

Thomas Blount, Mackenzie Nelsen

Coral Reef Ecology

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## African Dust Lesson Plan

**\*\*\*Teacher will begin by opening a discussion with the class *before* having them read the material.**

Predict the potential effects (negative and positive) that the global dust cycle has around the world?

Where do we think the dust is coming from?

Who/what is the dust affecting the most?

**\*\*\*Have the students read the summary below the activities/questions.**

1. True/False: African dust movement is a new phenomenon.

\_\_\_\_\_.

2. African dust has become an issue because of increased \_\_\_\_\_ and a changed \_\_\_\_\_.

\_\_\_\_\_.

3. List three things that have led to an increased quantity of dust.

a. \_\_\_\_\_  
b. \_\_\_\_\_  
c. \_\_\_\_\_

4. List four things that have led to a changed composition of the dust.

a. \_\_\_\_\_  
b. \_\_\_\_\_  
c. \_\_\_\_\_  
d. \_\_\_\_\_

5. List four coral diseases that result from African dust.

a. \_\_\_\_\_  
b. \_\_\_\_\_  
c. \_\_\_\_\_  
d. \_\_\_\_\_

6. List two human diseases that have been linked to African dust.

a. \_\_\_\_\_  
b. \_\_\_\_\_

### Watch USGS Video:

[http://coastal.er.usgs.gov/african\\_dust/documentary.html](http://coastal.er.usgs.gov/african_dust/documentary.html)

### Powerpoint Presentation

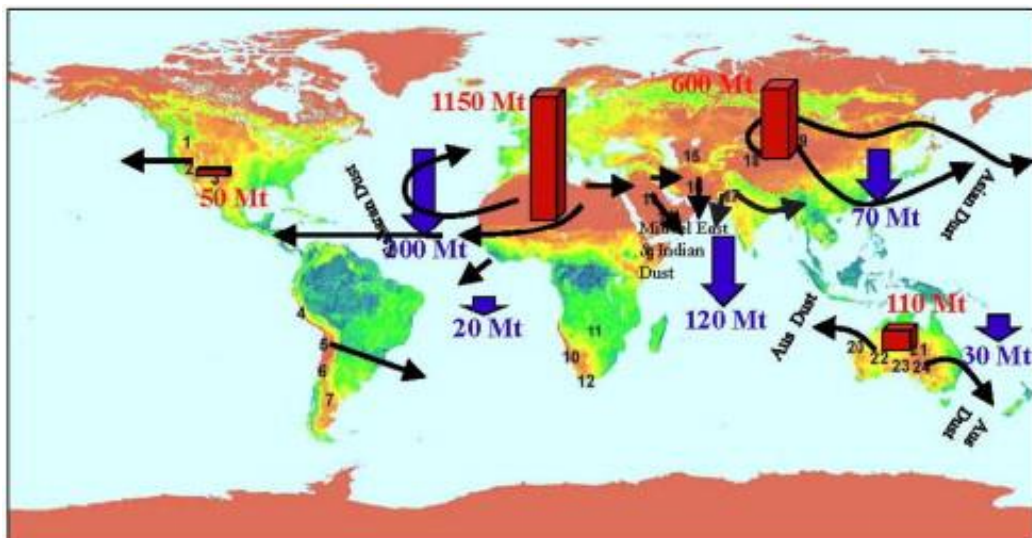
[https://docs.google.com/presentation/d/1Z1k7hlqUTQOctZzytDXbW\\_n9fXGrrOjS3RwVeumJ0Ik/edit?usp=sharing](https://docs.google.com/presentation/d/1Z1k7hlqUTQOctZzytDXbW_n9fXGrrOjS3RwVeumJ0Ik/edit?usp=sharing)

### World Map Activity

Give Students a blank map of the world and have them draw out the dust cycle sources and sinks. Indicate the direction and amount of dust coming out of each region. Use the map below as a key.

\*This activity can be adapted for different age groups.

- Beginning science courses can use actual sand to draw out dust cycle patterns.
- More advanced courses can draw box models and determine flux rates and reservoir times for each source and sink.



# Summary for Activity

## **Intro**

The transfer of African dust across the Atlantic Ocean is a phenomenon that has existed for centuries. However, only in the past 45 years has it become an issue, becoming a health risk for coral reefs and human beings alike.

## **Changes**

There are two reasons why African dust has shifted from a benign to a malignant process. The first is that there has been an increase in the quantity of dust. Global temperature increase has left once fertile soil dry and sandy. This is especially true in the Sahara and Sahel regions of Africa where we see the most dust originate from. Further, human activity has played a significant role in the increase of dust that gets carried across the Atlantic Ocean every year. Desertification and changing land-use patterns are consequential to the agricultural economy of the region and lead to further loss of habitable land and ultimately to an increase in dust sitting where topsoil once used to.

The second variable that has made the dust so dangerous for the Caribbean is the chemical composition of the dust. Human activities that again, result from an agricultural-based economy have made the dust into a toxic cloud carrying with it all sorts of microbes and heavy metals. Biomass combustion, burning of fossil fuels, the improper disposal of plastics, and the use of pesticides in the source region have all negatively affected corals. Andrew Negri of the Australian Institute says pesticides reduce coral larvae ability to settle on the ocean floor, which is a critical step for survival.

## **Effects**

The environmental effects of the now-toxic and overpowering dust are enormous. One of the metals that dust now carries with it is iron- an element critical for algae growth. The increase in algae creates an imbalance in the carbon cycle (the process by which carbon transfers through oceans, atmosphere, and living things). Algae are coral's kryptonite as it out-competes coral for light, food, and space. A fungus which has been linked to a rise in sea-fan disease has been traced back to the Sahel region of Africa as well.

However, coral is not the only organism at risk. Humans who reside in the Caribbean or surrounding gulf region are subject to the harmful effects of African dust as well. Heavy metals such as arsenic, lead, mercury have all been linked to tuberculosis and asthma. Gene Shinn of the US Geological Survey reports that asthma rates in the Caribbean are among the highest in the world. Further, Shinn sites the clear link between the dust and the asthma epidemic, "The incidence of asthma on Barbados and nearby Trinidad

has increased 17-fold since 1973, and that was the first year that graphs showed a big spike in the dust record there.” The dust has also had an effect on residents in Tampa, Florida. Shinn reports that “About half the particles breathed in South Florida during the summer months originate in Africa. The asthma epidemic in areas that are relatively free of industry correlates with the increased flux of African dust.”

### **Why do we point to dust?**

The issues affecting coral reefs are regional. Coral diseases are not limited to resort areas, they are affecting remote and protected reefs.

### **History of Research:**

Scientists have been collecting data on African dust since 1966. The issue has been so well studied that articles were posted in popular science magazines in the late 90's. The general public and people in the Caribbean began to understand the health side effects and potential environmental problems associated with dust transport. The African region has been heavily explored, but other areas of the world have been ignored in terms of research. Australia and Asian dust patterns have not been looked at until recently. 70% of global dust is coming out of Africa.

Dust has been linked to sea-fan disease, black band disease, white plague, white pox; bacterial induced bleaching and pink-spot disease.

### **Australia and Asia-**

A recent study of the Australian dust events stated that “too few investigations have been carried out on dust composition (in Australia) especially in regards to organic composition and microbiology.” While studies on African dust have been going on since the 1960's, the first study to fingerprint a dust sample in Australia occurred in 2008. This study found the *Aspergillus sydowii* fungi, a fungus linked directly to black band disease, in dust samples.

The effects of dust in the Pacific region have been linked to red tide events. Dust inputs trace elements into the water, which causes an increase in primary productivity in the Pacific. The human and ocean health effects need more research given the toxic nature of dust coming out of China.

### **Analyzing dust samples-**

Dust samples are analyzed by measuring grain size, extracting organic compounds, using satellite imagery, pollen samples and microbe identification. Currently there are research stations in the U.S Virgin Islands, Cape Verde, Trinidad and Tobago and Mali. Aerosol samples are collected in Mali, tracked across the Atlantic Ocean using satellite imagery and wind patterns and analyzed again in the Caribbean.