

LECTURE #13: Extreme Heat & Desertification

Date: 8 March 2021

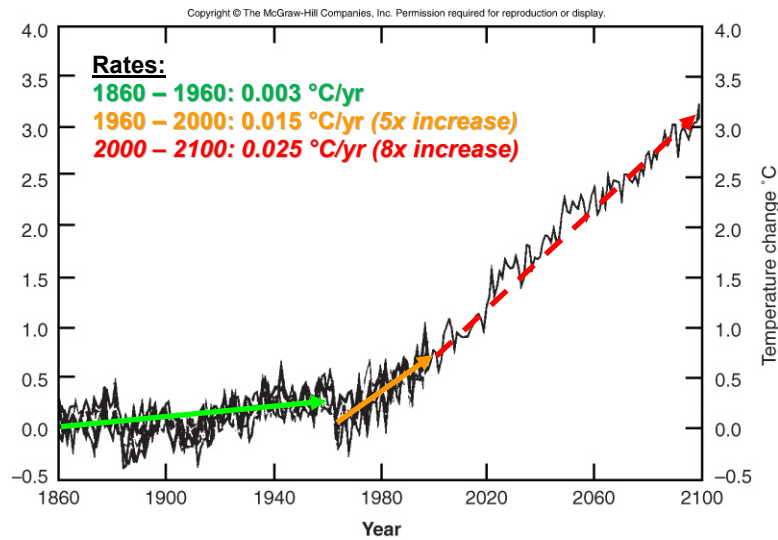
I. This is the Start of “Part 2” of the Course

- transitioning into the weather- and climate-related disasters

II. Dry Weather and Heat Waves

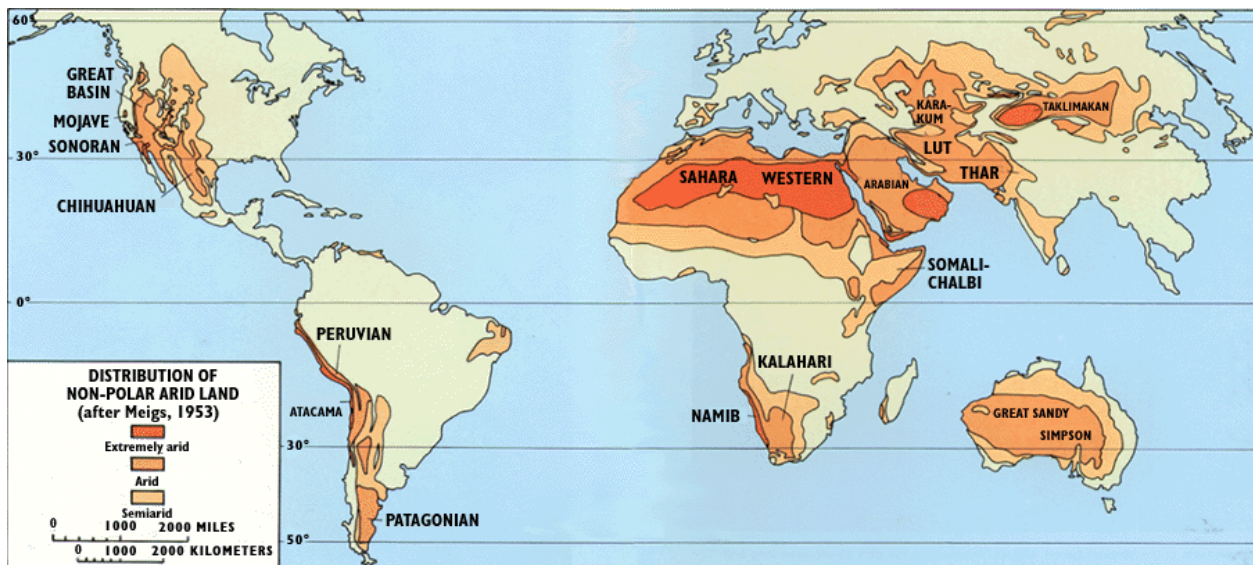
- critically important for loss of life and impact on the environment
 - occur on short to long time scales
 - short: heat wave (*lasting days to weeks*)
 - medium: drought (*months to years*)
 - longer: desertification (*years to decades*)
- News/history
 - Riyadh, Saudi Arabia (2009)
 - on March 10 a dust cloud engulfs entire city of 4 million
 - visibility reduced to only a 0-3 meters
 - caused traffic jams and stopped airport operations
 - storms may last only hours up to several days
 - becoming more frequent
 - Europe (2003)
 - a record heatwave in August
 - claimed an estimated 35,000 lives
 - in France alone, 14,802 people died from the searing temperatures
 - Chicago, IL (1995)
 - strong upper-level ridge of high pressure in the northern Plain states
 - 13-15 July: numerous heat records
 - high humidity also
 - 13-17 July
 - 465 people died in Chicago
 - most affected: poor and elderly
 - over ½ died on the upper floors and the first floor of apartment buildings
 - **why??**

- longer term climate change (*more on this at the end of the course*)
 - over the last 25 years the average global temperature rose by 1°F or 0.6°C
 - the rate of increase is 5 times more than the previous century
 - projected to increase to 8 times more over the next 100 years



III. Deserts & Desertification

- what is a desert??
 - a region with a mean annual precipitation < 25 cm (~ 10 inches) per year, with very little vegetation and support for life
 - 1/3 of the Earth's land surface is classified as a desert

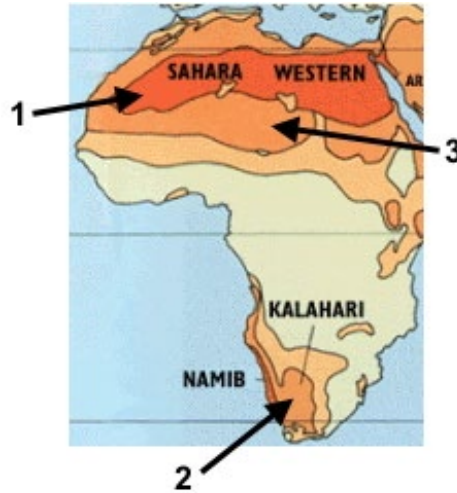


- numerous classifications of deserts
 - rely on some combination
 - the number of days of rainfall
 - the total amount of annual rainfall
 - temperature

- deserts are not restricted by latitude, longitude, or elevation
 - example: China has both the highest desert (the Qaidam @ 2,600 ASL) & one of the lowest (the Turpan @ 150 meters BSL)
 - example: in the US, we have 4 named deserts:
 - Sonoran, Mojave, Chihuahuan, and Great Basin
- *only about 20% of deserts are covered by sand*
- how do they form?
 - in regions where there is very high evaporation compared to the amount of precipitation
 - to meet this condition, there must be warm, dry air masses
 - **why??**
 - as cold air sinks, it is compressed by the overlying atmosphere
 - this produces warming of the compressed air mass
 - warm air can accommodate more water vapor
 - results in higher evaporation rates over the land surface
 - this is a high-pressure system
- four primary types of deserts:
 - polar:
 - an area of intense cold but very little snow/precipitation
 - example: Antarctica
 - mid-latitude (*a.k.a.*, “*continental desert*”)
 - typically, in basins of large continental land masses far from oceans
 - typified by low rainfall and sparse vegetation
 - example: Gobi Desert, China, Great Basin Desert, US
 - trade-wind
 - located at 30 degrees N and S latitude
 - controlled by persistent areas of sinking air masses
 - typified by very arid conditions
 - example: Sahara Desert
 - coastal
 - generally, on the western edges of continents
 - bounded by cold ocean currents
 - these cool the air starting the cycle of increased evaporation (*see above*)
 - example: coastal Peru and the Namibian Desert

IV. Climate Regimes:

- hyper-arid:
 - receives < 2.5 cm of precipitation/year
 - marked by little to no vegetation
 - form the central areas of larger desert systems
 - dunes and sand seas are common
 - example: central Saharan Desert



Africa Deserts:

(1) hyper-arid
(Sahara)

(2) arid
(Kalahari)

(3) semi-arid
(Sahel region)

- arid:
 - receives 2.5 - 25 cm of precipitation/year
 - marked by some drought-resistant vegetation
 - have playas (dry lake beds) and saline lakes in areas
 - dunes are less common
 - example: Kalahari Desert, Africa
- semi-arid:
 - receives 25 - 50 cm of precipitation/year
 - marked by semi-stable vegetation and sparse agriculture
 - flash-flooding and alluvial fans are common
 - able to sustain moderate human development
 - situated at the margins of larger deserts systems
 - *most at-risk regions for desertification!!*

V. Process of Desertification

- slowly advancing spread of desert conditions/sand along a desert edge due to:
 - climate change
 - anthropogenic (*human*) land degradation
- some desert fringes form a gradual transition from a dry to a more humid environment
 - example: Sahel region of West Africa
 - 1968-1973 drought combined with poor land-use practices
 - caused the deaths of more than 100,000 people and 12 million cattle
- causes?
 - climate change: shorter-term climate change causing years of drought
 - important to remember that drought ≠ desert
 - but it can lead to desertification and famine
 - land degradation/soil erosion: human land use patterns which lead to conditions favoring eventual desertification
 - several factors:
 - over-cultivation
 - over-grazing

- deforestation
- bad irrigation practices
- can lead to extreme dust conditions, dust storms, and poor respiratory health

VI. Monitoring and Mitigation

- monitoring
 - weather and soil moisture conditions using ground- and satellite-based instruments
 - human land use practices

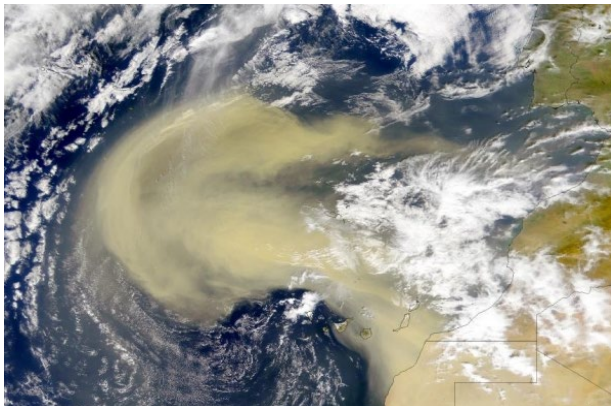


Kansas: dust storm advancing

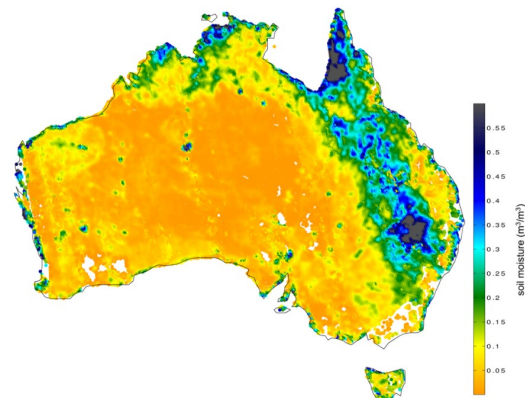


China: post dust storm

- mitigation
 - little that can be done once a long-term drought transitions to desertification



Africa (2002): large dust storm seen from space



Australia: satellite-based soil moisture