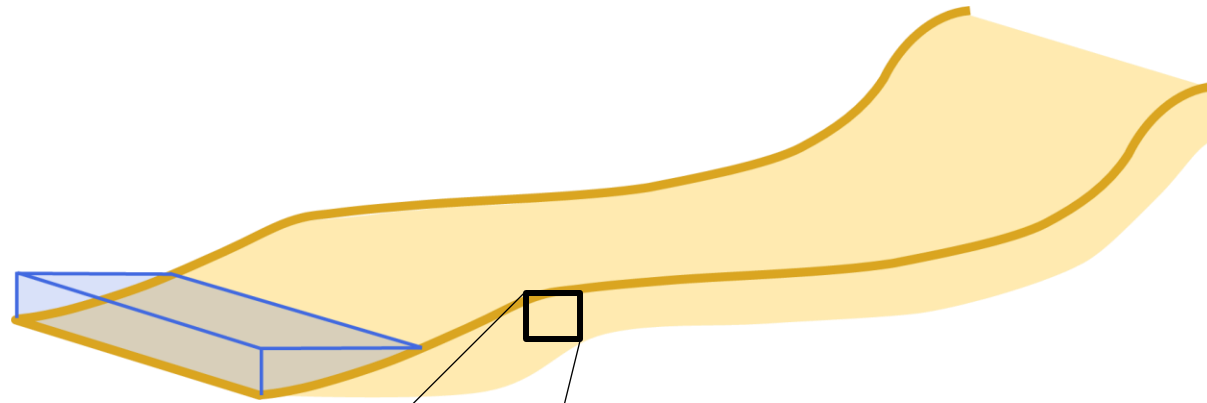
Natural grain size variability



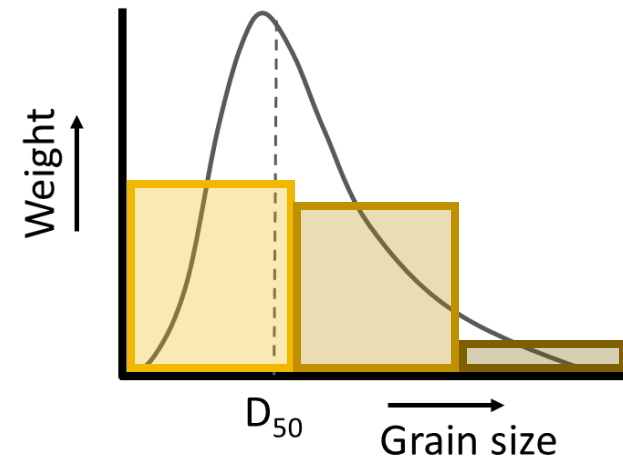
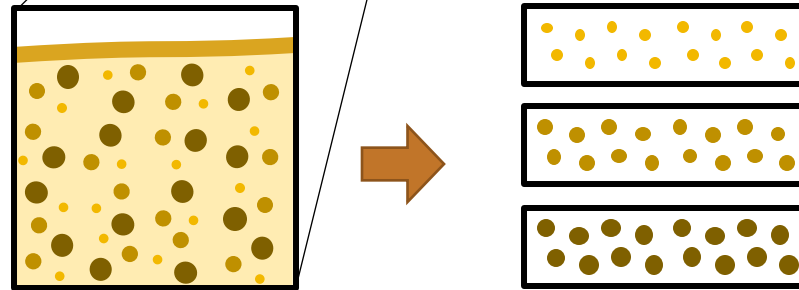
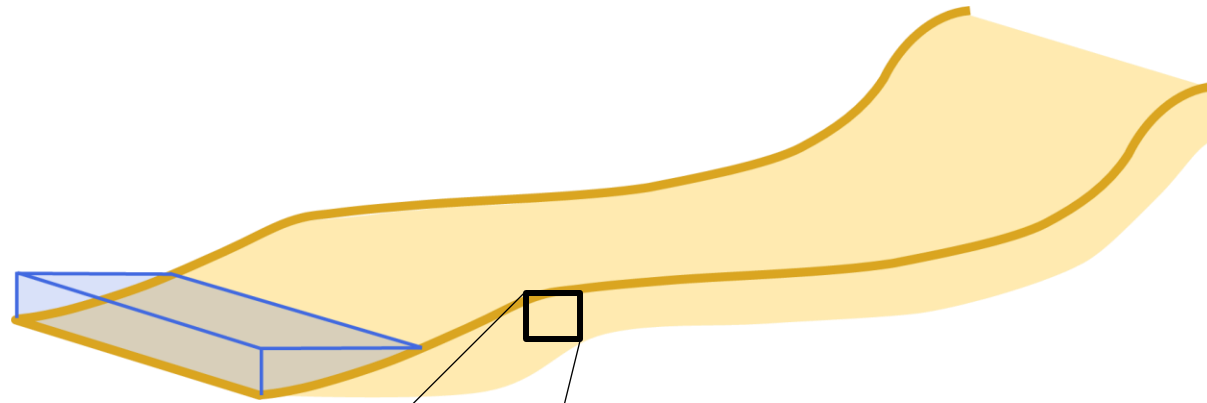
Grain size = design factor



Single fraction



Multi-fraction



A close-up photograph of sediment grains, likely sand or silt, showing a variety of colors from light tan to dark brown. The grains are irregular in shape and size, creating a textured background.

Multi-fraction transport

- Sediment transport is governed by
 - Transport capacity of the wind
 - Sediment supply
- Grain size related to both

A close-up photograph of sediment grains, likely sand or silt, showing a variety of colors from light beige to dark brown. The grains are irregular in shape and size, creating a textured background.

Multi-fraction transport

- Sediment transport is governed by
 - **Transport capacity of the wind**
 - Sediment supply
- Grain size related to both

Transport capacity

- Calculation of transport:

$$Q = C \sqrt{\frac{d}{D} \frac{\rho_a}{g}} (u_* - u_{t,*})^3$$

Bagnold (1937)

└─→ $\frac{d}{D} = 1$

- Calculated per fraction



Transport capacity

- Calculation of transport:

$$Q = C \sqrt{\frac{d}{D} \frac{\rho_a}{g}} (u_* - u_{t,*})^3$$

Bagnold (1937)

- Threshold shear velocity:

$$u_{t,*} = A \sqrt{\frac{\rho_s - \rho_a}{\rho_a} g d}$$

Transport capacity

- Calculation of transport:

$$Q = C \sqrt{\frac{d}{D} \frac{\rho_a}{g}} (u_* - u_{t,*})^3$$

Bagnold (1937)

- Shear velocity:

$$u_* = u_w \frac{\kappa}{\ln \frac{z}{z_0}} \quad \rightarrow \quad z_0 = \frac{k_s}{30} = \frac{d}{30}$$

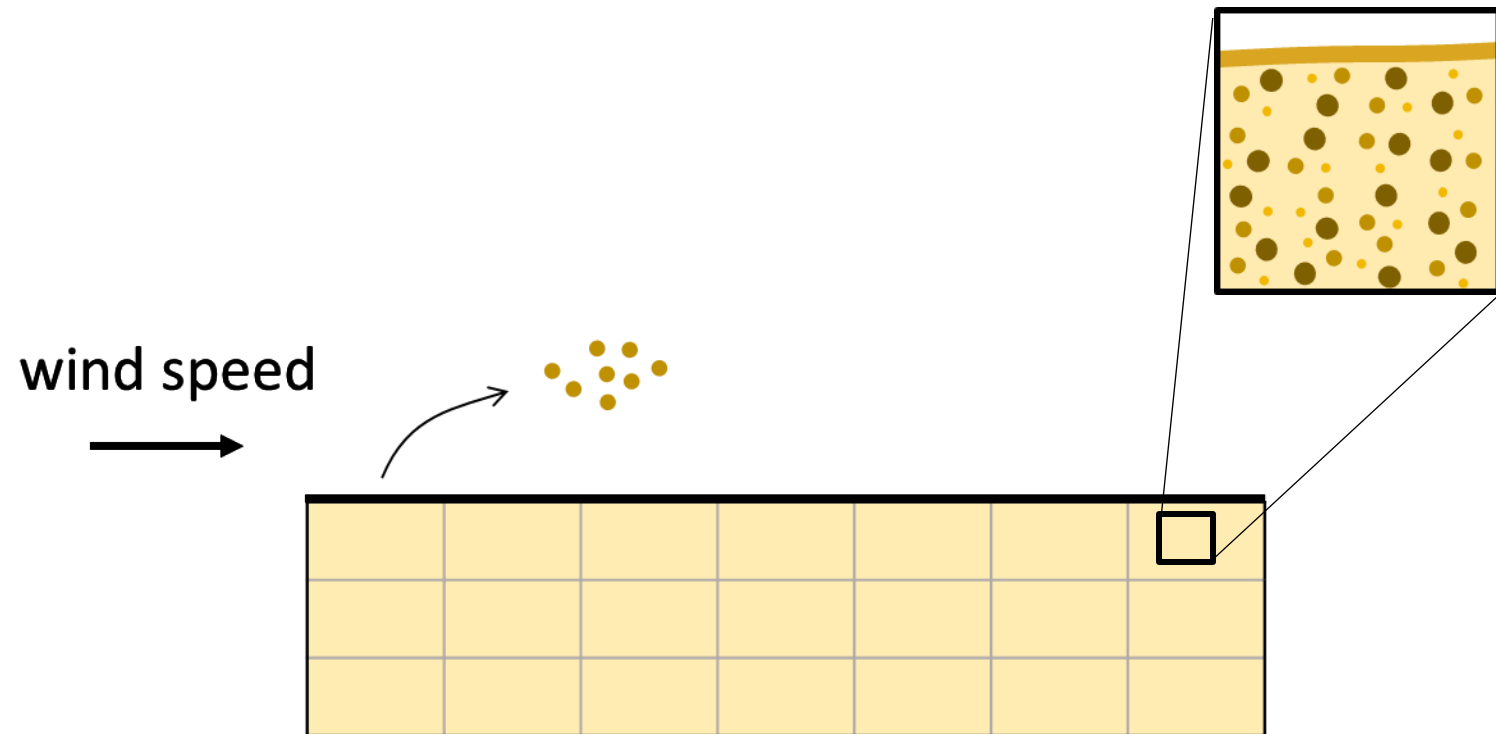




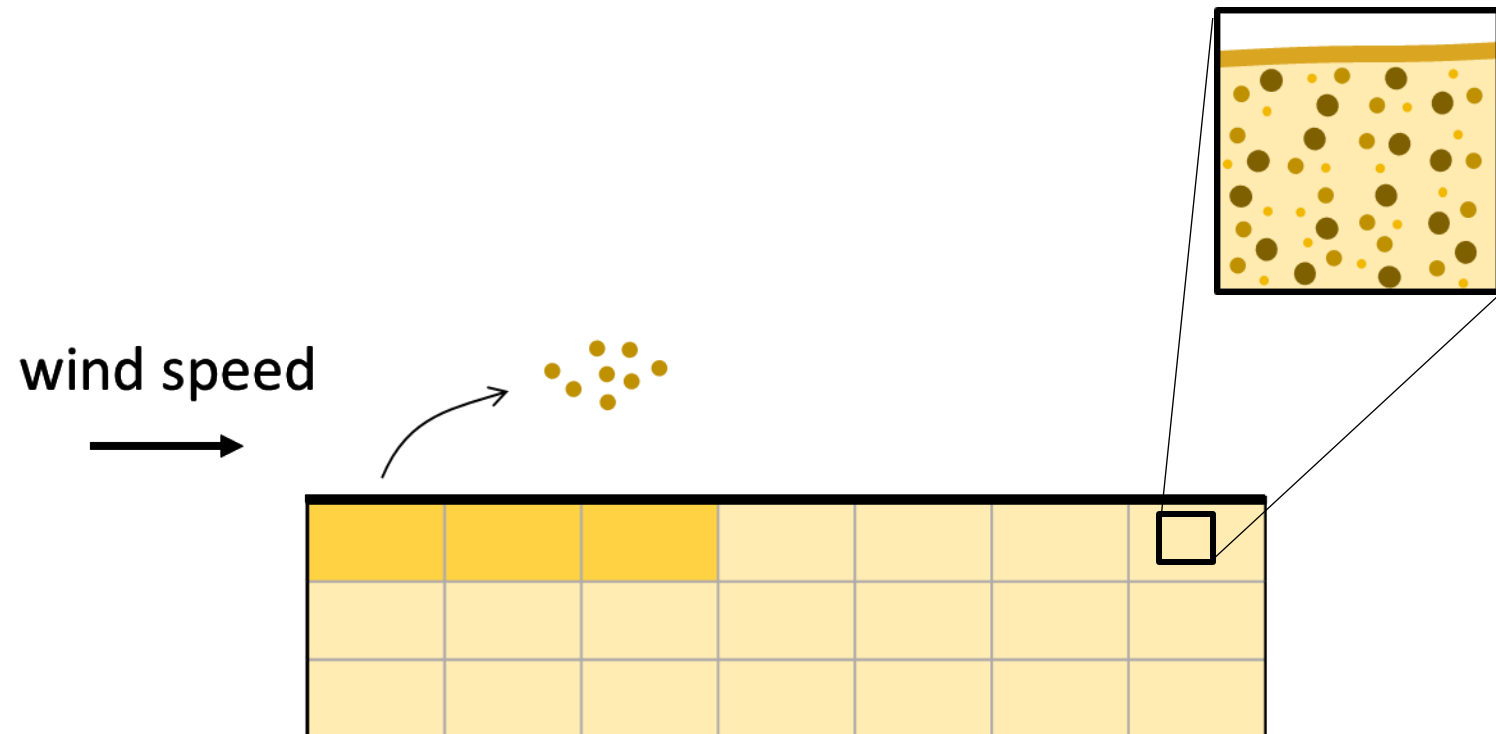
Multi-fraction transport

- Sediment transport is governed by
 - Transport capacity of the wind
 - **Sediment supply**
- Grain size related to both

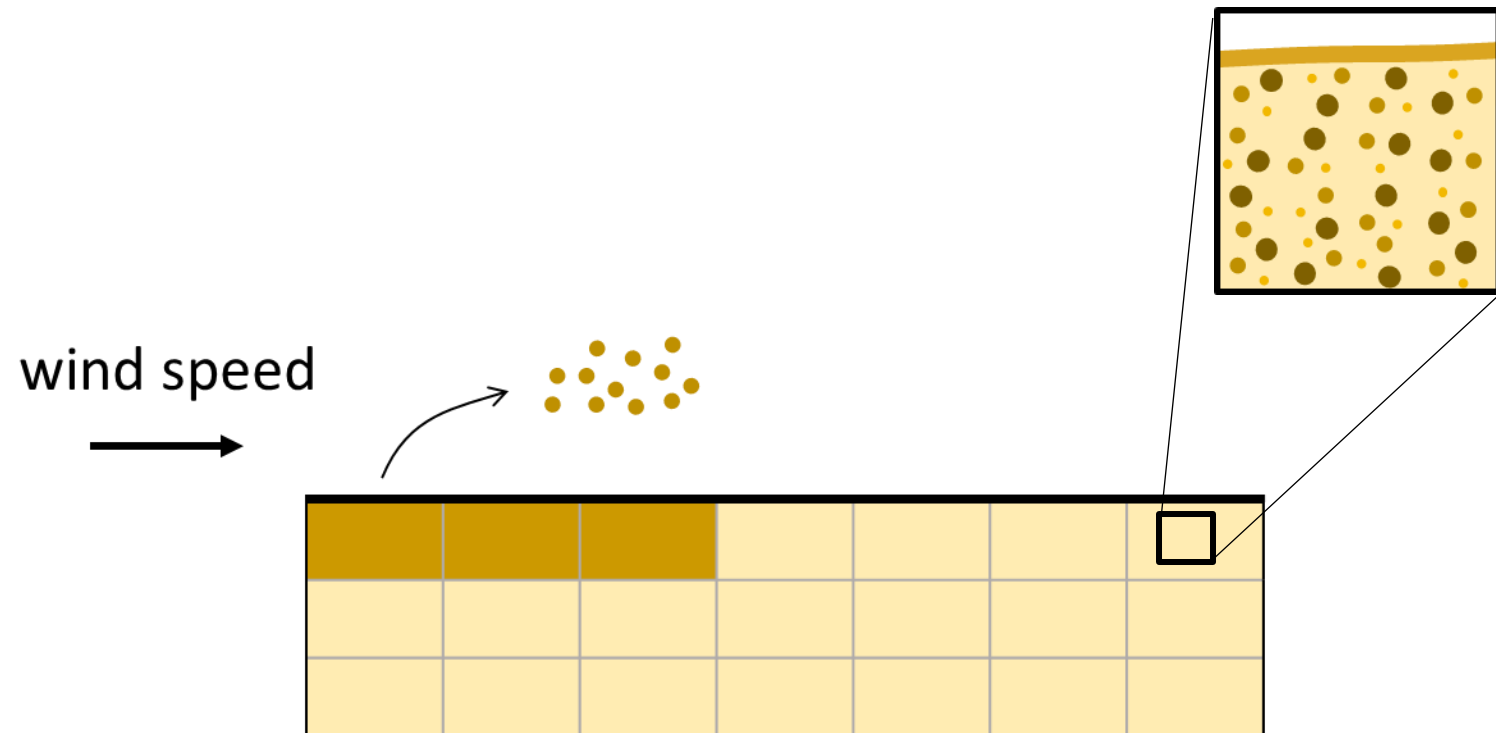
Sediment supply



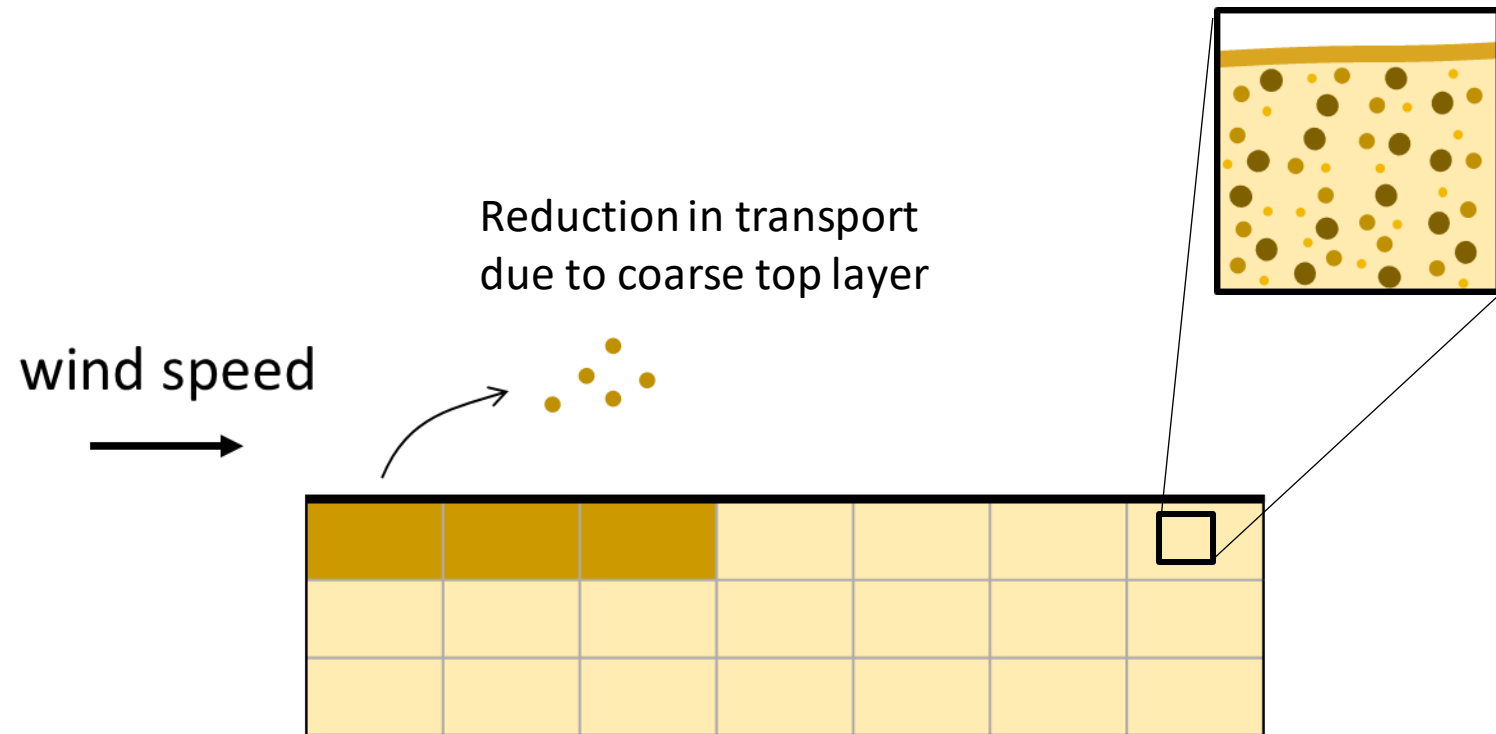
Sediment supply



Sediment supply



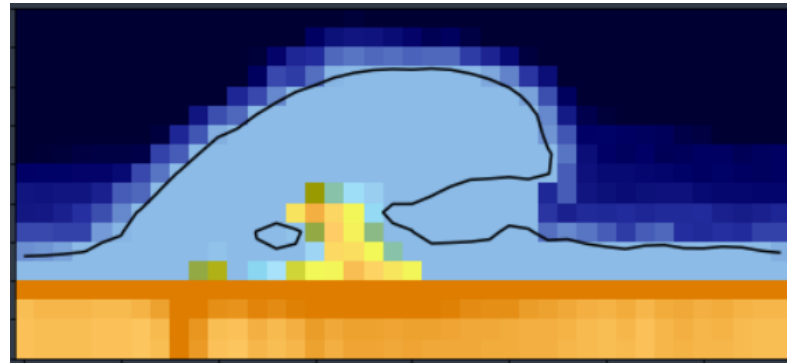
Sediment supply



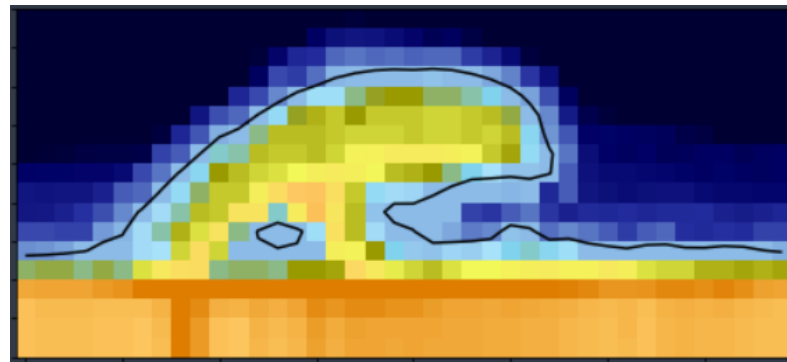
Sediment supply

- Sand Motor after 10 years:

without sorting



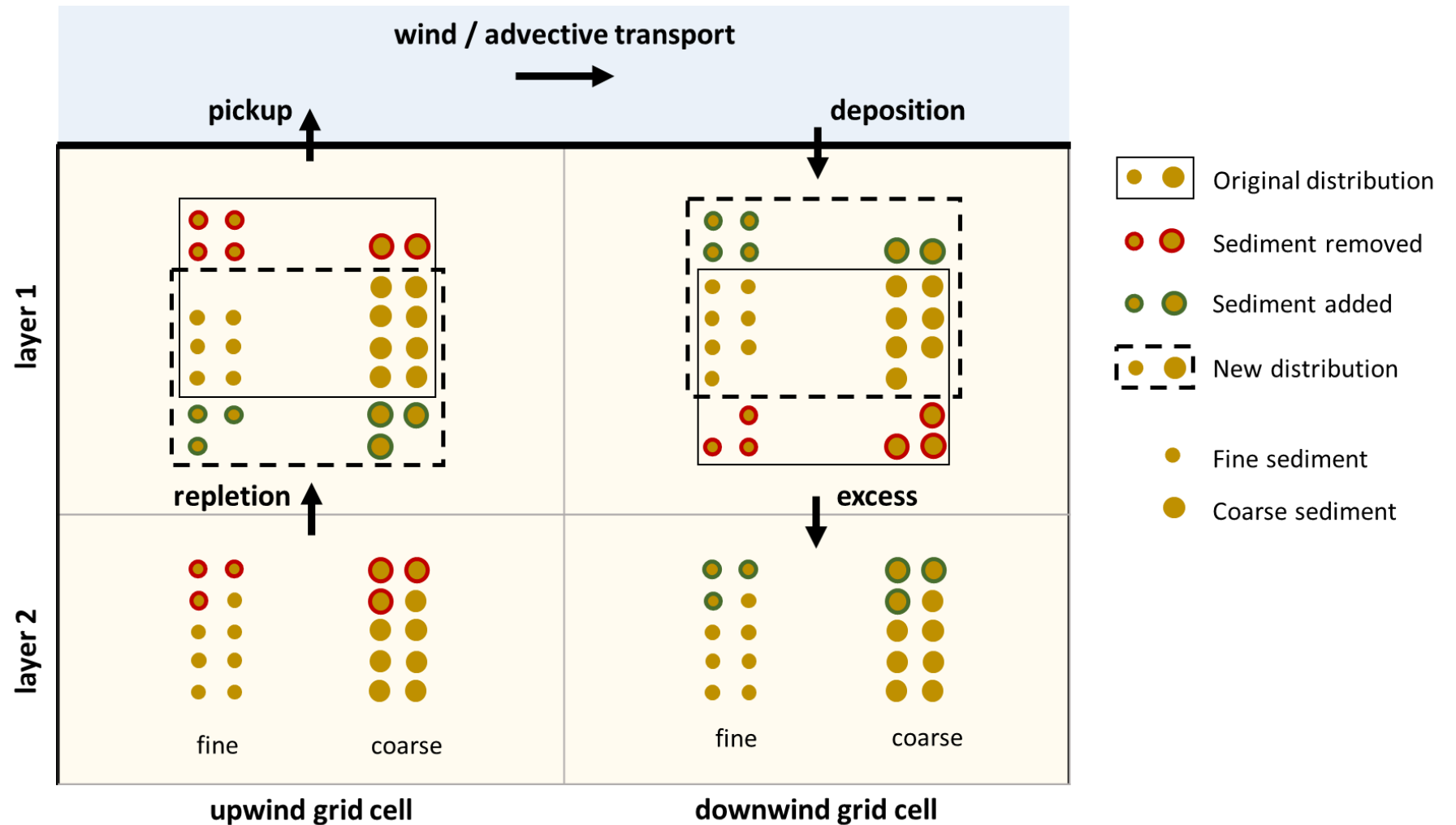
with sorting



Sediment supply

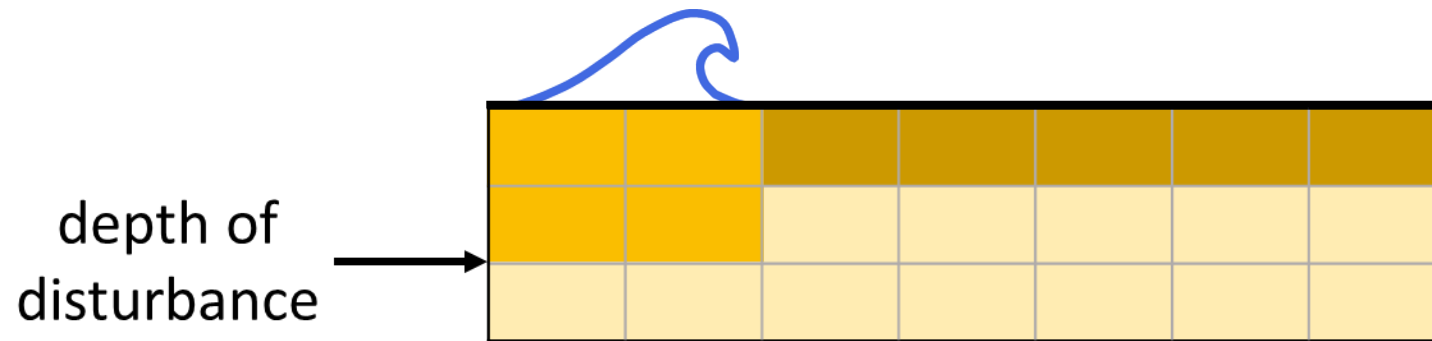


Sediment supply



Sediment supply

- Increased sediment availability due to hydraulic mixing



A close-up photograph of sediment grains, likely sand or silt, showing a variety of colors from light beige to dark brown. The grains are irregular in shape and size, creating a textured background.

Summary

- Grain size affects aeolian sediment transport
 - Transport capacity
 - Sediment supply
- Transport capacity calculated per grain size fraction
- Sediment supply:
 - Represented using vertical layering
 - Can decrease due to coarsening
 - Can increase due to hydraulic mixing
- Model simulations can be used to quantify these effects

PhD work

- Measurements of grain size variability
- Simulated effect in model simulations





Single fraction



Multi-fraction

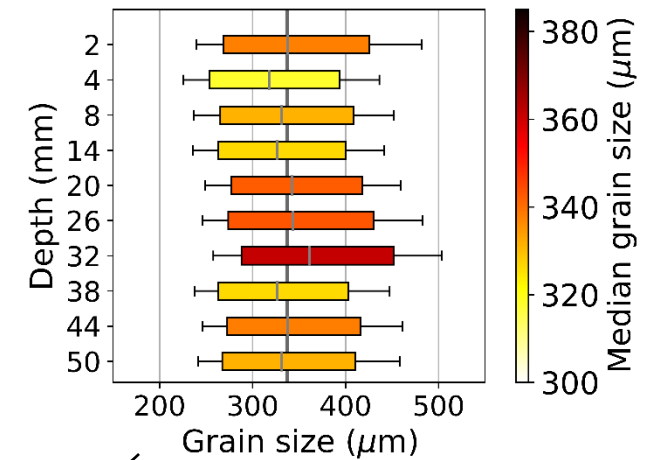


bed composition:  fine
 coarse

Horizontal variation



Vertical layering





Invitation
to the public defense of the doctoral thesis:

from Loose Grains
to **Resilient Dunes**

by
Christa van IJzendoorn

Thursday 22 June 2023
14.30 Introductory presentation
15.00 Defense
16.30 Reception

Aula of TU Delft
Mekelweg 5, 2628CC Delft

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Questions?

