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Identifying Saharan dust sources using remote sensing: a comparison of TOMS AI, Meteosat IDDI and a new MODIS Dust Index

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The TOMS aerosol index (AI) has shown that the Sahara desert is the world's largest source of dust and suggests that this dust is predominantly derived from closed basins. Notwithstanding this the exact geomorphological nature of many of the sources is still unclear, largely because of the poor spatial resolution of TOMS. More recently the Meteosat Infrared Difference Dust Index (IDDI) has been used to study Saharan dust, yet it reveals many different source areas from TOMS, also has a poor spatial resolution, and thus does not provide extra information on the nature of the sources.

To further our understanding of dust sources we have applied two different approaches. Firstly we have interpreted Landsat TM imagery and the SRTM digital elevation model of the entire Sahara to map all the large geomorphological features that are likely to contain fine material that is readily deflated (large palaeolakes ($>$500km2), river systems, inland deltas and gravel plains). We have then compared this geomorphological map to long-term average TOMS AI and IDDI maps. Results show that many, but not all, large palaeolakes are important sources. Dry rivers are also important, but only once they have emerged from the confined valleys of the Saharan mountains. Sometimes these unconfined rivers form extensive fluvial plains that appear to produce a moderate amount dust over large areas, thus forming regionally important sources.

The problem with this approach is that it does not consider small sources. To evaluate them we have developed and applied a MODIS Dust index to monitor dust storms at 1km2 resolution. Detected dust storms are then visually interpreted, traced back to their source and its location noted. Landsat TM imagery of the source location is then investigated to determine the landform/landuse at that location and thus the nature of the source. Of the 100 dust storms so far investigated 54 originate from palaeolakes, 17 from palaeorivers, 2 from fluvial plains and inland deltas, 1 from an apparently featureless Hamada, 1 from a transverse dune field, 5 five from cultivated areas surrounding oases and 1 from an urban area. For large landforms it is possible to determine where the dust comes from. For example, the Ahnet-Mouyder basin in Algeria contains a large Holocene palaeolake of about 5000 km2 and deflation is seen to occur 7 times on the margins of the lake near the junction between the deltas and the lake bed, once on the delta, but never from the centre of the desiccated lake bed. Eighteen dust storms yielded no source information either because their source was no longer deflating, or because when the location of the source was investigated in the Landsat TM imagery there were multiple landforms in the 1km2 pixel and thus it was not possible to determine which one the dust was emanating from.