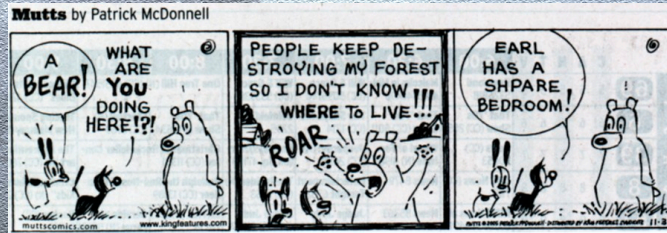


Topic 23: Anthropogenic Changes - Ground

<https://geowiki.ucsd.edu/sio15>



test 8: next Monday; includes questions for HW6!

Homework 8 due on Tuesday 5 pm;
absolutely no late submissions past midnight

upcoming: please participate in UCSD course review

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Dust and Sand Storms

- common in arid areas
- carry sand over large distances
- across oceans

a sand blaster locally ...

New South Wales, Australia

... a transport giant globally!

haboob

orange skies
Europe 2022

Apr 2005, from Syria/Jordan to Iraq

ges: Ground

sand storms in Sahara
-> red snow in Europe

Dust Storms - Sick Corals in the Caribbean

Why do Caribbean corals and sea fans and sea urchins die?

Pathogenic Microbes from Africa!



1988



1998



2001

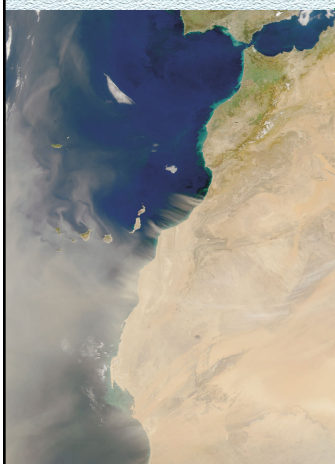
Images: Griffin et al.



open sewage ditch in Mali

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Sahara Dust Storms - Why should we Care?



February 11, 2001



Image: Griffin et al.

dust storms carry microbes, pathogens, toxic chemicals, pesticides, herbicides, fungi

cross oceans within a matter of days!

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Global Dust Storms - Why should we Care?



Image: Griffin et al.

Multiple circulation cells across planets
Pathogen transport in matter of days

Examples:

- Gobi desert dust
- U.S. 1930s Dust Bowl

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Global Dust Storms and Brown Clouds

- similar dust storms cause yellow rain in Eastern Asia
- clouds from pollution (Atmospheric Brown Clouds; aerosols)

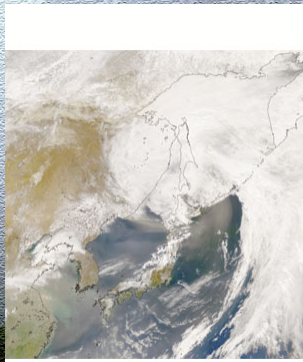
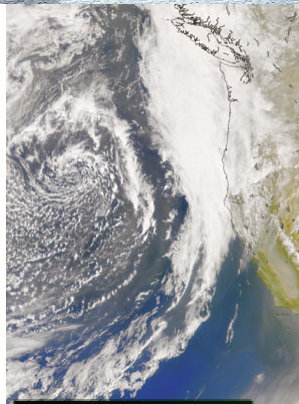
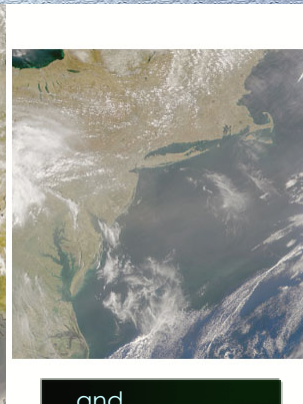


Image: Griffin et al.

Dust Storm from
Gobi Desert
Apr 13, 2001



...reached
West Coast
Apr 15, 2001



...and
East Coast
Apr 22, 2001

research pioneered at SIO

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Particulate Matter World's Most Polluted Cities

PM $\mu\text{g}/\text{m}^3$ (2004) City

169	Cairo, Egypt
150	Delhi, India
128	Calcutta, India
125	Taiyuan, China
123	Chongqing, China
109	Kanpur, India
109	Lucknow, India
104	Jakarta, Indonesia
101	Shenyang, China

source: Wikipedia

11/8/17 > 700 $\mu\text{g}/\text{m}^3$
 11/16/24 Lahore, Pakistan > 600 $\mu\text{g}/\text{m}^3$

PM mg/m^3 (2016/2020)

183	Damman, Saudi A.
173	Kanpur, India
172	Faridabad, India
149	Gaya, India
146	Varanasi, India
144	Patna, India
143	Delhi, India
138	Lucknow, India
132	Bamenda, Cameroon (2012)
131	Agra, India
.....	
101	Patiala, India - #171

93

Baoding, China #20

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Topic 17- Dust Storms and Human Impact: The 1930s Dust Bowl

NATURE:

five unusually dry seasons

HUMANS:

- massive/aggressive agriculture
- Great Plains, particularly Southern Plains (Oklahoma Panhandle)
- removal of Buffalo Grass

it takes 30 years to grow 1 in of soil in the U.S.

Dust Storms and Human Impact: The 1930s Dust Bowl

CONSEQUENCES:

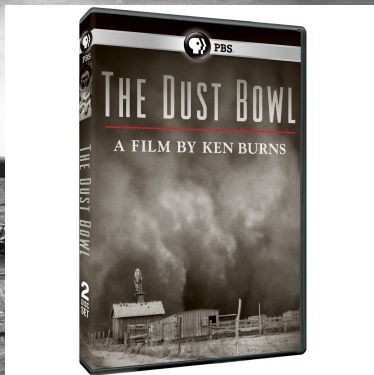
- massive dust storms
- massive soil erosion
- soil airborne
- transport across Atlantic
- mass wasting



- ~ 7000 "dustmonia" fatalities
- mass migrations (2.5 Mio) by 1940

it takes 30 years to grow 1 in of soil in the U.S.

Dust Storms and Human Impact: The 1930s Dust Bowl

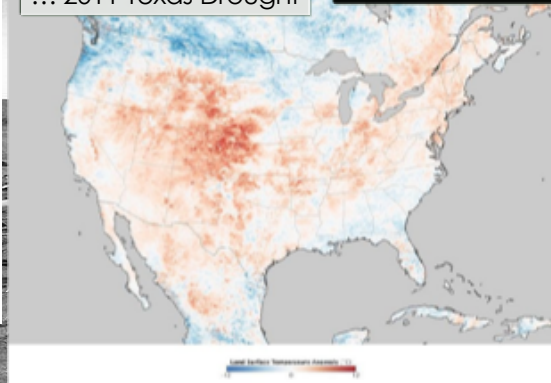


CAN THIS HAPPEN AGAIN?

- better farming techniques
- but several years of drought make a difference

... 2011 Texas Drought

source: wikipedia/NASA



2012 Summer Heat and Drought

2012-2017 Cali Drought
push to replace farm land with
housing developments

Deserts and Desertification



- < 10 in rain per year
- no permanent stream
- vegetation on < 15% of area

Desertification/Aridification
(expansion of deserts)

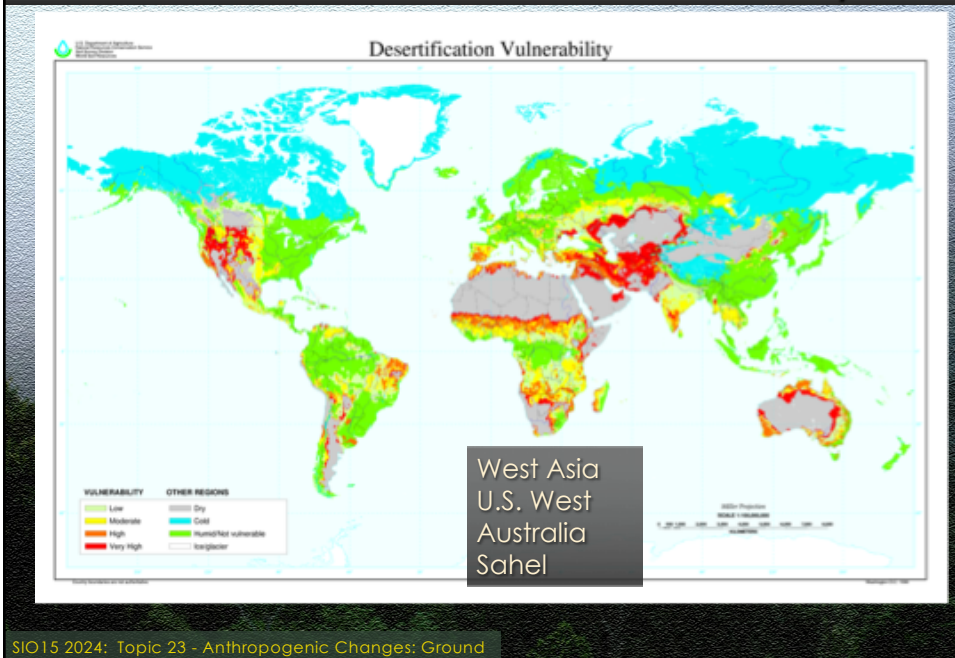
- prolonged droughts
- change in precipitation
- water diversion
- excess water usage
- deforestation

the romantic view

reality

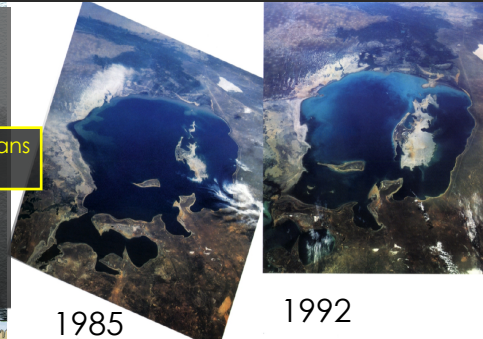
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Desertification – Global Vulnerability



Desertification - Land Degradation/Aral Sea

- diversion of water supply for farming (cotton industry; poor canals -> waste of water)
- 40% loss of area (75% by 2004; 90% by 2007)
- too salty to support fish (44g/l) Oceans 34g/l
- major fishing harbor now 20mi inland
- salty dust as far as Arctic Ocean
- foul water; throat cancer; high infant mortality



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Image: "Earth, Portrait of a Planet" by Marshak

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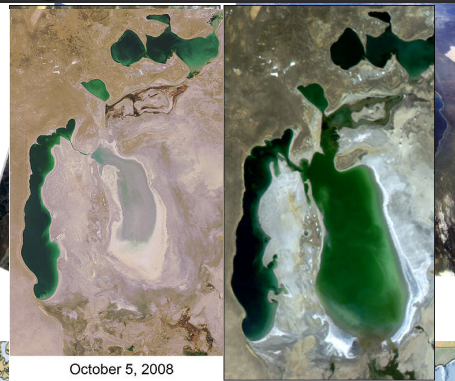


Image: wikipedia



2014: eastern basin completely dried up for first time - Aralkum Desert

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Image: "Earth, Portrait of a Planet" by Marshak

Desertification - Land Degradation/Elsewhere

Caspian Sea

world's largest inland body of water
av. depth: 211 m; residence time 250 years
no natural outflow
accelerated evaporation -> drop by 9-18 m this century
polluted Volga River 80% of inflow
Kazakhstan President: protocol to protect Caspian Sea

Great Salt Lake

8th-largest terminal lake
1980s pumping project stopped
but dry conditions still lead to further drop
increased evaporation releases toxins into air



Image: "Earth, Portrait of a Planet" by Marshak

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Humans and Desertification/Example Sahel

The Sahel

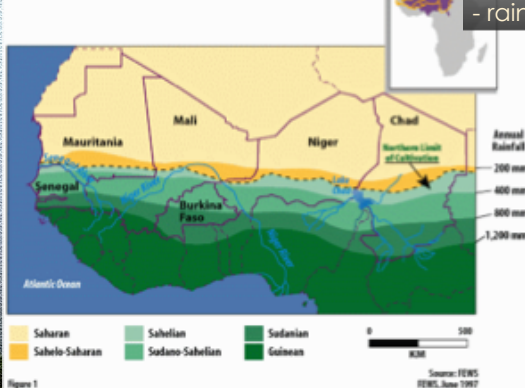


Figure 1

source: wikipedia

- Sahel used by nomadic people
- soil better in N than S
- nomadic life only sustainable way??

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- monsoon rains depend on shift of ITCZ
- rainy season: Jun - Aug

Sahelian Forest in rainy season, Mali



source: wikipedia



Humans and Desertification/Example Sahel

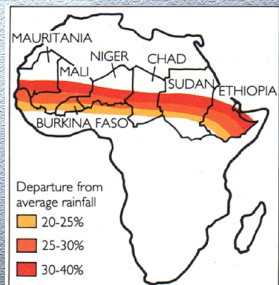
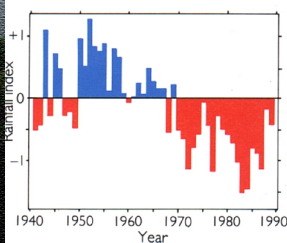


Image: "Earthshock" by Robinson



- 1) people stayed
- 2) decline in precipitation



Image: "Earthshock" by Robinson

- 1950s: people stayed N
 - overgrazing/overuse of wood
 - overpopulation in areas that could sustain original population
- > **famine**

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The 1970s/1980s Sahel Drought – Whose Fault was it?

- 1 Mio people starved to death (or only 100,000??)
- 50 Mio afflicted (1.5 times entire pop. of CA)

WHO'S TO BLAME?

pollution affected cloud formation

- ✧ local: slash-and-burn farming
- ✧ **global: coal burning in N. America**

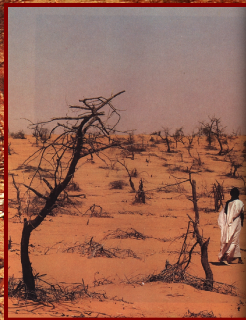


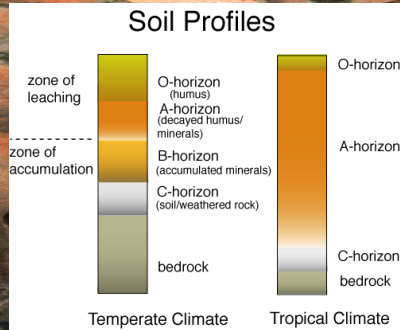
Image: "Earthshock" by Robinson

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The Tropical Rain Forest

- of all ecosystems, tropical rainforest has most biodiversity
- source of medicine
- Amazon RF produces 20% of O₂

rainforests (tropical and temperate) cover only 2% of Earth's surface but provide 50% of plants/animals



HUMUS

- partially decayed organic material
- important for plant growth

humus layer in tropics extremely thin!!

Image: "Earth's Dynamic Systems" by Hamblin

Deforestation in the Tropics

deforestation contributes 20% to increase in CO₂

- slash-and-burn for farming
- timber industry/mining
- > fast soil erosion
- badlands (desertification?)
- mass wasting

EXAMPLE: MEXICO



Image: wikipedia

it takes 1000s of years to re-grow a rain forest

Indigenous People of Brazil Amazon:

- before 1500 A.D.: 6,000,000
- early 1900s: less than 250,000

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Deforestation during the last 8000 years

TROPICAL RAINFOREST

- ✧ 57% now gone
- ✧ mass extinctions (100 species/day)

TEMPERATE FOREST

- ✧ 50% now gone
- ✧ Monocultures/no biodiversity

Early 2000s: rate of loss slowed
but Less forest to remove

... and then there was call for biofuels ...

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Deforestation – Late 2010s

New York Times 06/27/18

2017

- ✧ Brazil: 3 Mio acres (12,400 km²)
- ✧ Colombia: deforestation spiked after peace
- ✧ Atl hurricanes decimate Caribbean forests 2019
- ✧ unprecedented wildfires; international aide refused

2017 world: 39 Mio acres
(158,000 km²)
- second-worst ever (after 2016)



The western Amazon region of Brazil in September. Credit to Jonathan Poon/Photo - Getty Images

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Deforestation – Indonesia 2018

New York Times 11/20/18

Indonesia
#3 CO₂ contributor
#1 by deforestation
- mainly biofuels
-> drainage of swamp
-> peat fires

FEATURE

Palm Oil Was Supposed to Help Save the Planet. Instead It Unleashed a Catastrophe.

A decade ago, the U.S. mandated the use of vegetable oil in biofuels, leading to industrial-scale deforestation — and a huge spike in carbon emissions.

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Deforestation/Slash&Burn – Brazil 2019

Bolivia 1/8 area of Brazil
but same acreage
burns!

source: Wikipedia



we don't want any help!

Jan – Dec
2,240,000 acres
✧ cause: slash-and-burn
in unusually dry season
✧ Brazil slow to accept
international help
✧ Bolivia

deforestation:
increases CO₂
reduces O₂
displaces indigenous people

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Finally Some Good News!

11/17/22

At climate summit, Brazil's Lula promises new day for Amazon

President-elect vows to crack down on illegal deforestation

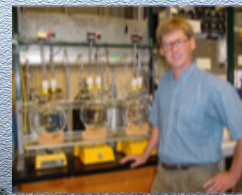
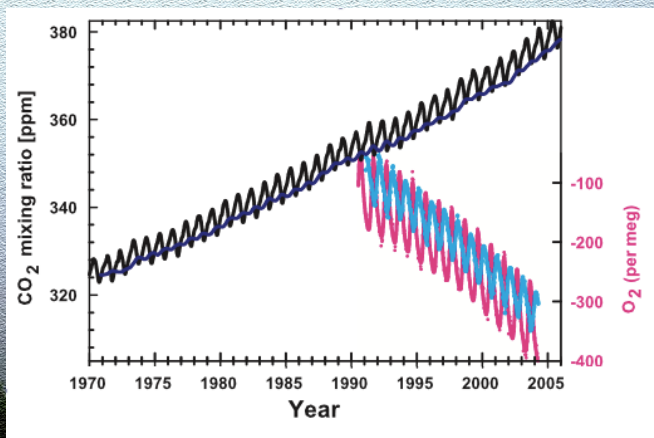


Brazilian President-elect Luiz Inacio Lula da Silva, speaks at the U.N. Climate Summit Wednesday. (Nariman El-Mofty AP)

good news for the
amazon rainforest ...
... and
indigenous people
living there

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Deforestation – Decline in O₂



research done by
Ralph Keeling, SIO

- deforestation already has a measureable impact on O₂
- Indonesia has highest deforestation rate globally
- 1/3 of Indonesia mammals endangered

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Deforestation – Late 2010s



Image: Hamblin "Earth's Dynamic Systems"

MADAGASCAR
-split from India 88 Mio yrs ago
-unique ecosystems



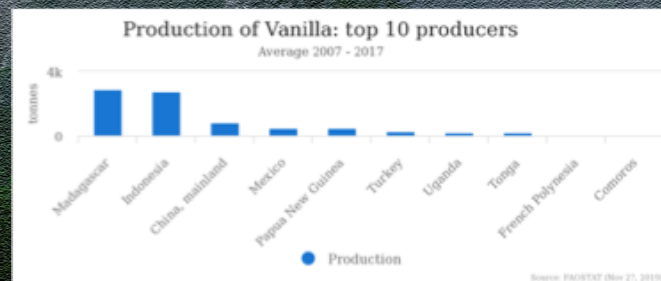
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Deforestation – Late 2010s



Image: wikipedia

Vanilla (Orchid)
difficult to grow
Hot/humid climate
price 4x last 10 years
2/3 grown in
Madagascar, Indonesia

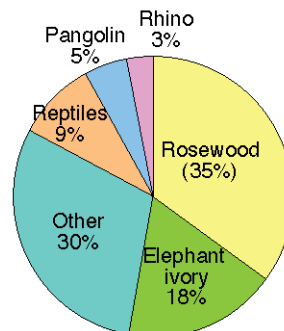


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Deforestation – Late 2010s

illegal logging
illegal trade rampant

Wildlife product seizures, 2005-2014
(120 countries)



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Farming and the Groundwater Table

-heavy pumping-
-> lowering of ground water table
-shallow wells go dry
-land subsides

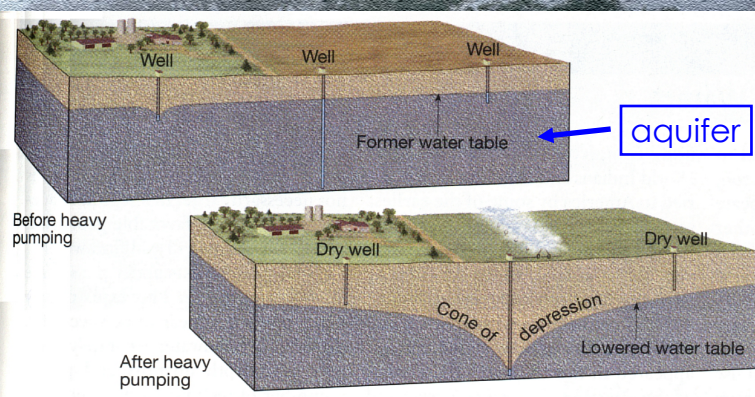
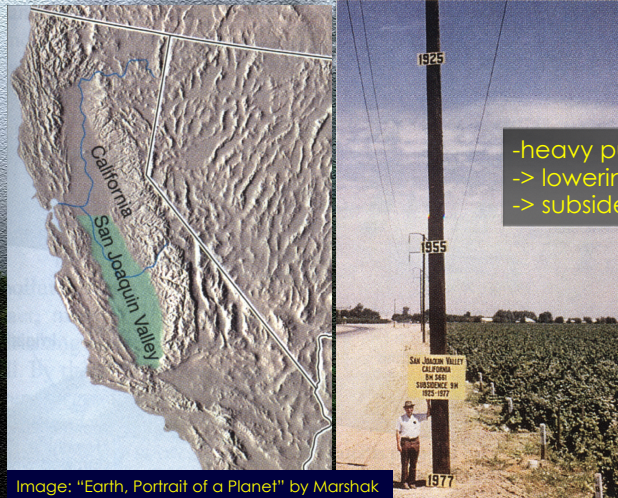


Image: "Earth, Portrait of a Planet" by Marshak

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Farming and Subsidence

- San Joaquin Valley
- drop of ground water table by 1970: 120m
- subsidence of ground: 8.5m



- heavy pumping
- > lowering of ground water table
- > subsidence

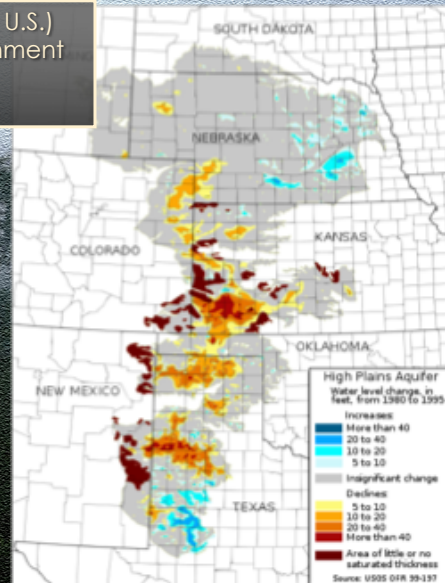
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Farming and Aquifers

- Ogallala Aquifer on High Plains (largest in U.S.)
- naturally cut off from Rockies for replenishment (now dependent on rain alone)
- water 2000 years old!

- withdrawal greater than replenishment (UNSUSTAINABLE WITHDRAWAL)
- groundwater level dropped; pumping from greater depth more expensive
- irrigated acreage declined



source: wikipedia/USGS

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The Colorado River and the All American Canal



1942

- brings Colorado River water to Imperial county
- valley's only source of water
- drinking water for 9 cities
- largest irrigation canal in world
- Salton Sea's only source of water

Image: <http://en.wikipedia.org>

runs entirely in U.S.
replaced Mexican Alamo Canal
leaks lead to "loss of water" -> repair planned/conducted
==> farmland south of border/wetlands dry up

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