ON THE RELATION BETWEEN PREDICTED AND OBSERVED AEOLIAN TRANSPORT RATES

A FIELD STUDY AT THE BELGIAN COAST

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INTRODUCTION & METHODOLOGY

To deal with storms, seasonal and decadal variations, restoration and maintenance of coastal beach and dune systems require knowledge of aeolian sediment transport processes for the prediction of system response to wind forces over short to long-term timescales. Accurate aeolian sediment transport equations are of utmost importance for modern geomorphology and coastal engineering practices. Although sand transport by wind is easily observable, reliable and accurate data sets of sand transport rates are still scarcely available due to measuring difficulties. The **main focus** is to get insight into the relationship between aeolian sand transport rate and wind speed. We have used three field data sets, (1) measurements by the authors at two Belgian beach sites (Koksijde and Mariakerke), (2) measurements by Campos (2018) at a Belgian beach (Koksijde) and (3) measurements reported in Sherman et al. (1998) to evaluate the predicting ability of six different aeolian transport models.

• AEOLIAN SAND TRANSPORT MODELS

$$Q_s = C_B \cdot \sqrt{\frac{d_{50}}{D} \cdot \frac{\rho_{air}}{g}} \cdot u_*^3$$ **Original Bagnold (1937)**

$$Q_s = C_{kw} \cdot \frac{\rho_{air}}{g} \left(u_* - u_{*,th}\right) \cdot \left(u_* + u_{*,th}\right)^2$$ **Kawamura (1951)**

$$Q_s = C_B \cdot \sqrt{\frac{d_{50}}{D} \cdot \frac{\rho_{air}}{g}} \left(u_* - u_{*,th}\right)^3$$ **Threshold Bagnold (1954)**

$$Q_s = C_{Hsu} \cdot \left(\frac{u_*}{\sqrt{g \cdot d_{50}}}\right)^3$$ **Hsu (1971)**

$$Q_s = C_{DK} \cdot \frac{\rho_{air}}{g} \cdot u_{*,th} \cdot \left(u_*^2 - u_{*,th}^2\right)$$ **De Kok (2012)**

$$Q_s = \alpha_B \cdot \sqrt{\frac{d_{50}}{D}} \cdot \left(\frac{\rho_{air}}{g}\right) \cdot \left(u_*^3 - u_{*,th}^3\right)$$ **Modified Bagnold (2018)**

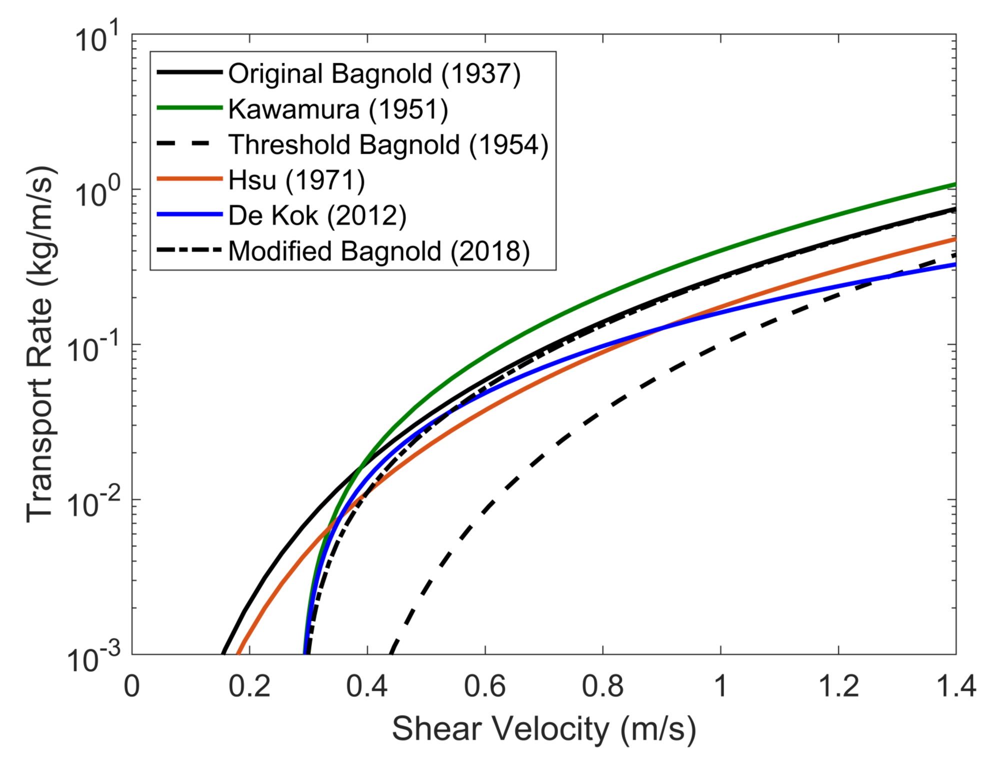

Figure 1. Comparison of six aeolian models based on shear velocity.

• RESULTS

Model	Slope (m)	R^2	RMSE (kg/m/min)
Original Bagnold (1937)	1.21	0.35	0.52
Kawamura (1951)	1.68	0.61	1.17
Threshold Bagnold (1954)	0.14	0.53	0.92
Hsu (1971)	0.69	0.44	0.42
Kok et al. (2012)	1.13	0.57	0.45
Modified Bagnold (2018)	**1.01**	**0.60**	**0.40**

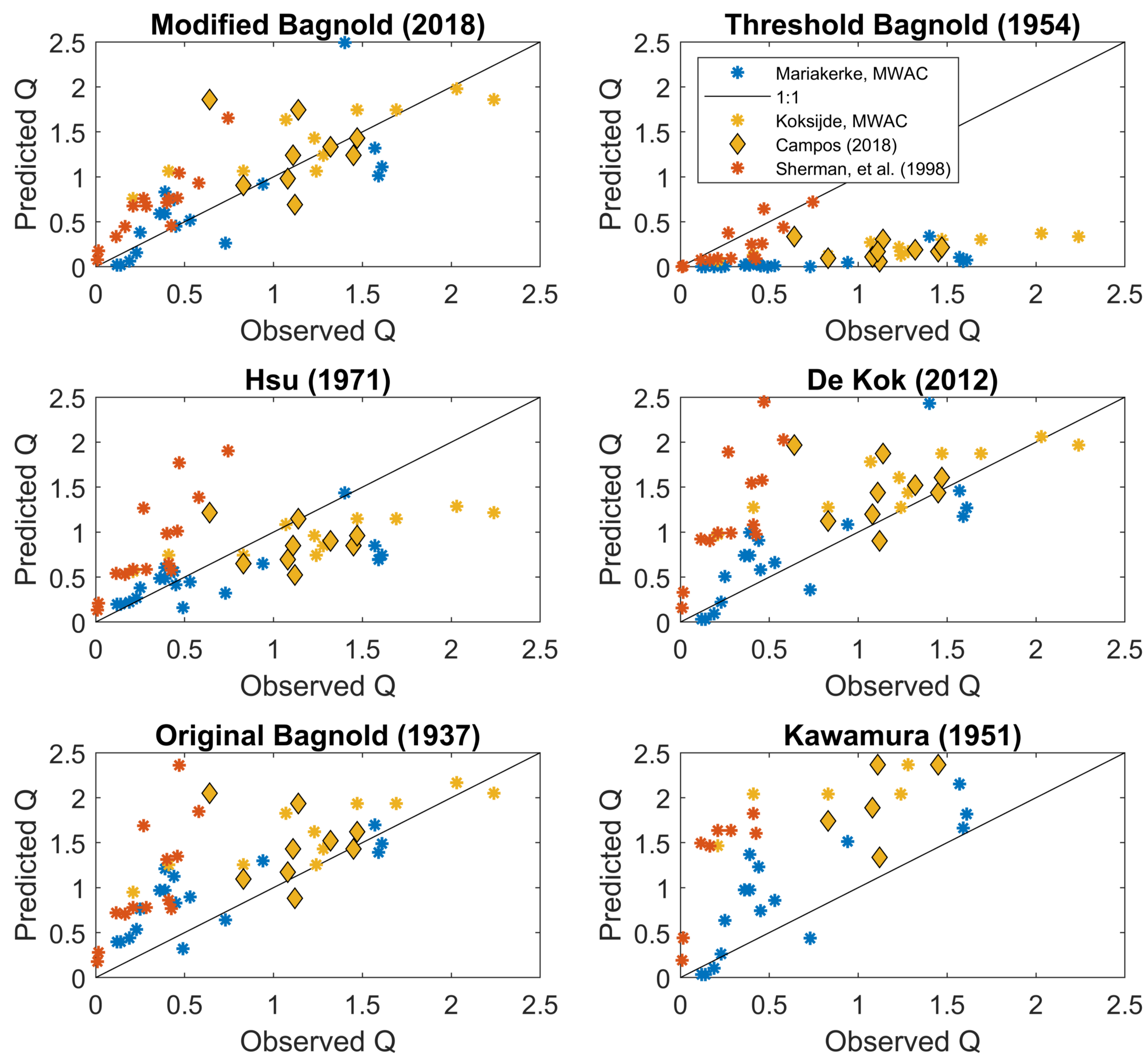

Figure 2. Comparison between observed and predicted sand transport rates for six aeolian models. Diagonal lines represent the 1 to 1 correspondence. All transport rates are in kg/m/min. Blue dots correspond to the measurements in Mariakerke. Yellow dots correspond to the measurements in Koksijde.

CONCLUSIONS

1. The modified Bagnold model was able to produce a strong one-to-one relation between observed and predicted transport rates. The model of Kok et al. (2012) was close second best.
2. The threshold model of Bagnold (1954) and the model of Kawamura (1951) produces the poorest results.
3. Observed transport rates also varied substantially between traps. The variability follows a similar relation as the transport itself, which would imply a constant coefficient of variation.

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