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November 21, 2011

Office of the State Engineer,
901 South Stewart Street, Suite 2002,
Carson City, Nevada 89701.

Attention: Susan Joseph-Taylor,
Chief Hearing Officer,

To Whom it May Concern:

These comments are being submitted for the hearings and public comments related to **Southern Nevada Water Authority.** I understand public comments are being accepted with respect to construction and use of a pipeline and water to be transported by SNWA from Delamar, Dry Lake, Cave and Spring Valleys to the Las Vegas area in the total amount of 125,976 acre-feet.

As a resident of the Wasatch in Utah, and a skier, hiker and snowshoer in that area, I believe the withdrawal of water from the northern and central valleys of Nevada has the potential to be damaging to our snow resources, and environment in Utah. I therefore oppose this water pipeline from the Delamar, Dry Lake, Cave and Spring Valley to Las Vegas.

It has been shown that dust deposition on snow accelerates snow melt rates. This is specifically the subject of research by the University of Utah, and in the Wasatch Mountains. (http://unews.utah.edu/old/p/062409-2.html enclosed article) The snow in these mountains is our key water resource for both culinary and irrigation use, and also as a natural resource. Consequently, any action that can potentially increase air dust levels that will deposit in the Wasatch is a matter of concern.

I have background in hydrogeology, and I am a member of the American Geophysical Union. I consider that actions that cause large quantities of water to be removed from the northern watersheds, to other areas, are likely to cause lower ground water conditions, and also drier soil conditions for longer periods of the year than under natural conditions. (See second enclosed article G.S. Okin et al "Dust: Small Scale Processes with Global Consequences" EOS Transactions Volume 92, Number 29 19 July 2011,)

Given that the prevailing winds are westerly, any airborne dust resulting from these changes will be transported towards Utah and the Wasatch, with the potential to be deposited in the Wasatch and Uintah Mountains. This has the potential to 1) Increase snow melt rates; 2) Decrease the length of time that there is snowcover, adversely affecting the management of water resources, and adversely affecting the ski industry in Utah.

I request your consideration of these issues and potential damage to the natural resources and commercial interests of the Utah ski interests in your decision about the pipeline and SNWA water relocation.

Yours sincerely,

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DESERT DUST ALTERS ALPINE MEADOW ECOLOGY

UNIVERSITY OF UTAH AND COLORADO RESEARCHERS ID ANOTHER DANGER OF GLOBAL WARMING

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Embargoed by the journal Proceedings of the National Academy of Sciences for release at 3 p.m. MDT Monday, June 29, 2009

June 29, 2009 -- Tom Painter, a University of Utah geographer, has conducted a number of studies showing how snowmelt is accelerated by wind-blown dust falling on mountains. His latest study - a collaboration with Colorado scientists - will be published Monday in the online edition of the journal Proceedings of the National Academy of Science.

Below is a modified version of a Colorado State University news release on the study.

FORT COLLINS, Colo. - A new study by a Colorado and Utah researchers indicates that accelerated snowmelt by desert dust that blows into the mountains changes how plants respond to seasonal climate cues that regulate their life cycles. As a result, climate warming may have a greater influence on their annual growth cycle.

"The observed changes in plant life cycles due to desert dust synchronize plant growth and flowering across the alpine (zone), which vary greatly in the absence of dust" said Heidi Steltzer, a Colorado State University researcher in the Natural Resource Ecology Laboratory, who led this study. "Synchronized growth was unexpected and may have adverse effects on plants, water quality and wildlife."

Current mountain dust levels are generally five times greater than they were prior to the mid-19th century, due in large part to increased human activity in the deserts. This year, 12 dust storms have painted the mountain snowpack red and advanced the retreat of snow cover, likely by more than a month across Colorado. Under climate change, warming and drying of the desert southwest is likely to result in greater dust accumulation in the mountains.

"It is striking how different the landscape looks as result of this desert-mountain interaction," said Chris Landry, director of the Center for Snow and Avalanche Studies, Silverton, Colo., who contributed to the study along with Tom Painter, an assistant professor of geography and director of the Snow Optics Laboratory at the University of Utah. "Visitors to the mountains arriving in late June will see little remaining snow, even though snow cover was extensive and deep in April, and the snow that remains will be barely distinguishable from the surrounding soils."

"Earlier snowmelt by desert dust depletes the natural water reservoirs of mountain snowpacks and in turn affects the delivery of water to urban and agricultural areas," said Painter.

The new research, published this week by the Proceedings of the National Academy of Sciences, now shows that this early snowmelt also affects the life cycles of alpine plants and that the dust effect on these plants differs from the effect of climate warming.

In an alpine basin in southwest Colorado's San Juan Mountains, the researchers simulated dust effects on snowmelt in experimental plots to measure dust's acceleration of snowmelt on the life cycles of alpine plants. The timing of snowmelt signals to mountain plants that it is time to start growing and flowering. When dust causes early snowmelt, plant growth does not necessarily begin soon after the snow is gone. Instead, plants delay their life cycle until air temperatures have warmed consistently above freezing.

"Climate warming could therefore have a greater effect on the timing of growth and flowering," said Steltzer.

Greening and flowering times were more similar across the alpine tundra when snowmelt occurred earliest in the researchers' study plots. Steltzer predicts that increasing dust inputs could synchronize plant life cycles in the alpine tundra but the full consequences of this synchronization are not yet understood. Competition for water and nutrient resources among plants should increase, leading to the loss of less competitive species. Delayed plant growth could increase nutrient losses, decreasing water quality. Similarity in flowering times and plant growth will result in abundant resources for wildlife for a short time rather than staggered resources over the whole summer.

The case is building that the transfer of desert dust to the mountains has environmental consequences for alpine plants, wildlife and people. Human use of desert landscapes is linked to the life cycles of mountain plants and changes the environmental cues that determine when alpine meadows will be in bloom, possibly increasing plants' sensitivity to climate warming.

"Desert dust alters the ecology of alpine landscapes from staggered to more synchronized plant growth. With increasing dust deposition from drying and warming in the deserts under global warming, the composition of alpine meadows could change as some species increase in abundance, while others are lost, possibly forever," Steltzer said.

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EOS

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EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

VOLUME 92 NUMBER 29 19 JULY 2011

Dust: Small-Scale Processes With Global Consequences

Desert dust, both modern and ancient, is a critical component of the Earth system. Atmospheric dust has important effects on climate by changing the atmospheric radiation budget, while deposited dust influences biogeochemical cycles in the oceans and on land. Dust deposited on snow and ice decreases its albedo, allowing more light to be trapped at the surface, thus increasing the rate of melt and influencing energy budgets and river discharge. In the human realm, dust contributes to the transport of allergens and pathogens and when inhaled can cause or aggravate respiratory diseases. Dust storms also represent a significant hazard to road and air travel.

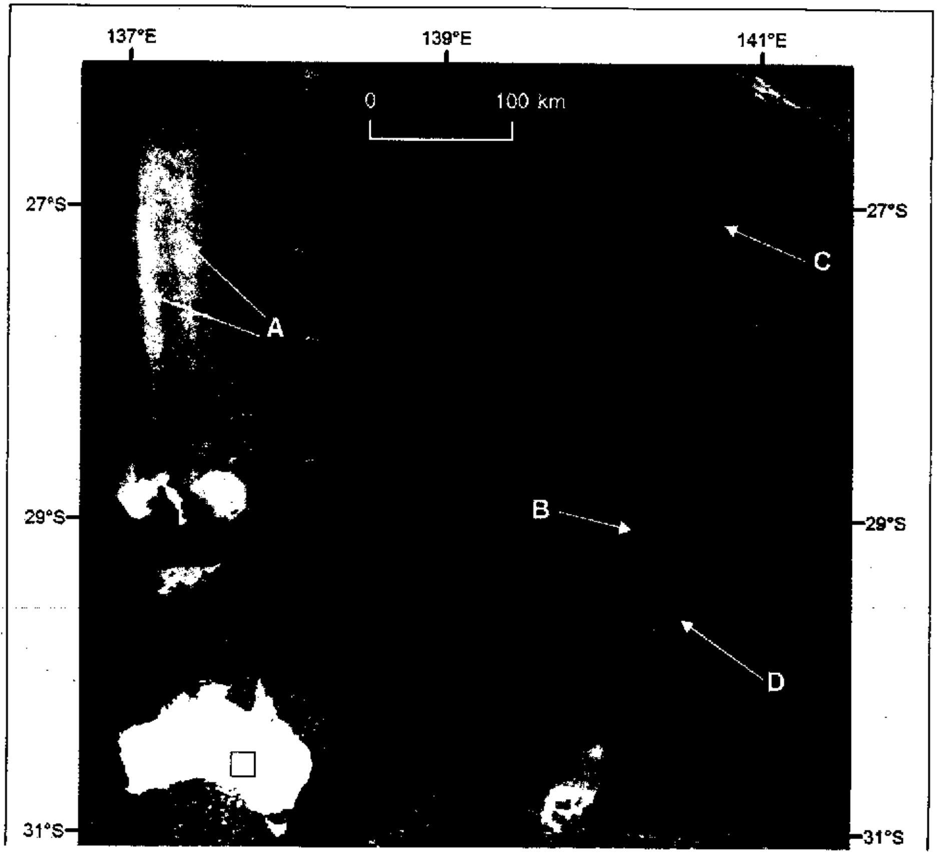
Because it affects so many Earth processes, dust is studied from a variety of perspectives and at multiple scales, with various disciplines examining emissions for different purposes using disparate strategies. Thus, the range of objectives in studying dust, as well as experimental approaches and results, has not yet been systematically integrated. Key research questions surrounding the production and sources of dust could benefit from improved collabora-

Once the diversity of dust-producing landforms is recognized, it becomes critical to quantify the relative importance and temporal behavior of these different sources. Meeting this challenge will require concerted and collaborative efforts from field scientists, remote sensing specialists, and modelers.

How Do Vegetation Properties Influence Dust Production?

Although vegetation typically reduces eolian activity, vegetation cover and dust emission are not related in a simple way, making it difficult to determine thresholds at which vegetation inhibits dust emissions or even whether such thresholds exist. Recent studies show that unvegetated gaps control dust production on vegetated landscapes [*Okin et al.*, 2006], meaning that dust emissions from areas with large gaps can be considerable even in the presence of extensive vegetation cover (Figure 2).

Distinguishing between perennial and annual vegetation is also important in understanding dust emission potential and timing. Perennial desert plants typically



These questions involve the origins of dust, factors that influence dust production and emission, and methods through which dust can be monitored.

Where Does Dust Come From?

A common generalization is that dust emission occurs mainly on dry lakes. Though many dry and drying lakes, whether natural (e.g., Australia's Lake Eyre, Chad's Bodélé Depression) or man-made (e.g., California's Owens Dry Lake, central Asia's Aral Sea), are significant sources of dust, research has shown that not all dry lakes are dust sources or, at least, not all the time [*Reynolds et al.*, 2007]. One consequence of this generalization is the notion that non-lake sources are not significant. Yet a growing body of literature reveals that vegetated landscapes and dune fields can emit dust [*Bullard et al.*, 2008; *Rivera Rivera et al.*, 2009] (Figure 1). Recent advances using satellite data over northern Africa have also shown that dust sources may be more diverse than previously believed [*Schepanski et al.*, 2007], and in the Mojave Desert of the southwestern United States, alluvial fans and plains may be larger overall contributors to total dust emission than dry lakes [*Reheis and Kihl*, 1995].

BY G. S. OKIN, J. E. BULLARD, R. L. REYNOLDS, J.-A. C. BALLANTINE, K. SCHEPANSKI, M. C. TODD, J. BELNAP, M. C. BADDOCK, T. E. GILL, AND M. E. MILLER

and dense growth of annual plants may follow precipitation, depending on its timing and amount. Thus, drylands with sparse perennial vegetation can emit dust but with reduced propensity when significant annual plant cover is supported by prior precipitation [*Urban et al.*, 2009]. The representation of responses of different plant functional types to intra-annual and interannual climate variation is critical for accurately simulating dust emissions over vegetated areas.

How Do Soil Processes Influence Dust Production?

The ability of a soil to emit dust is not a simple function of its surface particle size distribution, nor does the size distribution of dust mirror the size distribution of the source soil. Soil particle sizes are typically calculated from fully disaggregated suspensions in liquid, but dust emission is more a function of dry aggregate size distributions. Dust is largely produced by the collisions between saltators—bouncing particles transported as bed load, themselves often weakly consolidated aggregates of soil—or between saltators and the surface, though in some special cases, emissions are possible without saltation [see *Kjelgaard et al.*, 2004]. Additionally, mineral grains may have clay or oxide coatings that are accreted as soils form, abraded during transport, and released as dust, thus allowing deposits that nominally contain no fine particulates to be a source of aerosols [e.g., *Bullard and White*, 2005].

Fig. 1. True-color image from the Moderate Resolution Imaging Spectroradiometer (MODIS) on 2 February 2005 showing dust from a diversity of sources within an approximately 520- × 520-kilometer portion of a northwestern region of the state of South Australia, Australia. These include a combination of dry lake and alluvial terminus sources in Lake Eyre (arrows labeled A), dominantly dry lake sources in Lake Callabonna (arrow B), alluvial sources in the Cooper Creek Floodplain (arrow C), and sand dunes east of Lake Callabonna (arrow D).

The remote sensing of soil surfaces in a way that can contribute meaningfully to the study of dust is in its infancy, and though there are increasingly better geospatial databases of soil properties, these do not reflect aggregate formation, soil stability, or particle coatings. Better understanding of how soil reflectance or existing soil databases can be used in dust emission models that represent soil processes will ultimately lead to better predictions of dust emission and atmospheric loading.

What Role Does Human Activity Play in Dust Emission?

Dust plumes are commonly observed originating from areas of localized human disturbance such as roads, agricultural fields, military installations, construction sites, and off-road vehicle areas. Grazing is a widespread, dust-producing disturbance, and grazed areas consistently produce more dust than areas never grazed. Grazing removes vegetation, breaks protective soil crusts, and promotes large-scale shrub encroachment on grassland, which itself can lead to order-of-magnitude increases in emissions by changing the unvegetated gap size distribution in a landscape. A clear understanding of the myriad ways in which human disturbance promotes dust emission and the magnitude of the effects of different land use types on dust production are both critical for predicting how changes in land usage (and thus changes in land use policies) will influence dust emission, loading, and deposition in the future.

What Information Does Remote Sensing Provide About Dust Sources?

Satellite remote sensing has revolutionized the study of dust, particularly at the regional and global scales important for climate analysis. As a result, there is a very good picture of the major dust-producing areas of global importance. Dust plumes observed from satellites are vivid indications of concentrated dust emission and large sources of atmospheric dust.

However, field studies have shown that considerable dust emission can also occur from diffuse or relatively small sources that do not produce plumes visible from space. Dust plumes that are readily sensed remotely may originate from the strongest dust sources in a region, but generally the source areas for these plumes occupy a small fraction of the landscape. In contrast, diffuse sources (including dust devils [see *Koch and Renno*, 2005]) might produce dust at rates considerably lower than plume-producing areas but with spatial extents several orders of magnitude higher. Even when these diffuse sources produce a coalesced dust plume dense enough to be detected in satellite imagery, the source areas may be impossible to identify in remote sensing imagery. This condition leads to underestimation of the contributions of diffuse dust sources to regional and global emissions.

Furthermore, the relative timing of satellite overpass and dust emissions, the presence of undetectable dust beneath clouds, and the underestimatation of near-surface dust by some sensors all tend to bias remote sensing estimates of dust emission. Though identifying massive, plume-producing dust sources is important, it is also necessary to acknowledge less obvious dust sources so that a more comprehensive picture of the distribution, amount, and timing of dust emissions can be produced.

Global-scale research has provided breakthrough advances in understanding dust emissions and their role in the Earth system. However, one outcome of regional-scale and global-scale analyses at relatively coarse resolution—facilitated by satellite data and necessitated by current model resolution and computational constraints—is that

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complex processes have been simplified. The need to simplify multifaceted environments into manageable modeling problems inevitably produces generalizations about the location, intensity, and dynamics of different dust sources. It is critical not to take these generalizations as complete descriptions of dust emission processes. As the spatial resolution of models increases, research should focus on strategies for incorporating smaller-scale and short-term temporal variability of dust emissions. Some strategies are being explored for both past and contemporary dust emissions, but there is clearly also a need to expand these strategies to include anthropogenic influences.

A Comprehensive Approach

Finally, understanding the production and role of dust in the Earth system would greatly benefit from active dialogue among the different observation-oriented and model-oriented communities, as well as investigators who work on multiple scales, to ensure that dust emission processes can be included with high fidelity, while maintaining the computational simplicity required for ever more complex global and regional models. At present, both disciplinary boundaries and interest in dust at different, and difficult to reconcile, scales impede progress in the study of dust. In this sense, dust emission is not so different from a variety of other phenomena in which small-scale processes have global consequences, such as cloud formation, anthropogenic carbon dioxide emission, and land use change. Funding and workshop opportunities that directly address these difficulties, both generally and specifically with regard to dust, are required so that scientists can strive for better accuracy in the next generation of predictions about the future of the Earth system.

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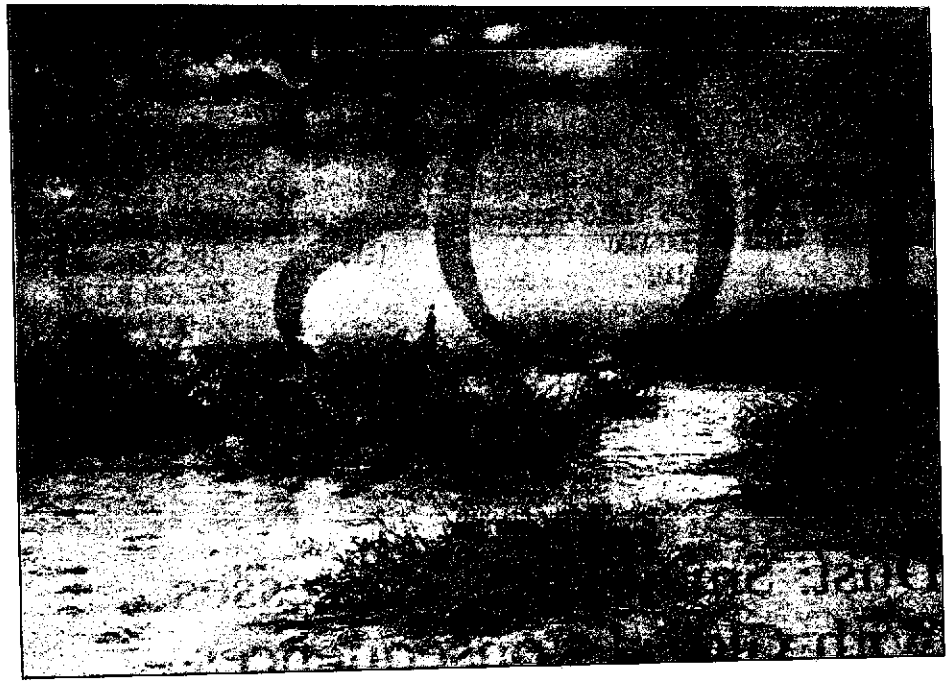

Fig. 2. Photograph of dust being emitted from a loamy mesquite shrubland during a dust storm in southern New Mexico in summer 2010. Photo by Matthew Baddock.

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