TOPICS IN DEVELOPMENT ECONOMICS
EC310
GEOGRAPHY/ENVIRONMENT

Professor Sharun W. Mukand

RECAP: SOURCES OF PROSPERITY (1)

- Vast differences in prosperity across countries today.
  - Income per capita in sub-Saharan Africa on average 1/15th of U.S. income per capita
  - In Burundi ($700 PPP), Democratic Republic of the Congo (PPP$1100), versus U.S. income per capita ($70,000).

- Why?

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- Why?
- Standard economic answers: (SOLOW Model)
  - Physical capital differences (poor countries don't save enough)
  - Human capital differences (poor countries don't invest enough in education and skills)
  - "Technology" differences (poor countries don't invest enough in R&D and technology adoption, and don't organize their production efficiently)

RECAP: SOURCES OF PROSPERITY (2)

- These are, however, *proximate* causes of differences in prosperity.
  - Why do some countries invest less in physical and human capital?
  - Why do some countries fail to adopt new technologies and to organize production efficiency?
- The answer to these questions is related to the *fundamental* causes of differences in prosperity.

RECAP: SOURCES OF PROSPERITY (2)

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  - Why do some countries invest less in physical and human capital?
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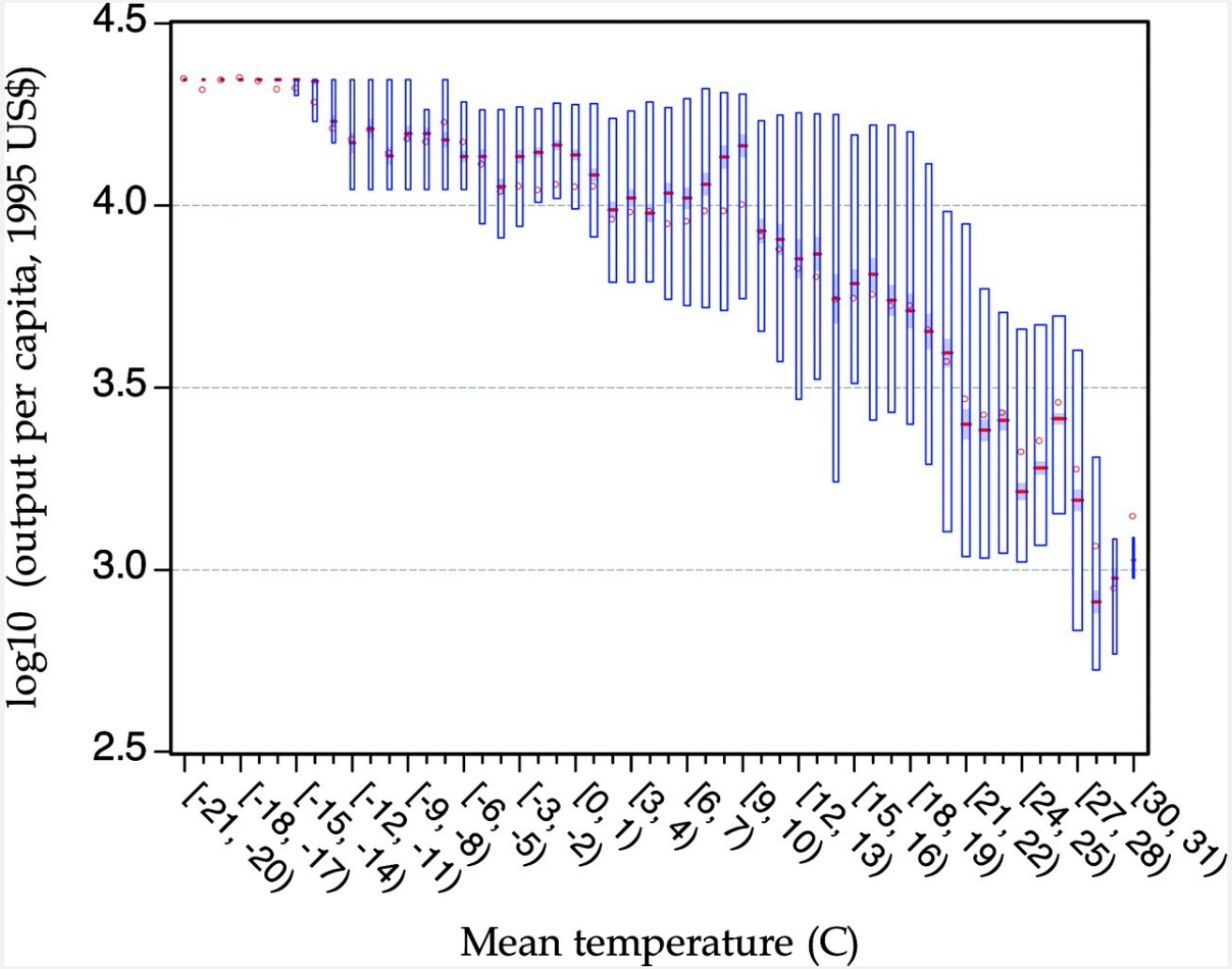
- The answer to these questions is related to the *fundamental* causes of differences in prosperity.
- Potential fundamental causes:
  - **Geography (exogenous differences of environment)**

GEOGRAPHY HYPOTHESIS: MONTESQUIEU

- Montesquieu (1753-94):
  - "The heat of the climate can be so excessive that the body there will be absolutely without strength. So, prostration will pass even to the spirit; no curiosity, no noble enterprise, no generous sentiment; inclinations will all be passive there; laziness there will be happiness,"
  - "People are ... more vigorous in cold climates. The inhabitants of warm countries are, like old men, timorous; the people in cold countries are, like young men, brave".
- Moreover, Montesquieu argues that lazy people tend to be governed by despots, while vigorous people could be governed in democracies; thus hot climates are conducive to authoritarianism and despotism.

Boxplot of output per capita and temperature.

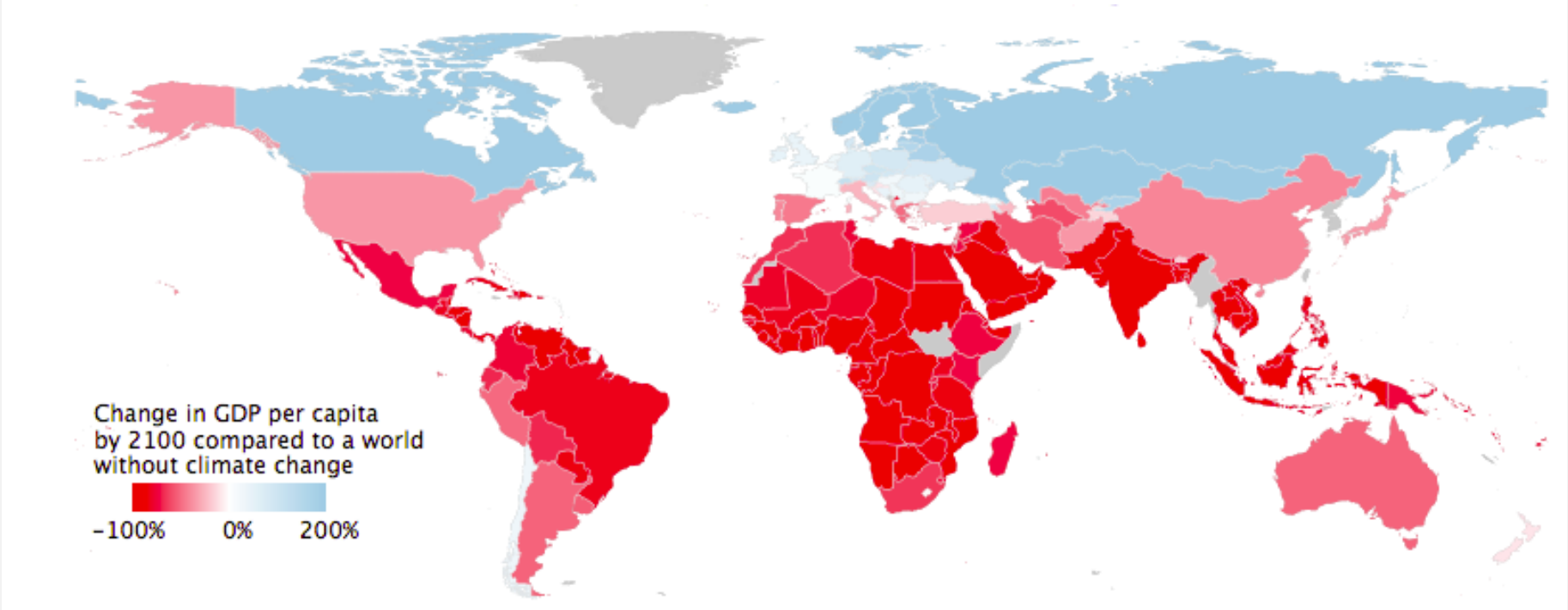


Nordhaus W D PNAS 2006;103:3510-3517

Per capita income drops approx. 8% for 1C temp. rise
(Dell, Olken and Jones, 2009)

GLOBAL WARMING & OUTPUT

- Burke, Hsiang and Miguel (2015) estimate **a 23% reduction in average per capita income!** Big distributional effects → (Small + benefit) richer countries and (large Negative) losses to developing countries!



AIR CONDITIONING & PRODUCTIVITY

- *"Before air-conditioning, American life followed seasonal cycles determined by weather. Workers' productivity declined in direct proportion to the heat and humidity outside — and on the hottest days employees left work early and businesses shut their doors. Stores and theaters also closed down, unable to comfortably accommodate large groups of people in stifling interiors. Cities emptied in summers…. and people spent summer days and evenings on porches or fire escapes."*
- *Steve Cox "Losing Our Cool" (2010)*

IMPACT OF TEMPERATURE ON WORKER PRODUCTIVITY: EVIDENCE FROM INDIA

- Somanathan et al (2021) show that there is a 2 percent drop in annual prodtuctivity for a One degree Celsius increase in temperature.
- Climate control (A/C) mitigates adverse impact. worker productivity, but only PARTIALLY.

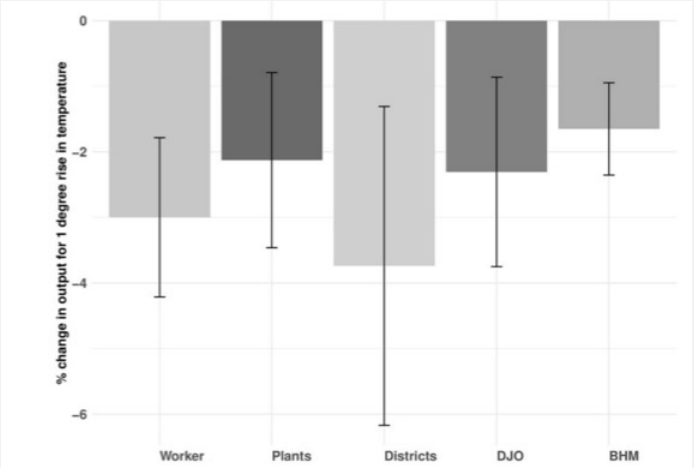
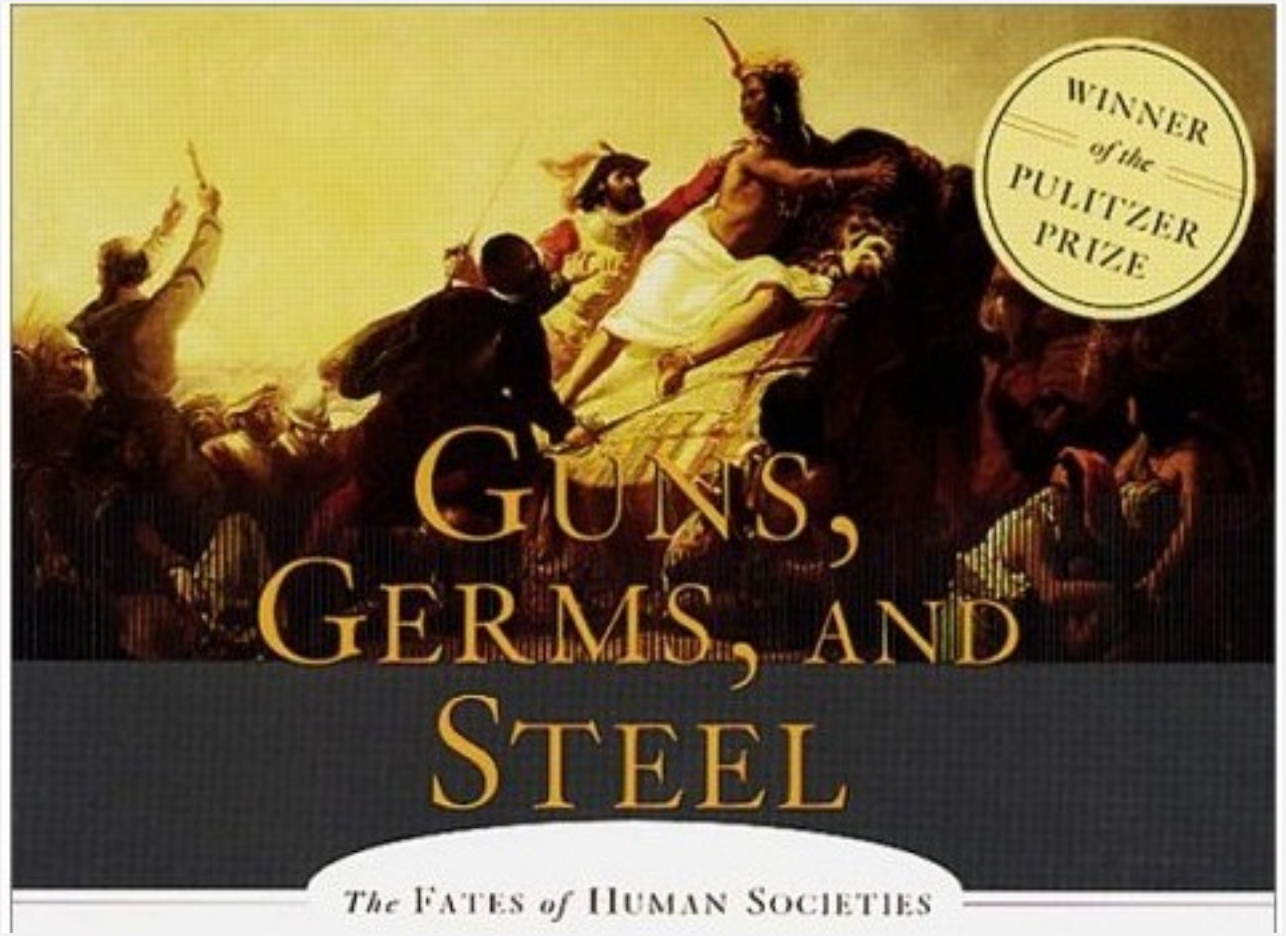


FIG. 3.—Bars 1–3 provide the marginal effect of temperature on log output at different levels of production with 90% confidence intervals as estimated in this paper. "DJO" provides the contemporaneous effect of temperature on industrial sector growth rates in poor countries in a model with no lags from Dell, Jones, and Olken's (2012) study. "BHM" provides the contemporaneous marginal effect of temperature on all-sector country output growth, at 30°C from a similar model with no lagged effects in Burke, Hsiang, and Miguel's (2015) study.

GEOGRAPHY HYPOTHESIS: MODERN VERSIONS

- Jared Diamond:
  - Importance of geographic and ecological differences in agricultural technology and availability of crops and animals.
  - Agriculture/Food Production was critical for growth of population, development of cities and technology.
  - Domestication of Animals crucial for development of agriculture.
  - Power


WINNER
of the
PULITZER
PRIZE
GUNS,
GERMS, AND
STEEL
The Fates of Human Societies

GEOGRAPHY HYPOTHESIS: DOMESTICATION OF ANIMALS

DOMESTIC VERSUS WILD SPECIES

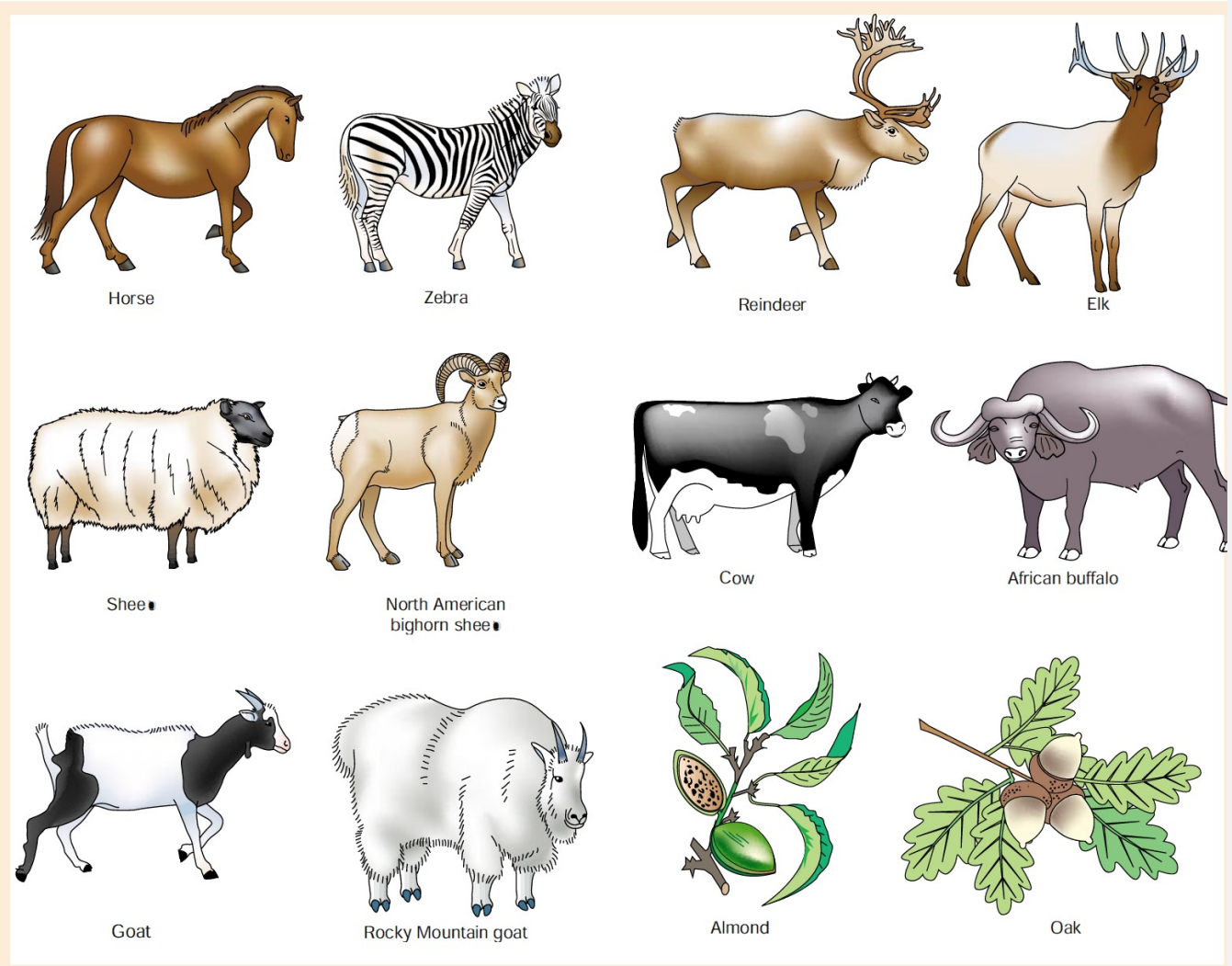


Figure 1 Comparisons of domesticated wild species (left of each pair) and their never-domesticated close relatives (right) reveal the subtle factors that can derail domestication.

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  - Diamond: **very few** domesticated animals: cows, sheep, goats, pigs and horses. (14 in total: llama, camels, reindeer, water buffalo, Yak….)
  - **Key Argument: Inequality in geographic distribution of wild animals who were ancestors of these domesticated animals.**
  - **150 large animals which would be good to domesticate.**

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  - **150 large animals which would be good to domesticate.**
  - **Only 14 domesticated. 13 had EURASIAN ancestors!**

GEOGRAPHY HYPOTHESIS: JARED DIAMOND

- Key Argument: Inequality in geographic distribution of wild animals who were ancestors of these domesticated animals.

- Without domesticated animals (especially for power), very difficult to **develop mass agriculture → cities → civilization.**

- Missing link: were wild animals that were domesticated, only the ones that were capable of being domesticated?

Why is domestication so difficult?

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GEOGRAPHY HYPOTHESIS: JARED DIAMOND

- Missing link: were wild animals that were domesticated, only the ones that were capable of being domesticated?

- Domestication happened several times independently. Indicating a demand for domestication.
- Diffusion of domestication to non-indigenous areas. Happens very easily.

Why is domestication so difficult?

1. Nasty disposition! Grizzlies, African Buffaloes, Zebras…
2. Diet is too limited (koalas/pandas) or diet to growth ratio not worthwhile…
3. Difficult to herd (cats, antelopes)…
4. ….sex in captivity…

BBC NEWS

Friday, 16 February, 2001, 00:41 GMT

Captive pandas too shy for sex

Wild pandas are at risk from poachers and habitat loss

The BBC's Richard Bilton
"Time is running out"
real 56k

The BBC's Tim Hirsch
"No one knows exactly how many giant pandas remain in the wild"
real 56k

By environment correspondent Alex Kirby

The innate modesty of one of the world's most charismatic and endangered creatures may prove its undoing.

Conservationists say the giant panda is being badly hit by poaching in the Chinese bamboo forests where it lives.

Its wild population has remained stable for several decades.

But attempts to breed pandas in captivity are meeting with little success, because the animals are largely uninterested.

The global environment network WWF says in a report that pandas remain "on the brink".

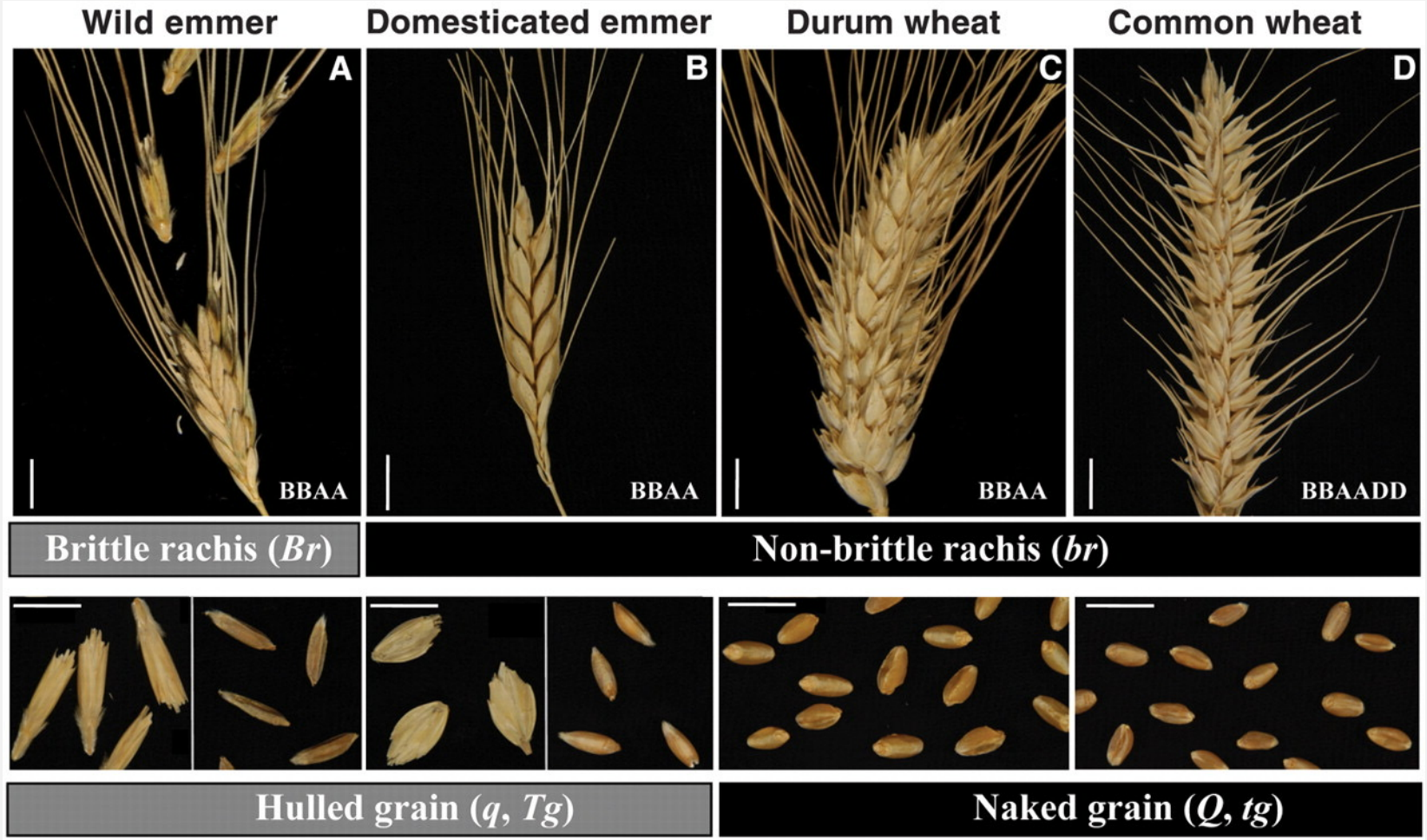
GEOGRAPHY HYPOTHESIS: JARED DIAMOND

- AGRICULTURE
- (However, many more plants can be potentially domesticated…after all tens of thousands of species exist).

- Observation: Wheat (Fertile Crescent)/Rice (China) (over 40% of total calories consumed in the world are from these two crops)

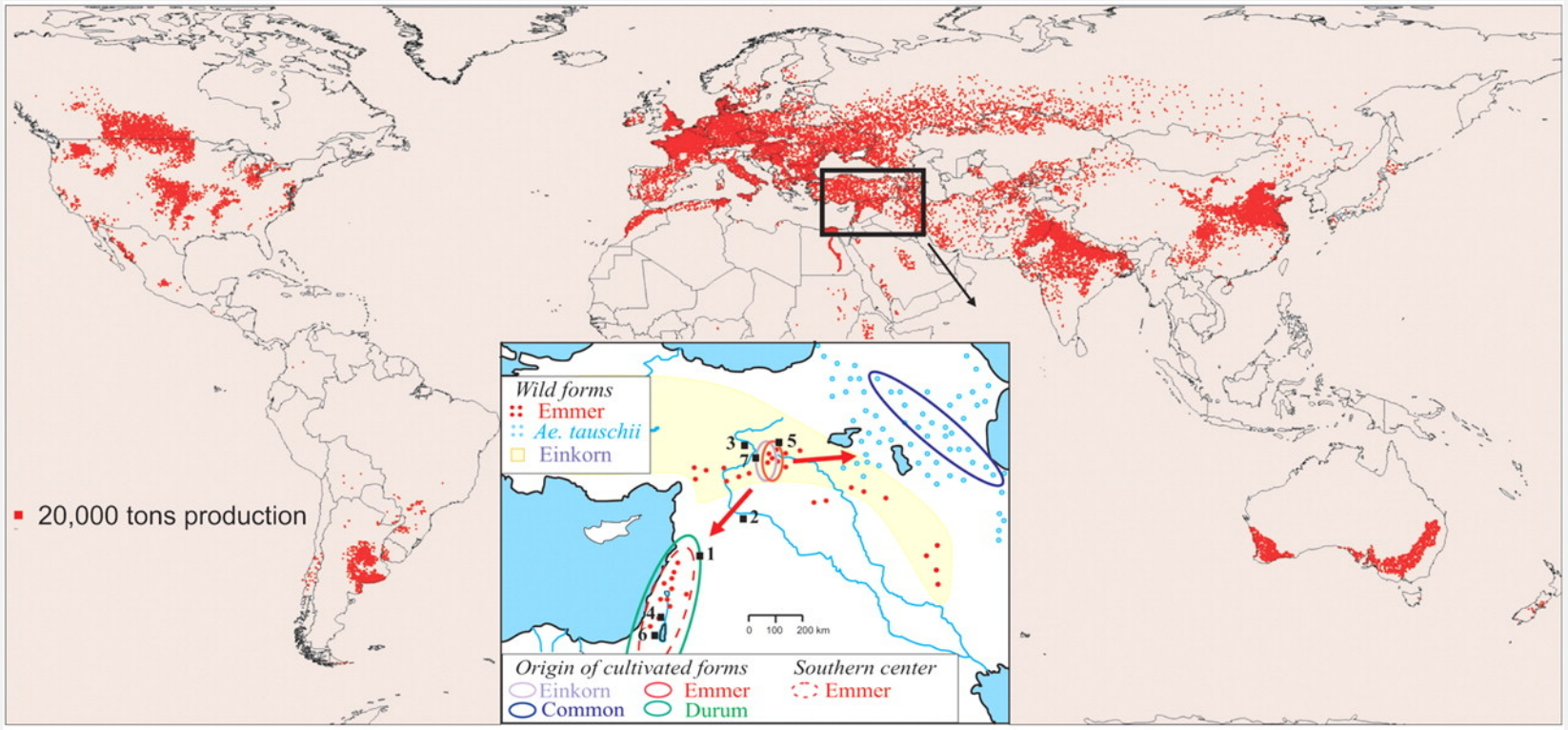
- Plants hard to domesticate!
- Even today 41% of ALL calories consumed are from wheat/rice!
- 4/5 (wheat, rice corn, barley, sorghum) indigenous to Eurasia. Corn: MesoAmerica
- Indigenous version of wheat, rice, barley, sorghum very similar to domesticated versions. Not so with Corn (harder to domesticate).

Fig. 1. Wheat spikes showing (A) brittle rachis, (B to D) nonbrittle rachis, (A and B) hulled grain, and (C and D) naked grain.



J Dubcovsky, J Dvorak Science 2007;316:1862-1866

Fig. 2. The origin and current distribution of wheat.



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Published by AAAS

GEOGRAPHY HYPOTHESIS: MODERN VERSIONS

- Uneven geographical distribution of plants that could be domesticated.

- Apples (grafting)

- So what?

- **Diamond's argument:** Axis of Orientation of Continents Matters.

DIFFUSION OF TECHNOLOGY

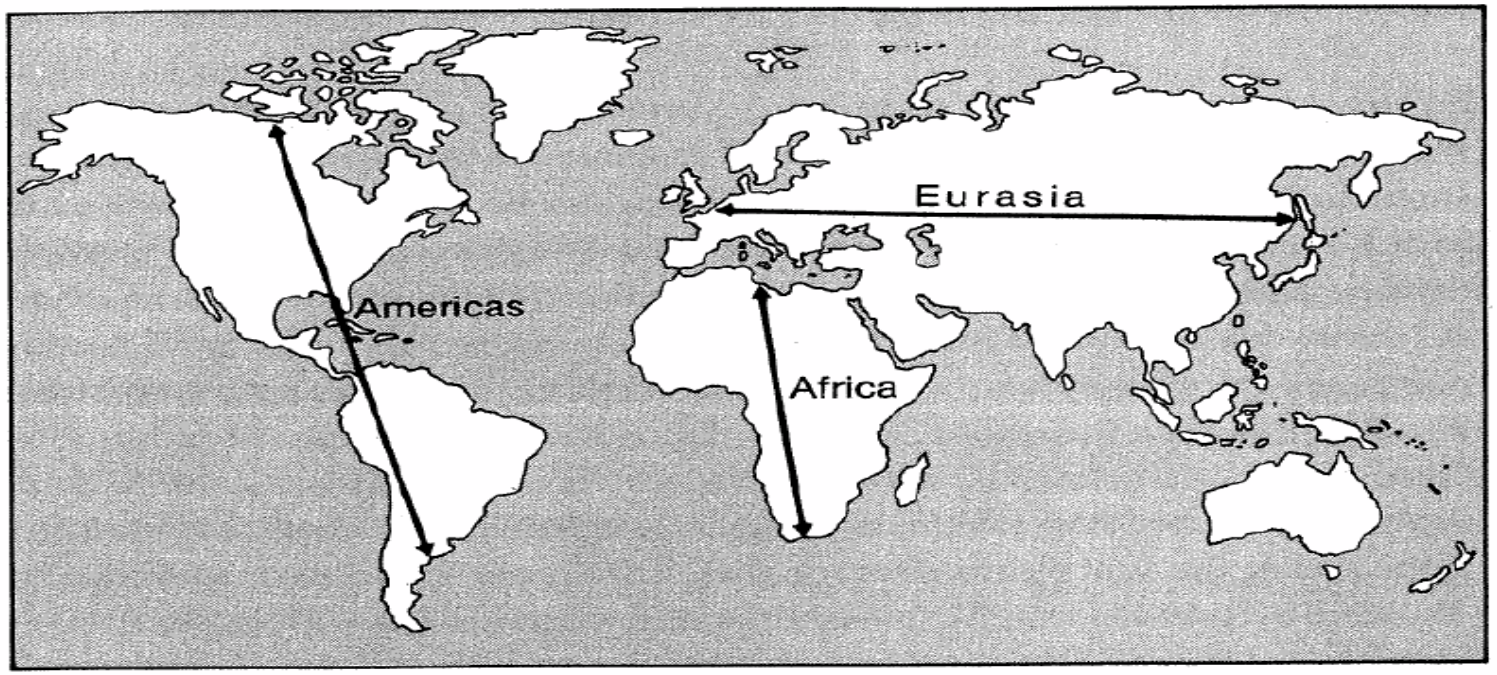

Figure 10.1. Major axes of the continents.

GEOGRAPHY HYPOTHESIS: MODERN VERSIONS

- **Diamond's argument:** Axis of Orientation of Continents Matters.

- Agricultural Technology easier to transmit on East-West Axis. Higher food production → higher population growth.
- Bigger population → greater innovation

- North-South Orientation disfavored (llama does not 'travel' from Incas to Mexico!)

- Isolation of Americas and Australia (after they had been settled during the last Ice Age) meant that they were cut-off from the transmission of innovation elsewhere!

GEOGRAPHY HYPOTHESIS: MODERN VERSIONS

- Diamond's argument:

- Conquest of Americas/Australia/Papua New Guinea…..
- Key role of Germs!

- Most major infectious diseases emerged/transmitted through contact with animals.
- TB/Flu/Malaria/Plague/Smallpox…

GEOGRAPHY HYPOTHESIS: MODERN VERSIONS

- Diamond's argument:

- Conquest of Americas/Australia/Papua New Guinea…..
- Key role of Germs!

- Most major infectious diseases emerged/transmitted through contact with animals.
- TB/Flu/Malaria/Plague/Smallpox…Eurasians lived in close contact with animals (often in same barn).

- Died like flies from these diseases….but those who survived had the right genes. i.e. Immunity!

- 1520. Smallpox through 1 infected person decimates **90% of population of South America!**

GEOGRAPHY HYPOTHESIS: MODERN VERSIONS

- British fishermen had been fishing off Massachusetts for decades before the Pilgrims landed.…(and) probably transmitted the illness to the Indians they met. Whatever it was, within three years this plague wiped out between 90 percent and 96 percent of the inhabitants of southern New England.

- The Indian societies lay devastated. Only "the twentieth person is scarce left alive," wrote British eyewitness Robert Cushman, describing a death rate unknown in all previous human experience. Unable to cope with so many corpses, survivors fled to the next tribe, carrying the infestation with them!

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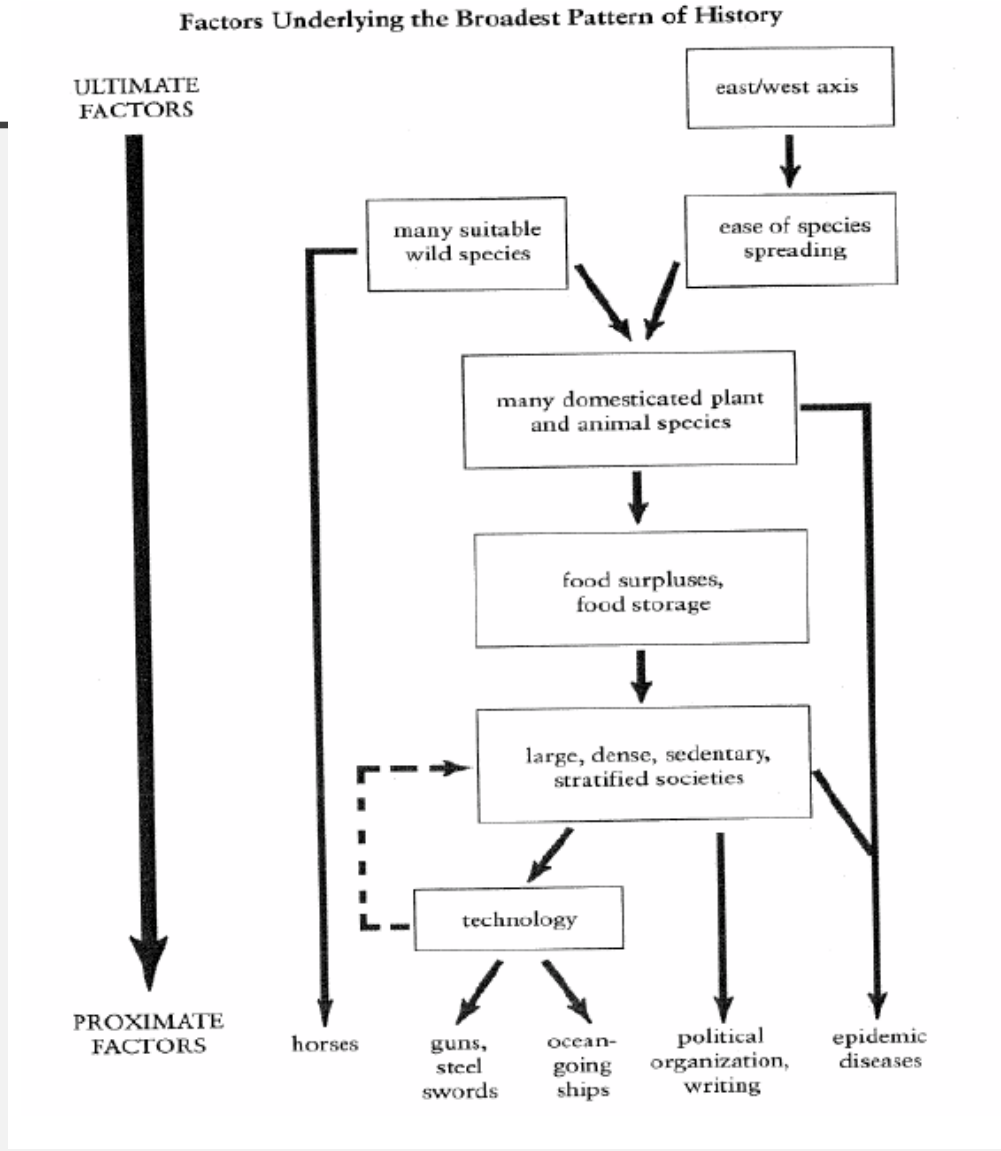
- John Winthrop, Governor of Massachusetts Bay Colony, called the plague "miraculous." To a friend in England in 1634, he wrote:

  "But for the natives in these parts, God hath so pursued them, as for 300 miles space the greatest part of them are swept away by the small pox which still continues among them. So as God hath thereby cleared our title to this place, those who remain in these parts, being in all not fifty, have put themselves under our protect...."


Factors Underlying the Broadest Pattern of History
ULTIMATE FACTORS
east/west axis
many suitable wild species
ease of species spreading
many domesticated plant and animal species
food surpluses, food storage
large, dense, sedentary, stratified societies
technology
PROXIMATE FACTORS
horses
guns, steel swords
ocean-going ships
political organization, writing
epidemic diseases

JARED DIAMOND

- Key Assumptions:
- (1) Bigger populations provide more opportunities for innovation
- (2) Geography matters, and for a long time

- Those populations that (i) got a late start (ii) had fewer animals to domesticate in the Neolithic revolution (iii) were not killed by disease/warfare became the poor of the world
- Model handles large time frame much better than it can handle the last 100 or, the last 1000 years

GEOGRAPHY HYPOTHESIS:

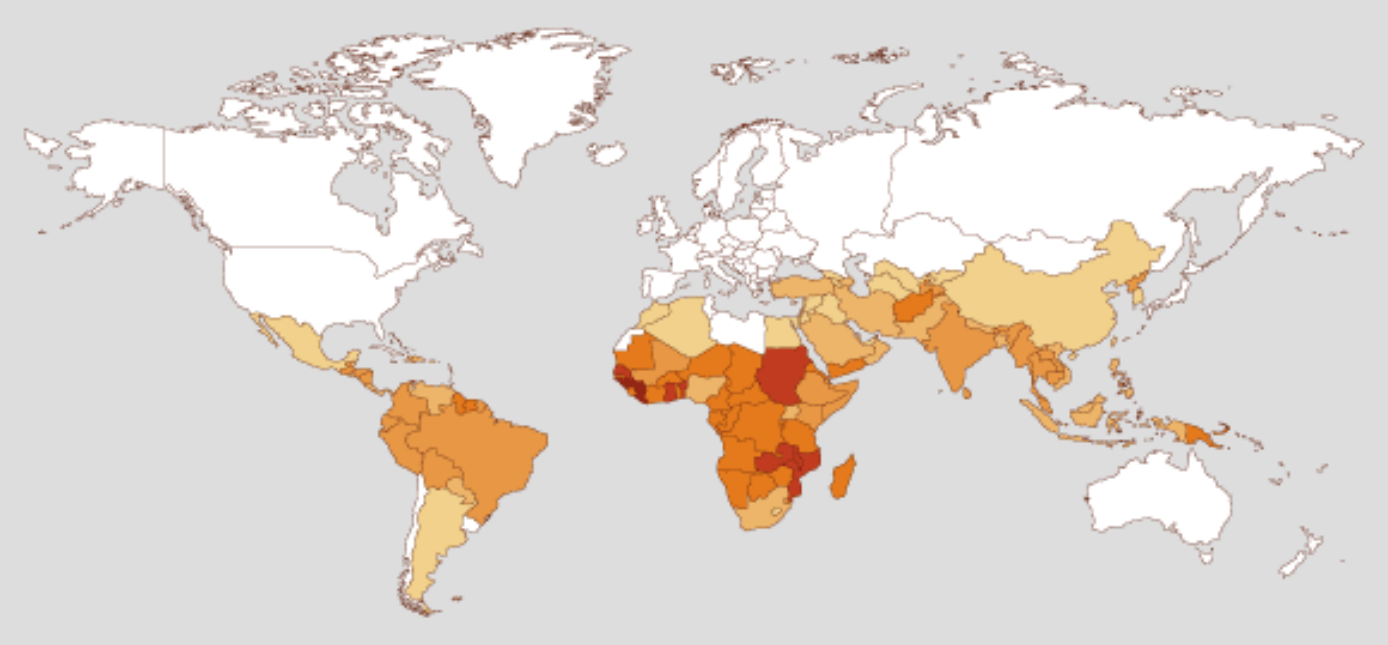
- Jared Diamond:
  - Importance of geographic and ecological differences in agricultural technology and availability of crops and animals.
  - Problems with the argument?
  - Netherlands versus China. Both in Eurasia.
  - Reversal of Fortune??

GEOGRAPHY HYPOTHESIS: MODERN VERSIONS

- Jeff Sachs:
  - "Economies in tropical ecozones are nearly everywhere poor, while those in temperate ecozones are generally rich" because "Certain parts of the world are geographically favored.."
  - **"The burden of infectious disease is higher in the tropics than in the temperate zones"**
  - **Malaria/Sleeping Sickness/River Blindness/Yellow Fever/Parasitic Worm**
  - Tropics are also worse for diseases that affect plants and animals and not just human diseases. Some **frost** is good! (kills off parasites/worms and more than makes up for shorter growing season!)

WORLD MALARIA MAP

- **1 person dies every 30 seconds;**
- **1 million deaths annually (90% in Sub-Saharan Africa)**
- **500 million cases every year.**



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  - **So what?**
  - **Good health → high productivity → high income (and expect to live long) → high savings → high investment → high productivity and better health!**
  - **Poor health → low life expectancy → why invest in education/saving. Better have more kids (cos many will die in any case!)…**

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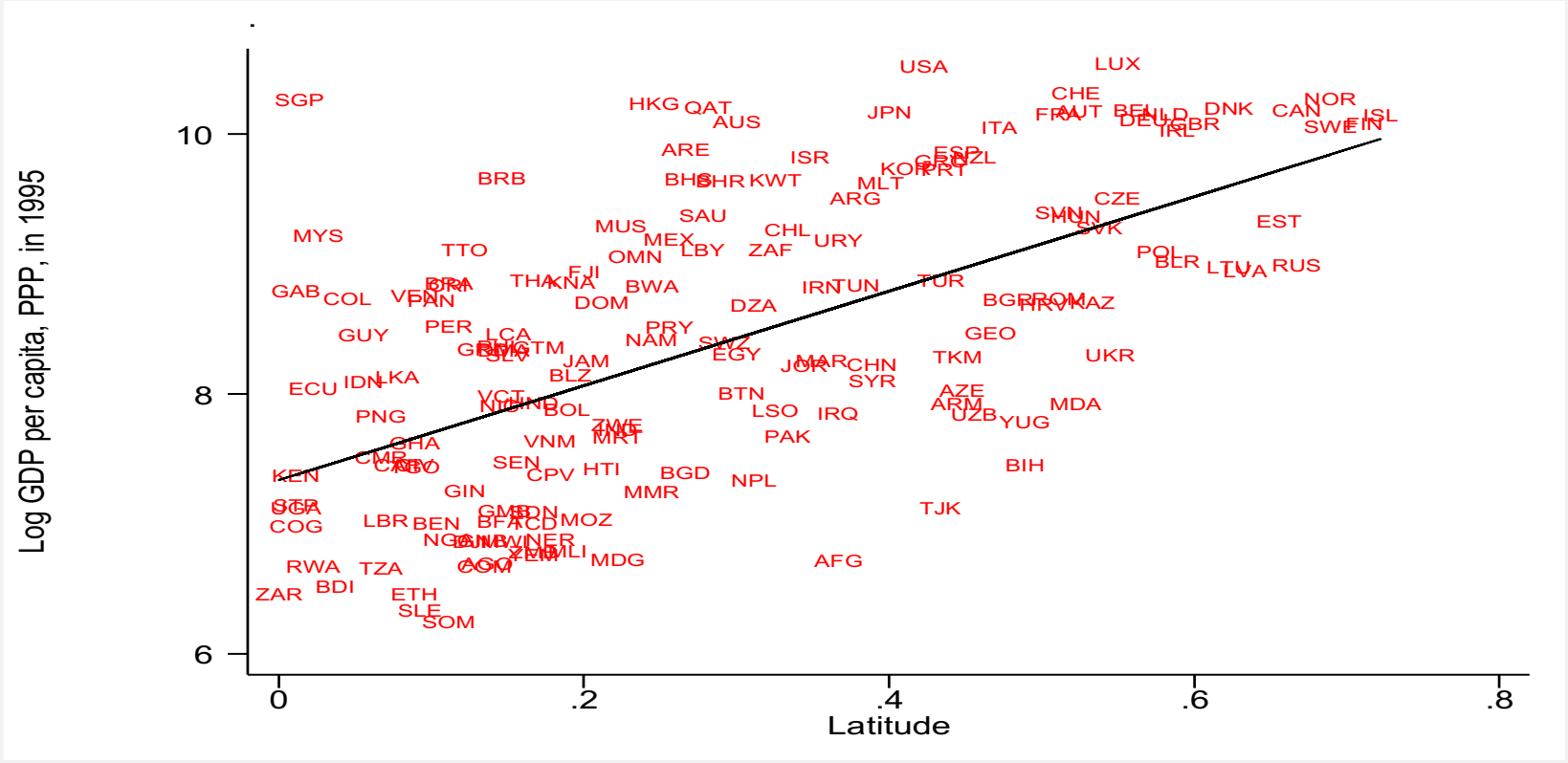


The **True Size** of **Africa**

A small contribution in the fight against rampant *Immappancy,* by **Kai Krause**

Graphic layout for visualization only (some countries are cut and rotated)
But the conclusions are very accurate: refer to table below for exact data

COUNTRY	AREA x 1000 km²
China	9.597
USA	9.629
India	3.287
Mexico	1.964
Peru	1.285
France	633
Spain	506
Papua New Guinea	462
Sweden	441
Japan	378
Germany	357
Norway	324
Italy	301
New Zealand	270
United Kingdom	243
Nepal	147
Bangladesh	144
Greece	132
TOTAL	**30.102**
AFRICA	**30.221**

In addition to the well known social issues of *illiteracy* and *innumeracy*, there also should be such a concept as "*immappancy*", meaning *insufficient geographical knowledge.*

A survey with random American schoolkids let them guess the population and land area of their country. Not entirely unexpected, but still rather unsettling, the majority chose *"1-2 billion"* and *"largest in the world"*, respectively.

Even with Asian and European college students, geographical estimates were often off by factors of *2-3*. This is partly due to the highly distorted nature of the predominantly used mapping projections (such as *Mercator*).

A particularly extreme example is the worldwide misjudgement of the true size of *Africa*. This single image tries to embody the massive scale, which is larger than the *USA, China, India, Japan* and *all of Europe..... combined!*

Top 100 Countries

Area in square kilometers, Percentage of World Total
Sources: Britannica, Wikipedia, Almanac 2010

		AREA km²	%
1	Russia	17.098.242	11,50
2	Canada	9.984.670	6,70
3	China	9.596.961	6,40
4	United States	9.629.091	6,40
5	Brazil	8.514.877	5,70
6	Australia	7.692.024	5,20
7	India	3.287.263	2,30
8	Argentina	2.780.400	2,00
9	Kazakhstan	2.724.900	1,80
10	Sudan	2.505.813	1,70
11	Algeria	2.381.741	1,60
12	Congo	2.344.858	1,60
13	Greenland	2.166.086	1,50
14	Saudi Arabia	2.149.690	1,40
15	Mexico	1.964.375	1,30
16	Indonesia	1.860.360	1,30
17	Libya	1.759.540	1,20
18	Iran	1.628.750	1,10
19	Mongolia	1.564.100	1,10
20	Peru	1.285.216	0,86
21	Chad	1.284.000	0,86
22	Niger	1.267.000	0,85
23	Angola	1.246.700	0,85
24	Mali	1.240.192	0,83
25	South Africa	1.221.037	0,82
26	Colombia	1.141.748	0,76
27	Ethiopia	1.104.300	0,74
28	Bolivia	1.098.581	0,74
29	Mauritania	1.025.520	0,69
30	Egypt	1.002.000	0,67
31	Tanzania	945.087	0,63
32	Nigeria	923.768	0,62
33	Venezuela	912.050	0,61
34	Namibia	824.116	0,55
35	Mozambique	801.590	0,54
36	Pakistan	796.095	0,53
37	Turkey	783.562	0,53
38	Chile	756.102	0,51
39	Zambia	752.612	0,51
40	Myanmar	676.578	0,45
41	Afghanistan	652.090	0,44
42	Somalia	637.657	0,43
43	France	632.834	0,43
44	C. African Rep	622.984	0,42
45	Ukraine	603.500	0,41
46	Madagascar	587.041	0,39
47	Botswana	582.000	0,39
48	Kenya	580.367	0,39
49	Yemen	527.968	0,35
50	Thailand	513.120	0,34
51	Spain	505.992	0,34
52	Turkmenistan	488.100	0,33
53	Cameroon	475.442	0,32
54	Papua New Guinea	462.840	0,31
55	Uzbekistan	447.400	0,30
56	Morocco	446.550	0,30
57	Sweden	441.370	0,30
58	Iraq	438.317	0,29
59	Paraguay	406.752	0,27
60	Zimbabwe	390.757	0,26
61	Japan	377.930	0,25
62	Germany	357.114	0,24
63	Rep o.t. Congo	342.000	0,23
64	Finland	338.419	0,23
65	Vietnam	331.212	0,22
66	Malaysia	330.803	0,22
67	Norway	323.802	0,22
68	Côte d'Ivoire	322.463	0,22
69	Poland	312.685	0,21
70	Oman	309.500	0,21
71	Italy	301.336	0,20
72	Philippines	300.000	0,20
73	Burkina Faso	274.222	0,18
74	New Zealand	270.467	0,18
75	Gabon	267.668	0,18
76	Western Sahara	266.000	0,18
77	Ecuador	256.369	0,20
78	Guinea	245.857	0,17
79	United Kingdom	242.900	0,16
80	Uganda	241.038	0,16
81	Ghana	238.539	0,16
82	Romania	238.391	0,16
83	Laos	236.800	0,16
84	Guyana	214.969	0,14
85	Belarus	207.600	0,14
86	Kyrgyzstan	199.951	0,13
87	Senegal	196.722	0,13
88	Syria	185.180	0,12
89	Cambodia	181.035	0,12
90	Uruguay	176.215	0,12
91	Suriname	163.820	0,11
92	Tunisia	163.610	0,11
93	Nepal	147.181	0,10
94	Bangladesh	143.998	0,10
95	Tajikistan	143.100	0,10
96	Greece	131.957	0,09
97	Nicaragua	130.373	0,09
98	North Korea	120.538	0,08
99	Malawi	118.484	0,08
100	Eritrea	117.600	0,08
	TOP 100 TOTAL	132.632.524	89,34


United States


Europe

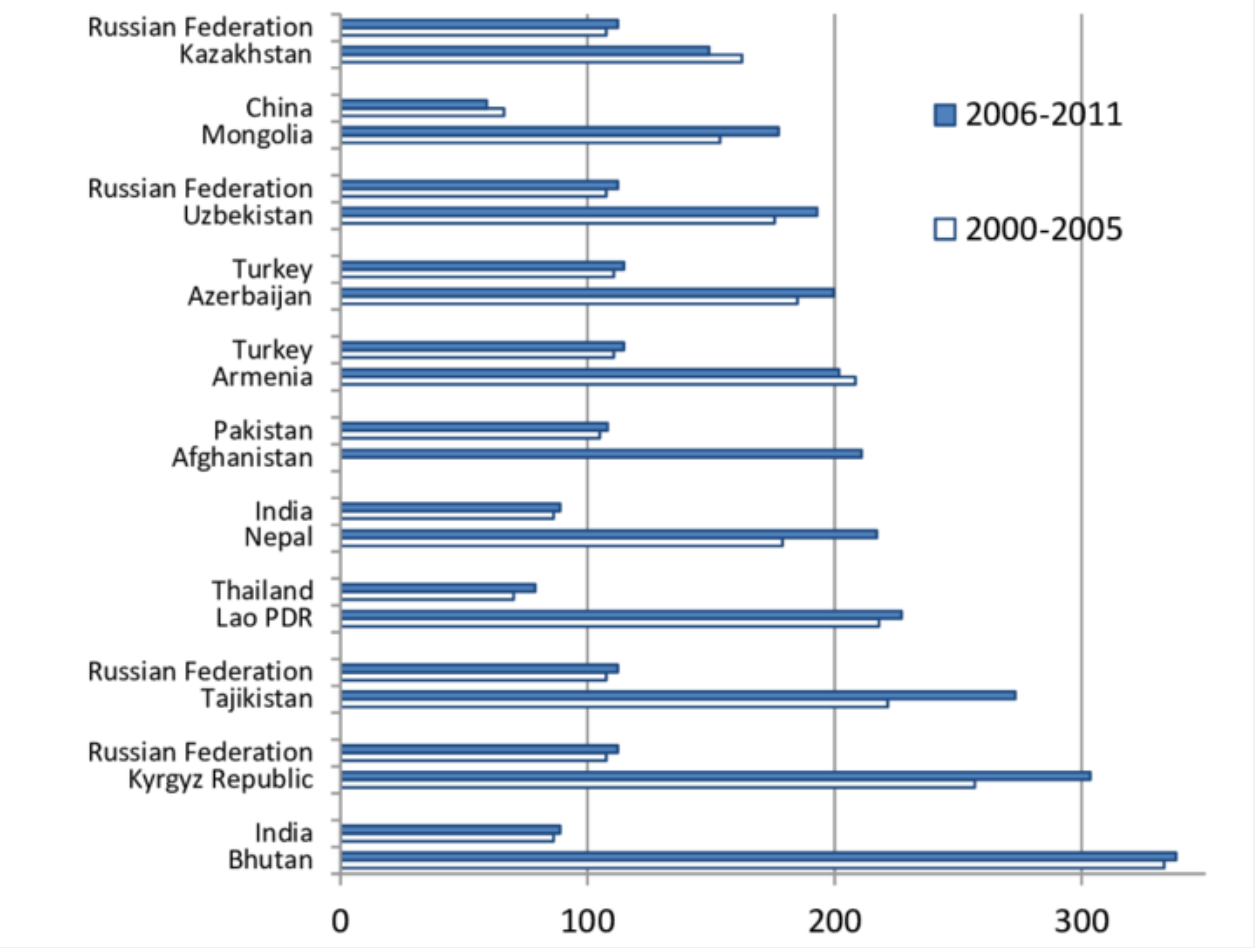

India


Japan


China

GEOGRAPHY & TRANSPORT COSTS

- Europe and coastline versus African coastline. Landlocked countries.



WHY ARE SOME RICH AND OTHERS POOR?

- GEOGRAPHY? Drawbacks??

- Not very useful in accounting for differences between continents in Eurasia. Jared Diamond's theory is best at explaining intercontinental differences in per capita income.

- Hierarchy of incomes in the Americas is not due to geography.
- Reversal of fortune between North and South America. Aztecs had writing/money while natives of North America were a stone age culture….

- Geography and the Middle East. What accounts for the rise and fall? Leader during neolithic age, first towns anywhere develop in Iraq, smelting of Iron first achieved in Turkey….but geography is unchanged.
- Similar issue with rise and fall of China/Japan….

GEOGRAPHY/ENVIRONMENT: POLICY IMPLICATIONS?

- Technological innovations and adaptation?

- diffusion of the internet, rise of services sector?...

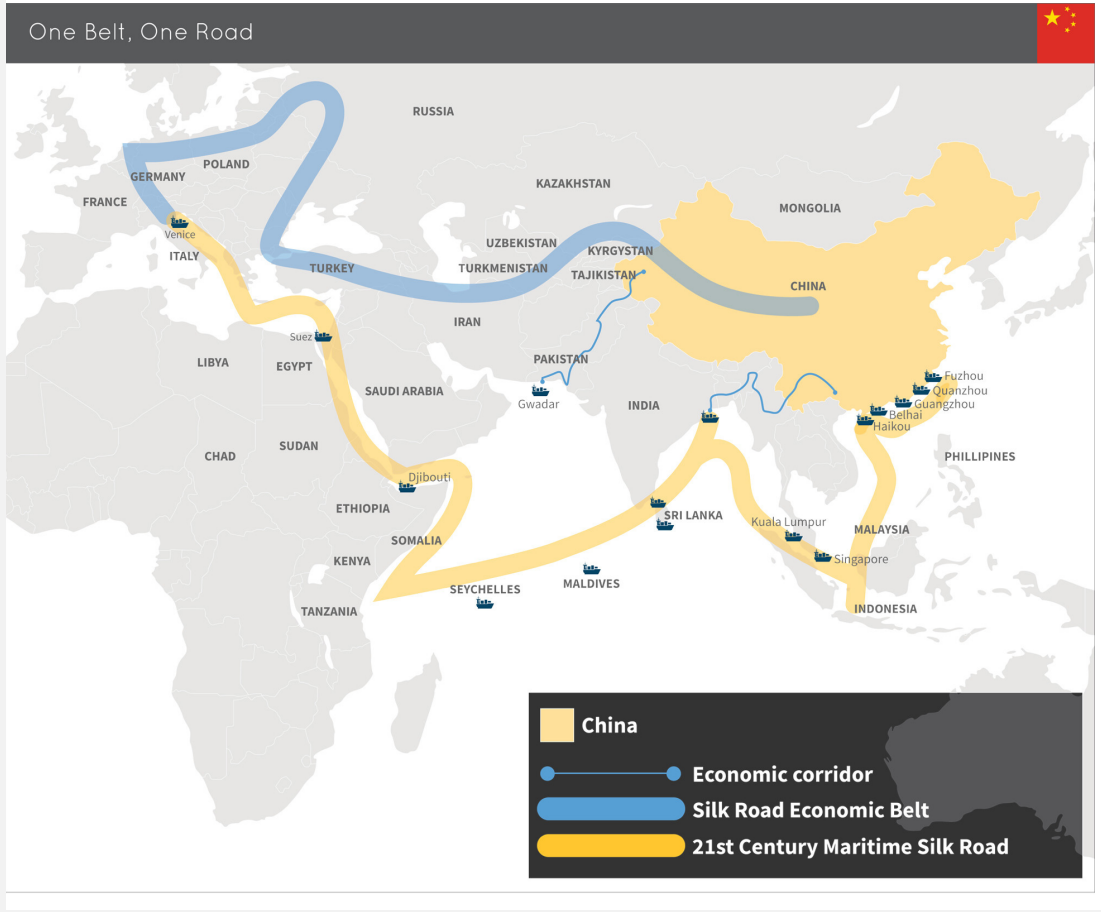
- Silk Road ($900 bn)

- Common Markets (EU, NAFTA)

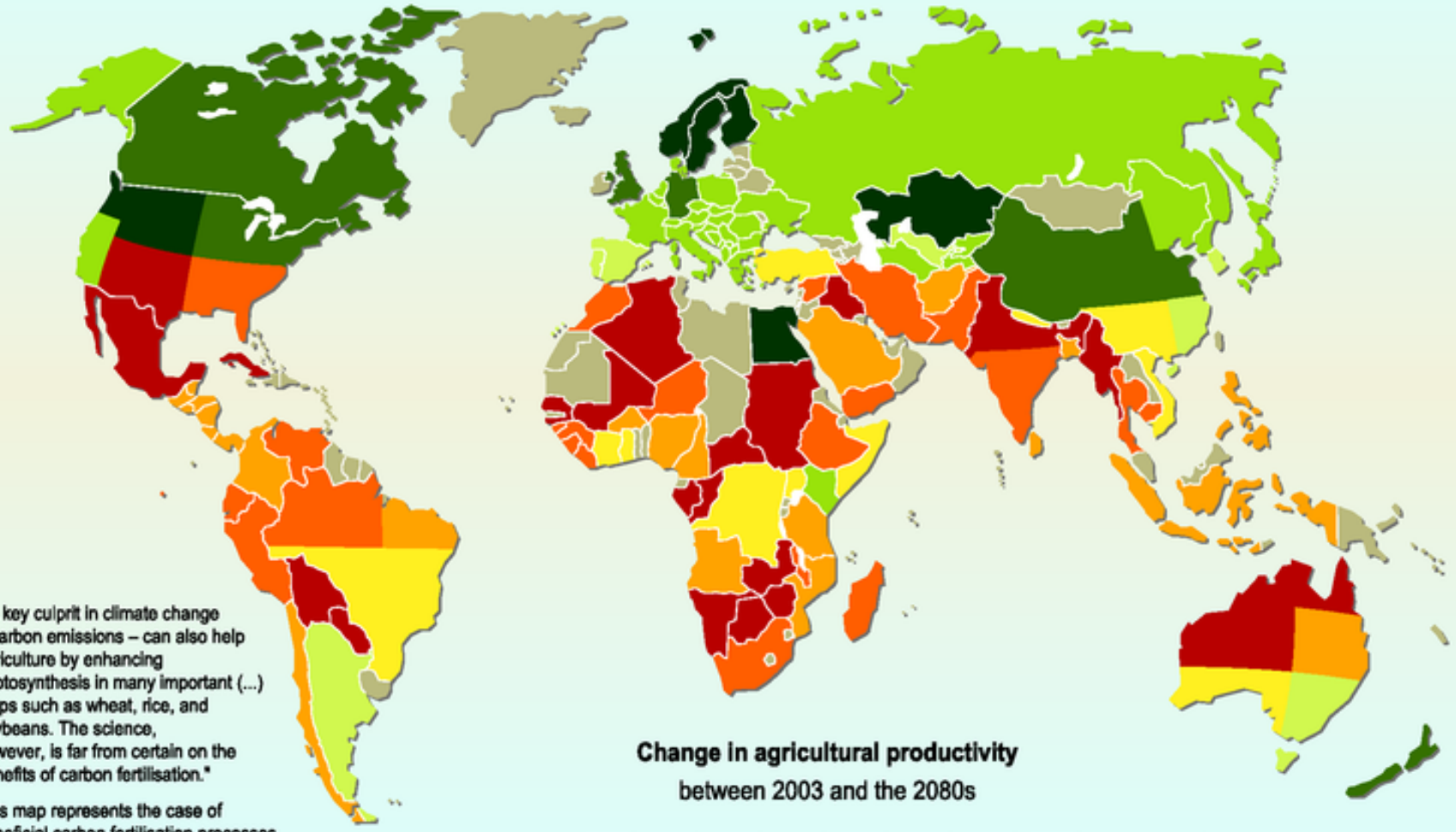
- Technological solutions to tackle climate change….! (e.g. carbon concrete)

- air conditioning

- drought resistant crops….



Projected impact of climate change on agricultural yields

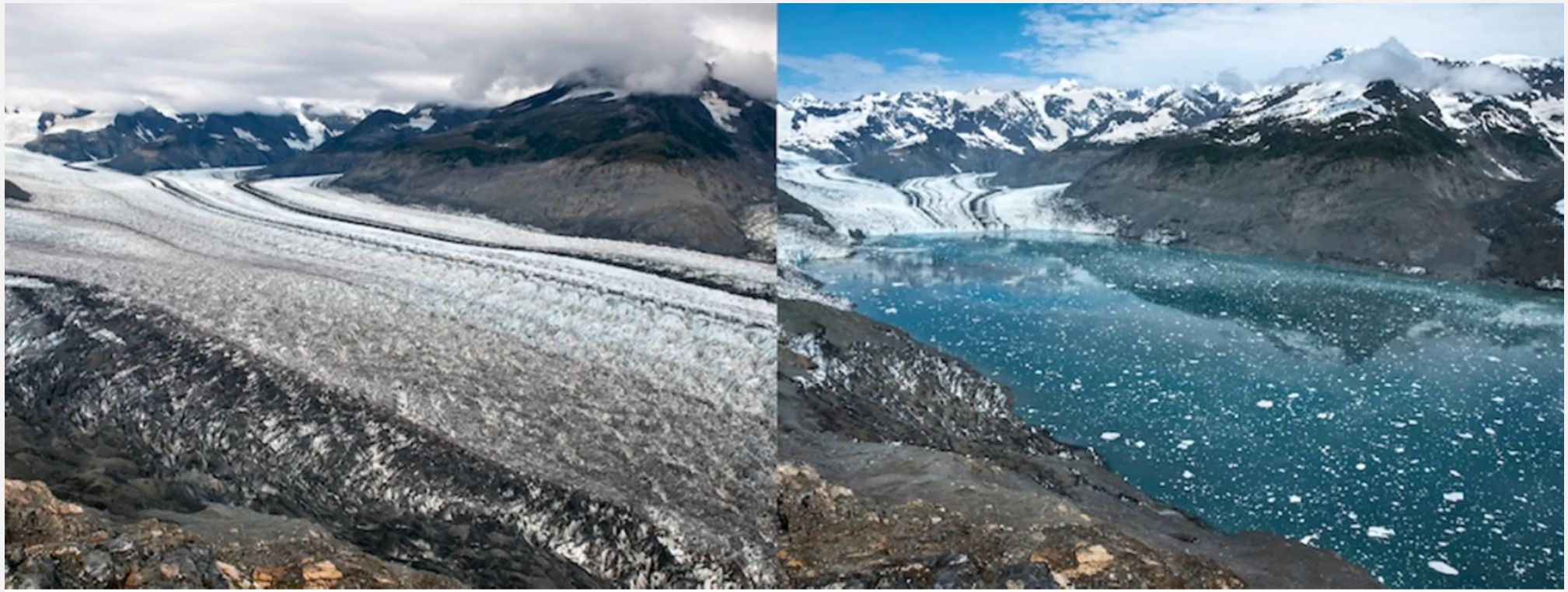


" A key culprit in climate change – carbon emissions – can also help agriculture by enhancing photosynthesis in many important (...) crops such as wheat, rice, and soybeans. The science, however, is far from certain on the benefits of carbon fertilisation."

This map represents the case of beneficial carbon fertilisation processes.

Source: Cline W., 2007, *Global Warming and Agriculture.*

GLACIERS RETREATING
(COLUMBIA GLACIER IN ALASKA RETREATED 6.5KM BETWEEN 2009-2016)



2/6 *Columbia Glacier, Alaska, has retreated by 6.5 km (4 miles) between 2009 (left) and 2015 (right)* James Balog and the Extreme Ice Survey