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A geomorphic application of a coupled, dynamic model of sediment transport and desert shrub populations in the Southwestern United States under anticipated climate-change scenarios

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Across the Southwestern United States, desert shrubs modulate sediment transport on arid hillslopes, wherein rainsplash processes create mounds beneath shrub canopies. These mounds act as capacitors which ultimately influence the sediment flux. Yet, complex plant community dynamics make it difficult to predict changes in the surface of the Earth over extended timescales, such as those associated with climate change. Climate predictions for the American Southwest suggest changes in precipitation which can affect desert shrub populations and in turn, sediment transport rates. To better understand the complex, abiotic-biotic interaction between vegetation and sediment transport on arid hillslopes we couple a biologically-informed, stochastic model of desert shrub population dynamics (presented in a complimentary abstract by Worman et al.), with a model of rainsplash sediment transport. This coupled model allows us to track changes in the total vegetation present on the hillslopes, which we measure in terms of biomass using the WBE allometric scaling model, and relate it to sediment transport rates. We find that the simulated values from the model confirm intuitive assumptions, in which higher amounts of shrub biomass are indeed inversely correlated to sediment flux values. Therefore, it is possible to generalize erosion rates obtained from the model in terms of hillslope biomass. We explore how different climate change scenarios affect desert shrubs and the associated sediment flux. The model suggests that shrub morphology acts as a control on how shrubs respond to climate change, specifically to increased aridification. This work provides an opportunity to develop techniques for large scale monitoring, and possibly prediction, of changes in shrub populations and associated sediment transport on desert hillslopes.