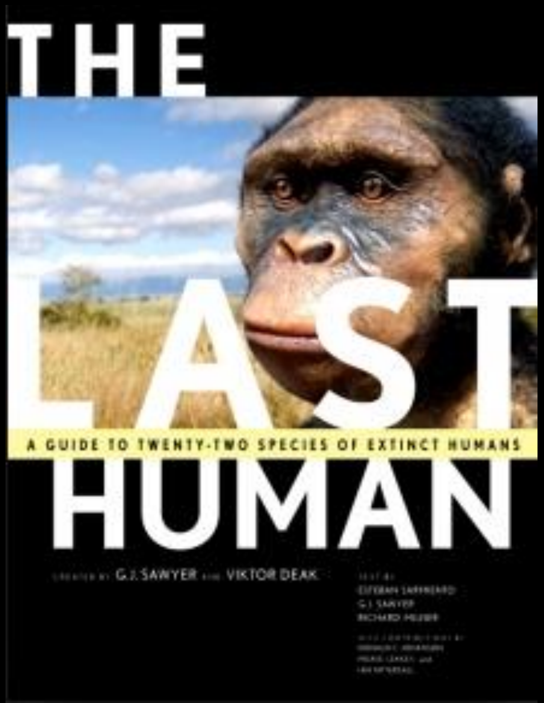
# 12. Our Gaian Planet:
# Anthropic destruction and the Psychozoic

New Kids
on the Block → Resources → Positive Notes




Is the Anthropocene Synonymous with "age of environmental Awareness"?

NO

While it is true we are aware
Of our impact on the
Environment, the Anthropocene
Is a stratigraphic marker bed.
This may lead some humans to
Seek ‘sustainability’, but not all.

# The geological cycle of plastics and their use as a stratigraphic indicator of the Anthropocene

H
A

Ove
evi

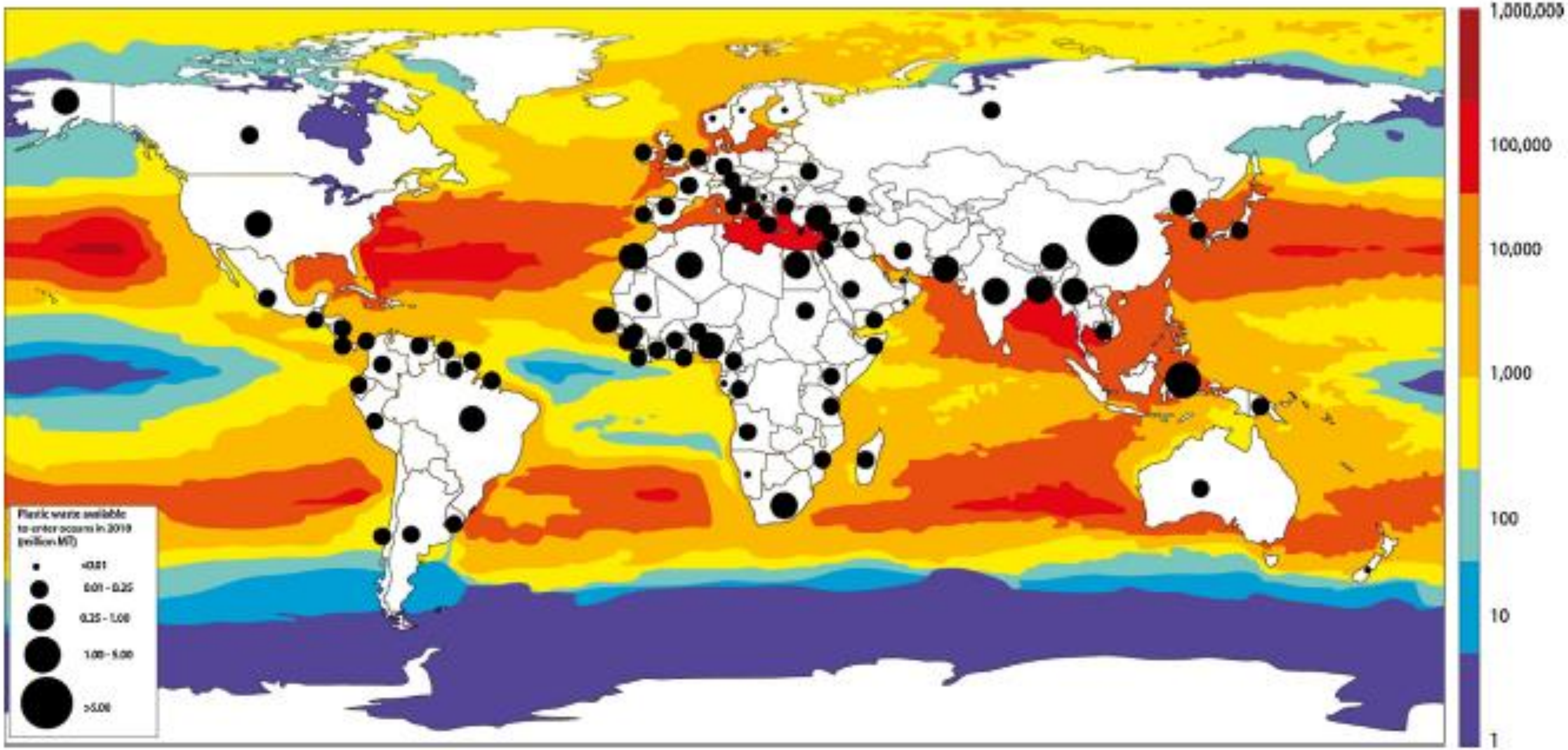
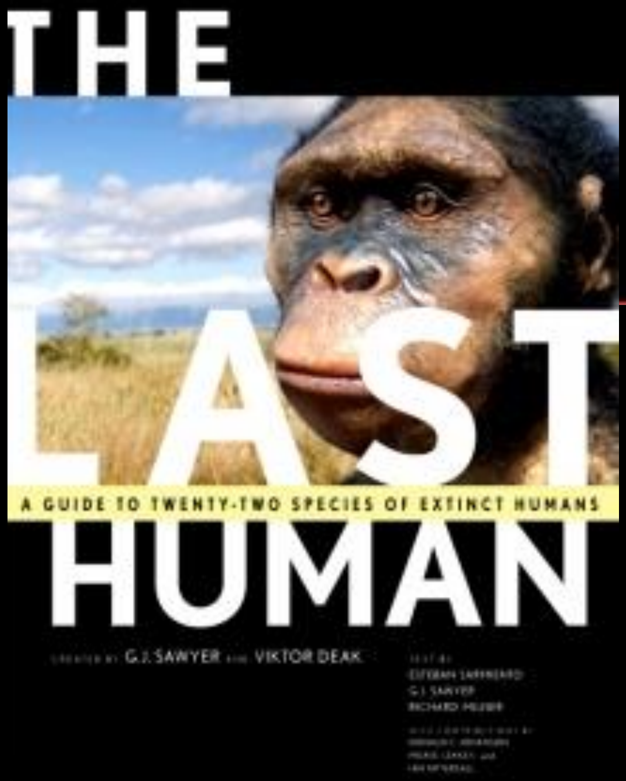
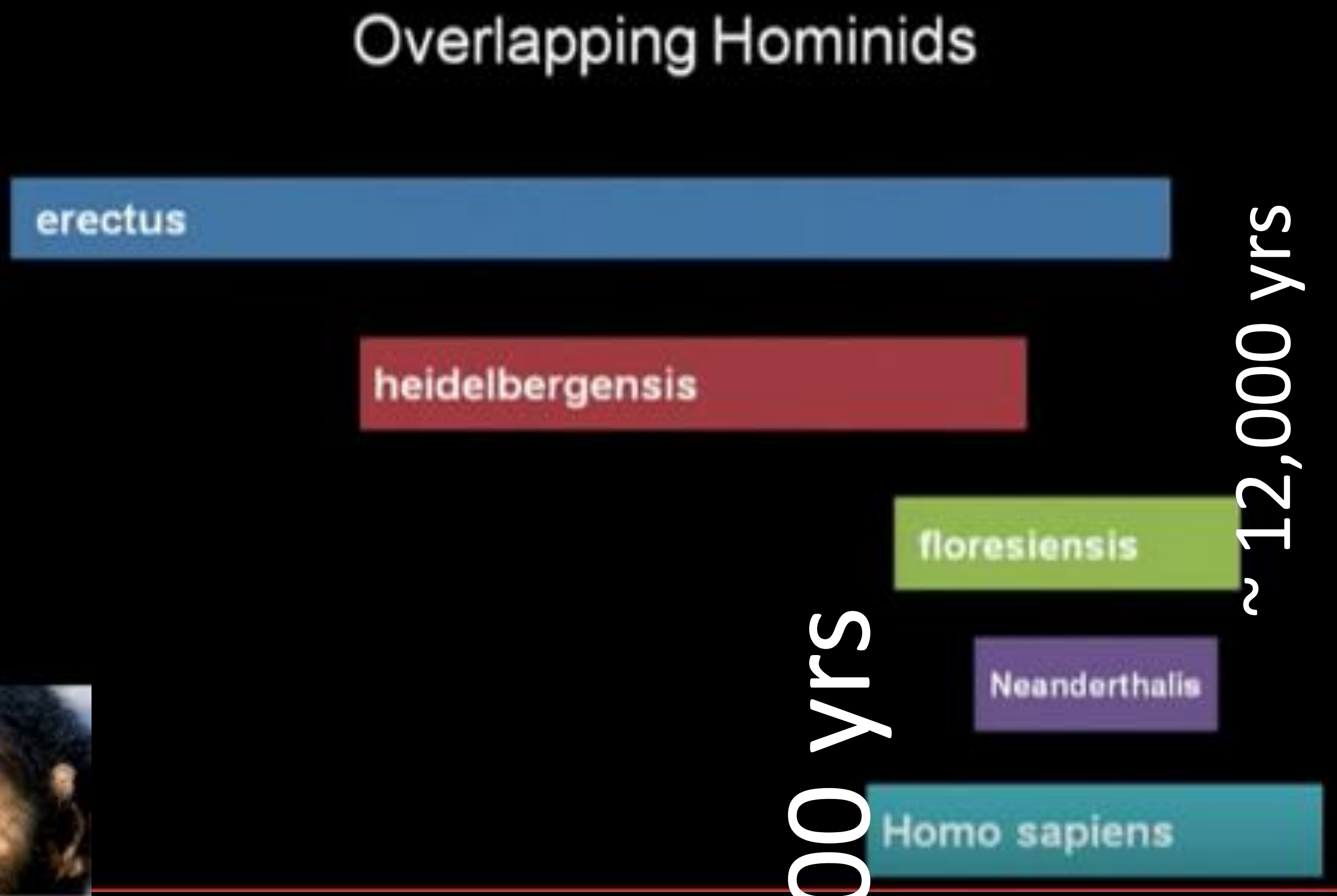



**Fig. 11.** Modelled distribution of microplastics in ocean surfaces shown by Eriksen et al. (2014, Fig. 2) (1 mm ≤ 4.75 mm). Onshore estimated mass of mismanaged plastic waste is in millions of metric tons, generated by 2010 within 50 km of the coast (Jambeck et al., 2015).

# We were Not Alone…


~ 12,000 yrs

~ 250,000 yrs

# Megafaunal extinction in the late Quaternary and the global overkill hypothesis

Stephen Wroe , Judith Field , Richard Fullagar & Lars S. Jermin

| | Extinct | Living | Total | % Extinct | Landmass km$^2$) |
|---|---|---|---|---|---|
| Africa | 7 | 42 | 49 | 14.3 | $30.2 \times 10^6$ |
| Europe | 15 | 9 | 24 | 60.0 | $10.4 \times 10^6$ |
| North America | 33 | 12 | 45 | 73.3 | $23.7 \times 10^6$ |
| South America | 46 | 12 | 58 | 79.6 | $17.8 \times 10^6$ |
| * Australia | 19 | 3 | 22 | 86.4 | $7.7 \times 10^6$ |

*Table 1*. Late Quaternary (last 100 000 years) extinct and living genera of terrestrial megafauna >44 kg adult body weight) of five continents. Adapted after Martin (1984). Data for extinct and living European megafauna from Martin (1984). For Australia it may be that as many as eight genera were already extinct before human arrival (Roberts *et al*. 2001). If so, this reduces both the number and percentage of megafaunal extinctions that could conceivably be attributed to human activity.

# Human acceleration of animal and plant extinctions: A Late Pleistocene, Holocene, and Anthropocene continuum

Todd J. Braje [a,*], Jon M. Erlandson [b]

[a] San Diego State University, Department of Anthropology, San Diego, CA 92182-6040, United States
[b] Museum of Natural and Cultural History and Department of Anthropology, University of Oregon, Eugene, OR 97403-1224, United States

## 6. Summary and conclusions

The wave of catastrophic plant and animal extinctions that began with the late Quaternary megafauna of Australia, Europe, and the Americas has continued to accelerate since the industrial revolution. Ceballos et al. (2010) estimated that human-induced species extinctions are now thousands of times greater than the background extinction rate. Diamond (1984) estimated that 4200 (63%) species of mammals and 8500 species of birds have become extinct since AD 1600. Wilson (2002) predicted that, if current rates continue, half of earth's plant and animal life will be extinct by AD 2100. Today, although anthropogenic climate change is playing a growing role, the primary drivers of modern extinctions appear to be habitat loss, human predation, and introduced species (Briggs, 2011:485). These same drivers contributed to ancient megafaunal and island extinctions – with natural forces gradually giving way to anthropogenic changes – and accelerated after the spread of domestication, agriculture, urbanization, and globalization.

# Human impact overwhelms long-term climate control of weathering and erosion in southwest China

Shiming Wan[1]*, Samuel Toucanne[2], Peter D. Clift[3], Debo Zhao[1], Germain Bayon[2,4], Zhaojie Yu[5], Guanqiang Cai[6], Xuebo Yin[1], Sidonie Révillon[7], Dawei Wang[1], Anchun Li[1], and Tiegang Li[1]

nature geoscience
PROGRESS ARTICLE
PUBLISHED ONLINE: 20 SEPTEMBER 2009 | DOI: 10.1038/NGEO629

“close to half a billion people live on or near deltas”

**Sinking deltas due to human activities**

James P. M. Syvitski, *et al.*, 2009 (University of Colorado)

“Sediment compaction from the removal of oil, gas and water from the delta’s underlying sediments, the trapping of sediment in reservoirs upstream and floodplain engineering in combination with rising global sea level”

Mississippi, USA
Nile, Egypt
Yellow Delta, China
Po, Italy
Vistula, Poland
Shatt al Arab, Iraq

Mekong, Vietnam
Irrawaddy, Myanmar
Pearl Delta, China
Indus delta, Pakistan
Chao Phraya, Thailand
Ganges-Brahmaputra, Bangladesh

# Recently Extinct Animals



*Review*

THE
ANTHROPOCEN
REVIEW

The Anthropocene Rev
I-

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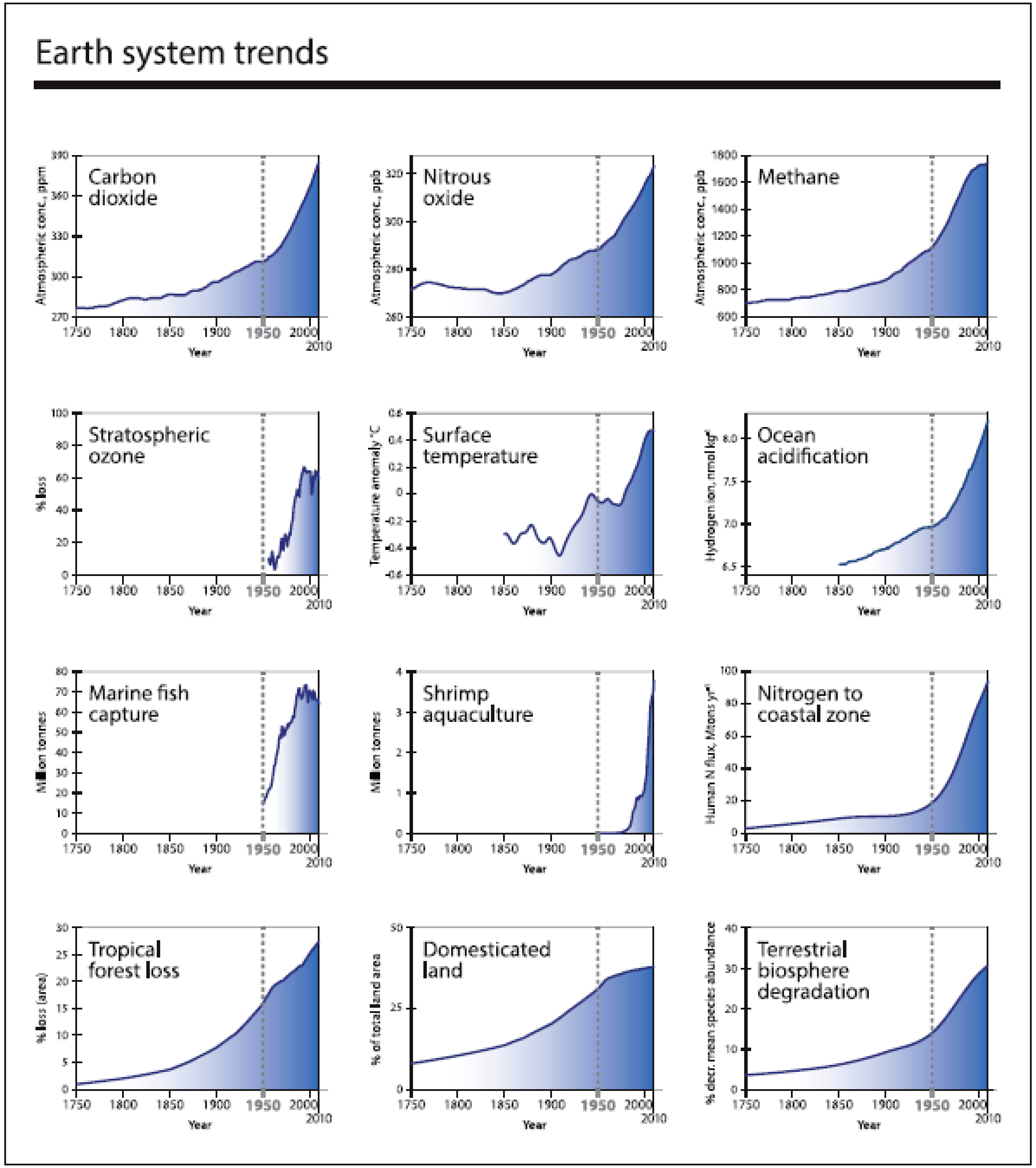
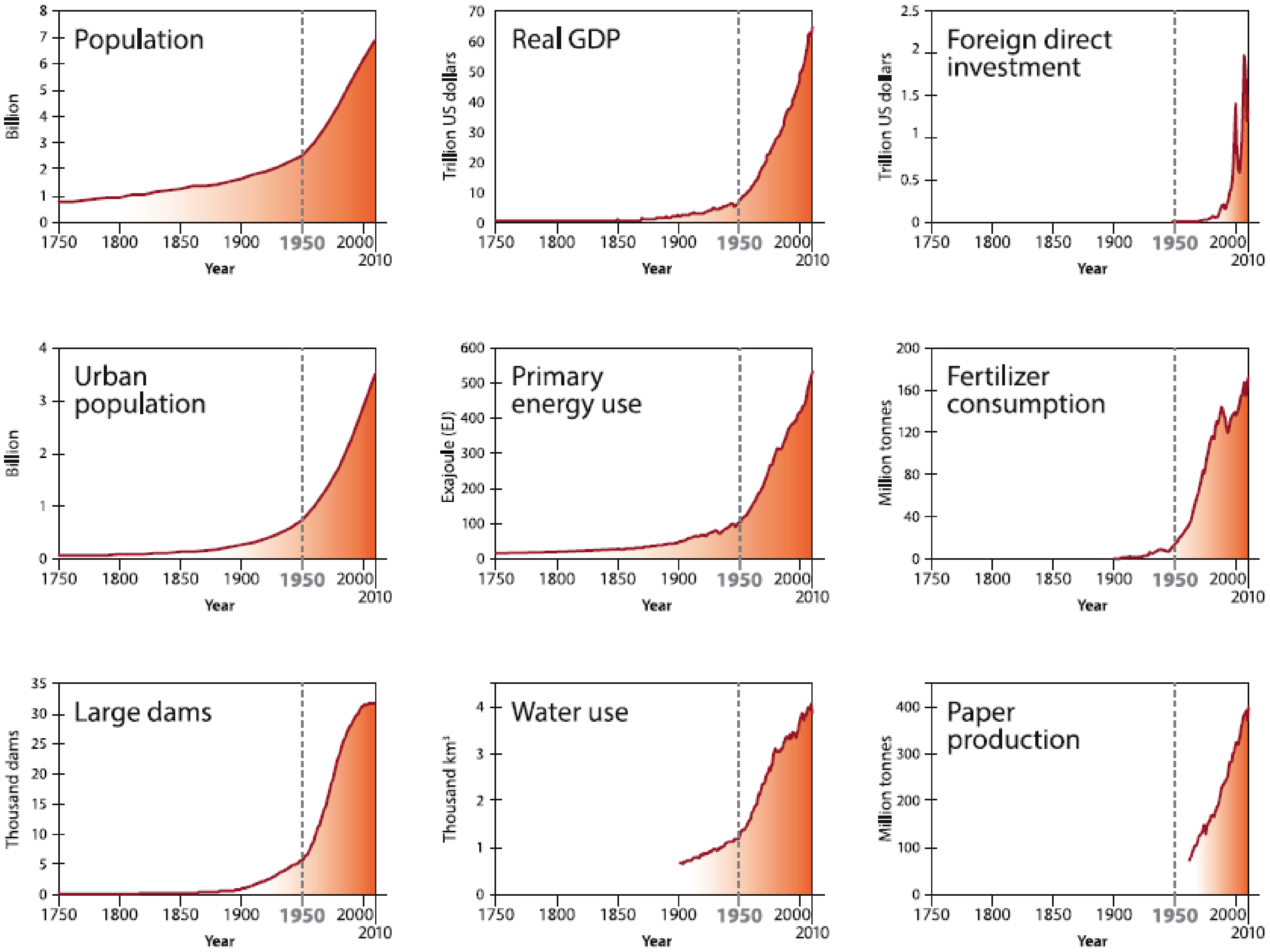
DOI: 10.1177/20530196145641
anr.sagepub.c
SAG

# The trajectory of the Anthropocene: The Great Acceleration

**Will Steffen,[1,2] Wendy Broadgate,[3] Lisa Deutsch,[1] Owen Gaffney[3] and Cornelia Ludwig[1]**



# Socio-economic trends



# Every American Born Will Need...

27,471 lbs.
Salt

11,994 lbs.
Clays

1.20 million lbs.
Stone, Sand, & Gravel

978 lbs.
Copper

521 lbs.
Zinc

72,556 gallons
Petroleum

1.77 Troy oz.
Gold

840 lbs.
Lead

16,306 lbs.
Phosphate Rock

plus 52,288 lbs.
Other Minerals
& Metals

445,903 lbs.
Coal

6,107 lbs.
Bauxite
(Aluminum)

27,416 lbs.
Iron Ore

43,721 lbs.
Cement

6.63 million cu. ft.
Natural Gas

**3 million pounds of minerals, metals, and fuels in their lifetime**



**Learn more at www.MineralsEducationCoalition.org**

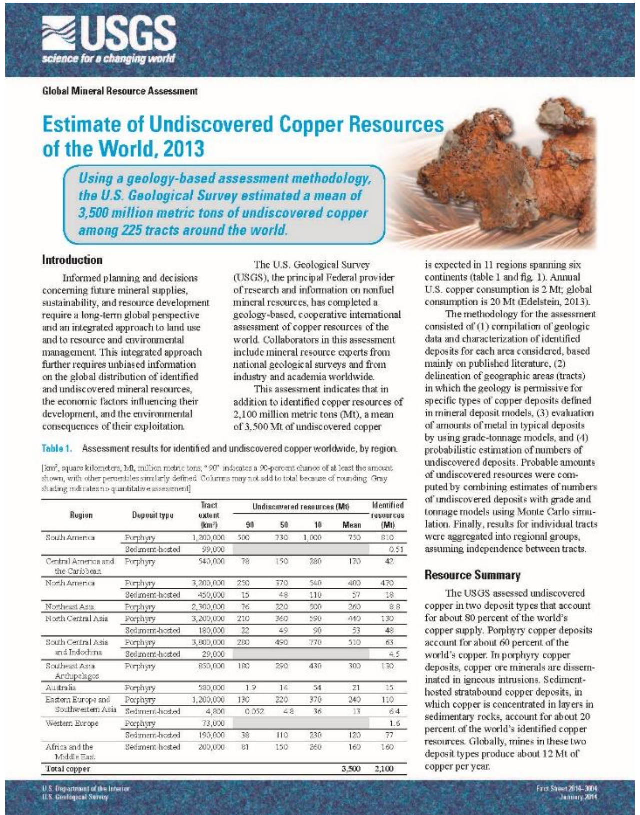
USGS science for a changing world

# USGS: Science for a Changing World

## “It’s time to know the planet’s mineral resources”

2001 USGS launched ‘Global Mineral Resource Assessment’

http://minerals.usgs.gov/global/



USGS science for a changing world

Global Mineral Resource Assessment

### Estimate of Undiscovered Copper Resources of the World, 2013

*Using a geology-based assessment methodology, the U.S. Geological Survey estimated a mean of 3,500 million metric tons of undiscovered copper among 225 tracts around the world.*

#### Introduction

Informed planning and decisions concerning future mineral supplies, sustainability, and resource development require a long-term global perspective and an integrated approach to land use and to resource and environmental management. This integrated approach further requires unbiased information on the global distribution of identified and undiscovered mineral resources, the economic factors influencing their development, and the environmental consequences of their exploitation.

The U.S. Geological Survey (USGS), the principal Federal provider of research and information on nonfuel mineral resources, has completed a geology-based, cooperative international assessment of copper resources of the world. Collaborators in this assessment include mineral resource experts from national geological surveys and from industry and academia worldwide.

This assessment indicates that in addition to identified copper resources of 2,100 million metric tons (Mt), a mean of 3,500 Mt of undiscovered copper is expected in 11 regions spanning six continents (table 1 and fig. 1). Annual U.S. copper consumption is 2 Mt; global consumption is 20 Mt (Edelstein, 2013).

The methodology for the assessment consisted of (1) compilation of geologic data and characterization of identified deposits for each area considered, based mainly on published literature, (2) delineation of geographic areas (tracts) in which the geology is permissive for specific types of copper deposits defined in mineral deposit models, (3) evaluation of amounts of metal in typical deposits by using grade-tonnage models, and (4) probabilistic estimation of numbers of undiscovered deposits. Probable amounts of undiscovered resources were computed by combining estimates of numbers of undiscovered deposits with grade and tonnage models using Monte Carlo simulation. Finally, results for individual tracts were aggregated into regional groups, assuming independence between tracts.

**Table 1.** Assessment results for identified and undiscovered copper worldwide, by region.

[km², square kilometers; Mt, million metric tons; "90" indicates a 90-percent chance of at least the amount shown, with other percentiles similarly defined. Columns may not add to total because of rounding. Gray shading indicates no quantitative assessment]

| Region | Deposit type | Tract extent (km²) | Undiscovered resources (Mt) 90 | 50 | 10 | Mean | Identified resources (Mt) |
|---|---|---|---|---|---|---|---|
| South America | Porphyry | 1,200,000 | 500 | 730 | 1,000 | 750 | 810 |
| | Sediment-hosted | 99,000 | | | | | 0.51 |
| Central America and the Caribbean | Porphyry | 540,000 | 78 | 150 | 280 | 170 | 42 |
| North America | Porphyry | 3,200,000 | 250 | 370 | 540 | 400 | 470 |
| | Sediment-hosted | 450,000 | 15 | 48 | 110 | 57 | 18 |
| Northeast Asia | Porphyry | 2,300,000 | 76 | 220 | 500 | 260 | 8.8 |
| North Central Asia | Porphyry | 3,200,000 | 210 | 360 | 590 | 440 | 130 |
| | Sediment-hosted | 180,000 | 22 | 49 | 90 | 53 | 48 |
| South Central Asia and Indochina | Porphyry | 3,800,000 | 280 | 490 | 770 | 510 | 63 |
| | Sediment-hosted | 29,000 | | | | | 4.5 |
| Southeast Asia Archipelagos | Porphyry | 850,000 | 180 | 290 | 430 | 300 | 130 |
| Australia | Porphyry | 580,000 | 1.9 | 14 | 54 | 21 | 15 |
| Eastern Europe and Southwestern Asia | Porphyry | 1,200,000 | 130 | 220 | 370 | 240 | 110 |
| | Sediment-hosted | 4,800 | 0.052 | 4.8 | 36 | 13 | 6.4 |
| Western Europe | Porphyry | 73,000 | | | | | 1.6 |
| | Sediment-hosted | 190,000 | 38 | 110 | 230 | 120 | 77 |
| Africa and the Middle East | Sediment-hosted | 200,000 | 81 | 150 | 260 | 160 | 160 |
| **Total copper** | | | | | | 3,500 | 2,100 |

#### Resource Summary

The USGS assessed undiscovered copper in two deposit types that account for about 80 percent of the world's copper supply. Porphyry copper deposits account for about 60 percent of the world's copper. In porphyry copper deposits, copper ore minerals are disseminated in igneous intrusions. Sediment-hosted stratabound copper deposits, in which copper is concentrated in layers in sedimentary rocks, account for about 20 percent of the world's identified copper resources. Globally, mines in these two deposit types produce about 12 Mt of copper per year.

U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet 2014–3004
January 2014

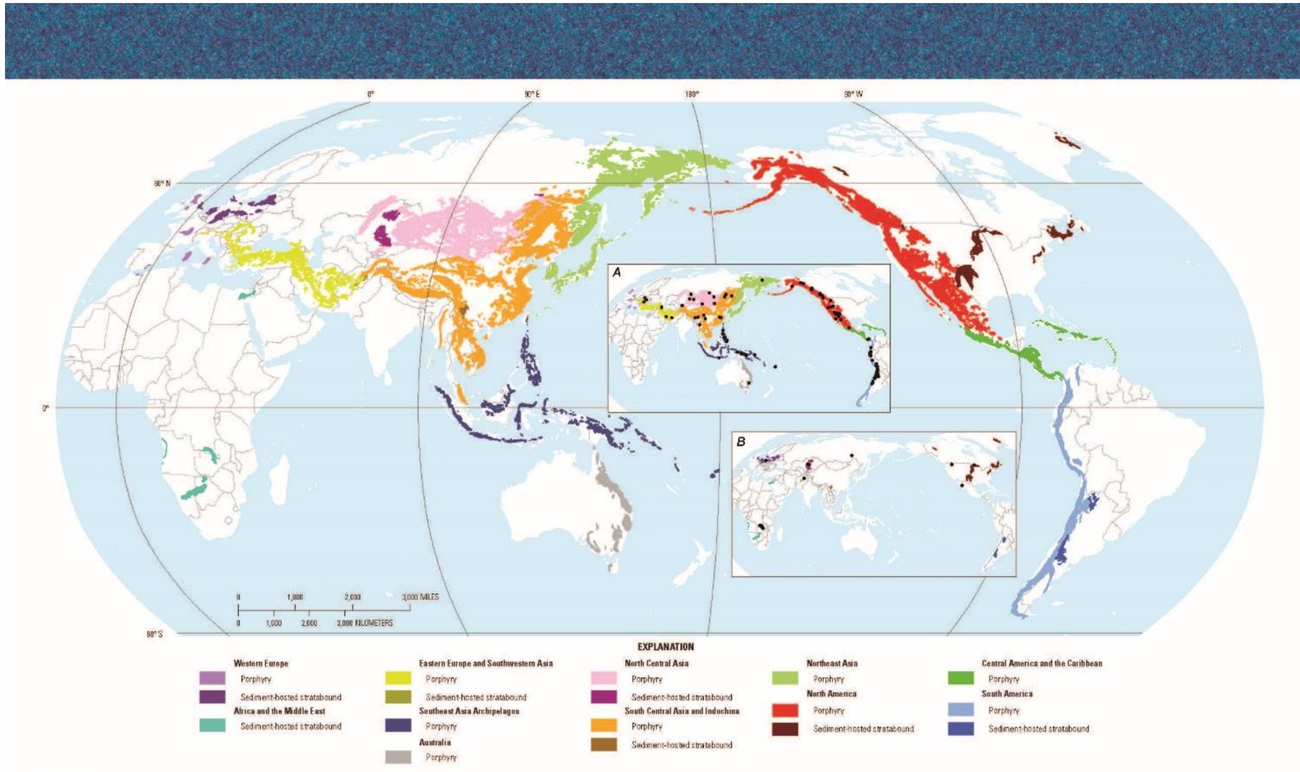



**Figure 1.** Locations of tracts assessed for this study, grouped by region and deposit type. Inset maps show identified deposits containing more than 2 million metric tons copper (black dots); *A*, porphyry copper; *B*, sediment-hosted stratabound copper.

# USGS: Science for a Changing World

The first-ever, geologically-based global assessment of undiscovered copper resources estimates that 3.5 billion metric tons of copper may exist worldwide. The U.S. Geological Survey outlined 225 areas for undiscovered copper in 11 regions of the world. The amount of undiscovered global copper estimated by the USGS would be enough to satisfy current world demand for more than 150 years.

According to the assessment, South America is the dominant source for both identified and undiscovered copper resources. Particularly important, several regions of Asia including China have a large potential for undiscovered copper resources.

"This ground-breaking USGS assessment of future copper resources identifies a huge potential supply that is roughly six times greater than all the copper mined throughout human history," said Interior Assistant Secretary for Water and Science, Anne Castle. "If enough of this copper can be developed in an environmentally responsible and economical way, it will be a boon to new manufacturing and other initiatives that rely on the availability of copper such as the Administration's energy efficiency initiative."

If it cant be grown,
It must be mined.

--Minerals Education Coalition

Google

corn fertilizer

All | Shopping | Images | News | Videos | More | Settings | Tools

About 2,480,000 results (0.58 seconds)

Many **soils** already contain enough **potassium**, **magnesium** and other **nutrients** for corn to grow healthily. An all-purpose fertilizer containing more **nitrogen** and **phosphorus** than **potassium** -- such as a 16-16-8 **ratio fertilizer** -- helps ensure healthy growth when applied to the **soil** before planting.

What Kind of Fertilizer Is Best for Planting Sweet Corn? | Home Guides ...
homeguides.sfgate.com/kind-fertilizer-planting-sweet-corn-71656.html

USGS
*science for a changing world*

**Global Mineral Resource Assessment**

**Platinum-Group Elements in Southern Africa—Mineral Inventory and an Assessment of Undiscovered Mineral Resources**

The first-ever inventory and geological assessment of known and undiscovered platinum-group element (PGE) resources estimates that more than 150,000 metric tons of PGEs may exist in the two southern African countries that produce most of the global supply of these critical elements.

Increased population and higher standards of living have doubled global demand for PGEs in only 20 years. The global net demand for PGEs in 2012 was approximately 470 metric tons.

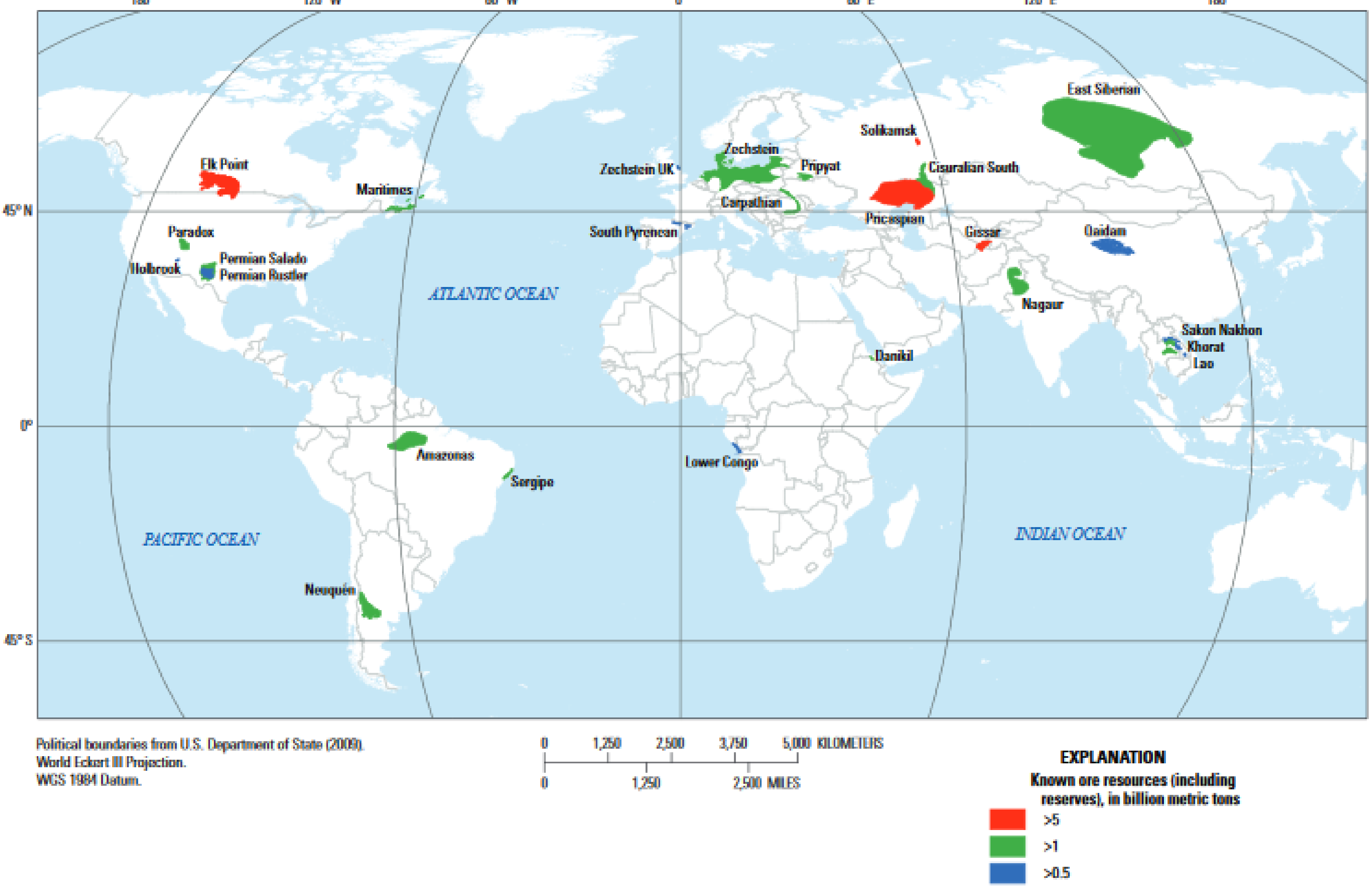
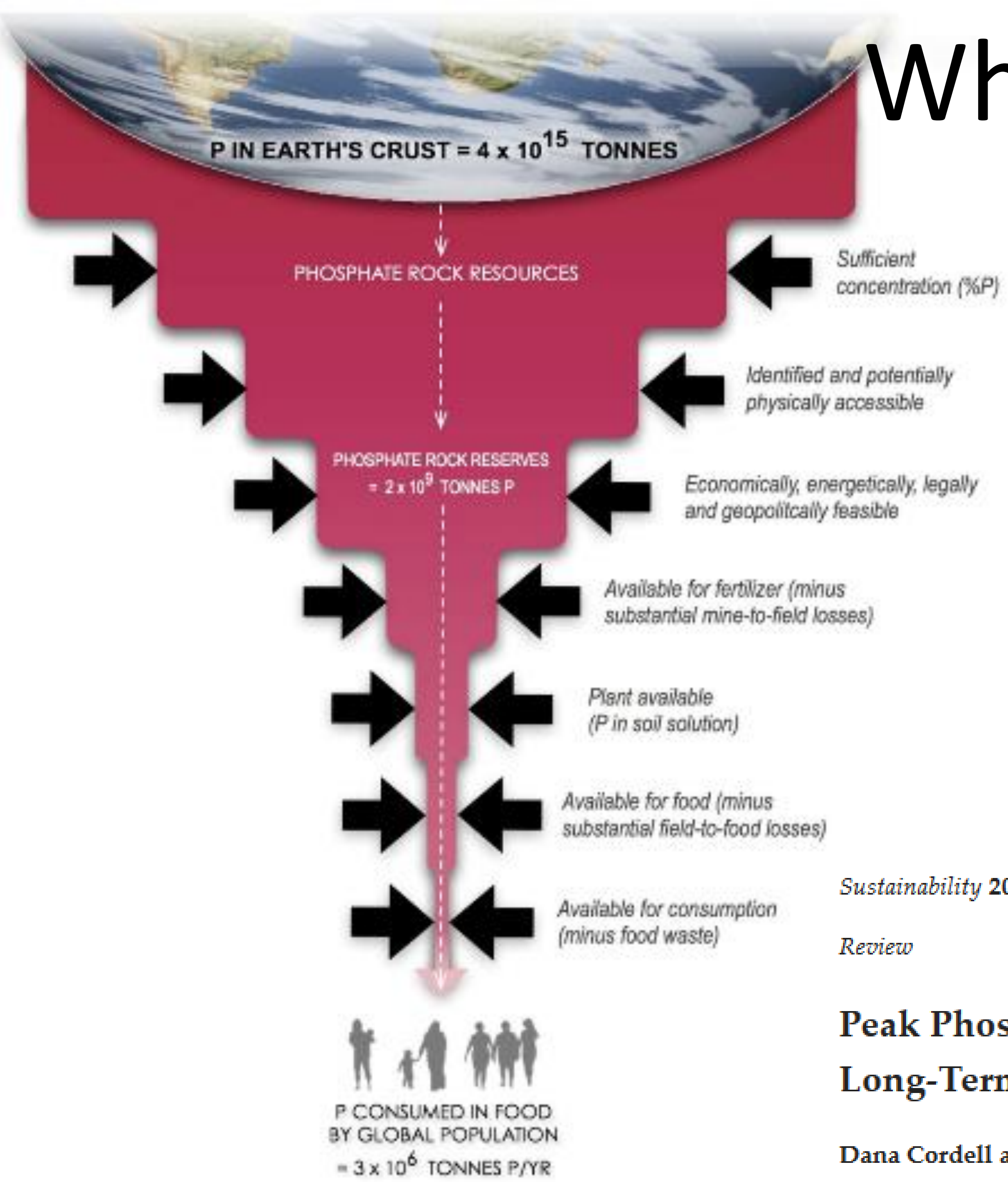



**Figure 3-4.** Map showing cumulative known potash ore resources for selected potash tracts.

# USGS: Science for a Changing World

While the earth contains enough potash to meet the increased global demand for crop production and U.S. supplies are likely secure, some regions lack potash deposits needed for optimal food crop yields. According to a recent USGS global assessment of potash resources, the costs of importing potash long distances can limit its use and imports are subject to supply disruptions.

# What about Phosphorus?




*Sustainability* **2011**, *3*(10), 2027-2049; doi:10.3390/su3102027 Open Access

*Review*

**Peak Phosphorus: Clarifying the Key Issues of a Vigorous Debate about Long-Term Phosphorus Security**

**Dana Cordell and Stuart White** *

**Table 1. Estimates of lifetime of current world phosphate rock reserves by different authors.**

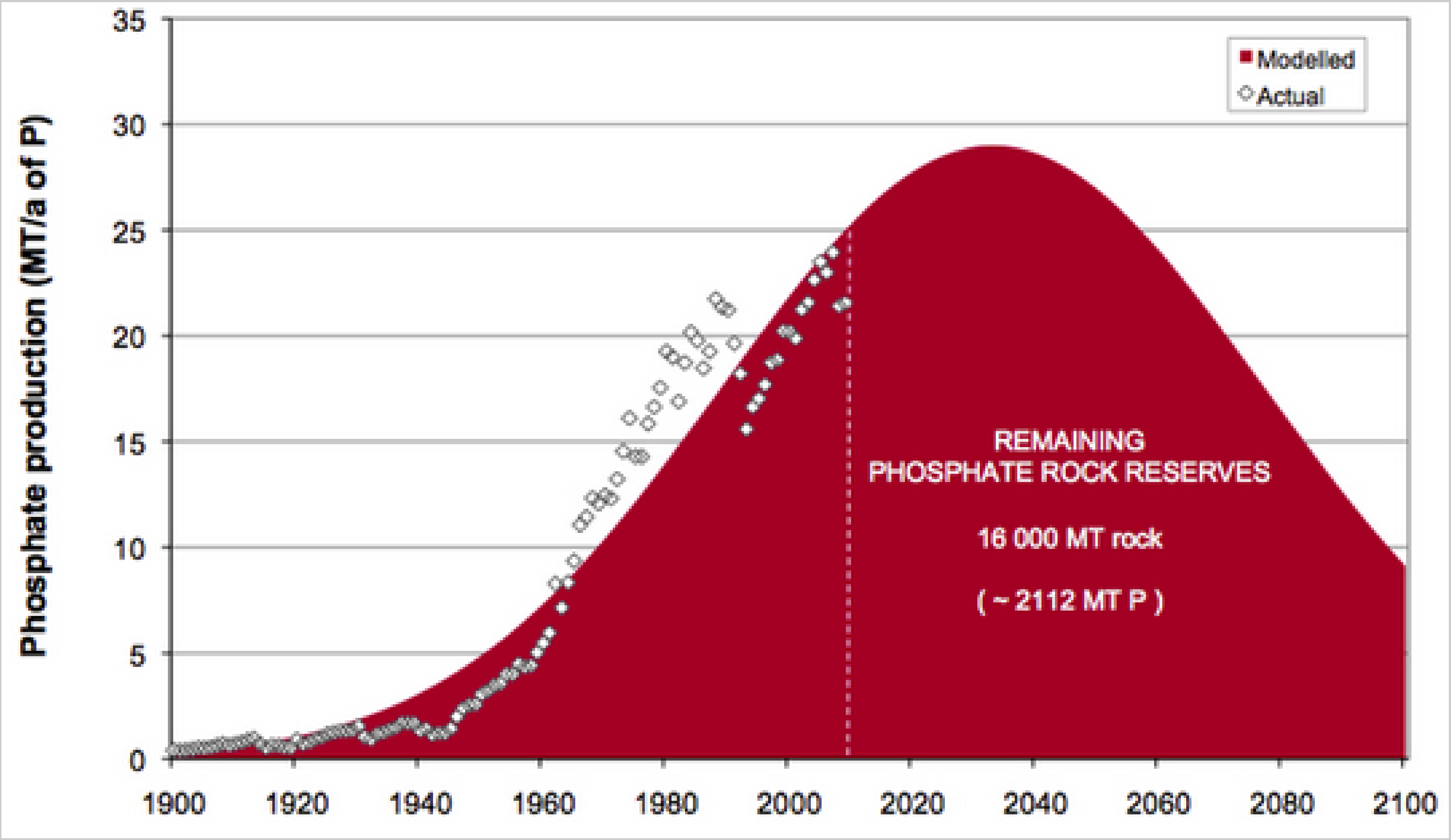
| Author | Estimated Lifetime of reserves | Estimated year of depletion * | Assumptions |
|---|---|---|---|
| Tweeten [16] | 61 years | 2050 | Assumes 3.6% increase in demand; in [19] |
| Runge-Metzger [17] | 88 years | 2083 | Assumes 2.1% increase, based on 1992 World Bank/FAO/UNIDO/Industry Fertilizer Working Group |
| Steen [18] | 60–130 years | 2058–2128 | Based on range of 2–3% increase demand rates, plus a 'most likely' 2% increase until 2020 and 0% growth thereafter if efficiency and reuse measures are implemented. |
| Smil [7] | 80 years | 2080 | At 'current rate of extraction' |
| Fixen [19] | 93 years | 2102 | At 2007–2008 production rates |
| Smit *et al.* [20] | 69–100 years | 2078–2109 | Assuming 0.7–2% increase until 2050, and 0% increase after 2050. |
| Vaccari [15] | 90 years | 2099 | At 'current rates' |
| Van Kauwenbergh [13] | 300–400 years | 2310–2410 | At 'current rates' |

*year of depletion assumes lifetime estimated from date of publication.

The concept and analysis of peak phosphorus is based on the following premises:

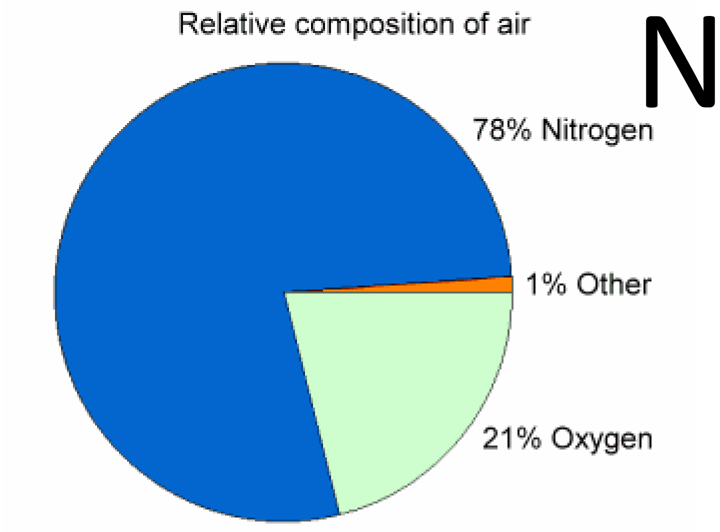
1. Phosphate rock is a finite resource that takes 10s to 100s of millions of years to cycle or 'renew' naturally;
2. Phosphate rock is non-homogenous resource, where the higher quality, more easily accessible layers are mined first;
3. As a result of 1 and 2 above, this means that over time, the average quality of phosphate rock is decreasing, in terms of $P_2O_5$ percentage (and also the increasing presence of impurities and heavy metals). This is also supported by empirical evidence [39];
4. Premise 3 means that increasing energy, resources, and costs are required per unit output of nutrient. That is, to extract the same nutrient content (e.g., $P_2O_5$) over time requires increasing inputs;
5. Premise 3 also means that extracting the same nutrient output generates more waste byproducts;
6. While the short and medium tern costs may fluctuate due to short term changes in demand or improvements in production methods, over the long term costs and energy inputs will increase, and indeed will increase not linearly, but exponentially as ore concentrations decline and will require an increasing amount of phosphate rock to be mined. Observable changes over time typically occur once approximately 50% of the resource has been consumed;
7. While there may be some fluctuations causing year-to-year variation in phosphate production (due to supply-side or demand-side variables), there will always be a global demand for phosphorus, as argued in section 2);
8. This means at some critical point, the increasing annual production of phosphate rock will become unviable due to increasing energy, economic and other constraints, while demand will continue to increase.

**Figure 4.** Peak phosphorus curve indicating a peak in production by 2033, derived from US Geological Survey and industry data. Source: [1].

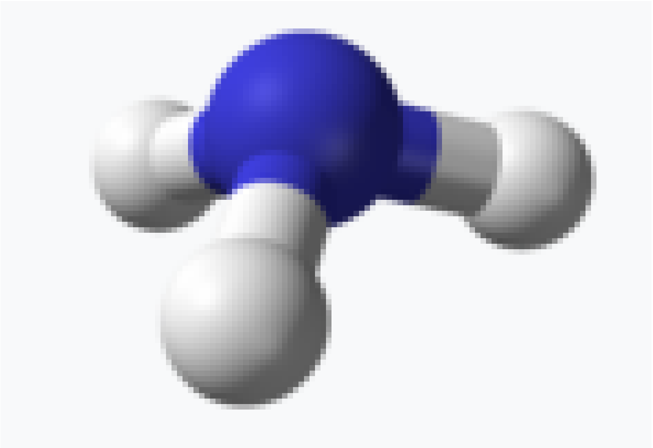


# What about Nitrogen?

# Doesn’t that come from the Atmosphere?




# Nope. Post WWII: Haber Process



## Table 1. Nutrient Uptake and Removal by 230 Bushel Corn

| Nutrient | Required to Produce | Removed with Grain | Harvest Index |
|---|---|---|---|
| | lb acre$^{-1}$ | | % |
| N | 256 | 148 | 58 |
| $P_2O_5$ | 101 | 80 | 79 |
| $K_2O$ | 180 | 56 | 32 |
| S | 23 | 13 | 57 |
| Zn (oz) | 7.1 | 4.4 | 62 |
| B (oz) | 1.2 | 0.3 | 23 |

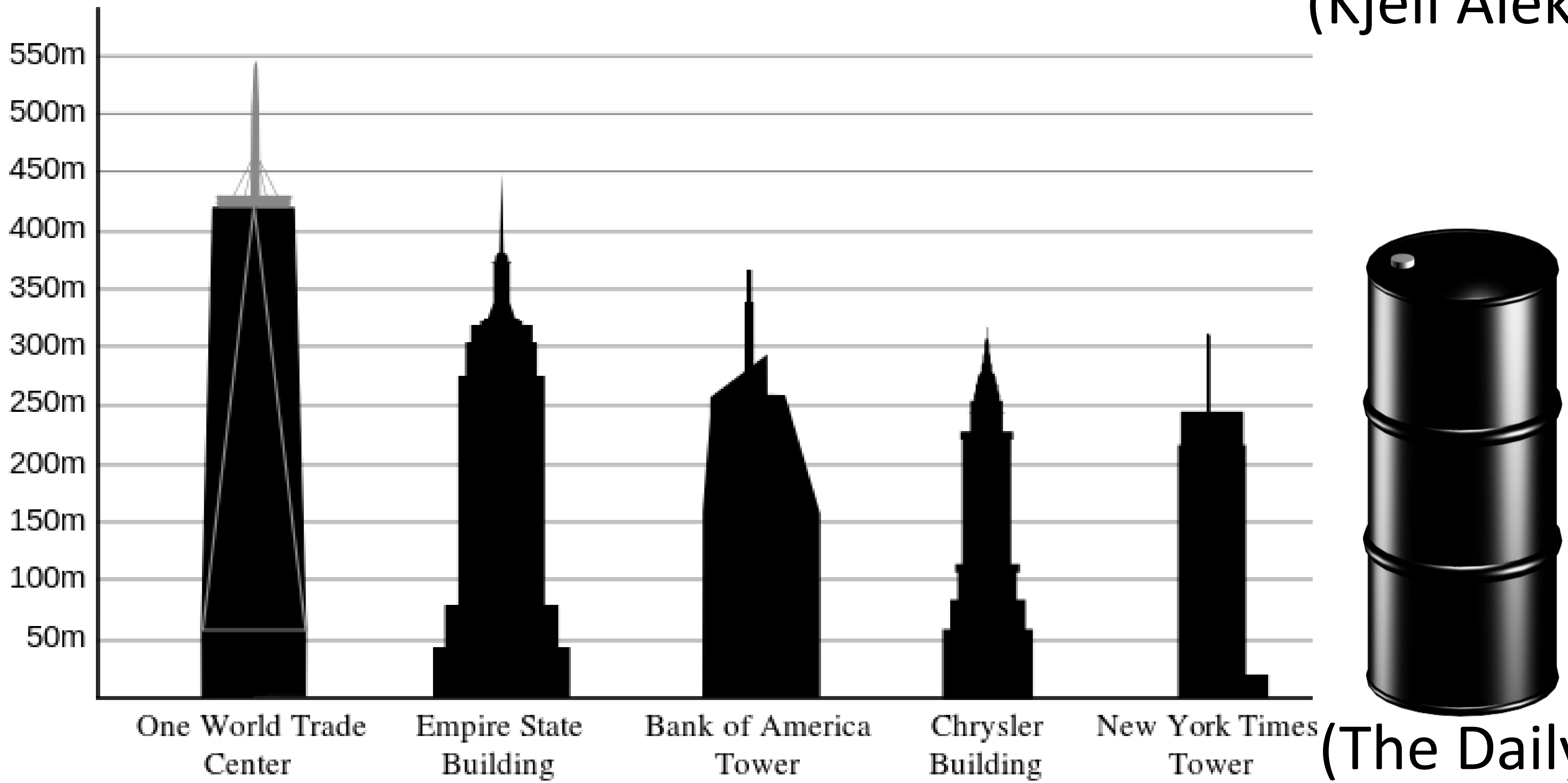
Agron J. 105:161-170 (2013)

Crop Physiology

# Give us this Day our Daily BARREL…

# 340 meters High, 128 meters Wide

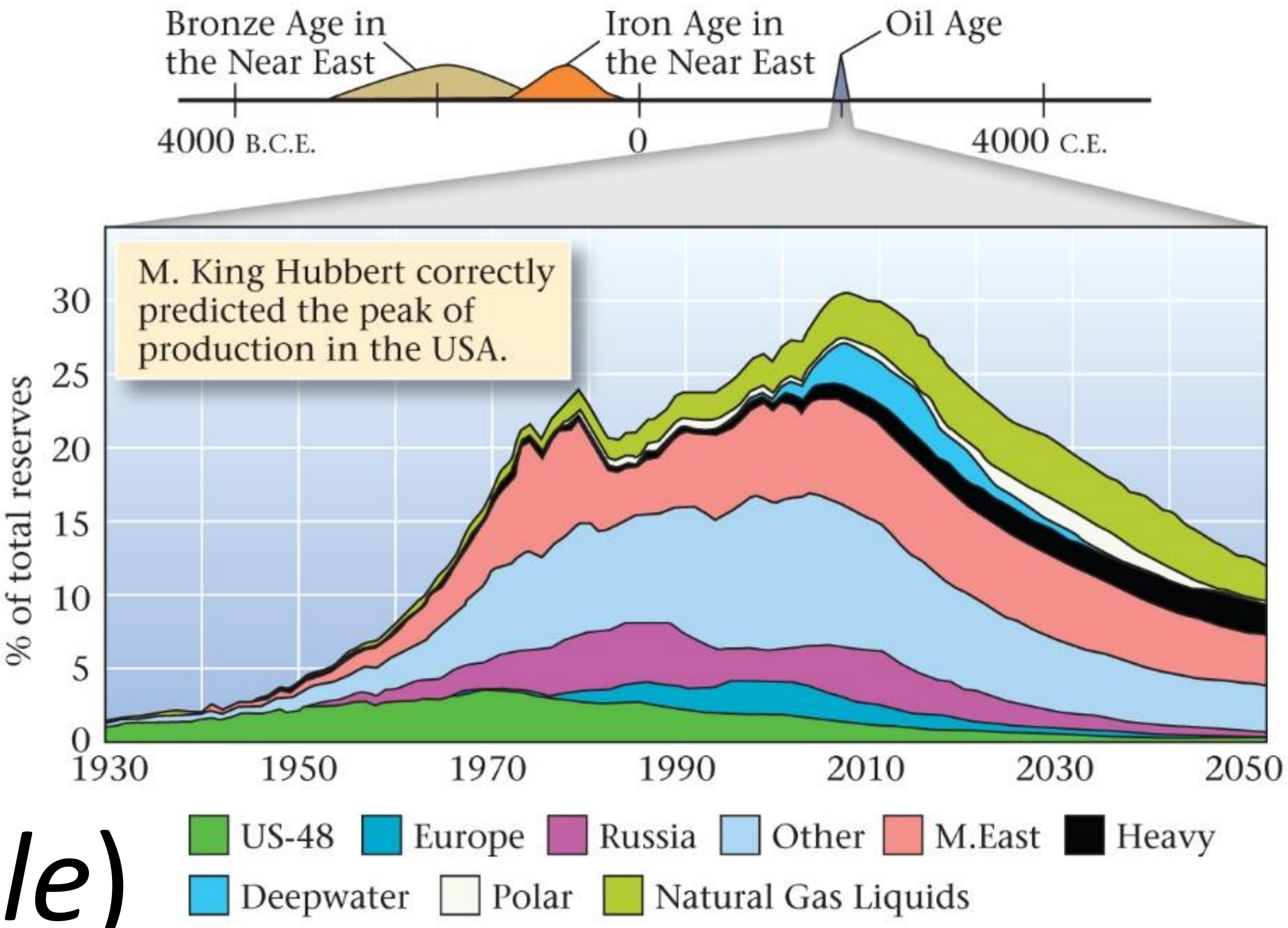
(Kjell Aleklett, 2013)




(The Daily Barrel)

Resource Depletion Peaks

# Peak Production Of Global Oil



(d)

(A physical *principle*)

1,032,000,000,000 Barrels
Left in Known Reserves

76,000,000 Barrels
*Current* World Consumption per DAY

1,032 Gb/0.076 Gb per day =
13,578 DAYS =

**37 YEARS**

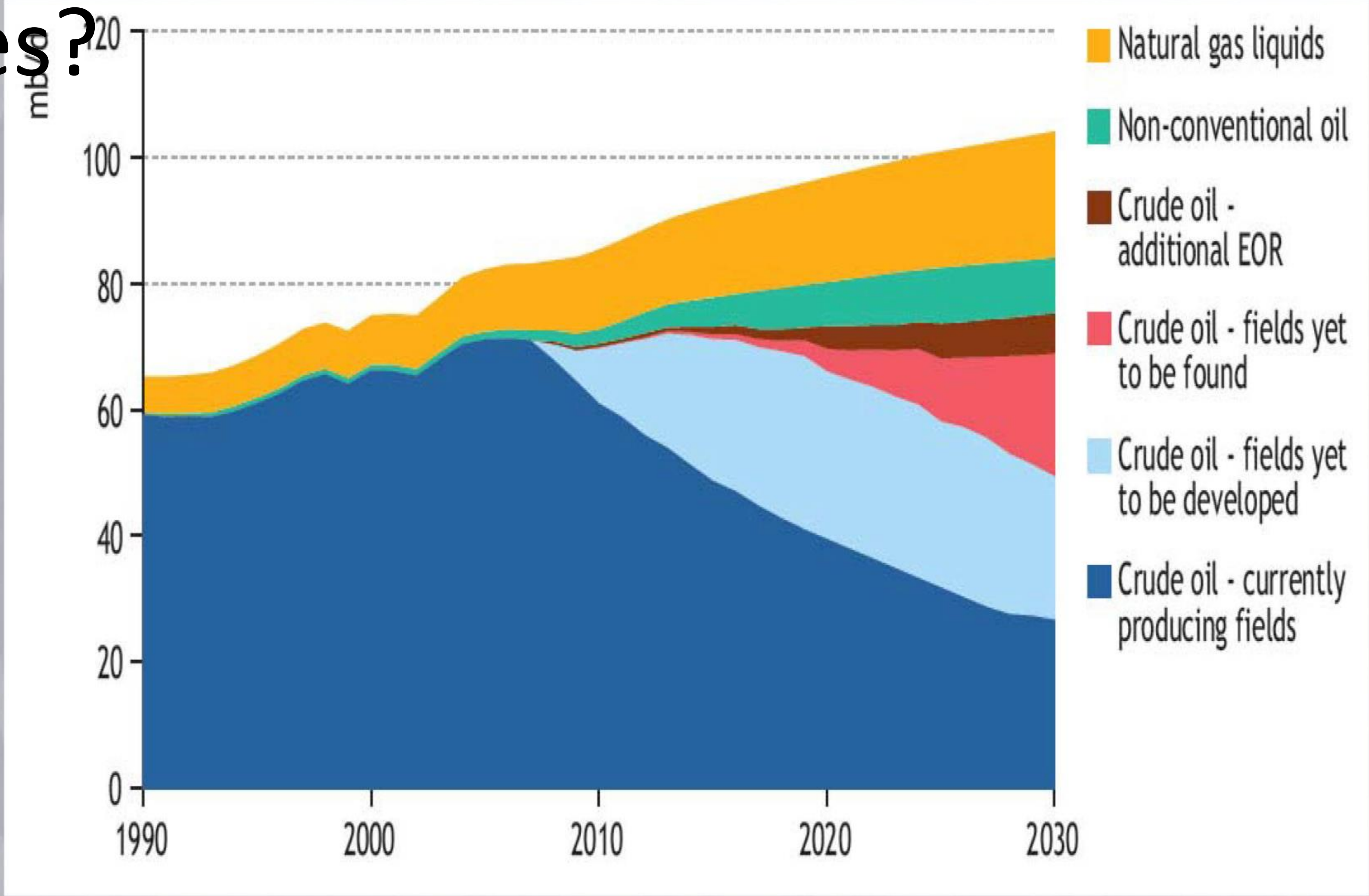
| Country | Reserves[2] (billion bbl) | Production (millions bbl/day) | Consumption[3] (millions bbl/day) |
|---|---|---|---|
| Saudia Arabia | 265 | 8.5 | 1.4 |
| Iraq | 115 | 2.4 | 0.5 |
| Kuwait | 99 | 1.8 | 0.3 |
| Iran | 96 | 3.8 | 1.1 |
| United Arab Emirates | 63 | 2.6 | 0.3 |
| Russia | 54 | 7.0 | 2.5 |
| Venezuela | 48 | 3.1 | 0.5 |
| China | 31 | 3.3 | 4.9 |
| Libya | 30 | 1.4 | 0.2 |
| Mexico | 27 | 3.6 | 1.9 |
| Nigeria | 24 | 2.2 | 0.3 |
| United States | 22 | 8.1 | 20.0 |
| Qatar | 15 | 0.6 | 0.03 |
| Norway | 10 | 3.4 | 0.2 |
| Algeria | 9 | 1.5 | 0.2 |
| Brazil | 8 | 1.6 | 2.1 |
| World | 1,032 | 75.2 | 76.0 |

What about
New discoveries?

And increased
Efficiency?

And enhanced
Recovery?

# IEA - World Energy Outlook 2008




UPPSALA
UNIVERSITET

Kjell Aleklet

# Positive Notes…

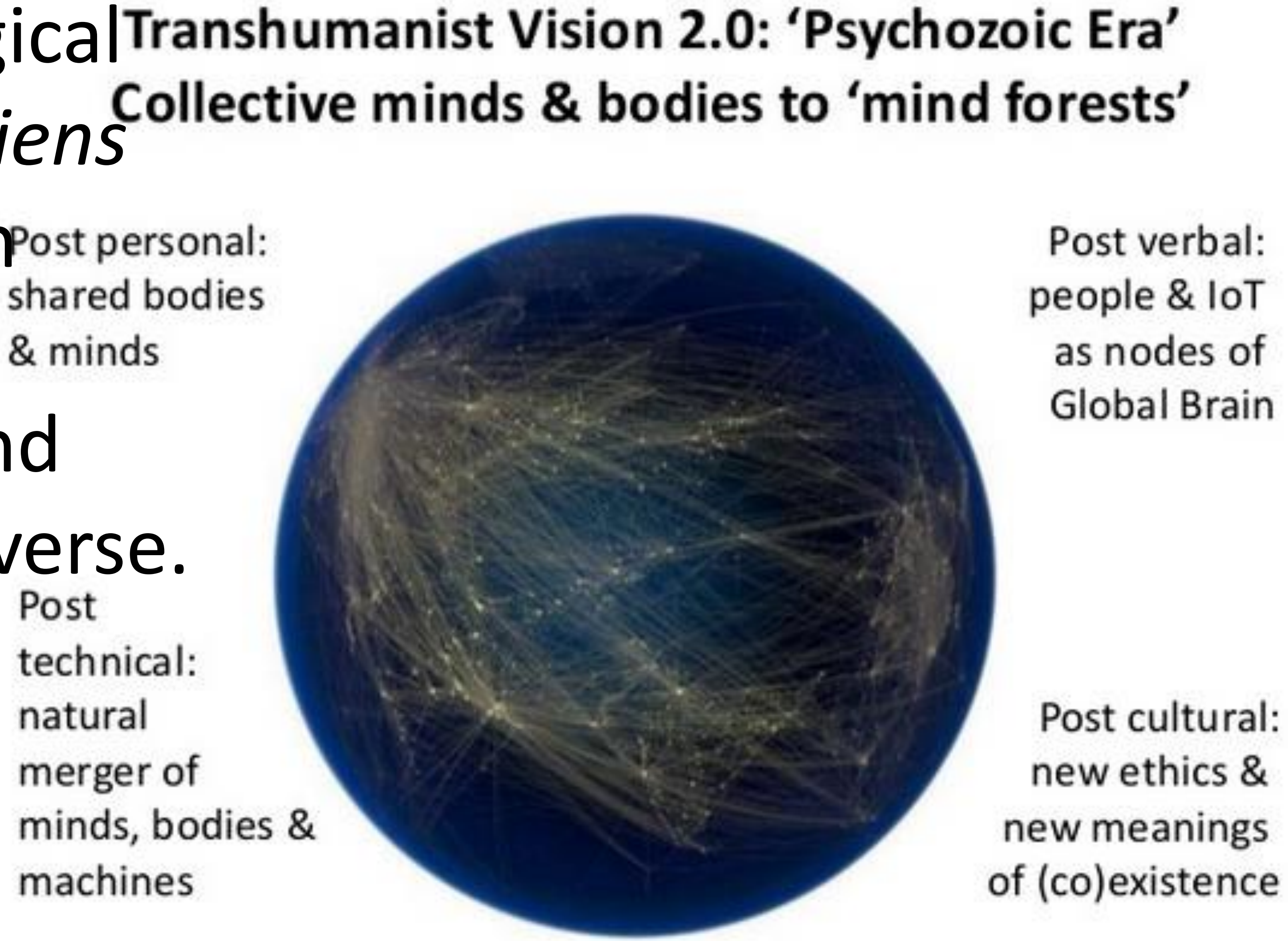
The Earth Has a Future

**Steven Ian Dutch**
*University of Wisconsin–Green Bay, Green Bay, Wisconsin 54311-7001, USA*

http://geosphere.gsapubs.org/content/2/3/113/suppl/DC1

# Not only the Anthropocene, but the Psychozoic.

From all paleontological
Evidence, *Homo sapiens*
Is the first species on
Earth to be aware
Of itself, the Gaia, and
Our place in the Universe.



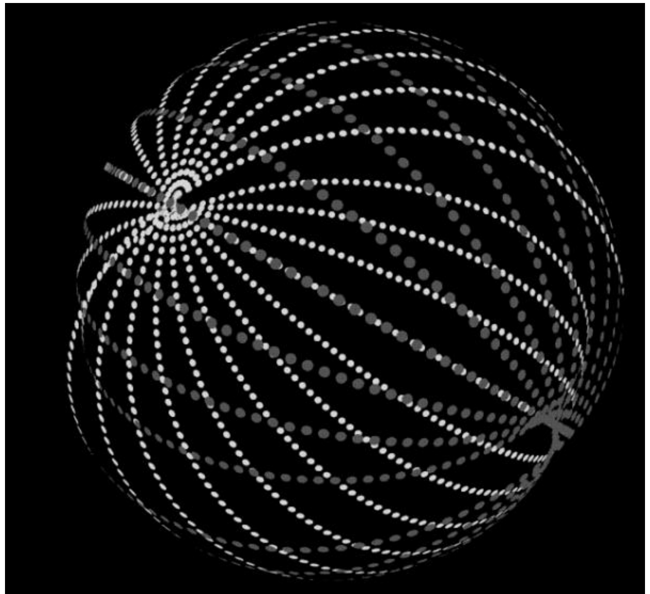
The Dinosaurs had NO idea…. We at least have a shot at detecting a bolide, but we do not yet posses the ability to do much about it.

As we move through adolescence, (early Anthropocene), we are Leaving a path of destruction. But Can we mature to actually be the Stewards of the Earth?

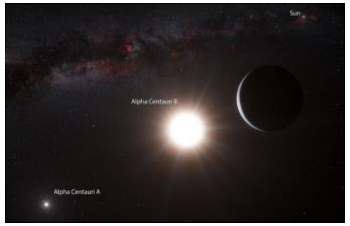
SETI INSTITUTE

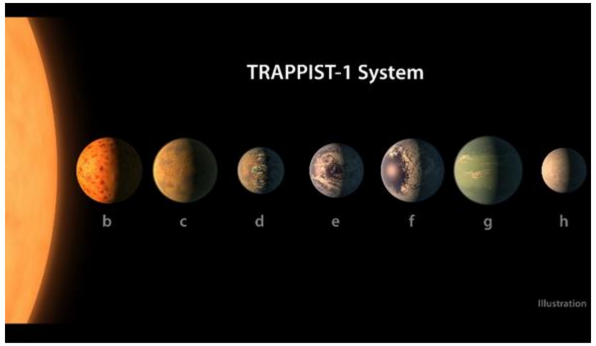
# Kardeshev Scale

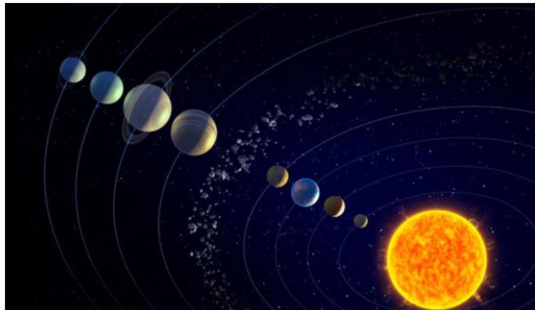
In 2015, a study of galactic mid-infrared emissions came to the conclusion that "Kardashev Type-III civilizations are either very rare or do not exist in the local Universe".[8]

# SETI and Time

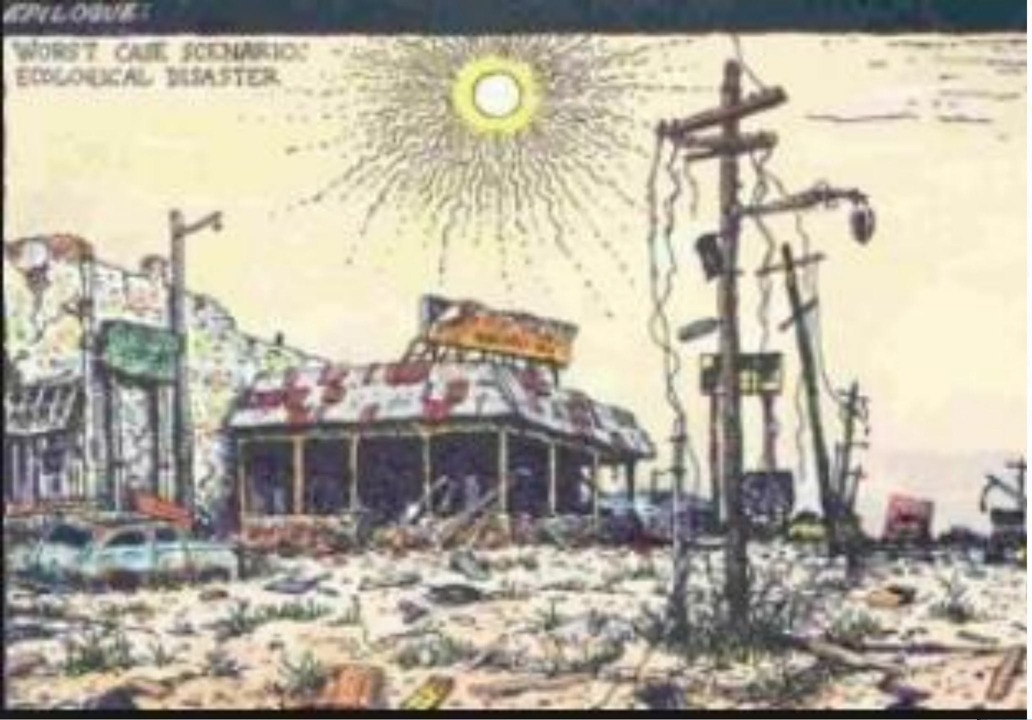


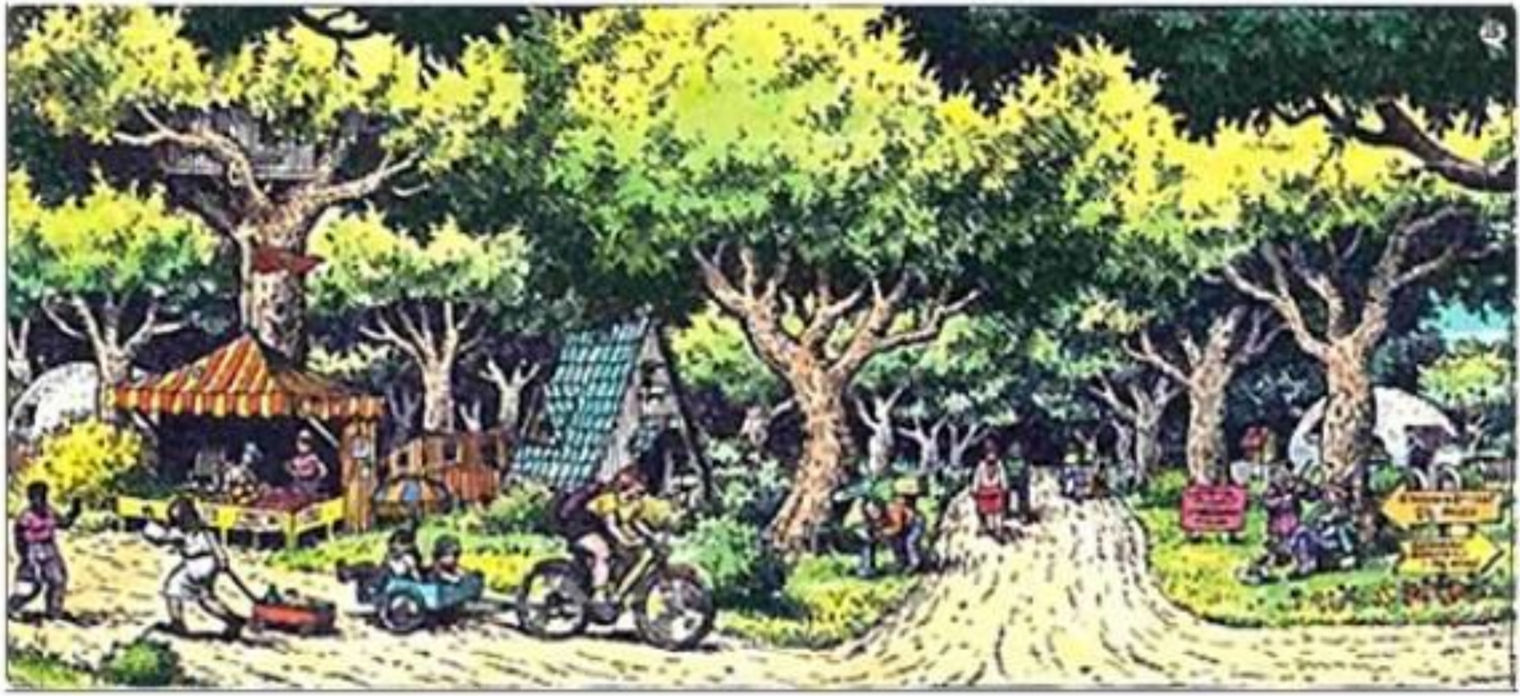



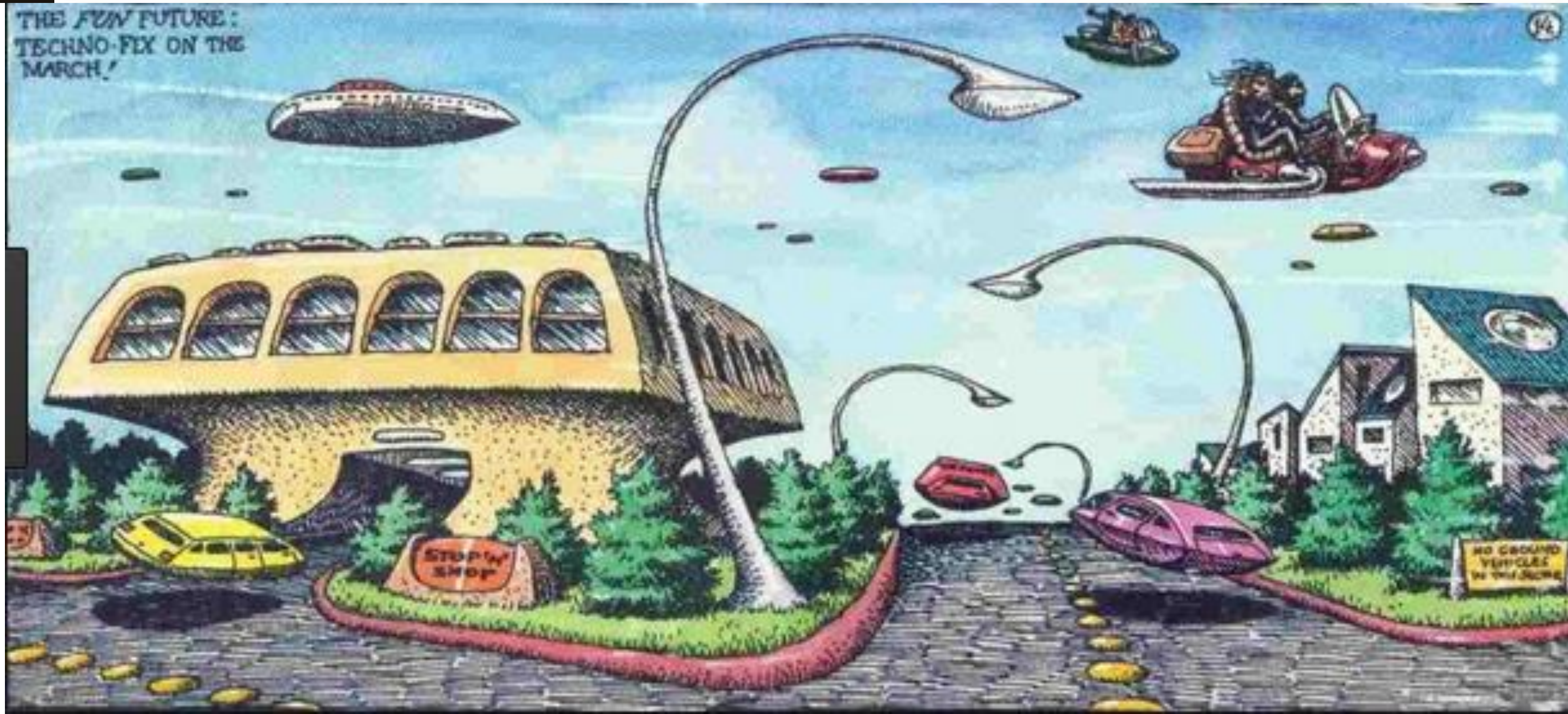




Short History of America by Robert Crumb


TEXACO
TEXACO


EPILOGUE:
WORST CASE SCENARIO:
ECOLOGICAL DISASTER




THE FUN FUTURE:
TECHNO-FIX ON THE MARCH!
STOP'N SHOP
NO GROUND
VEHICLES

# Todays Dose of Violence…. And hope.

David Grinspoon

Lynn Margilis

Carl Sagan