



Global existential risks:

Is climate change one of them?

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Defining the concept

Global = planetary-wide

Existential - whose existence:
- of our civilization?
- of human species?
- of many species and ecosystems?
- of the life on the Earth ?

Risks - probability?
- time horizon (recent generations?)

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Introductory caveat :

Life and world are complex and climate change indeed is just one of global risk factors.

Many other factors will play major role - such as peak oil, depletion of water resources and other mineral resources, soil, destruction of ecosystems, increasing ocean acidity etc.

Important among the risks have always been adaptations and mal-adaptations of human societies - the **risk of "autoimmune" reactions**

Limits to our knowledge :

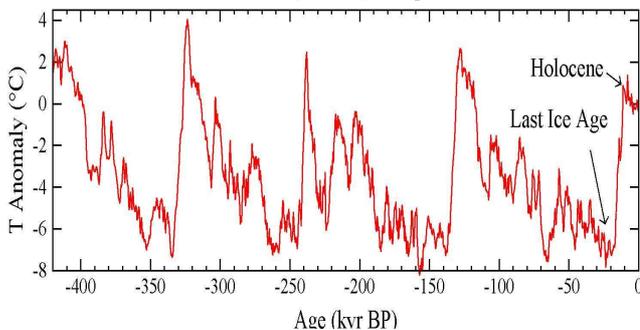
- Things we know that we know:
for instance paleo-climatological data
- Things we know that do not know:
for instance dynamics of CH₄ release from permafrost, methane hydrates
- Things we do not know that we know: ???
maybe the way humans deal with major stress (1358-1352, 1917, 1933...)
- Things we do not know that we do not know
???

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Global climate context – glacials and interglacials

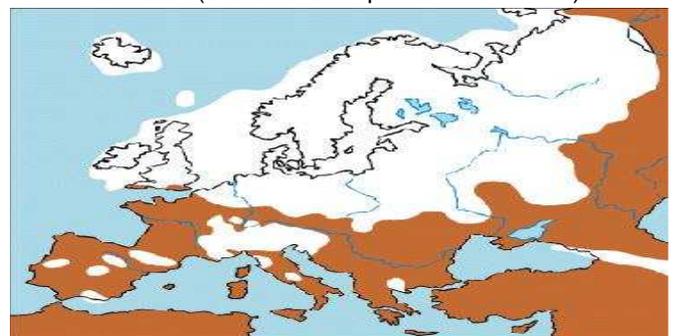
Genesis of Homo sapiens – emergence 200 000 years BP
- over 190 000 years hunters and gatherers
- all civilizations emerged in Holocene

Antarctic (Vostok) Temperature



Europe 20 000 years BP

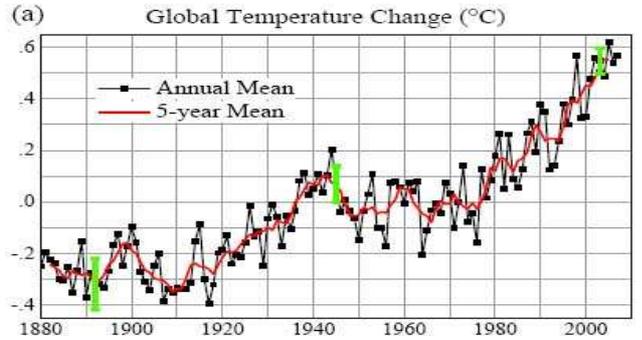
Average global temperature 6 C lower compare to 1800 (Slovakia/CR apr. 10-12 C colder)



Areas covered with glacial ice during the Pleistocene Note JM: Wrong shape of coastal line

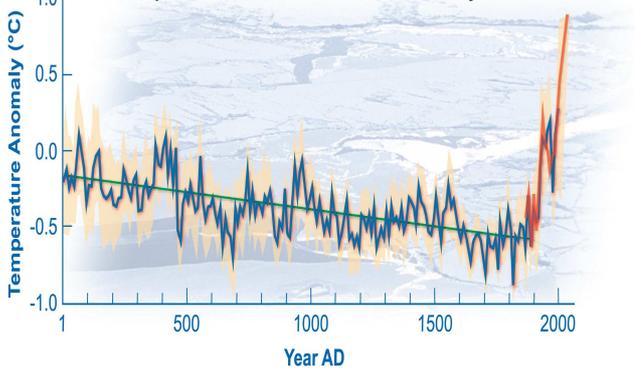


Recent times: increase in average global temperature by 0.8 C - growth accelerates since 1970



http://www.nasa.gov/centers/goddard/images/content/208488main_global_temp_change.jpg

„Anthropocene“ - reconstruction of average global temperature over the last 2000 years



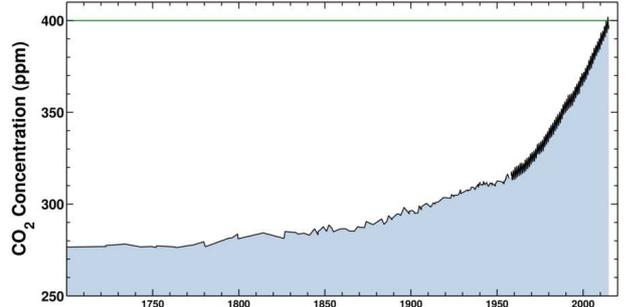
http://www.ucar.edu/news/releases/2009/images/fig.final_11.jpg

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Why? Anthropogenic emissions of CO₂, CH₄ etc.

Latest CO₂ reading
December 05, 2014
398.09 ppm

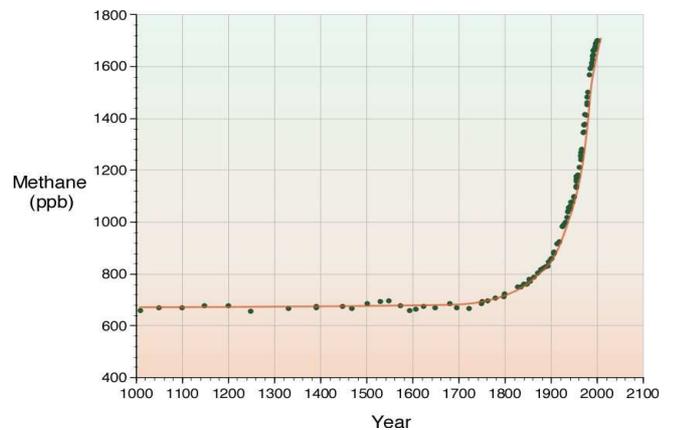
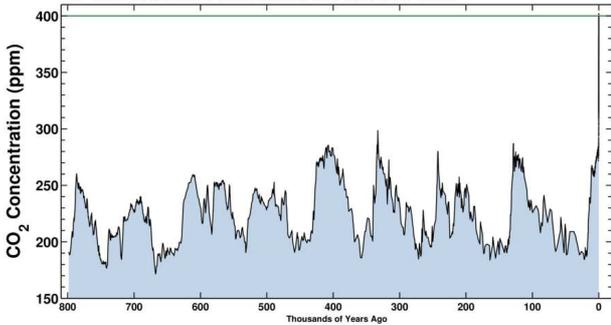
Ice-core data before 1958. Mauna Loa data after 1958.



Out of geological scale: Anthropogenic emissions of CO₂ from geological perspective

Latest CO₂ reading
December 05, 2014
398.09 ppm

Ice-core data before 1958. Mauna Loa data after 1958.



http://www.eoearth.org/files/145501_145600/145558/methane_eoe_atmosphere.jpg
(Encyclopedia of Earth)

How fast and how far can the climate change?

What we know from paleoclimatology:

- Sea level rise at the height of „great warming“ 15.000 BP + 5 m per century
- Last time there were 360 to 400 ppm CO₂ in the atmosphere - in Pliocene 3 million years ago - oceans level was 25 m higher than today

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The **speed** of current changes is from geological perspective **unprecedented** – yet it is realistic to expect further acceleration due to reinforcing feedbacks

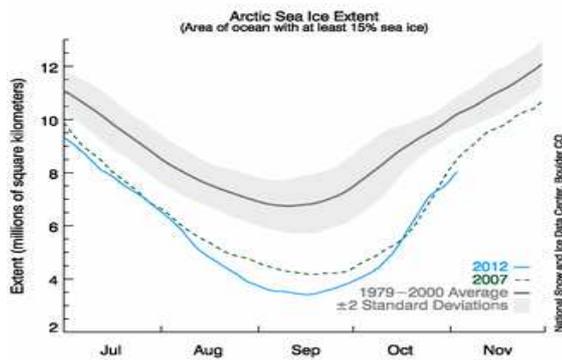
Ecosystems are **left without time to adapt** – species mass extinction is already reality

However CC affects also **agrarian ecosystems**, which are the very basis of your civilization

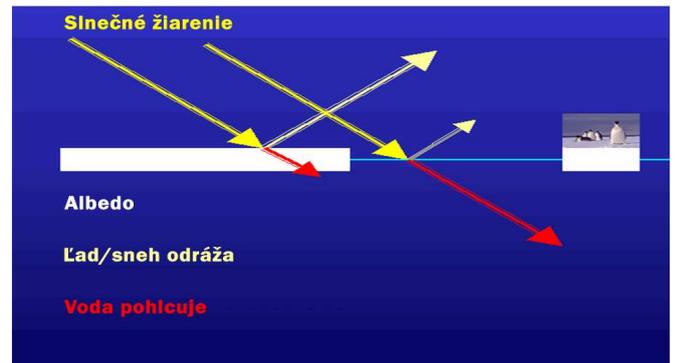
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Reinforcing feedbacks

Changing albedo in Arctic – less snow and ice
50% of summer sea ice gone (compare to 25 years ago)



Less snow and ice – more absorbed heat

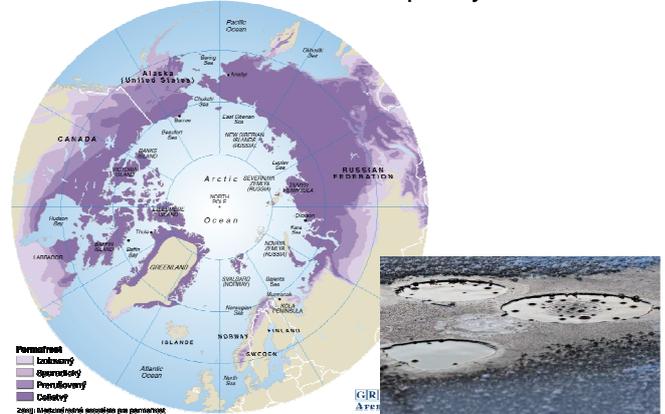


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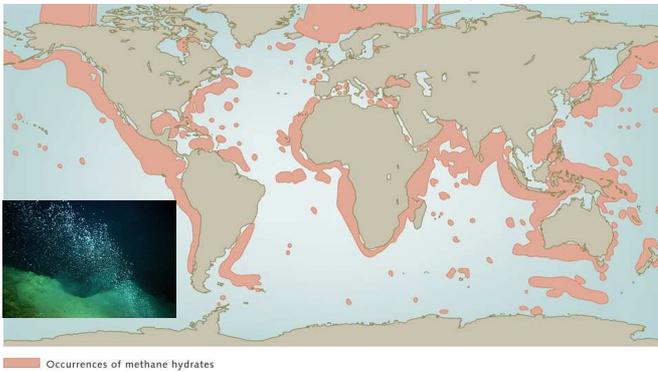
Dark snow – southern Greenland, 8/2014



Permafrost melting = CH₄ release
How much = ? How quickly = ?



Methan-hydrates melting in shelf seas
 = CH₄ release (www.ameg.me)
 How much = ? How quickly = ?



Growing intensity of wildfires –
 carbon sinks turning source of atmospheric C
 How much = ? How quickly = ?



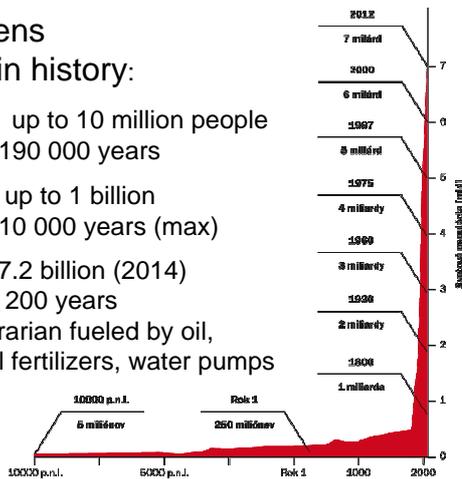
Homo sapiens
 population in history:

Pre-Neolithic - up to 10 million people
 190 000 years

Agrarian - up to 1 billion
 10 000 years (max)

Industrial - 7.2 billion (2014)
 200 years

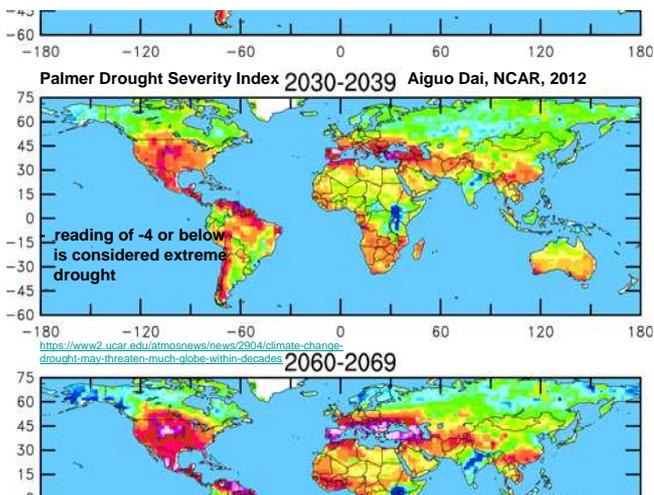
Industrial = agrarian fueled by oil,
 mineral fertilizers, water pumps



A hypothetical scenario of climate existential
 crisis 2030 - 2040

Cascade of events:

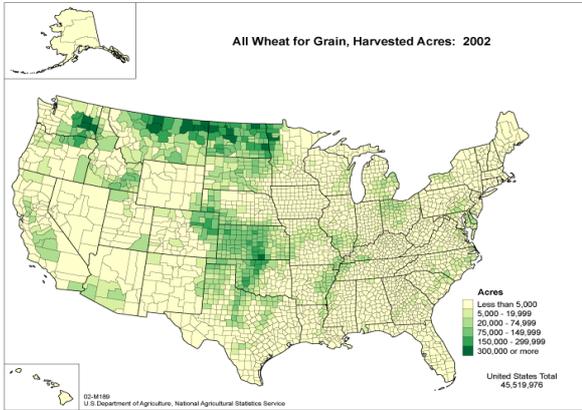
1. Stubborn drought hit US in 2030-2034
 (100th anniversary of the Dust Bowl)
2. US President declares grains export embargo
 (Russia 2010)
3. World food prices go „through the roof“



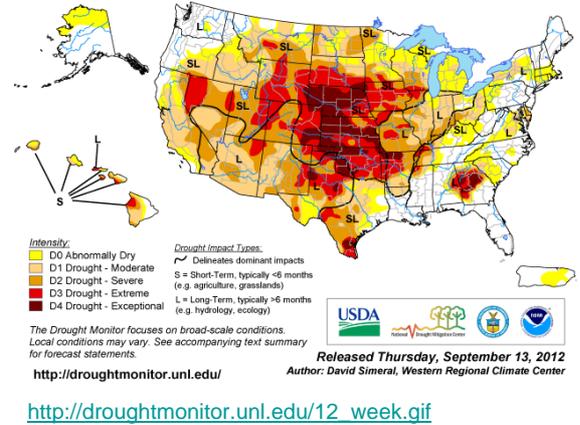
Dust Bowl, 1930 - 1936



USA: the world biggest exporter of grains (wheat, corn)



U.S. Drought Monitor September 11, 2012



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Food price shock of 2010

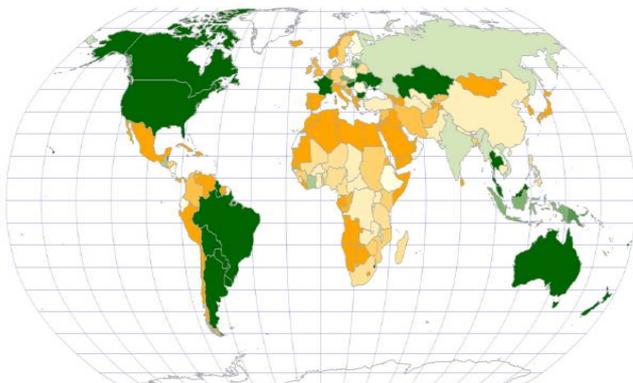


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A hypothetical scenario of climate existential crisis 2030 – 2040 - cascade of events continues:

- In the Arab world famine broke out and the next wave of revolutions / wars („Arab Spring on steroids“)
- Oil production in Persian Gulf collapses, oil exports with them
- Global energy crisis sets in and leads to dramatic decrease in industrial production
- Global dimming reduced by 50% within weeks - global temperature jumps up by 0,4 C

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Net Trade in Food: Vulnerability of MENA but also Pakistan, China, Mexico...

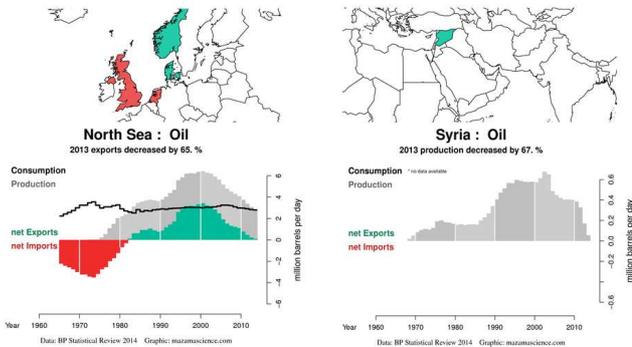
<http://www.fao.org/docrep/015/am081m/PDF/am081m05.pdf>



Syria war: 200-280 000 killed, more than 3.2 million people have fled Syria, 7.6 million have been displaced inside the country. WFP has been forced to suspend a critical food aid scheme for more than 1.6 million refugees because of a funding crisis (Dec. 2, 2014)



**Oil production decrease
– natural and accelerated by war**

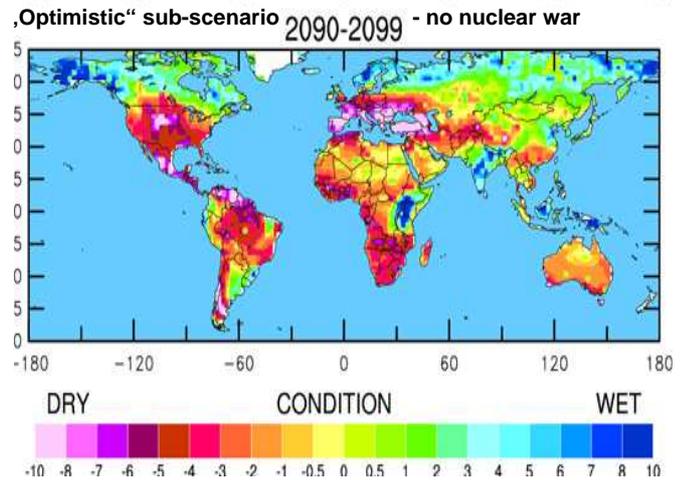
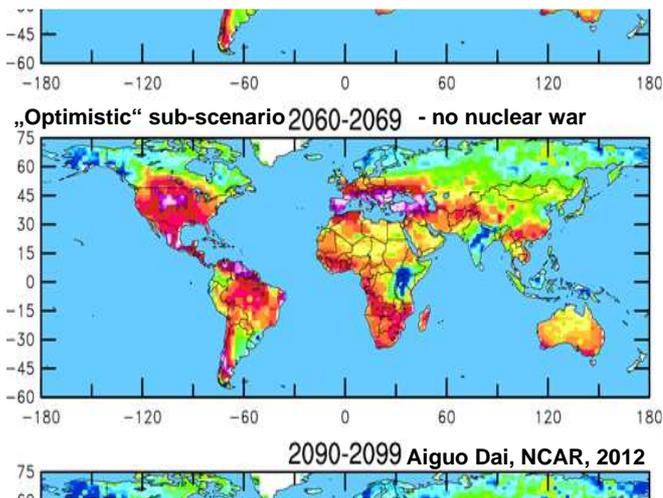


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A hypothetical scenario of climate existential crisis 2030 – 2040 - cascade of events continues:

8. Famines spread further in subtropical countries dependent on food imports – Pakistan (projected population in 2030 - 234 M.), India (1,523 B.), China (1,393 B.), Bangladesh (182 M.) ...
9. A. „Optimistic sub-scenario“ - Most of the world population in subtropical and tropical regions devastated by famines, local wars and epidemics
9. B. „Pessimistic sub-scenario“ - Small nuclear war between a, India and Pakistan (water) b, Russia and China (water, Siberia)

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**9 B Scenario - consequences
of a „small“ nuclear war Pakistan versus India
using 100 15-kT (Hiroshima-size) weapons?**

This would be only 0.03% of the current world arsenal.

Scenario: Weapons dropped on the 50 targets in each country that would produce the maximum smoke.

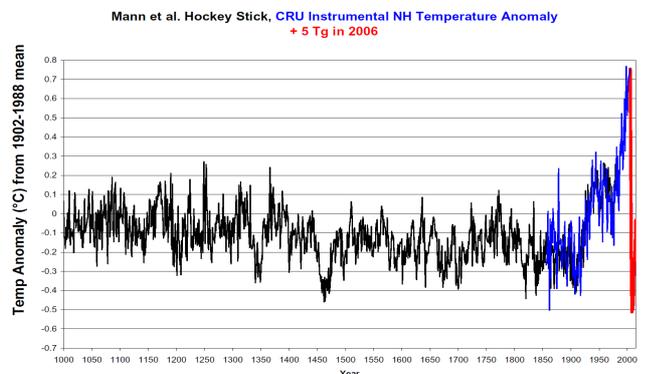
20,000,000 people would die from direct effects, half of the total fatalities from all of World War II.

Portions of megacities would likely be abandoned indefinitely.

5 Tg (1 M tons) of smoke injected into the upper troposphere
(Alan Robock, Rutgers U., February 2014 - <http://www.envsci.rutgers.edu/~roboc/>)

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Temperature drop as a result of „small“ nuclear war - note 1815 – „Year without Summer“ – Tambora eruption (A. Robock, 2014)



Ways Agriculture Can be Affected by Nuclear War

- **Colder temperatures**
 - shortened frost-free growing season
 - cold spells during growing season
 - slower growth → lower yield
- **Darkness**
- **Less rainfall**
- **Enhanced UV-B (later)**
- Radioactivity
- Toxic chemicals in atmosphere, soil, and water
- **Lack of water supplies + Lack of fertilizer + Lack of fuel for machinery + Lack of pesticides (but not of pests) + Lack of seeds (those that do exist are engineered for the current climate) + Lack of distribution system**

How agricultural production would change in the 10 years following a nuclear war between India and Pakistan

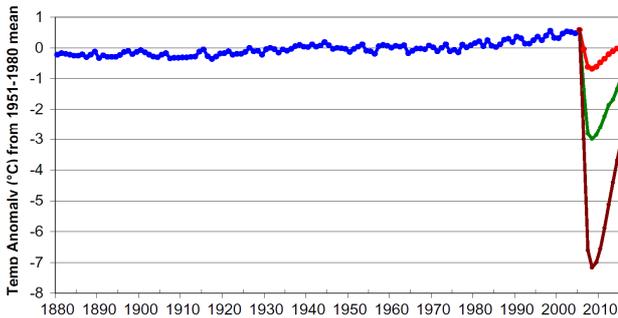
Summary:

	<u>First 5 years</u>	<u>Second 5 years</u>
US maize	-20%	-10%
US soybeans	-15%	-10%
China maize	-17%	-15%
China middle season rice	-20%	-14%
China spring wheat	-33%	-25%
China winter wheat	-39%	-23%

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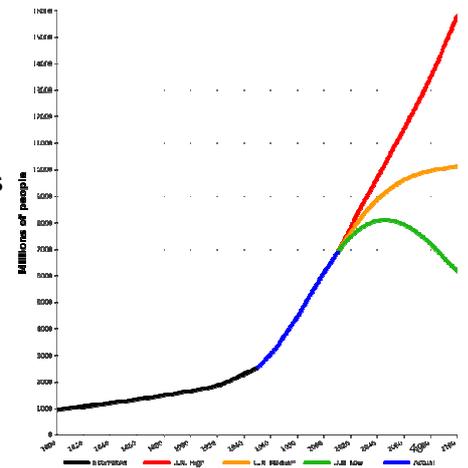
A „small“ nuclear war between China and Russia over Siberia opens „whole new horizons“

GISS Global Average Temperature Anomaly
+ 5 Tg, 50 Tg, 150 Tg smoke in 2006

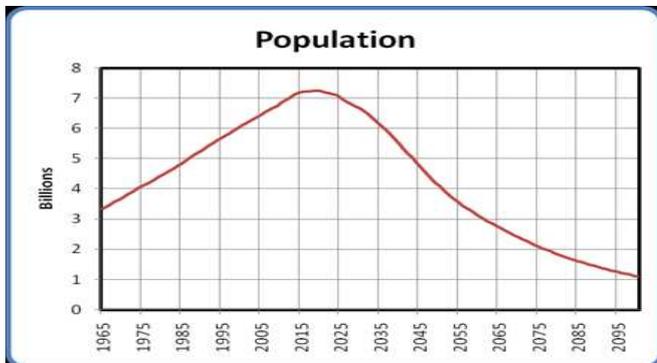


World Population 1800-2100

United Nations Projections 2010

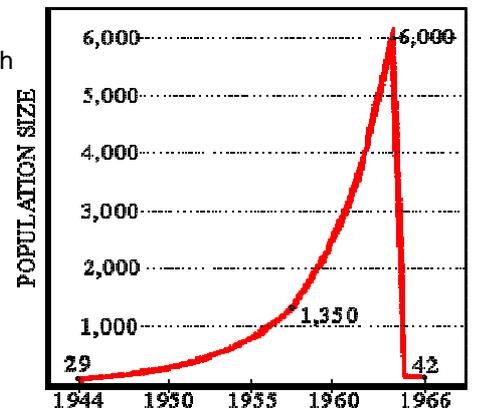


Alternative population projection considering exhaustion of accessible fossil fuels and ecosystems capacity - Elimination of industrial revolution effect



<http://www.paulchefurka.ca/WEAP/WEAP.html>

Alternative with „small nuclear war“ would more remind fate of the St. Matthew reindeers in 1962-63



Assumed population of the St. Matthew Island reindeer Herd. Actual counts are indicated on the population curve.

Some of the open questions:

-Can current civilization survive climate crisis – and following food and socio- economic crisis and decline – **without violent revolutions and wars?**

- „Arab spring“ experience gives bleak answer

-**Can Europe/** moderate climate zone countries survive such development **without violent revolutions and wars?**

- management of intra-European migration northward, impoverishment of middle class, social polarization, Russian militarism/ aggression

-Could USA, China and EU agree on effective and rapid CO₂ and CH₄ reduction program? - No reasons for optimism

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Some of the open questions:

-How big is **risk of abrupt** fall in global dimming effect (potential increase of average global temperature + 0.9 C!) – could be triggered by deep decline in global industrial production and transport due to collapse of banking system, deadly flu pandemics, revolution in S. Arabia/ war in Persian Gulf...

Abrupt change would mean much less time for adaptation or mitigation measures!

-Can global community implement effective **geoengineering measures** (Arctic Methane Emergency Group)? Will it sustain necessary industrial capacity? („Last man on the Moon“)

- How big CC is already „committed“? How much CH₄ will be released from permafrost and shelf seas? How extensive will be wildfires? – Is „**Venus syndrome**“ **realistic option?**

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Can some form of recent civilization survive what will follow in 2150 – 2200 – 2300

-Survival of small human populations in high Arctic, Greenland, Antarctica?

-Catabolic collapse – „metabolizing“ materials and technologies of the past (Doomsday Seed Vault, metals/ lasting materials, energy technologies...)

-Preservation of key knowledge, experience and understanding what happened (J. Lovelock - Revenge of Gaia)

-If so – at what population levels?

- How shall we get to those levels?

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The last stand
of Homo sapiens?

Thank you
for your attention!

