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Predicting Local to Regional Dust Emission in Deserts Using Soil-Landscape Models in Support of Military Activities

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During the past two decades, the U.S. armed forces have been called on repeatedly to operate in the deserts of the Middle East and southwest Asia. Methods are required to predict both local to regional sources of dust because the airborne dust can have a negative impact on critical military operations (i.e. loss of visibility), create adverse health impacts to military personnel, and for increasing the abrasion and corrosion to military equipment operating in desert regions. One of the most significant impacts of dust during military operations in Iraq (Operation Iraqi Freedom) and Afghanistan (Operation Enduring Freedom) was the loss of over 400 aircraft (mostly rotary-wing aircraft) from dust brownouts, commonly referred to a Degraded Visual Environments (DVE). Determining sources of dust and estimating dust emission potential requires the ability to predict basic soil characteristics and the related potential emissivity; however, areas of important strategic interest often from lack required terrain and soil information and are often in areas of dynamic and changing environmental conditions.

Many years of soil and geomorphic research have shown that the dust content, and the related dust emission potential, in soils (generally considered particles <0.125 mm in diameter) in most desert regions is commonly associated with specific landforms and soil types. We have developed an expert-based system that integrates rapid mapping of desert landforms with conceptual models of soil-landscape evolution that have a demonstrated ability to predict primary soil and terrain conditions. This integrated effort is performed in a geographic information system (GIS) framework using expert-based analysis of airborne and spaceborne imagery to identify terrain elements. Furthermore, new instrumentation that measures soil dust emission and new techniques of surface characterization using digital elevation models, provides additional critical information that enhances predictions of dust soil content and emissivity. The objective of this presentation is to summarize the results of previous published studies and reports where we have used our GIS-based soil-landscape model to produce derivative map-based predictions of the spatial distribution and content of dust-sized particle in soils and surface sediments. Applications include providing regional critical dust data sets for input for US Air Force-based regional atmospheric models used to predict dust and sandstorms in SW Asia and as a potential tool to predict areas most likely to produce dangerous DVE conditions.