Longshore Sediment Transport

Among the numerous reasons to develop an understanding of LST are:

- Process by which the products of terrestrial erosion (riverine sediments, sea cliff failures, etc.) are removed from a site (river mouth, sea cliff toe, etc.).

- Responsible for building depositional coastal features (spits, dunes, etc.)

- LST plus human manipulation of the coast equals major obstacles for coastal communities.

- Pathway for movement of sediment in littoral cells; must be known to develop coastal sediment budgets.

Beach Drift

When waves approach obliquely, swash moves sediment up the slope at an angle to normal, but the return flow is dominated by gravity and moves sediment in a direction normal to the slope. This results in a saw toothed path, which has a non-zero, net transport in the direction away from that of wave approach.

In situations where infiltration of the swash is low, an alongshore (downdrift) component of momentum is maintained by the backwash, which enhances the transport rate.

On beaches that promote a narrow zone of wave breaking (steep foreshore, small waves, plunging breakers), beach drift will be a major component of the total LST.

On beaches that have a wide surf zone (gently sloped with spilling breakers), beach drift is of limited significance in the total LST.
**Surf Zone Transport - Theory**

Within the surf zone, obliquely approaching waves generate a longshore current which can carry sand entrained by wave motions alongshore at a rate proportional to the speed of the longshore current.

**Surf Zone Transport - Complications**

On planar beaches, the surf zone transport might be relatively simple to calculate because the longshore current is uncomplicated.

However, on complex, wide surf zones with multiple bars and rip cell circulation, the surf zone transport is much more complex because of the spatial inconsistency of the various fluid motions.
**Instantaneous vs. Annual Transport Rates**

Gross longshore sediment transport is the summation of volumes transported, with no care for the direction of transport - simply a measure of how much sand motion existed over a period of time.

Net longshore sediment transport is the difference between volumes transported in either direction over a period of time, which is the quantity of concern if we are interested in the annual evolution of a beach/coast. I.e. Is the beach widening or narrowing from one year to the next?

Though net transport is very difficult to measure directly, we can utilize coastal features (natural and man-made) to estimate the directions and quantities of annual transport.

**What is the transport direction at this site?**

**How would you estimate the net annual transport at this site?**
LST Measurements – Wave Tanks

Early studies from “3d” wave tanks have been largely discredited, due to the problems arising from scaling effects.

Some more recent work from wave tanks has revealed the need to include breaker index – plunging breakers dramatically increase suspended sediment concentrations.

LST Measurements – Tracers

Used to measure instantaneous transport rates. Two principle methods:

1. Coat sand grains with fluorescent dye visible under UV light.
2. Tag the sediment with a radioactive isotope with a short half life.

Lagrangian approach - numerous samples taken over multiple time steps over a regularly spaced grid, to determine the advection velocity of a sediment plume.

Eulerian approach - make frequent measurements of tracer concentration at a single point, then integrate the time series and divide by the quantity of tracer injected, to obtain the advection velocity.

Results of a sand tracer experiment by Komar and Inman (1970) show the spatial distribution of surf zone longshore transport.
**LST Measurements – Streamer Traps**

Typically deployed in the surf zone, for only a few minutes, because they are not particularly durable under energetic wave conditions.

A series of traps are usually installed along a vertical array to obtain a suspended sediment profile through the water column.

Measurements show that trapped sediment quantities decrease with distance from the bed, as expected.

However, because they: (1) require much labor and (2) are not durable, OBS instruments are preferred.

**Prediction of Longshore Sediment Transport Rates**

Due to the complicated interrelationship of waves, currents, and sediment entrainment, the most widely used predictive model for calculating longshore sediment transport is a semi-empirical relationship based on the longshore component of wave energy flux:

\[ P_L = (ECn)_b \sin \alpha_b \cos \alpha_b \]

The major contribution by Inman and Bagnold (1963) was that they related the immersed weight transport rate to wave energy flux through a dimensionless constant.

\[ I_L = KP_L \]
Prediction of Longshore Sediment Transport Rates

Title

[Diagram showing the prediction of longshore sediment transport rates with data points and a line of best fit.]
Presentation Lottery