

Development Towards Sustainability what are the rational options?

University Rio de Janeiro,
December 3, 2015

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- **Results from 20 years of “Sustainable Development” Policies.**
“Our problems can not be solved with the same methods that created the problem!” Einstein
- **“Sustainability” and “Development Towards Sustainability”**
Negation concept provides unambiguous and quantifiable definitions!
- **A rational “Development Towards Sustainability” strategy:**
Minimal speed requirements for the roadmap towards sustainability
- **The remaining natural capital: Energy Resources.**
Finite oil reserves, the Achilles of the global economy.
Implications for regional roadmaps towards a sustainable way of life.

20 (40) years of “Sustainable Development” (1)

Ehrlich and Holdren (1971): Human pressure on finite, but unquantified natural capital:

$$\text{Impact} = \text{population} \times \text{affluence} \times \text{technology (I=PAT)}$$

(affluence \times technology \approx “energy resource use”.)

- World population: 3.9 billion (1972) to 5.5 billion (1992) to 7 billion (2012); (without collapse \approx 9 billion humans by 2030).
- Non renewable energy resource consumption almost doubled between 1972 and 2012 (with roughly equal fractional increase in both 20 year periods). Our CO2 impact grew from 330 ppm (1972) to 359 ppm (1992) to 397 ppm (2012).

Unsustainable human impact increased during last 20 years (since 1992) roughly by a factor of 1.5! (similar to the growth from 1972-1992)

**Whatever the real policy goals were/are, the facts demonstrate:
“Sustainable Development” policies made “us globally” less sustainable!**

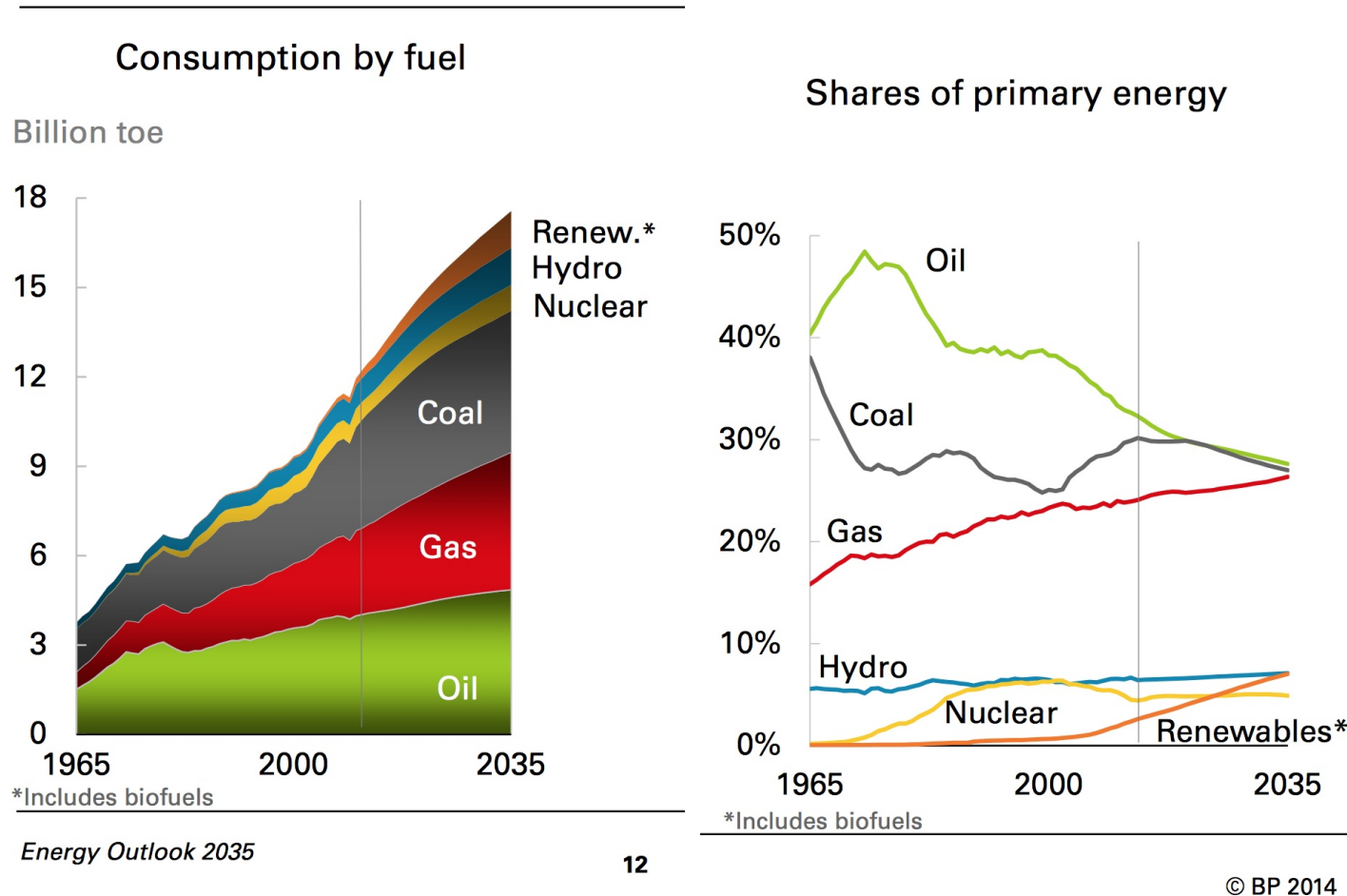
we relearned (roughly) what Einstein knew already decades back:

“The (sustainability) problem can not be solved with the methods that created the problem!”

Our Global Energy Impact: 1965-2035? (1)

Governments around the planet (G7/G20/UN): “pray for economic growth”!

absolute global growth from oil, gas and coal (thus even more CO2!)
despite unsustainable(?) $\approx 10\%$ /year growth of new renewables (sun and wind)



Source <http://www.bp.com/en/global/corporate/press/press-releases/energy-outlook-2035.html>

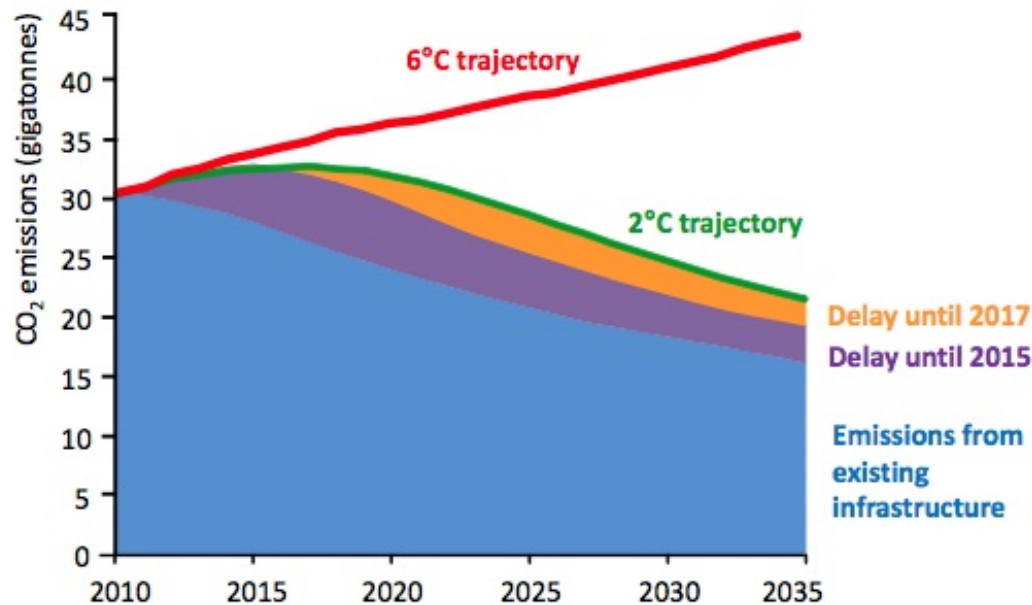
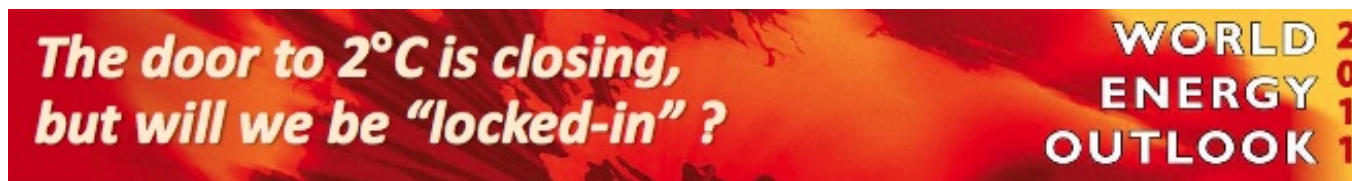
Such growth scenarios are unsustainable (and not even wanted!)

Our Global Energy Impact: 1965-2035? (2)

World leaders (G7/G20/UN/IEA etc) promised less than +2 degree C
We are not even along +6 degree C, a path to man made global hell!

CO₂ emissions in 2013(2014) \approx 36 Gtons even higher than the +6 degree C scenario

<http://www.reuters.com/article/2013/11/19/us-global-carbon-emissions-idUSBRE9AI00A20131119>



Without further action, by 2017 all CO₂ emissions permitted in the 450 Scenario will be “locked-in” by existing power plants, factories, buildings, etc

20 (40) years of “Sustainable Development” (2)

UN meetings Stockholm (1972), Rio (1992) and Rio+20 (2012)

“Quotes and details” from “Global Environmental Outlook”, UNEP, June 6, 2012
at http://www.unep.org/geo/pdfs/geo5/GE05_report_full_en.pdf

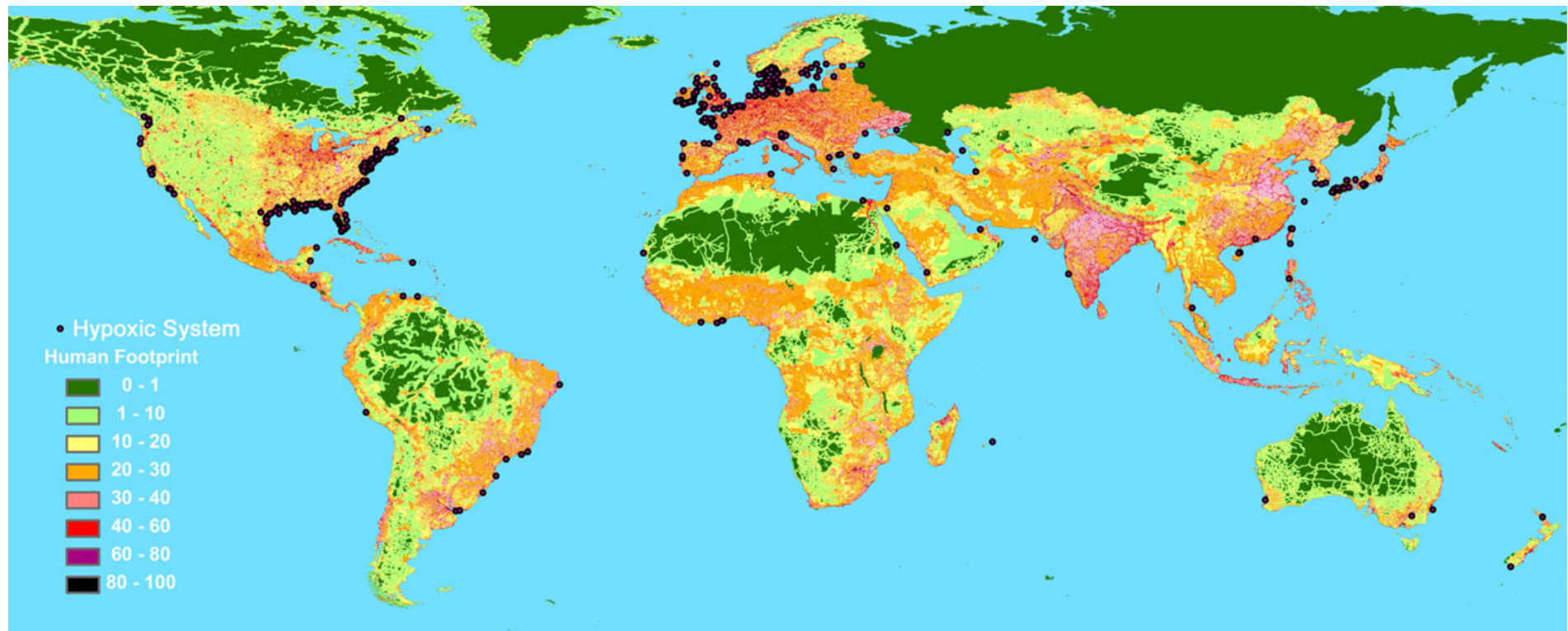
- 20 million hectares/year of agricultural land (potentially feeding 100 million people) become too degraded for crop production, or are lost to urban sprawl (from a total of 1500 million hectares);
- since 2000 alone, (pristine) forests equivalent to the size of Germany have been lost;
- 80% of the world's fish stocks are (close to collapse) fully or overexploited or have collapsed already.
- The world failed to reach the Millennium Development Goal (MDG) target of a significant reduction in the rate of biodiversity loss by 2010.
“The pressure on biodiversity continues to increase. Habitat loss and degradation from agriculture and infrastructure development, overexploitation, pollution and invasive alien species remain the predominant threats.”

In short: “Sustainable development” policies did not work!

Results from our Industrial Agriculture (1)

(More or less) **dead zones in the oceans (black dots)**

map and more details from Scientific American <http://tinyurl.com/lhsb2d>



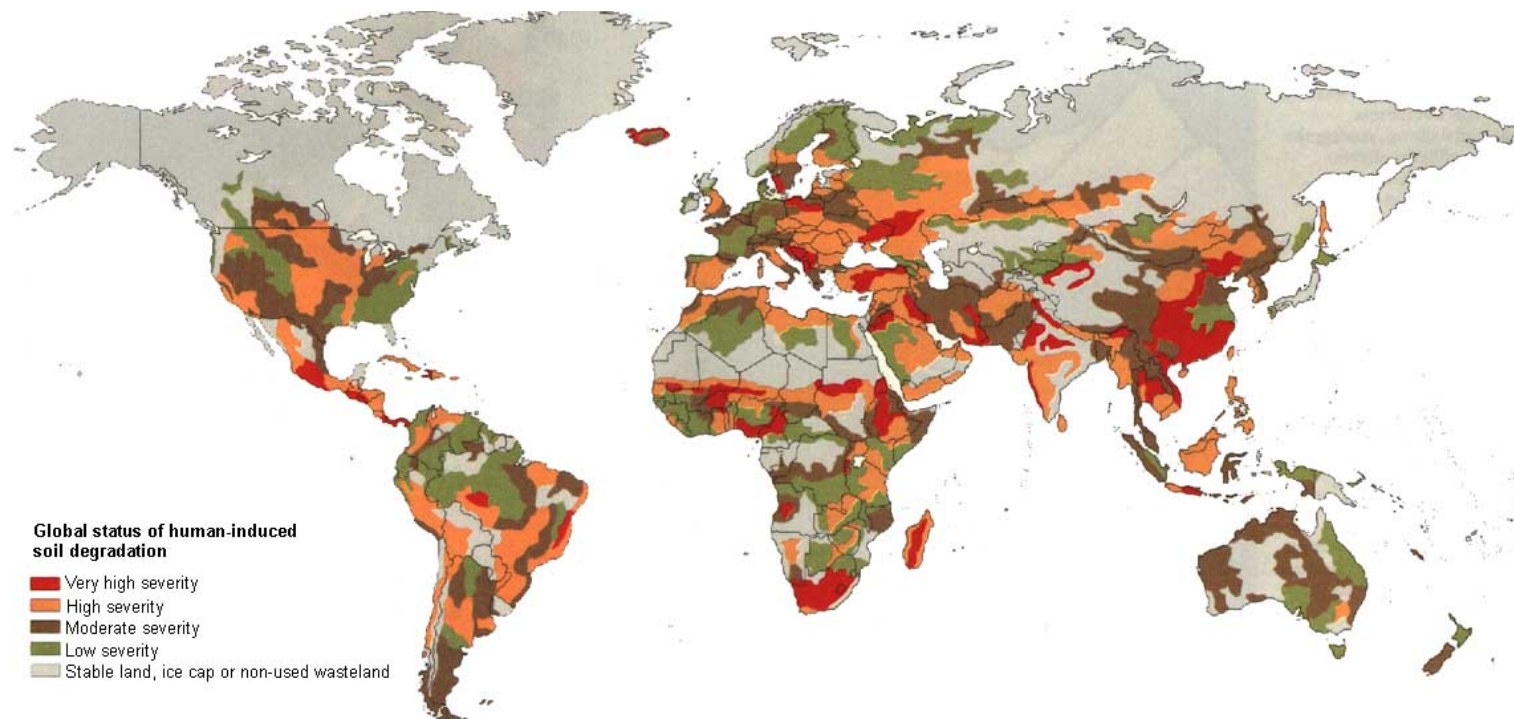
our global Industrial Agriculture is totally unsustainable!

Results from our Industrial Agriculture (2)

red and orange regions means the situation is “short term” unsustainable (bad!)
Large scale agriculture leads to soil erosion and desertification,

(the FAO map seems to indicate only some qualitative regional trends!)

Source: FAO <http://www.fao.org/docrep/u8480e/u8480e0d.htm>; <http://tinyurl.com/pp2kcbp>



our global Industrial Agriculture is totally unsustainable!

A new approach to our problem is needed: it must be unambiguous and quantifiable! (1)

more quotes from UNEP (2012) “Global Environmental Outlook”:

- **“Without a new path of development and a change in consumption patterns,** *the pressure on ecosystems and poor communities is set to intensify as the global population is projected to rise from the current 7 billion to 9 billion by 2050.”*
- *“As human pressures within the Earth System increase, several critical thresholds are approaching or have been exceeded, beyond which abrupt and non-linear changes to the life-support functions of the planet could occur. This has significant implications for human well-being now and in the future.”*

Result: **More and more people realize that we live on a modern version of the Titanic, it seems that the moment of inertia is far too large to change the direction.**

**When lost in the wilderness: use the STOP principle
(Stop-Think-Observe-Plan)**

A new approach to our problem is needed: it must be unambiguous and quantifiable!(2)

Stop to: Think, Observe and Plan:

- new Ansatz: a clear and unambiguous definition of **sustainable living**:
define Sustainability with the help of the “negation principle”*!
- If our way of life is not sustainable today, we are confronted with two options for the transition:
 1. **Follow a rational “Development Towards Sustainability” (roadmap)**
or
 2. **continue as before and “Mother Nature” enforces sustainability on us.**
- For a rational and successful transition: **We need to know how much time is left before nature decides for us?**

* *“Though it seems a contradiction of terms, it is actually possible to give meaning to a term, not only by describing what it is, but also by describing what it is not. This exercise may work better with terms that are abstract or somewhat complicated.”*

<http://english.tjc.edu/jbru/1301/negation.htm>.

Defining sustainability with the negation concept

Important unsustainable domains in our way of life, society and culture:

- **Usage of “non renewable” energy resources** (oil, gas, coal, uranium).
- **Usage of non renewable mineral resources**
(if recycling is based on non renewable and cheap energy resources).
- **Unsustainable use of (energy) renewables** (water, soil, wood, sun and wind)
(e.g. destruction of pristine forests for our timber “needs”)
- **Non compostables toxic waste with a long lifetime** (asbestos, plastics, chemical and radioactive toxic waste and CO₂) reduces and destroys the remaining natural capital.
- **Industrial agriculture** is based on the availability of cheap oil and gas and is responsible for soil erosion, poisoning of water and oceans dead zones.

“Development Towards Sustainability” defined with the negation concept:

1. As long as parts of the system are unsustainable, the entire system is unsustainable!
2. Unsustainable systems develop eventually into sustainable systems.
3. Today's unsustainable system was made by humans and is maintained collectively by them.
4. This system will develop (evolve) into a sustainable system: either by **collapse** or by **rational behavior change**.
5. When all essential parts of our “way of life” become less and less unsustainable, “we” begin to move towards sustainable living!
6. **“Development Towards Sustainability”** stands for a rational behavior change to avoid collapse.

A roadmap which leads us towards sustainability should be developed. Such a roadmap must contain measurable (annual?) reductions of all unsustainable practices and at any level of the regional and global society.

How much time remains for a successful transition into sustainability?

The negation principle provides:

- an unambiguous definition for (our) unsustainable practices, and
- a “tool” to judge if proposed policies (and their results) make us less (or more) unsustainable.

In addition, a successful “Development Towards Sustainability” policy must include/determine a minimal transition “speed” requirement:

1. Identify most important unsustainable domains for “our everyday life”.
2. Estimate accurately the accessibility of remaining energy reserves (like for oil).
3. Identify uncontrollable “tipping points” (or “icebergs”) in front of us.
Like a maximum CO₂ level corresponding to negligible risk of “run away global warming”.
4. Quantify the sustainable “carrying capacity” as a function of the remaining natural capital.
5. Understand how to provide support for natural “repair” mechanisms of damaged natural capital.

A revised “Impact equation” which includes remaining natural capital

old equation: $I=PAT$ (P.R. Ehrlich, J.P. Holdren, Impact of population growth, Science, 1971)

A new (M.D. 2013?) modified quantifiable impact equation:

The human impact in relation with the local/global **Carrying Capacity (CC)**
(or the remaining natural capital)

CC (time) = number of people who can live infinitely (sustainable!) on an isolated “island” or planet?

$$CC(\text{time}) = CC(t=0) - \text{Impact}(t) + \text{Restoration}(t)$$

$$\text{Impact}(\text{time}) = \text{nat. Reductions (like volcanic eruptions)} + I(=PAT)$$

$$\text{Restoration}(\text{time}) = \text{natural Restoration}(t) + \text{human Restoration}(t)$$

The sustainability principle (locally and globally) is violated if the natural capital (or carrying capacity) is destroyed faster than it is repaired.

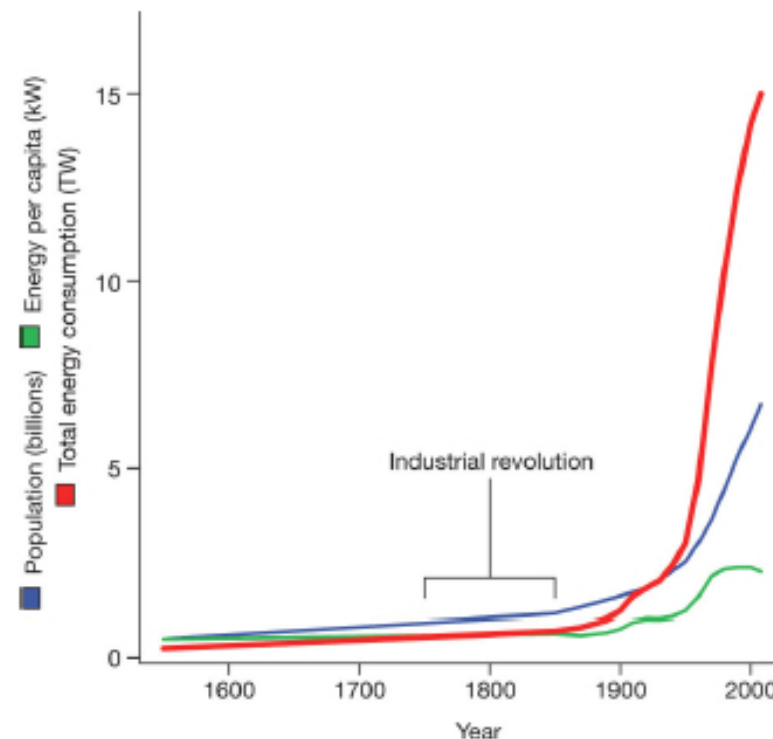
Today's human impact is not sustainable; It must change! How much time is left? (1)

knowing that “bridges collapse at their weakest points”

“Peak Energy/capita usage likely our weakest point!”

- (1) Industrial civilizations seems to function (well?) only during periods of economic growth.
- (2) Growth requires cheap/abundant energy (especially oil and electric energy!)
- (3) The decline following “peak energy” will coincide with the decline of industrial civilizations!**

History of growth in world population and environmental impact of *Homo sapiens*, indicated by its surrogates, per capita and total human energy use.



P R. Ehrlich *et al.* *Nature* **486**, 68-73 (2012) doi:10.1038/nature11157

**Today's human impact is not sustainable;
It must change! How much time is left? (2)**

**Almost nothing works today without electric energy
and almost nothing moves without oil!**

- produce, transform and transport our food;
- make heat and stuff (industrial processes);
- move us and stuff around and
- transform other energy forms into electric energy
(with thousands of useful and useless applications)

**Today's globalised world unimaginable with long distance oil
based transports of almost everything.**

**A relatively comfortable(?) “way of life” today appears to
be unimaginable without electric energy and without the oil!**

Today's human impact is not sustainable; It must change! How much time is left? (3)

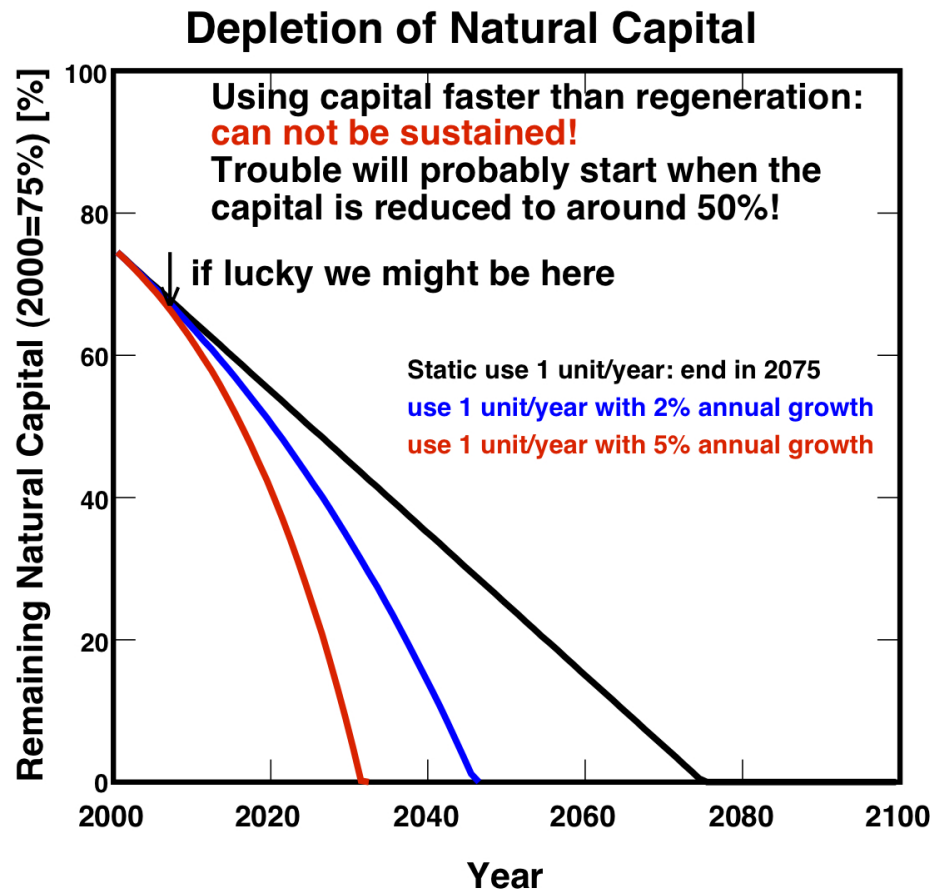
How much natural capital remains before serious troubles begin?

Example Oil (the lifeblood of the global industrial societies):

(conventional) oil already burned ≈ 1000 Gb(arrel), now ≈ 30 Gb/Year;

oil reserves (BP report 2013): ≈ 1300 (convent.) and 350 Gb (non convent.)

$\approx 65\%$ (55% for conventional oil!) of the original oil capital remain!



Today's human impact is not sustainable; It must change! How much time is left? (4)

knowing that “bridges collapse at their weakest points”
“Peak Energy/capita usage likely our weakest point!”

**Biggest risks for Switzerland, Western Europe and the globalised world
and how we do (not yet) react locally?**

Peak Oil (“plateau” and decline) the most important problem?

- Industrial food supply chain (1 Cal. food = 10 Cal. from oil/gas) and the global trade (economy) is based on this cheap oil.
- Crude oil is our most important energy carrier and it seems we have reached the global extraction plateau.
(\approx 77 million barrel per day + about 15 mbd of “other liquids”).
- Conflicts about the access to the remaining oil reserves in the Middle East (2/3 of the remaining good oil!)?

Today's human impact is not sustainable; It must change! How much time is left? (5)

Oil and electric energy usage in different regions:

The consumer and producer countries

Country	electricity use kWh/year/person	oil* consumption liter/year/person	oil* production liter/year/person
World	2 900	720	720
Europe/USA			
Switzerland	7800	1740	0
Germany	6700	1720	0
France	6850	1500	0
USA	12100	3420	2040
BRICS			
Brazil	2350	880	740
Russia	7300	1300	4300
China	4000	460	180
India	600	150	35
Latin America			
Venezuela	3300	1570	5000
Bolivia	648	650	340
Cuba	1470	790	270
Africa			
Algeria	1100	550	2550
Angola	240	390	5500
Nigeria	140	100	755

sources: CIA world fact book and BP yearly report 2014 oil* = oil equivalent liquids

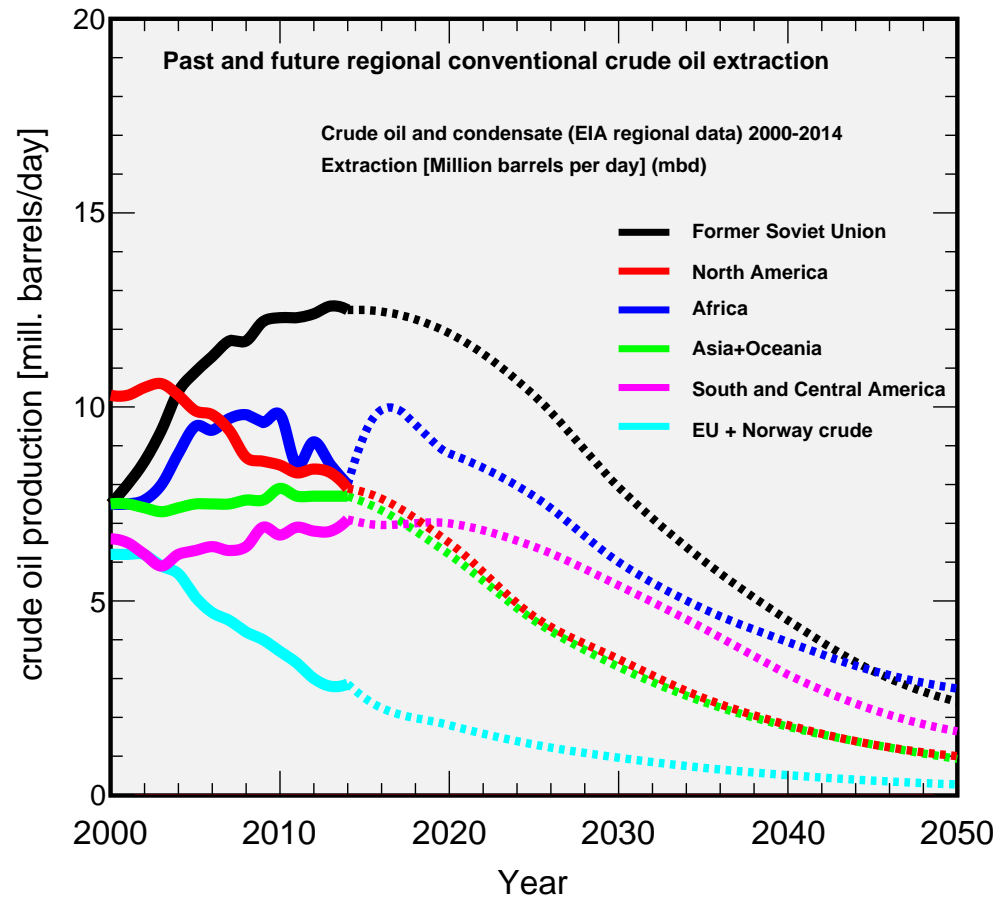
Today's human impact is not sustainable; It must change! How much time is left? (6)

(My) A Regional oil production model to 2050

(more details http://ihp-lx2.ethz.ch/energy21/Riotalk_October2015.pdf)

1) **Middle East OPEC countries: many decades at today's level ≈ 24 mbd**

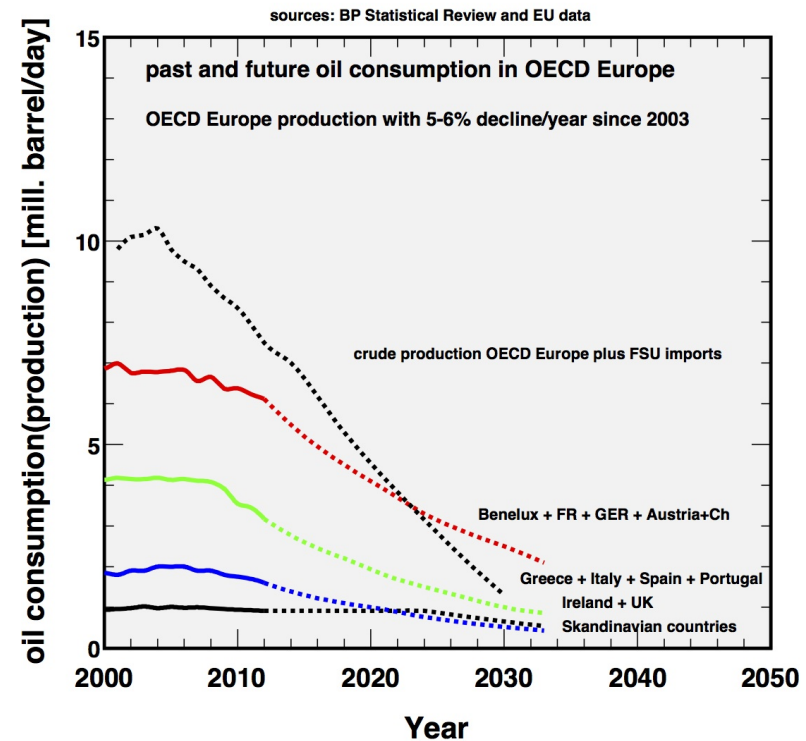
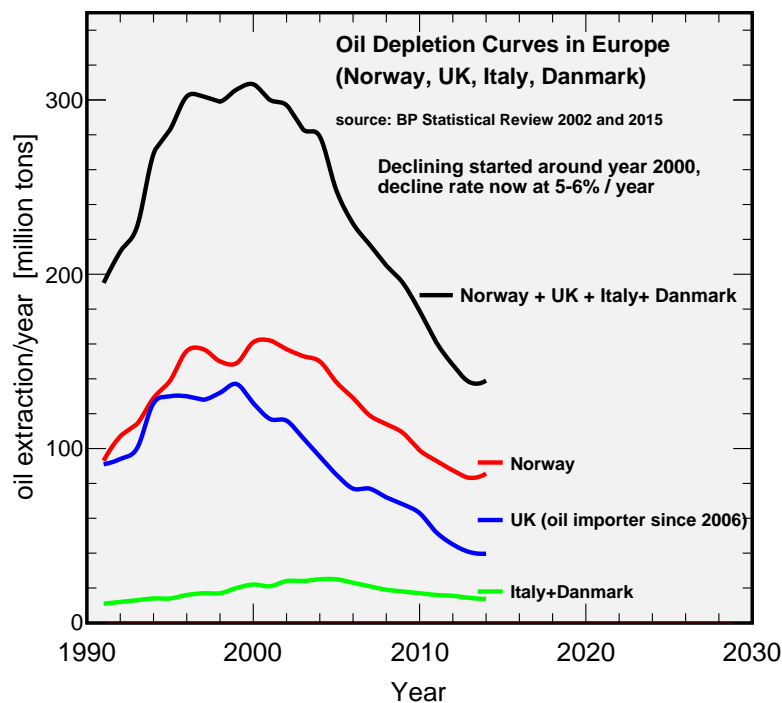
2) Shale oil, oil sands and other (unconventional) liquids:
about 20 mbd (about 20-25% of today's global consumption).



Future regional oil production/consumption (1)

My model results for Western Europe:

Oil (Gas) supply from and through Russia can become critical every “moment”.



Decline of oil imports by 5-6% per year (starting essentially now)
 curves perhaps with ± 2 years uncertainty. Europeans should/must learn to live with less oil every year (-5%/year?)!

Future regional oil production/consumption (2)

My model results for Brazil and Latin America:

some observations for South and Central America:

- Oil is your most important (transport!) energy source. Only Venezuela, Brazil and Ecuador with known significant reserves. Some crude oil from Venezuela, Colombia and Ecuador currently exported USA and China.
- Small production increase (7%) during last 5 years, but consumption increased by 14%.
- **Venezuela:** Production is 30% lower today than during the 70ies. Official reserves are a doubtful mixture of oil sands and conventional oil. Expect a roughly constant or small production growth during next decades.
- **Brazil:** Small growth during past years but difficult to predict deep sea exploration future. Expect production decline of -3% from 2016 onwards.
- **Other South and Central America:** Rather constant production during past years. Expect declining production -3%/year (2016-2020) and -6%/year afterwards.
- **If exports to other continents end,** expect overall constant oil consumption to 2020 (7 mbd). Followed by consumption decline to 6.4 mbd (2025), 5.4 mbd (2030) and 3.1 mbd (2040).

Future regional energy perspectives: Resource realities: Brazil and Latin America

Population and Energy: Brazil and South/Central America

Brazil 2015: 204 Million humans, growing by about 0.9%/year

South and Central America: \approx 500 Million, growing about 1%/year

All countries have:

- (1) a relatively small per capita energy consumption;
- (2) transport-oil as most important energy carrier;
- (3) and the known oil*, gas and coal reserves are small!

according to BP 2015: Remaining known reserves
(in Million Tons of oil equivalent (MTOE))

oil* = conventional easy to get oil!

Country	oil reserves MTOE	gas res. MTOE	coal res. MTOE	oil consumption MTOE/year	gas+coal cons. MTOE/year
Argentina	300	270	-	31	42 + 1
Brazil*	2300	450	2200	142	36 + 15
Chile	-	-	-	17	4 + 7
Colombia**	400	180	4500	15	10 + 4
Venezuela***	12 000-47000	5000	320	59	26 + 0.2
South/Central Am.	16 600-51 600*	7000	8000	326	153 + 32

* Brazil: oil reserves (difficult to extract) deep sea oil. Lignite coal reserves (dirty coal)

** Colombia: Oil reserves 7 years(!?) current production. anthracite coal reserves (less dirty)

*** Venezuela: unconventional/difficult to extract oil sands

Unsustainable living and how to minimise cognitive dissonances? (1)

Our destructive impacts create cognitive dissonance stress!

<http://psychology.about.com/od/cognitivepsychology/f/dissonance.htm>

“According to Festinger’s theory of cognitive dissonance, people try to seek consistency in their thoughts, beliefs, and opinions. So when there are conflicts between cognitions, people will take steps to reduce the dissonance and feelings of discomfort. They can go about doing this a few different ways.”

Little behaviour changes due to “automatic human key strategies”:

- Humans focus on more supportive beliefs that outweigh the dissonant belief or behaviour. Like: “my behaviour can’t be so bad” and a very selective (ignoring) collection of new information.
- Reduce the importance of the conflicting belief.
The behaviour will be constructed as being forced: “I did not have a choice”.
(drugs and alcohol might also “help” to reduce tensions.
- Change the conflicting belief, so that it is consistent with other beliefs or behaviours. Particularly in the case of deeply held values and beliefs, change can be exceedingly difficult.

Successful “Development towards sustainability” strategies with real people must include ideas far beyond “automatic dissonance” reduction.

Unsustainable living and how to minimise cognitive dissonances? (2)

If we can not solve our problems with the same methods that created them and if it is true that:

1. Some humans, like adventurers and “successful” scientists (you!) look for dissonances (“problems”) and enjoy to “solve” them!
2. More tolerant and more open people have less problems to accept new ideas and new informations.

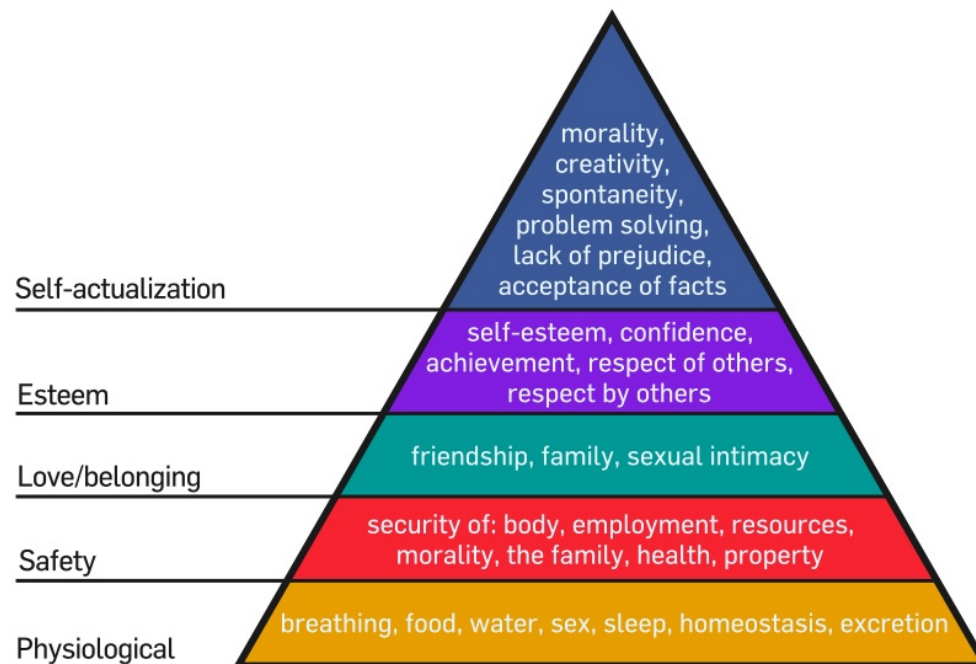
It follows that we have to accept scientific facts (the results of our destructive impact) and:

- (1) learn and demonstrate how “natural repair processes” can be accelerated with a different “human impact”;
- (2) learn about such examples, try to learn and adapt them locally and
- (3) distribute the know how and the fun of achieving such “success”.

It seems we know what we should do locally (Moral-Ethics-Earth Care) and why we will probably fail to use what we know(1)

Minimal conditions for a sustainable and “good” life?

Maslow's hierarchy of needs http://en.wikipedia.org/wiki/Maslow's_hierarchy_of_needs



Most points could theoretically be reached easily in a functioning community and without oil and electric energy!

Why does this not even function in rich industrialised countries?

(See child poverty developed countries http://en.wikipedia.org/wiki/Child_poverty#Developed_countries)

*Poor man meets rich man. Looking at each other, the poor man to the rich:
“Wouldn't I be poor, you would not be rich!” B. Brecht*

Living well and sustainably: Theoretical Ideas (1)

Perhaps the single most critical basic physiological need of human life:

- About 2500 Calories/day/person are required. Such a diet can be satisfied in many cultural/historical variations and more or less healthy (vegetarian or not).
- Most “experts” think that “healthy food” requires large fractions and varieties of fruits and vegetables.

Sufficient healthy food production: how many people per hectare or per km²?

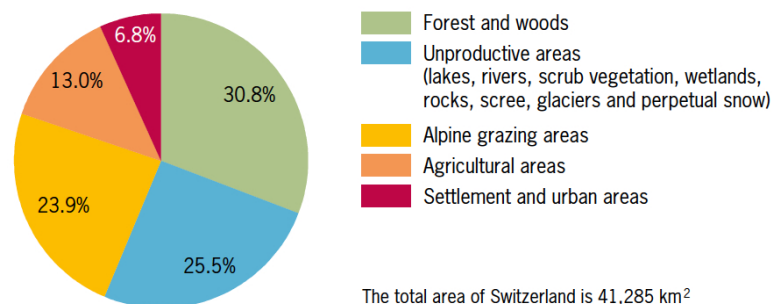
Example Switzerland: More than sufficient “food” is available for 8 million people.

The system feeds about 10 people/per hectare. But, the swiss food system is not sustainable:

(1) about a factor of 10 calories from fossil fuels are “hidden” in every eatable calorie and
(2) about 50% of the food is imported (corresponding to about 500 000 “ghost” hectares, often far away!)

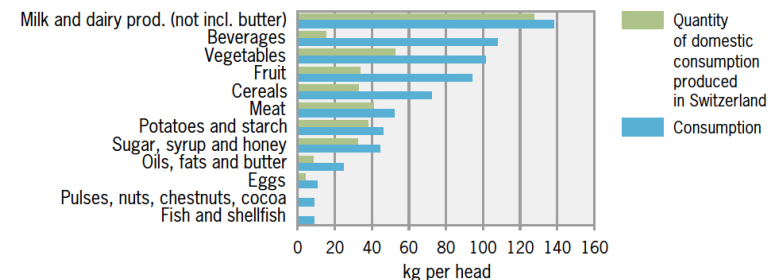
Land use

Areas surveyed between 1992 and 1997



© FSO

Food consumption¹, 2009



¹ Does not represent quantities actually consumed as losses (e.g. unsold or spoilt food) are not recorded completely.

Source: Swiss Farmers' Union

© FSO

Living well and sustainably: Theoretical Ideas (2)

The food situation in Switzerland: Some more details:

Swiss agriculture exploits currently about 400 000 ha (plus “700 000” ha “mountain” grazing land). http://www.swissworld.org/en/economy/farming/facts_and_figures/

To produce all grains/vegetables/fruits/ products **within Switzerland**, roughly 500 000 ha additional good agricultural land outside of Switzerland. (Or per capita: 1000 m²/year with current unsustainable agricultural methods)

In theory: With an established, sustainable bio-intense (manual labor!) local system:

A swiss like vegetable/fruit diet can be achieved with only 100 m²/person/year! Another 300 m²/person/year are required for grains, vegetable oils and farm animals “cows, chicken etc”.

Who has the knowledge, time, access to land and in addition “the wish” to establish prototypes for sustainable and partially sufficient food production?

Summary thoughts for the roadmap: “Development Towards Sustainability” (1)

Can we learn to live good lives within our local and regional possibilities?

Realists accept that our way of life is unsustainable and we are on slippery grounds near a dangerous cliff.

Pessimists believe that “our way of life is the best ever” and pray for some magic techno fix to keep on going. They live without joy and wait passively for the unavoidable collapse.

Optimists, when lost in the wilderness, apply the STOP principle (Stop-Think-Observe-Plan) and collectively enjoy to:

- **increase the knowledge** about different dangerous tipping points and **study** how much time is left to avoid the collision and **determine** the required transition speed to change direction.
- **They try to avoid** dangerous icebergs on the path to sustainability and **work on alternatives** to end our dangerous oil and gas import dependence.
- **They construct local,** safe and sustainable food production systems.
- **They learn and apply** techniques which can “repair” damaged natural capital and **enjoy to swim,** like living fish, against the mainstream!

Summary: Living well during the transition period towards sustainability (2)

For those who care about the “Development towards Sustainability” period, and those who want to contribute for optimal living conditions during and after the transition:

1. Learn (and practice) how to live less and less unsustainably and how to enjoy this.
2. Contribute to the defense, conservation and enlargement of the remaining biodiversity and small scale human cultures.
3. Learn to create sustainable “permaculture islands” and contribute to their flowering.
4. Contribute to development of small scale sustainable communities. A satisfactory and sustainable life for future generations can not be achieved in isolation!

Different people have different talents and interests: Develop those within you that can facilitate the above transitions.

Good Luck