The Bruun Rule

The Bruun Rule (1962) provides a relationship between sea level rise and shoreline retreat, and has been widely cited by the engineering and scientific communities to interpret shoreline change and to design beach stabilization projects. The Bruun Rule assumes that all sand removed from the upper profile is deposited offshore as sea level rises.

However, attempts to verify the Bruun Rule based on field measurements have proven quantitatively inconclusive, in part due to the "noisiness" of the data. This, along with further examination of the processes associated with relative sea level rise (see also Dean and Mauermeyer 1983; Davidson-Arnott, 2005), has brought attention as to whether the Bruun Rule is based on a complete consideration of the underlying processes. Here we propose a modified form of the Bruun Rule that accounts for both landward (Aeolian and overwash transport) as well as seaward transport of sand.

Conversatory Evidence to the Bruun Rule

Examples of Overwash Transport

Shoreline Recession:

\[
\frac{dR}{dt} = \frac{W_d + V_0}{h_c + B} \left( \frac{h}{h_c + B} \right) \cdot \frac{dS}{dt}
\]

Solution to Shoreline Recession Equation:

With landward deposition of volume \( V_0 \):

\[
R = \left( \frac{W_d}{h_c + B} \right) \cdot \left( \frac{h}{h_c + B} \right) + V_0 \cdot \frac{1}{A} \left( \frac{h}{h_c + B} - \frac{R}{h_c + B} \right)
\]

For only landward transport, critical recession, \( R_c \), and associated volume, \( V_0 \), are a function of previously-discussed parameters as well as the profile scale factor, \( A \):

\[
R_c = \left( \frac{h_c - S}{h_c} \right)^2 \cdot V_0 = R B - S W + \frac{3}{4} A \left( W_d^2 - (W_d - R)^2 \right)
\]

Modified Bruun Rule

The Modified Bruun Rule incorporates landward transport (due to Aeolian and overwash transport) and seaward transport as a function of relative sea level rise. Diminishing berm crest elevation as a function of rising sea level is incorporated, a morphologic change that is not usually considered in the Bruun Rule.

Examples of Profile Lowering Offshore

Shoreline Recession:

\[
\frac{dR}{dt} = \frac{W_d}{h_c + B} \left( \frac{h}{h_c + B} \right) \cdot \frac{dS}{dt}
\]

Solution to Shoreline Recession Equation:

With landward deposition of volume \( V_0 \):

\[
R = \left( \frac{W_d}{h_c + B} \right) \cdot \left( \frac{h}{h_c + B} \right) + V_0 \cdot \frac{1}{A} \left( \frac{h}{h_c + B} - \frac{R}{h_c + B} \right)
\]

For only landward transport, critical recession, \( R_c \), and associated volume, \( V_0 \), are a function of previously-discussed parameters as well as the profile scale factor, \( A \):

\[
R_c = \left( \frac{h_c - S}{h_c} \right)^2 \cdot V_0 = R B - S W + \frac{3}{4} A \left( W_d^2 - (W_d - R)^2 \right)
\]

Conclusions

- Profile response must include landward transport of sediments, as evidenced by:
  - Overwash deposits
  - Aeolian deposits
  - Profile deepening offshore
  - Lack of evidence for offshore deposits
- Profile response to relative sea level rise depends on:
  - Excess or deficit of sand in profile
  - Potential for overwash during storms
- Increasing relative sea level will increase likelihood for overwash

Implications of Modified Bruun Rule

- Landward and seaward transport both contribute to beach recession
- Need to develop a greatly improved understanding of the dynamics of beaches; i.e., what governs long-term offshore versus onshore transport and deposition?
- Data on landward transport and deposition not readily available

Uncertainties and Unknowns

- Resolution of offshore datums in older surveys

Additional Data Needs

- Field data on beach response to storms
- Volume and distribution of landward and seaward deposits
- Long-term data sets of profile response

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