

V a VI. Biogeochemické toky P a N

Earth System process	Control variable	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Biogeo-chemical flows: interference with P and N cycles	<p>P: inflow of phosphorus to ocean, increase compared with natural background weathering</p> <p>N: amount of N₂ removed from atmosphere for human use, Mt N yr⁻¹</p>	<p>P: avoid a major oceanic anoxic event (including regional), with impacts on marine ecosystems.</p> <p>N: slow variable affecting overall resilience of ecosystems via acidification of terrestrial ecosystems and eutrophication of coastal and freshwater systems.</p>	<p>P: < 10× (10× - 100×)</p> <p>N: Limit industrial and agricultural fixation of N₂ to 35 Mt N yr⁻¹, which is ~ 25% of the total amount of N₂ fixed per annum naturally by terrestrial ecosystems (25%–35%)</p>	<p>P: (1) Limited knowledge on ecosystem responses; (2) High probability of threshold but timing is very uncertain; (3) Boundary position highly uncertain.</p> <p>N: (1) Some ecosystem responses known; (2) Acts as a slow variable, existence of global thresholds unknown; (3) Boundary position highly uncertain.</p>

Boundary N: < 35 million tonnes of N fixed from the atmosphere per year

Current level: 121 million tonnes per year

Diagnosis: Boundary far exceeded and effects worsening

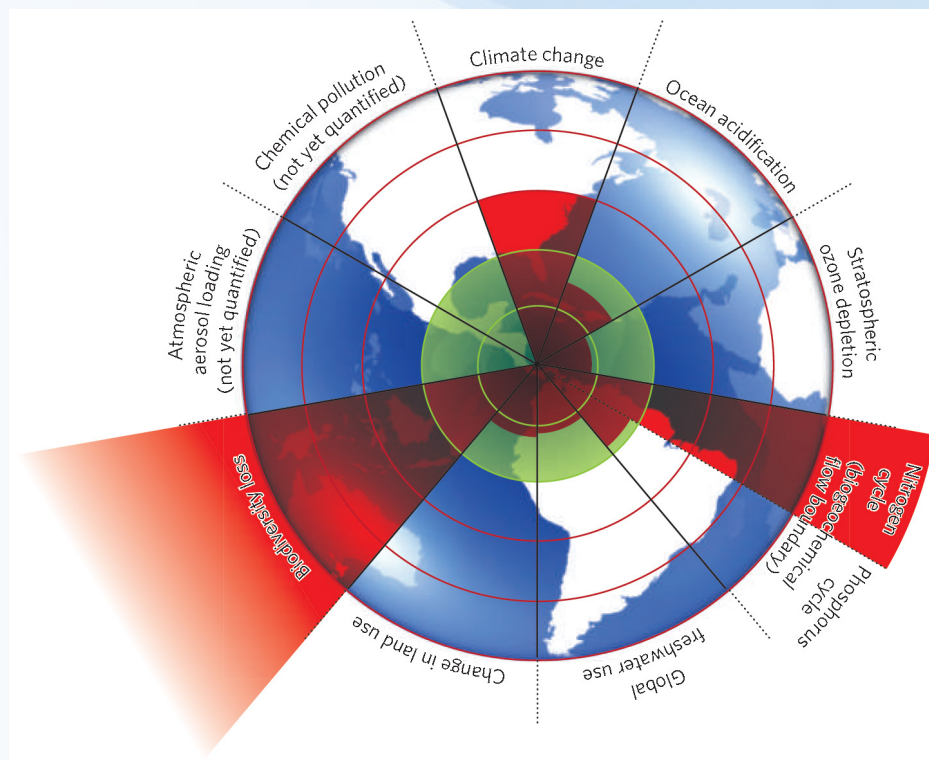
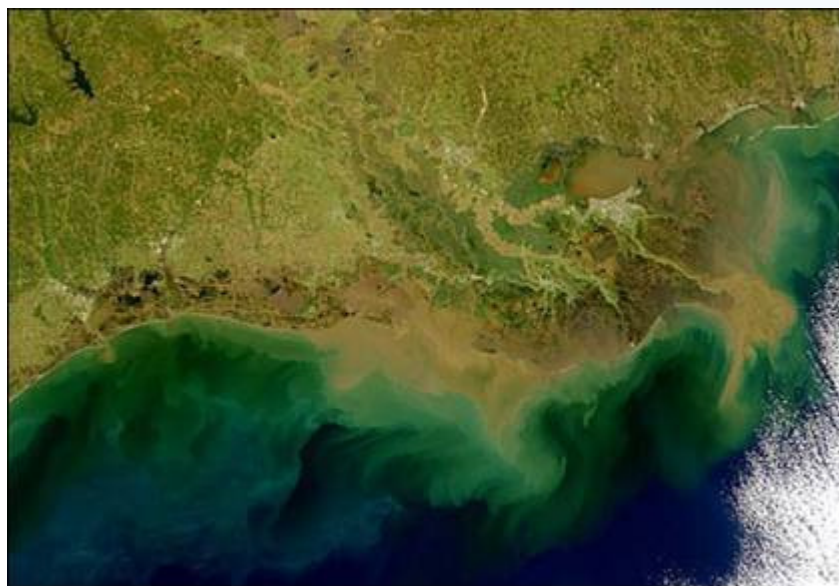
Boundary P: < 11 million tonnes of P to flow into the oceans per year

Current level: 9 million tonnes per year

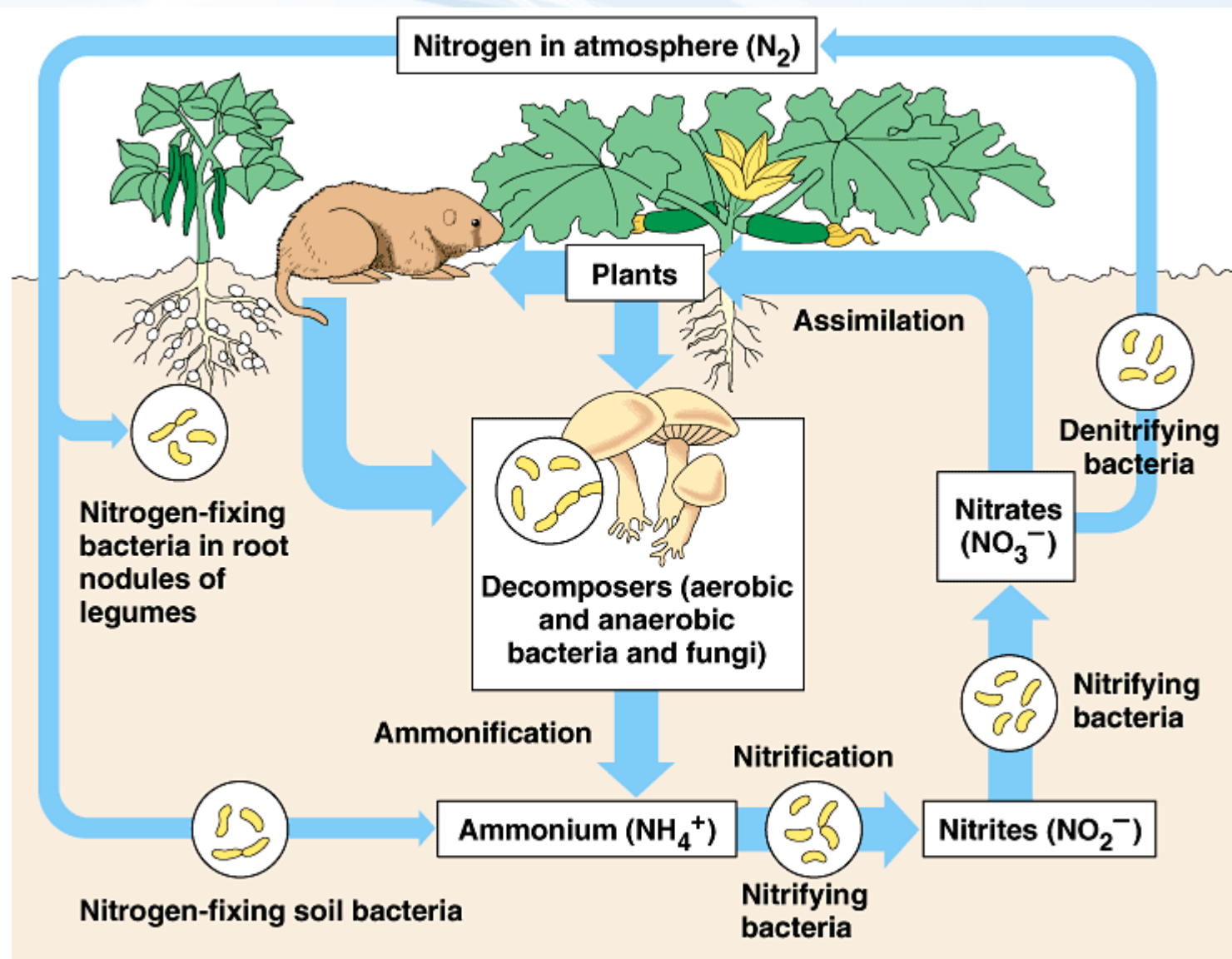
Diagnosis: Boundary not yet exceeded

Změny

- ovlivňování biogeochemických cyklů P a N s důsledky:
 - 1) na lokální až regionální úrovni náhlé změny v jezerních a mořských ekosystémech (např. anoxie v jezerech a Baltickém moři)
 - 2) nelineární změny z oligotrofního stavu do eutrofního



Dusík



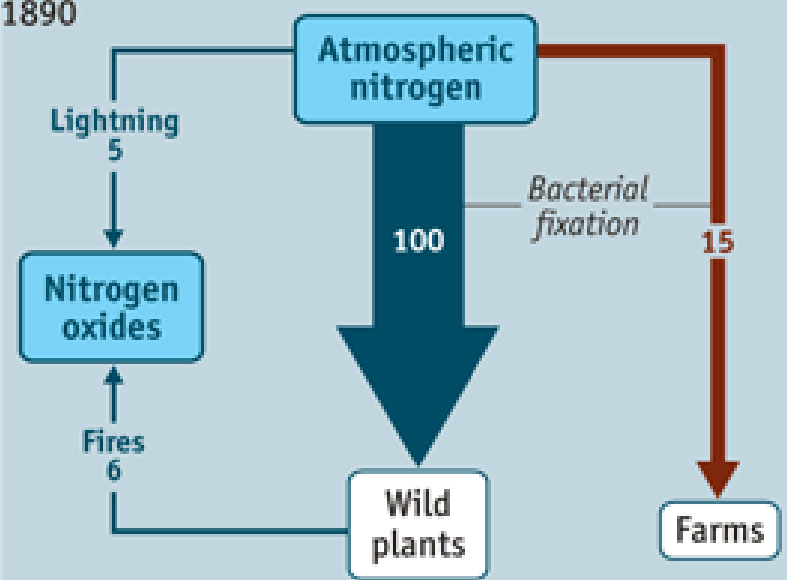
Dusík

- lidskou aktivitou je dnes přeměněno více N_2 na reaktivní formy N, než ve všech terestriálních procesech dohromady
- Haber-Bosch 80 Mt_N/yr, leguminózy 40 Mt_N/yr, spalování fosilních paliv 20 Mt_N/yr, spalování biomasy 10 Mt_N/yr

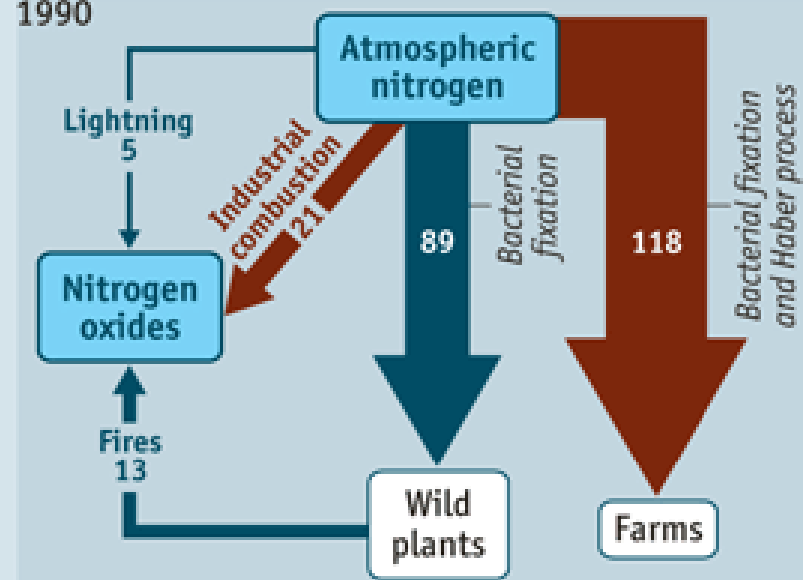
Unbalancing the cycle

Nitrogen flows, megatonnes

1890



1990



Source: Galloway and Cowling, *Ambio*

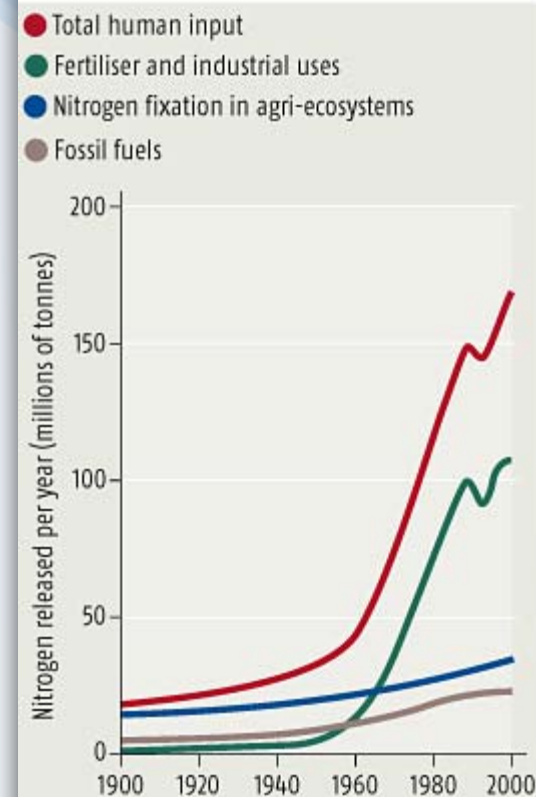
Dusík

- primární důvod výroby reaktivních forem N ?
- většina končí ve vodě - eutrofizace
- či v atmosféře - N_2O je významný skleníkový plyn + O_3 „rozkladač“
- nebezpečné je celkové snižování pružnosti planetárních subsystémů v důsledku vnášení velkého množství reaktivního N do Zemského systému (skleníkový jev + úbytek ozónu + hypoxie vod)

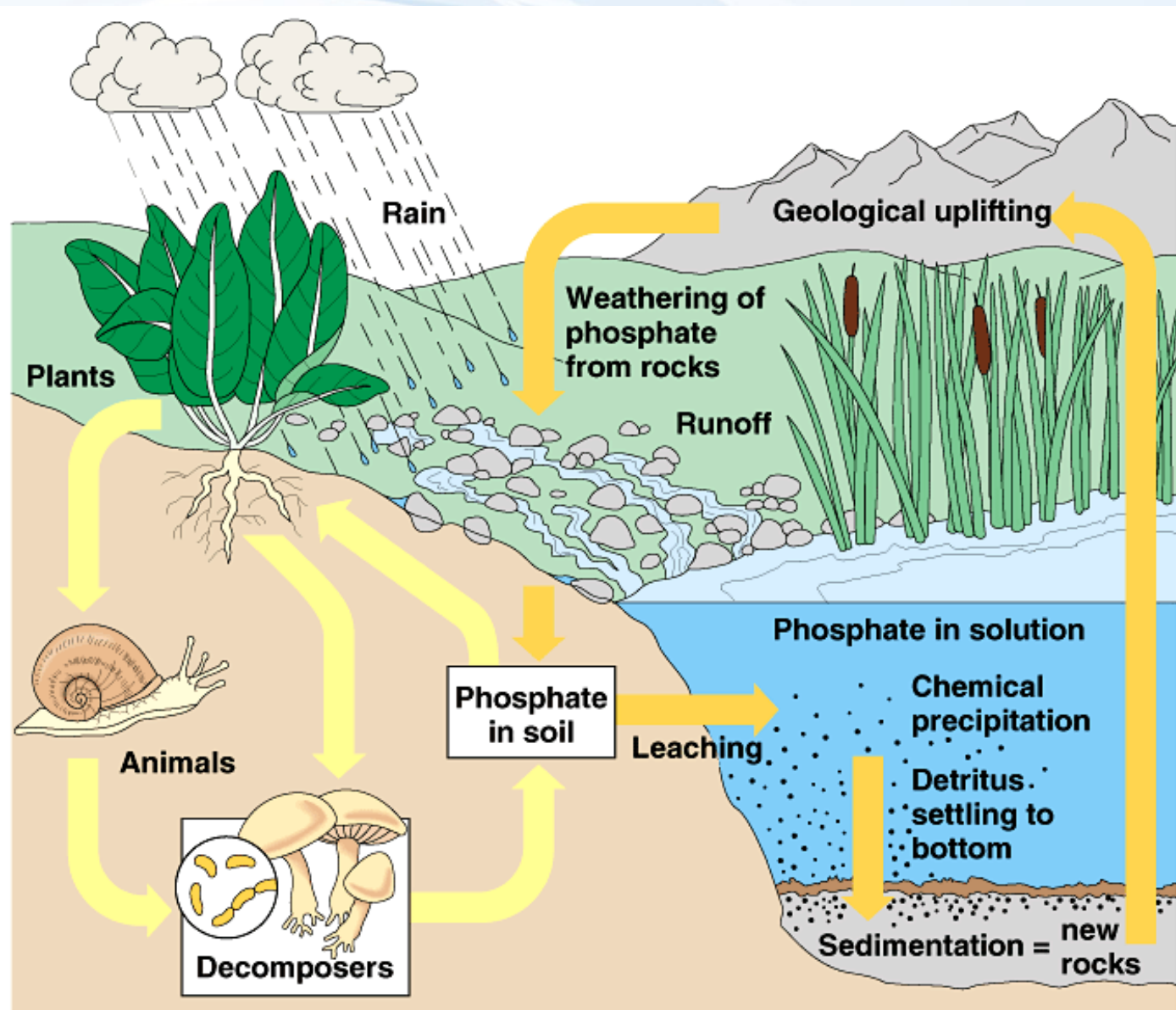


NITROGEN POLLUTION

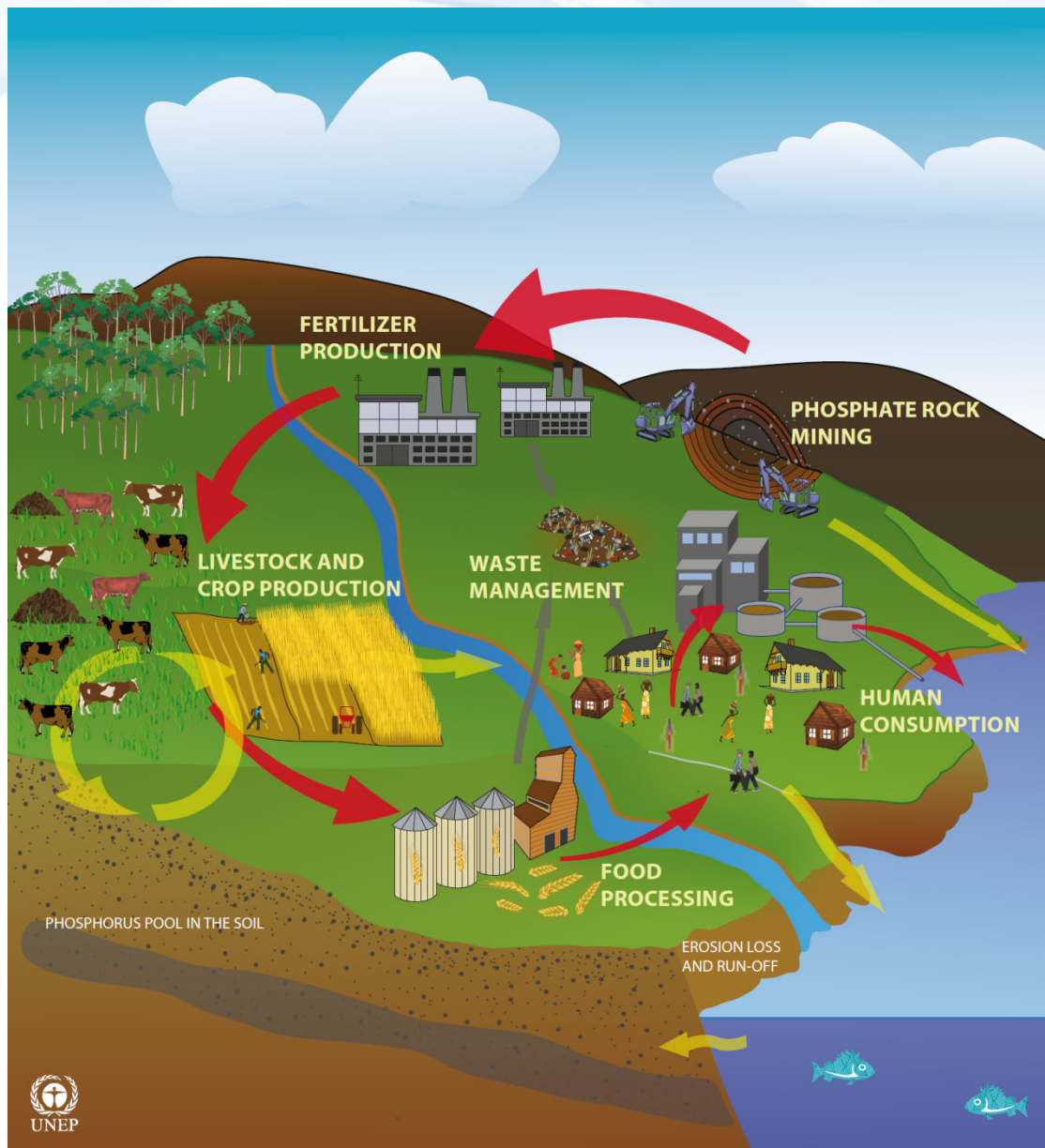
The amount of reactive nitrogen released into the environment is increasing



Fosfor – přirozený cyklus

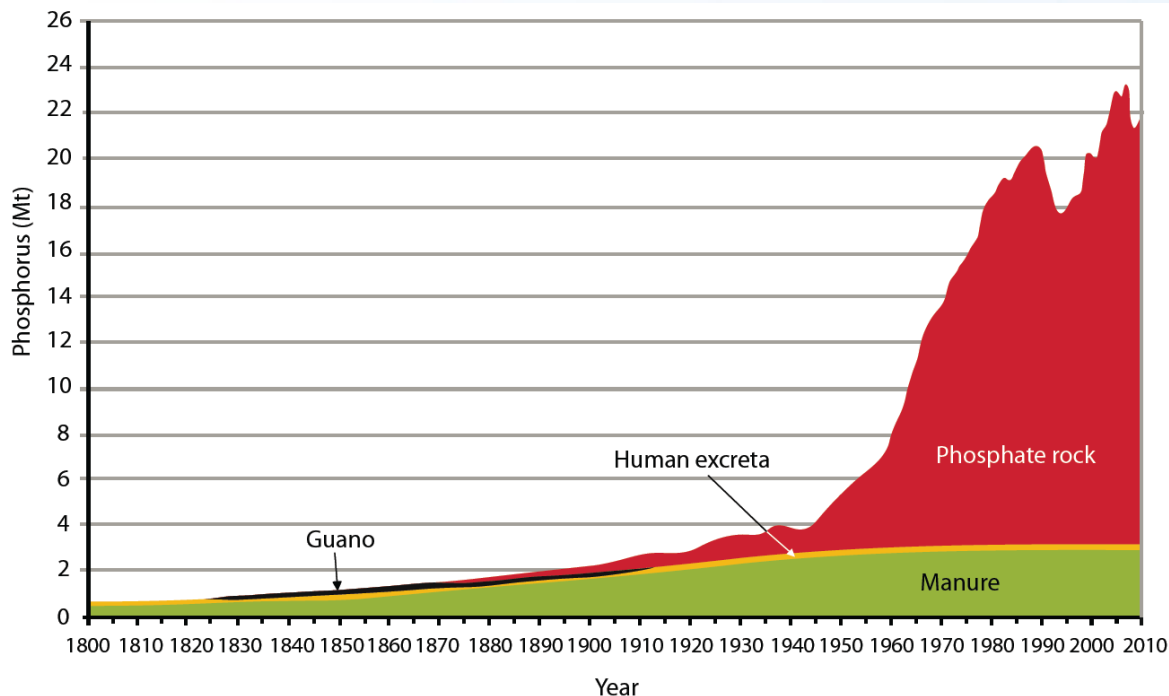


Fosfor – cyklus ovlivněný člověkem



Fosfor

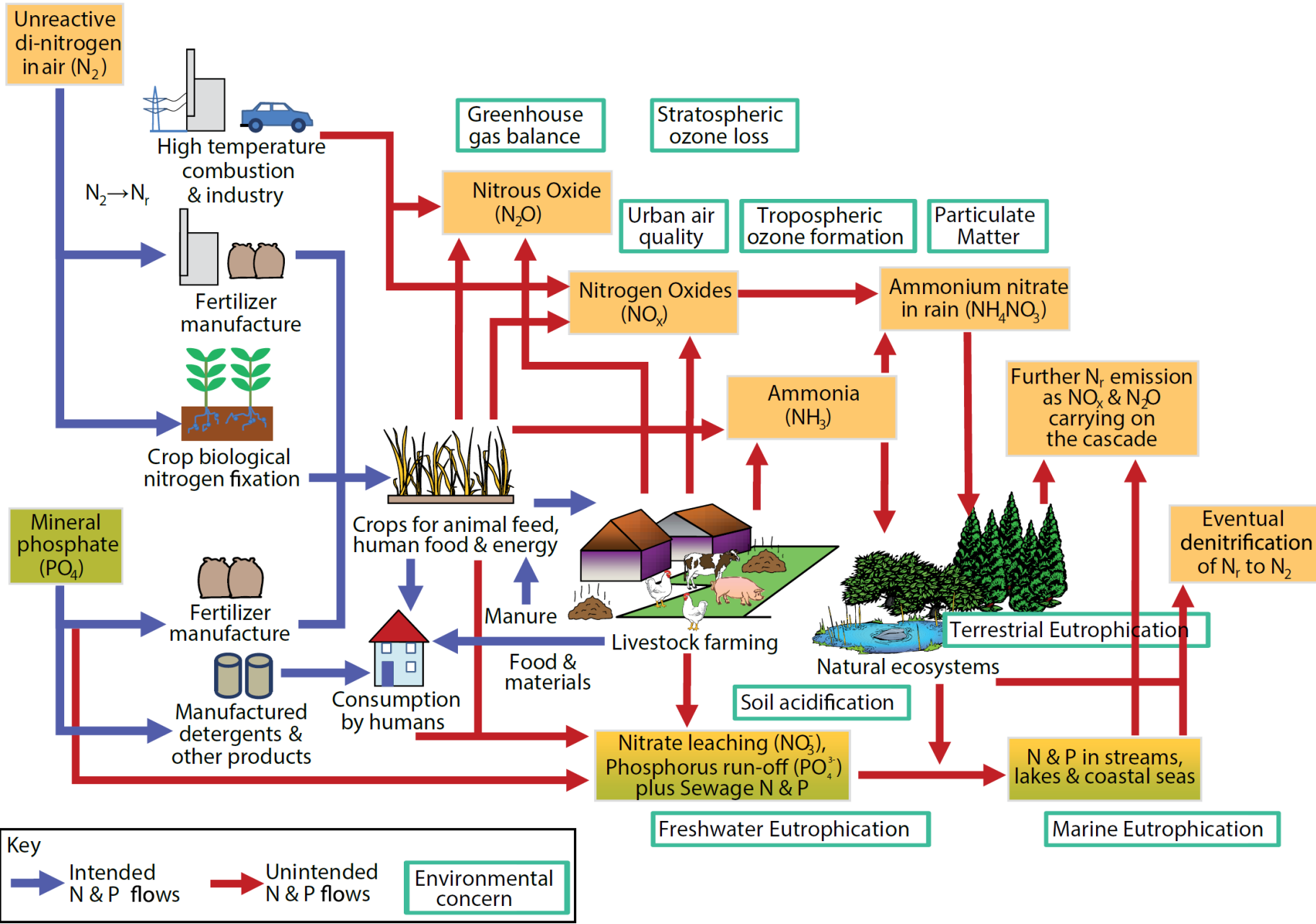
- primární zdroj P v ekosystému – **zvětrávání** či **těžba apatitu**
- lidskou činností proudí do oceánů 8-9x větší množství P než přirozeně
- z 20 Mt_N/yr průmyslového fosforu skončí polovina v mořích
- přítok P do oceánů zvyšuje riziko **anoxických událostí**, práh nastání této události je ale zatím nejasný



Dopady těžby guana na ostrůvku Nauru



Simplified view of the nitrogen and phosphate cascade

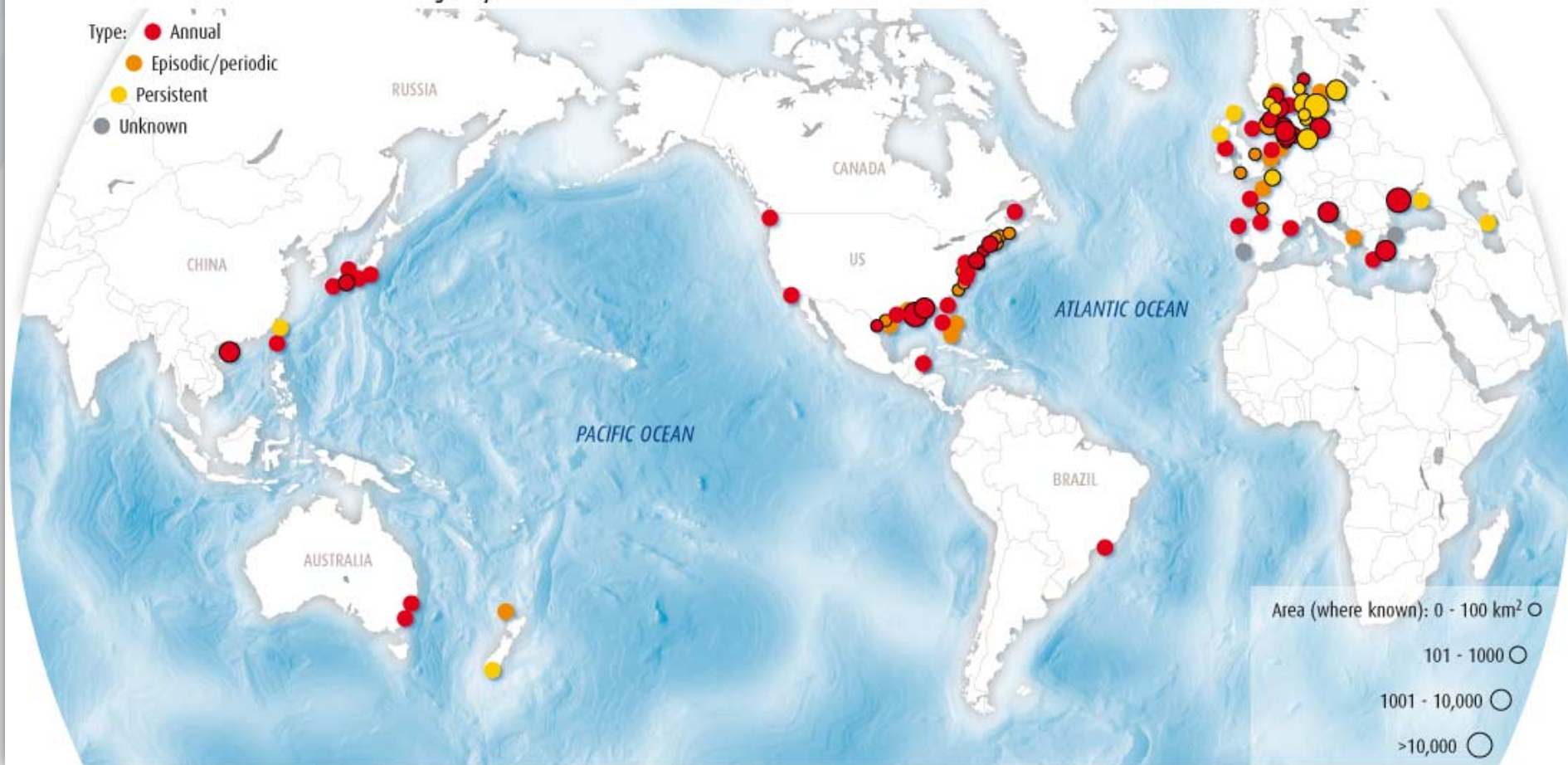


Fosfor + dusík = anoxické zóny v mořích

200 AND COUNTING

The number of dead zones around the world is doubling every decade

- Type:
- Annual
 - Episodic/periodic
 - Persistent
 - Unknown

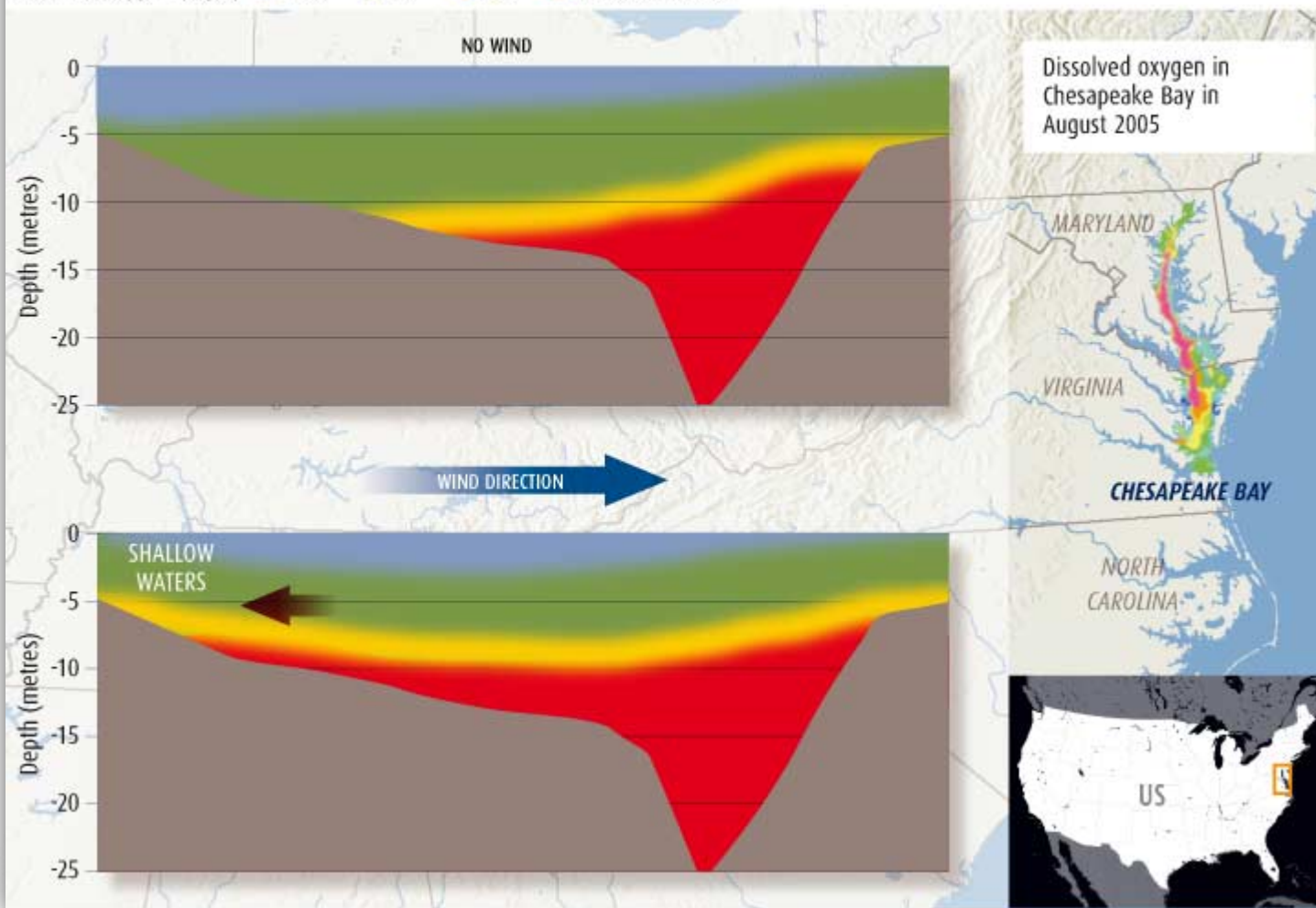


Fosfor + dusík = anoxické zóny v mořích

ANNUAL PLAGUE

Every summer, oxygen levels in Chesapeake Bay plummet. Strong winds can make surface water pile up on one side of the bay, causing the dead zone to spill over into the shallow waters

Dissolved oxygen (mg/l) ● 10.0 ● 5.0 ● 2.5 ● 0.0 (dead zone)



Vznik a zánik anoxických zón – ne vše jasné

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Pacific dead zone has been shrinking for a century

› 19:00 07 August 2014 by [Anna Williams](#)

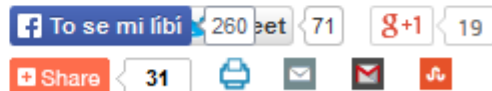
› For similar stories, visit the [Endangered Species](#), [Mysteries of the Deep Sea](#) and [Climate Change](#) Topic Guides

Huge areas of ocean could suffocate as a result of global warming. But one of these "dead zones" has been shrinking for a century, we now know. Freak local conditions may be at work, but the discovery offers hope that at least one region of the ocean will still be breathable.

Most tropical coastlines have [oxygen minimum zones](#), which form when plankton die, sink and get eaten by bacteria, a process that consumes oxygen. The majority of marine animals [cannot breathe in low-oxygen water](#), and either leave or die.

Around the world, [oxygen minimum zones have been growing](#), partly due to [the effects of global warming](#). But one such zone, in the eastern Pacific off the coast of North and Central America, has been bucking the trend, says [Curtis Deutsch](#) of the University of Washington in Seattle.

Using coastal sediments that carry traces of past oxygen levels, Deutsch and his colleagues reconstructed changes in oxygen levels in the eastern tropical Pacific since 1850. They found that the oxygen minimum zone has been shrinking nearly all that time.



Weakening winds can help dead zones recover
(Image: Image Source/Getty)



Vznik a zánik anoxických zón – ne vše jasné

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Pacific dead zone has

› 19:00 07 August 2014 by [Anna V](#)
› For similar stories, visit the [Enda](#)

Huge areas of ocean could suffocate these "dead zones" has been shrinking. Local conditions may be at work, but one region of the ocean will still be

Most tropical coastlines have [oxyg](#) plankton die, sink and get eaten by oxygen. The majority of marine animals either leave or die.

Around the world, [oxygen minimum](#) the effects of global warming. But on the coast of North and Central America [Deutsch](#) of the University of Washin

Using coastal sediments that carry his colleagues reconstructed changes in the Pacific since 1850. They found that the dead zones are shrinking nearly all that time.



toxických látek
v prostředí

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The oceans are heating, acidifying and choking

› 19:58 04 October 2013 by [Fred Pearce](#)
› For similar stories, visit the [Climate Change](#) Topic Guide

We know the oceans are warming. We know they are acidifying. And now, to cap it all, it turns out they are suffocating, too. A new health check on the state of the oceans warns that they will have lost as much as 7 per cent of their oxygen by the end of the century.

The cascade of chemical and biological changes now under way could see coral reefs irreversibly destroyed in 50 to 100 years, with marine ecosystems increasingly taken over by [jellyfish](#) and toxic algal blooms.

The [review](#) is a repeat of a study two years ago by the [International Programme on the State of the Ocean \(IPSO\)](#), a coalition of scientists. It concludes that things have become worse since the first study.

"The health of the oceans is spiralling downwards far more rapidly than we had thought, exposing organisms to intolerable and unpredictable evolutionary pressure," says [Alex Rogers](#) at the University of Oxford, the scientific director of IPSO.

Deadly trio

Rogers describes a "deadly trio" of linked global threats. The first is global warming: surface sea water has been [warming](#) almost as fast as the atmosphere. The second is [acidification](#) – a result of the water absorbing ever more CO₂ from the atmosphere. The third is [deoxygenation](#).

To see mi libi 626 pet 256 g+1 109

Share 171



Getting harder to breathe underwater (Image: Incredible Features/Barcroft Media)

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Hyundai i40 2013, 1.7 CRDI

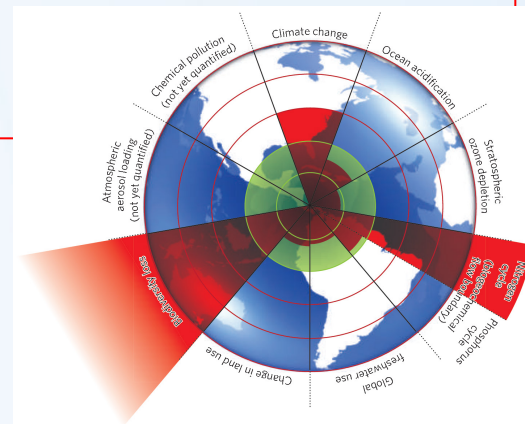
VII. Globální spotřeba vody

Earth System process	Control variable	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Global freshwater use	Consumptive blue water use, km ³ yr ⁻¹	<p>Could affect regional climate patterns (e.g., monsoon behavior).</p> <p>Primarily slow variable affecting moisture feedback, biomass production, carbon uptake by terrestrial systems and reducing biodiversity</p>	<4000 km ³ yr ⁻¹ (4000–6000 km ³ yr ⁻¹)	<ol style="list-style-type: none"> 1. Scientific evidence of ecosystem response but incomplete and fragmented. 2. Slow variable, regional or subsystem thresholds exist. 3. Proposed boundary value is a global aggregate, spatial distribution determines regional thresholds

Boundary: No more than 4000 km³ of fresh water consumed per year

Current level: 2600 km³ per year

Diagnosis: Boundary will be approached by mid-century



Nedostatek sladké vody

- člověk je dominantní silou měnící globálně tok vody v řekách
- přibližně 25 % vody z povodí vůbec nedoteče do oceánů
- vážné důsledky pro stav biodiverzity, produkci potravin, zdravotní rizika, snižování pružnosti ter. a aqua. ekosystémů

8 Mighty Rivers Run Dry From Overuse

[Main](#) [About the Freshwater Initiative](#) [Restoring Rivers](#) [Reducing Water Use](#) [News](#) [Videos](#)



Colorado

Hoover dam

The Hoover, Davis and Parker dams have released 130 billion litres of water, destined for the delta in Mexico. The water will be first to cross the US-Mexico border for environmental purposes



Morelos dam

The last barrier between the Colorado river and the Gulf of California, the dam diverts the river into the irrigated fields of the Mexicali valley. On 23 March, its gates will open, spilling water into the dry riverbed

Colorado river delta

It could take up to a week for the water pulse to reach its destination. The delta will burst into life, with the first saplings appearing about three weeks after the flood



Aralské Jezero - Kazachstán, Uzbekistán



Aralské Jezero

What has happened...



1957

from a map



1977

from satellite images



1982

from satellite images



1984

from satellite images



1993

from a map

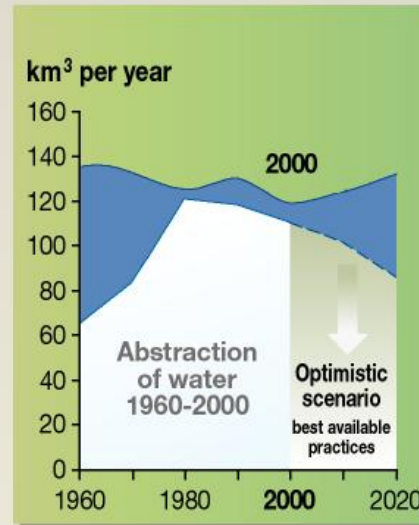
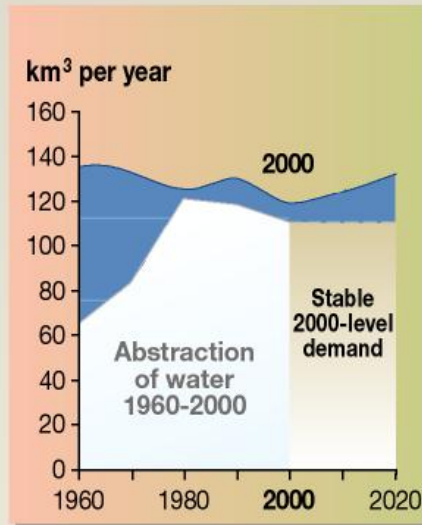
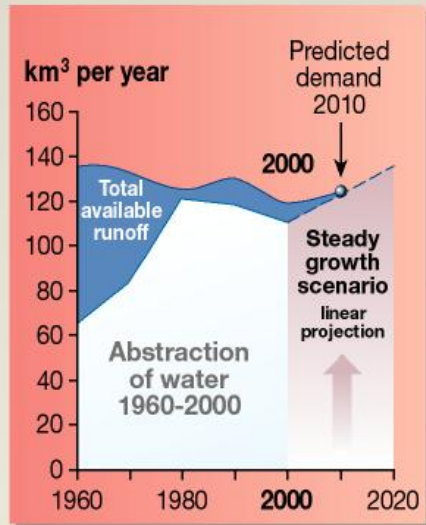


November 2000

from satellite images

In 1989-1990, the Aral Sea separated into two parts: the 'Large Aral' and the 'Small Aral'

What could happen...



Between November 2000 and June 2001, Vozrojdeniya Island joined the mainland to the south

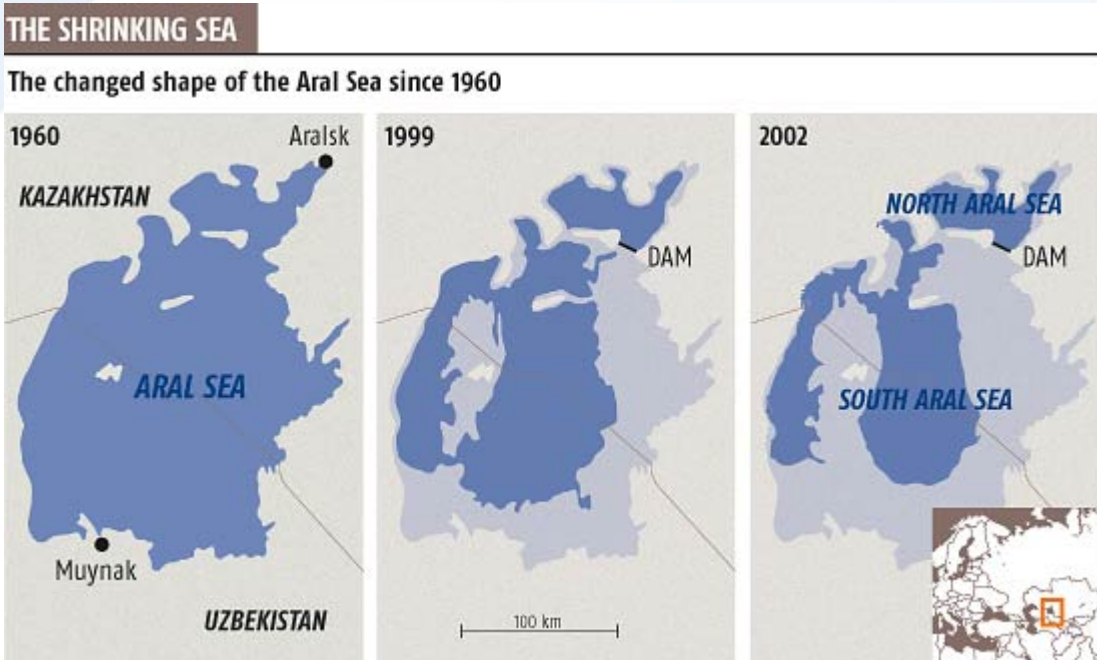


November 2007

from satellite images

Sources: Nikolai Denisov, GRID-Arendal, Norway (especially for the graphics below); Scientific Information Center of International Coordination Water Commission (SIC ICWC); International Fund for Saving the Aral Sea (IFAS); The World Bank; National Aeronautics and Space Administration (NASA); United States Geological Survey (USGS), *Earthshots: Satellite images of environmental change*, United States Department of the Interior, 2000.

Aralské Jezero - Kazachstán, Uzbekistán



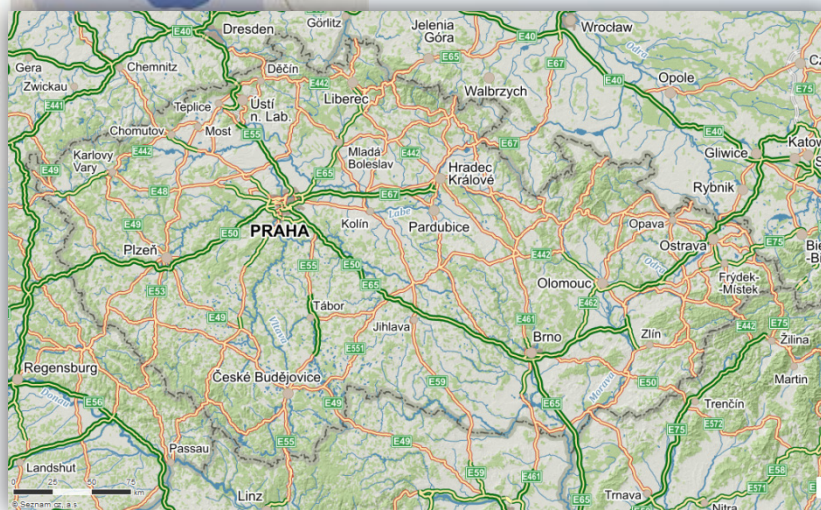
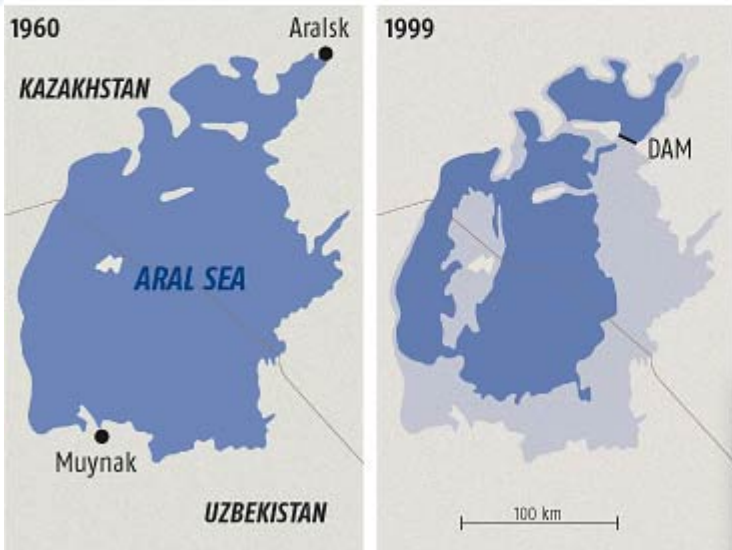
- 2005 postavena přehrada mezi S a J částí
- co se následovalo?



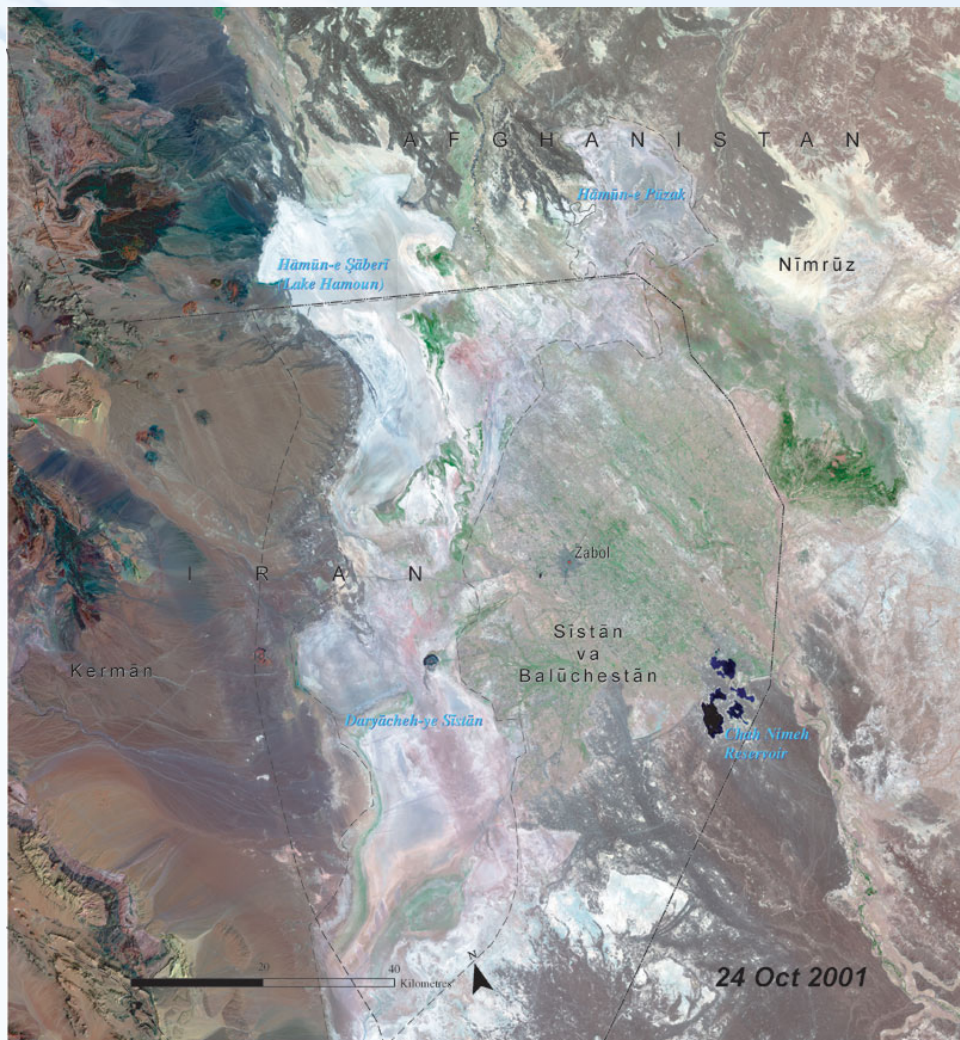
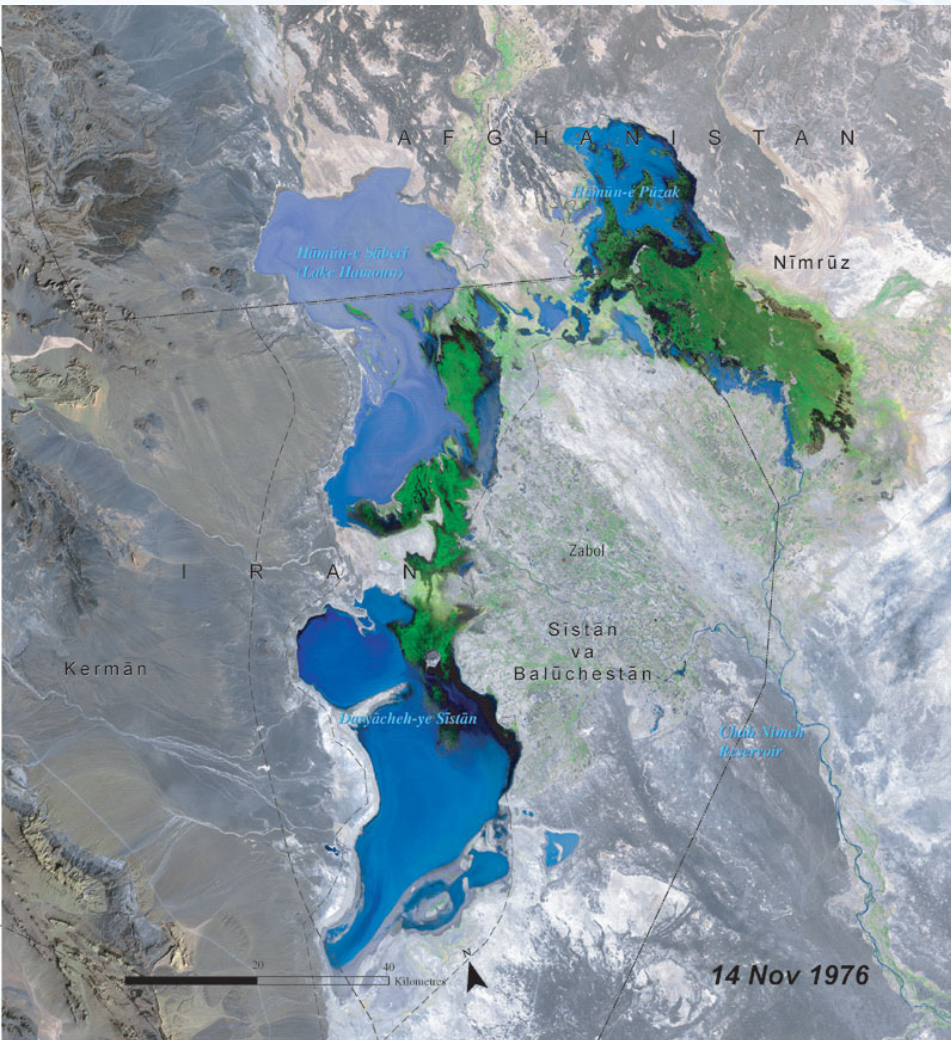
Aralské Jezero

THE SHRINKING SEA

The changed shape of the Aral Sea since 1960



Lake Hamoun – Irán, Afghánistán





Lake Turkana Keňa ???

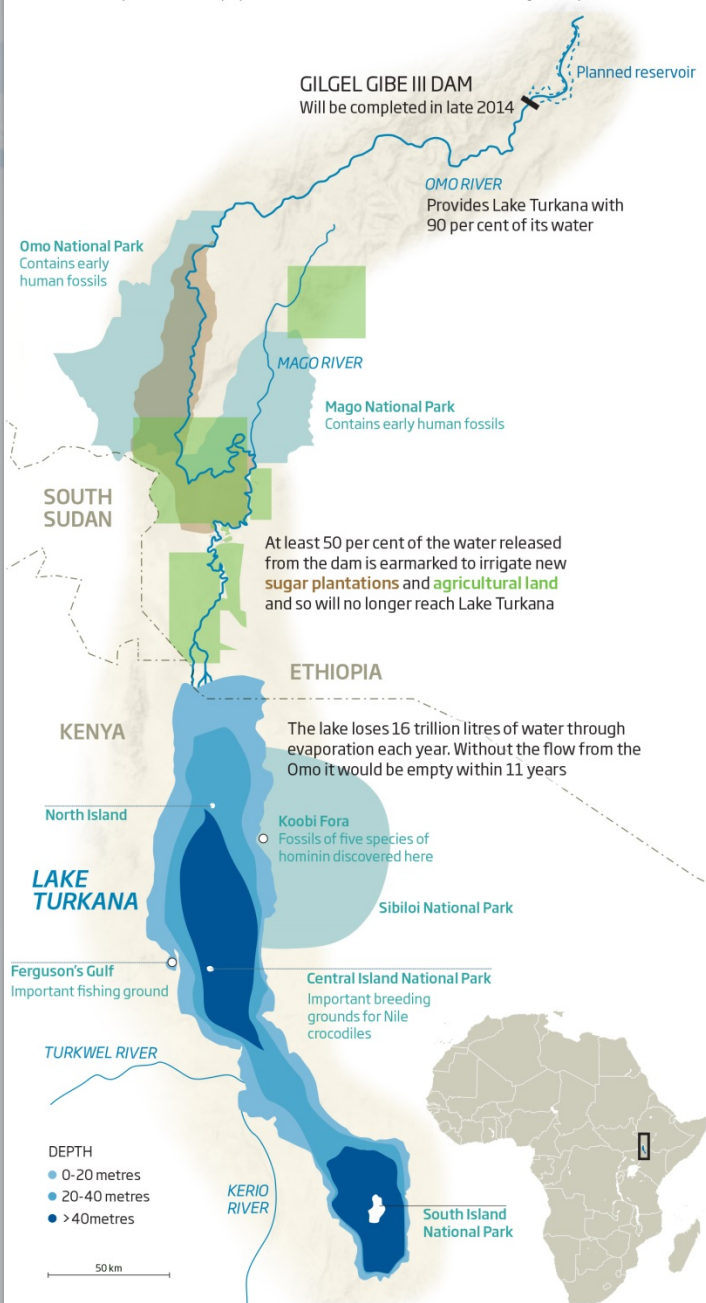
blahobyt

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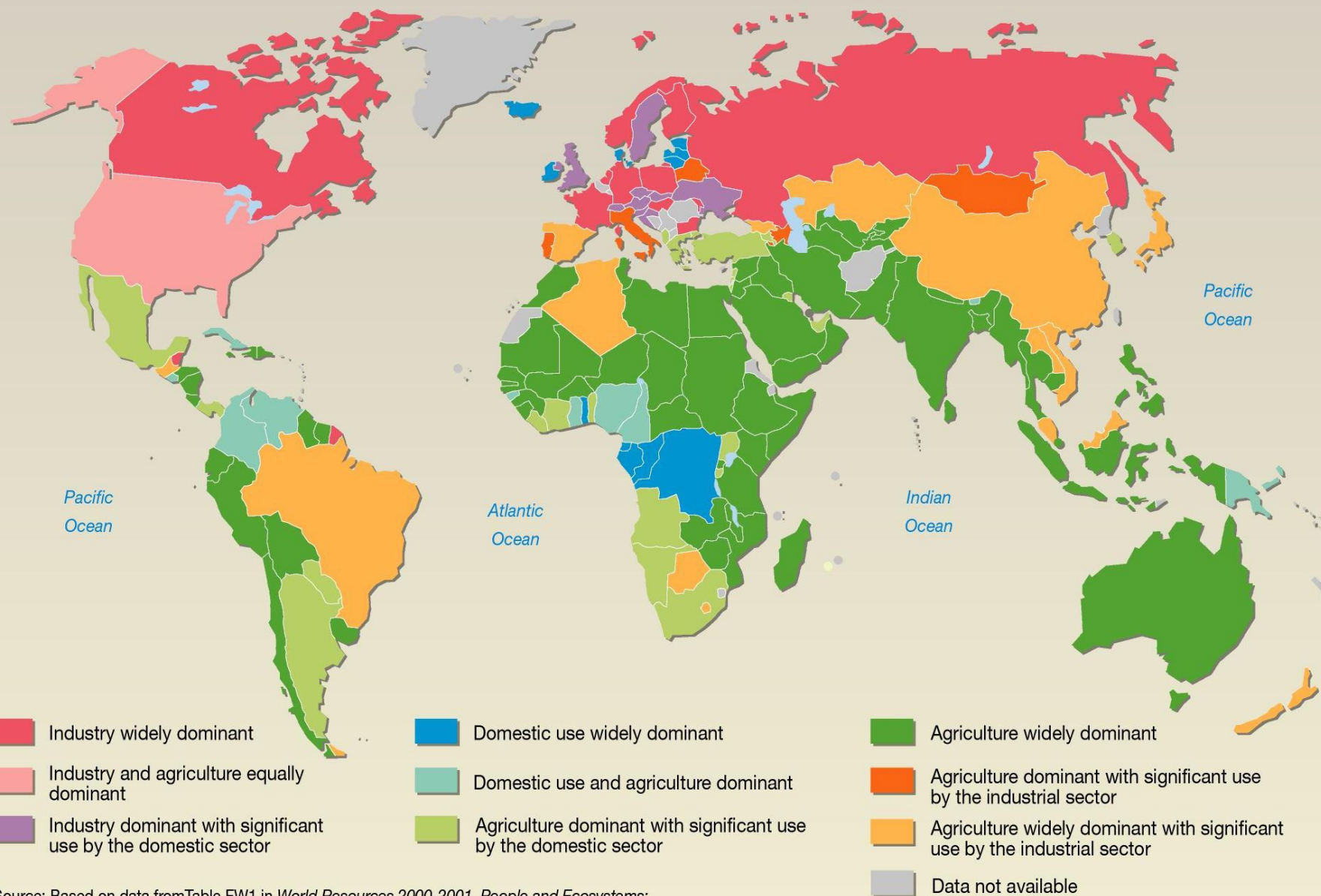
přírodní dědictví

Harnessing the Omo's waters

Today Lake Turkana in Kenya has a surface area of 6400 square kilometres and is the world's largest desert lake. It is replenished mostly by water from the river Omo, which flows through Ethiopia



Odvětví spotřeby vody



Source: Based on data from Table FW1 in *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life*, World Resources Institute (WRI), Washington DC, 2000.

Oblasti a příčiny nedostatku vody

Areas around the globe suffering from depleted water resources

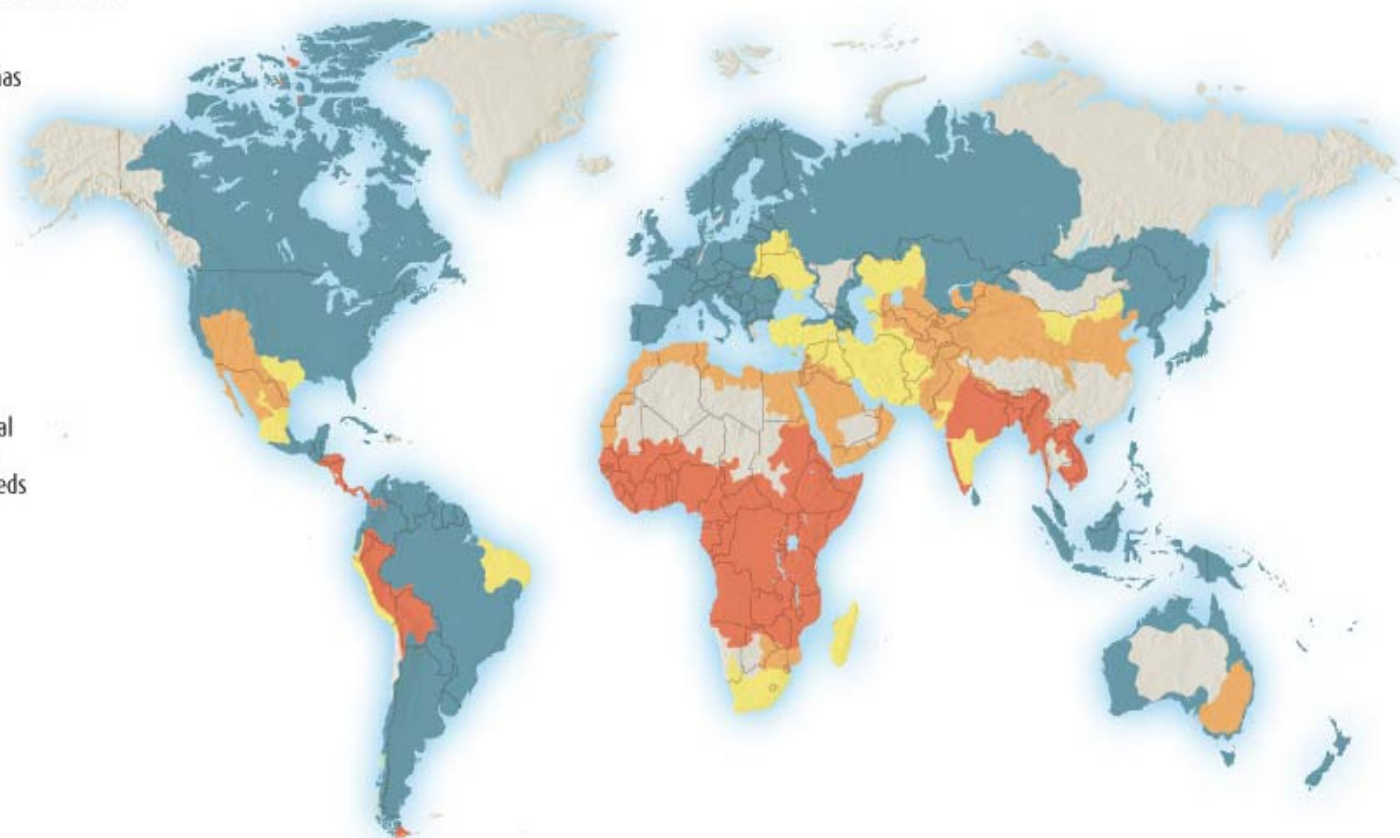
Physical water scarcity
Water resource development is approaching or has exceeded sustainable limits. More than 75% of river flow is extracted for agriculture

Approaching physical water scarcity
More than 60% of river flow is extracted. These areas will experience physical water scarcity in the near future

Economic water scarcity
Limited access to water even though natural local supplies are available to meet human demands. Less than 25% of water extracted for human needs

Little or no water scarcity
Abundant water resources relative to use, with less than 25% of water extracted for human purposes

Not estimated



SOURCE: INTERNATIONAL WATER MANAGEMENT INSTITUTE



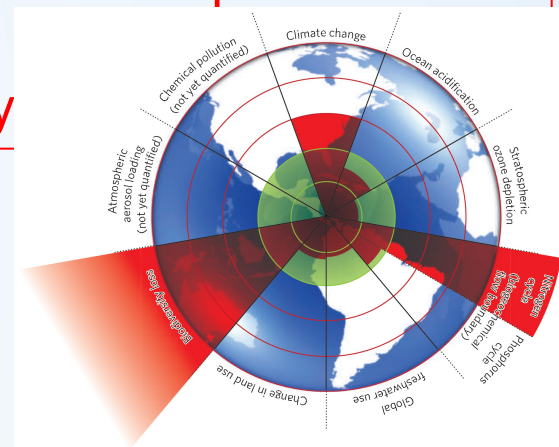
VIII. Změna využívání krajiny

Earth System process	Control variable	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Land-system change	Percentage of global land cover converted to cropland	<p>Trigger of irreversible and widespread conversion of biomes to undesired states.</p> <p>Primarily acts as a slow variable affecting carbon storage and resilience via changes in biodiversity and landscape heterogeneity</p>	≤15% of global ice-free land surface converted to cropland (15%–20%)	<p>1. Ample scientific evidence of impacts of land-cover change on ecosystems, largely local and regional.</p> <p>2. Slow variable, global threshold unlikely but regional thresholds likely.</p> <p>3. Boundary is a global aggregate with high uncertainty, regional distribution of land-system change is critical.</p>

Boundary: No more than 15 % of ice-free land to be used for crops

Current level: 12 %

Diagnosis: Boundary will be approached by mid-century



Změna využívání krajiny

- poháněno expanzí zemědělství a jeho intenzifikace
- posledních 50 let byly lesní a další ekosystémy měněny na zemědělskou půdu rychlostí 0,8% ročně
- hlavní síla řídící ztrátu **ekosystémových funkcí a služeb** (např. produkce potravin a cyklus vody), ztrátu biodiverzity a podkopává lidský blahobyt a dlouhodobou udržitelnost
- **maximální únosná míra přeměny ekosystémů na zeměd. půdu je přibližně 15 % nezaledněné plochy souše – v současnosti je to 12 %**
- při překročení únosné míry využívání v určitém regionu může dojít k náhlé změně charakteru krajiny
- **např. nadkritická přeměna Amazonských pralesů na zemědělské plochy či pastviny může „skokově“ změnit celý charakter povodí na polosuchou savanu**



Změn

- pohá
- posl
- zem
- hlav
- (nap
- a po
- max
- půdu
- souč
- při překročení únosné míry využívání v určitém regionu může dojít k náhlé změně charakteru krajiny
- např. nadkritická přeměna Amazonských pralesů na zemědělské plochy či pastviny může „skokově“ změnit celý charakter povodí na polosuchou savanu

Parts of Amazon close to tipping point

- › 13:52 05 March 2009 by [Catherine Brahic](#)
- › For similar stories, visit the [Endangered Species Topic Guide](#)

The Mato Grosso, the most scarred region of the Amazon rainforest, is teetering on a deforestation "tipping point", and may soon be on a one-way route to becoming a dry and relatively barren savannah.

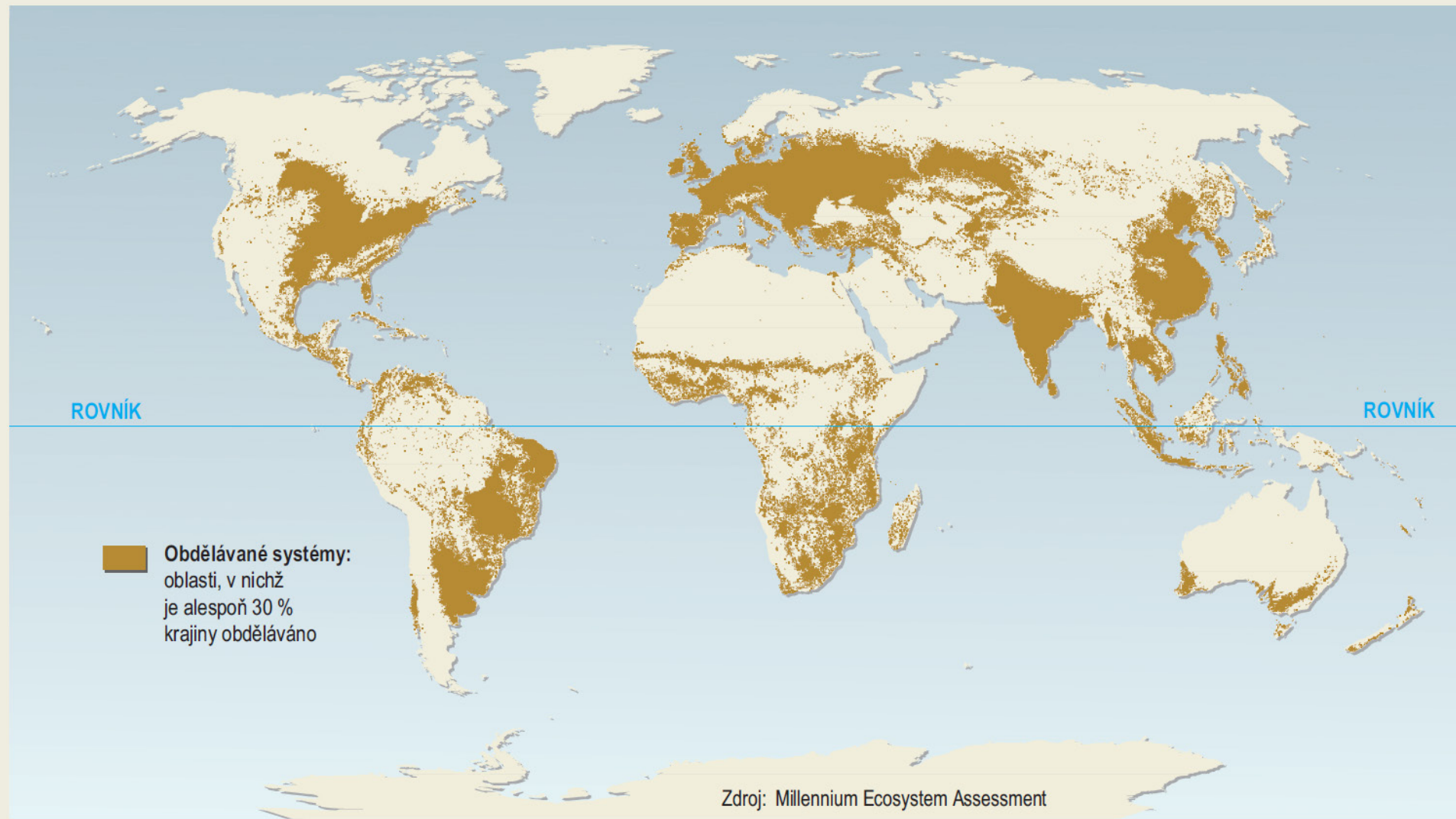
[Mônica Carneiro Alves Senna](#) and colleagues at the Federal University of Viçosa, Brazil, used computer models to simulate how the Amazon would recover from various amounts of deforestation. Their simulations ranged from a complete wipe-out of the entire forest to a situation where just one fifth of the forest would be removed.



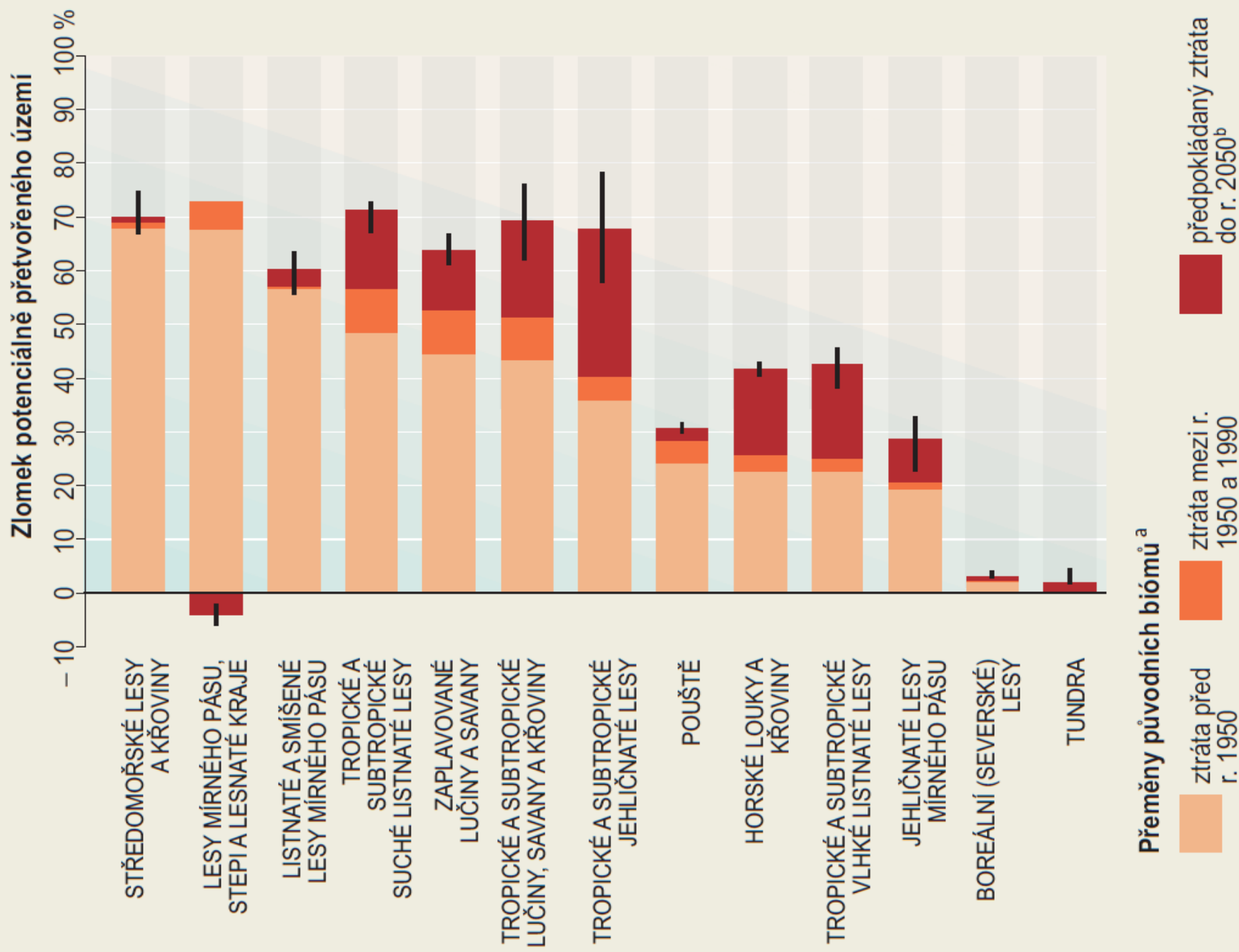


Graf 1: ROZLOHA OBHOSPODAŘOVANÝCH SYSTÉMŮ V ROCE 2000

Obhospodařované systémy pokrývají 24 % suchozemského povrchu.



PŘEMĚNA SUCHOZEMSKÝCH BIOMŮ

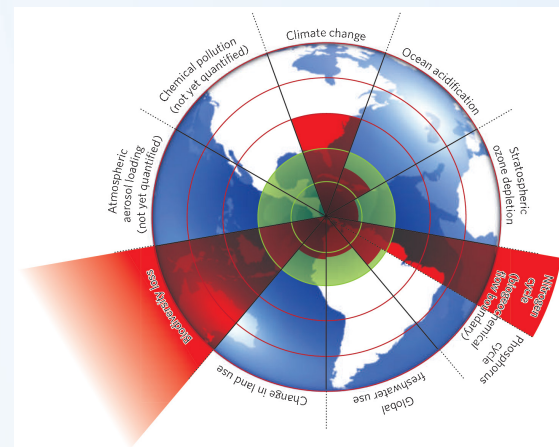




IX. Chemické znečištění

Earth System process	Control variable	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Chemical pollution	For example, emissions, concentrations, or effects on ecosystem and Earth System functioning of persistent organic pollutants (POPs), plastics, endocrine disruptors, heavy metals, and nuclear wastes.	Thresholds leading to unacceptable impacts on human health and ecosystem functioning possible but largely unknown. May act as a slow variable undermining resilience and increase risk of crossing other thresholds.	To be determined	<ol style="list-style-type: none"> 1. Ample scientific evidence on individual chemicals but lacks an aggregate, global-level analysis. 2. Slow variable, large-scale thresholds unknown. 3. Unable to suggest boundary yet.

Boundary: Not yet identified





MIDWAY

Message From the Gyre

03:54

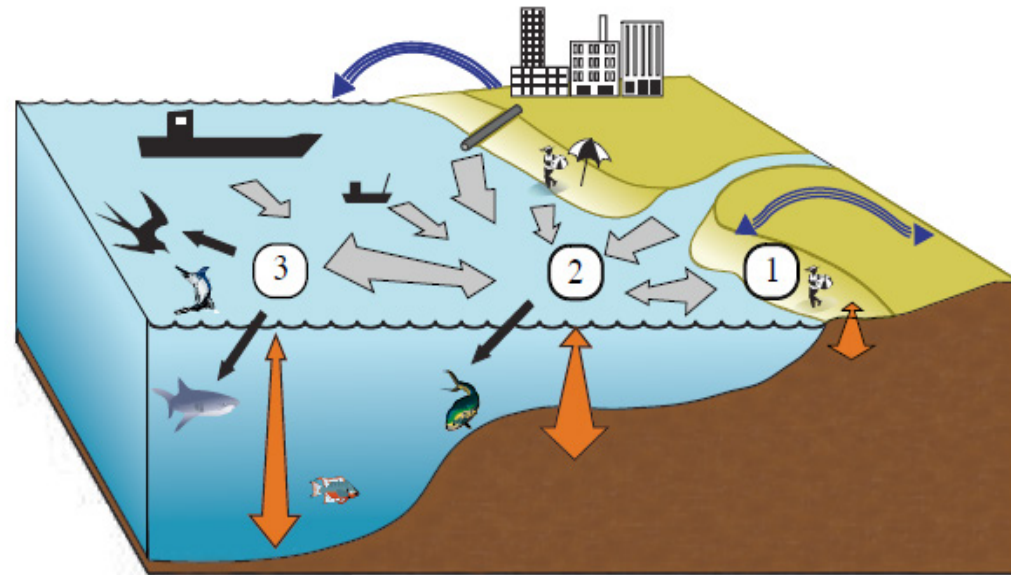
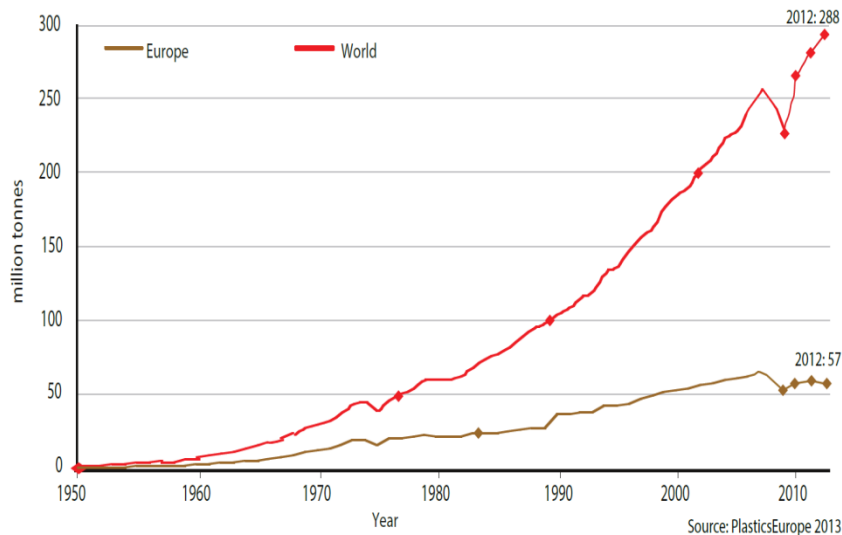
HD



Centrum pro výzkum
toxických látek
v prostředí

Plastikové kousky v ŽP

Growth in plastics production 1950-2012



Main sources and movement pathways for plastic in the marine environment.

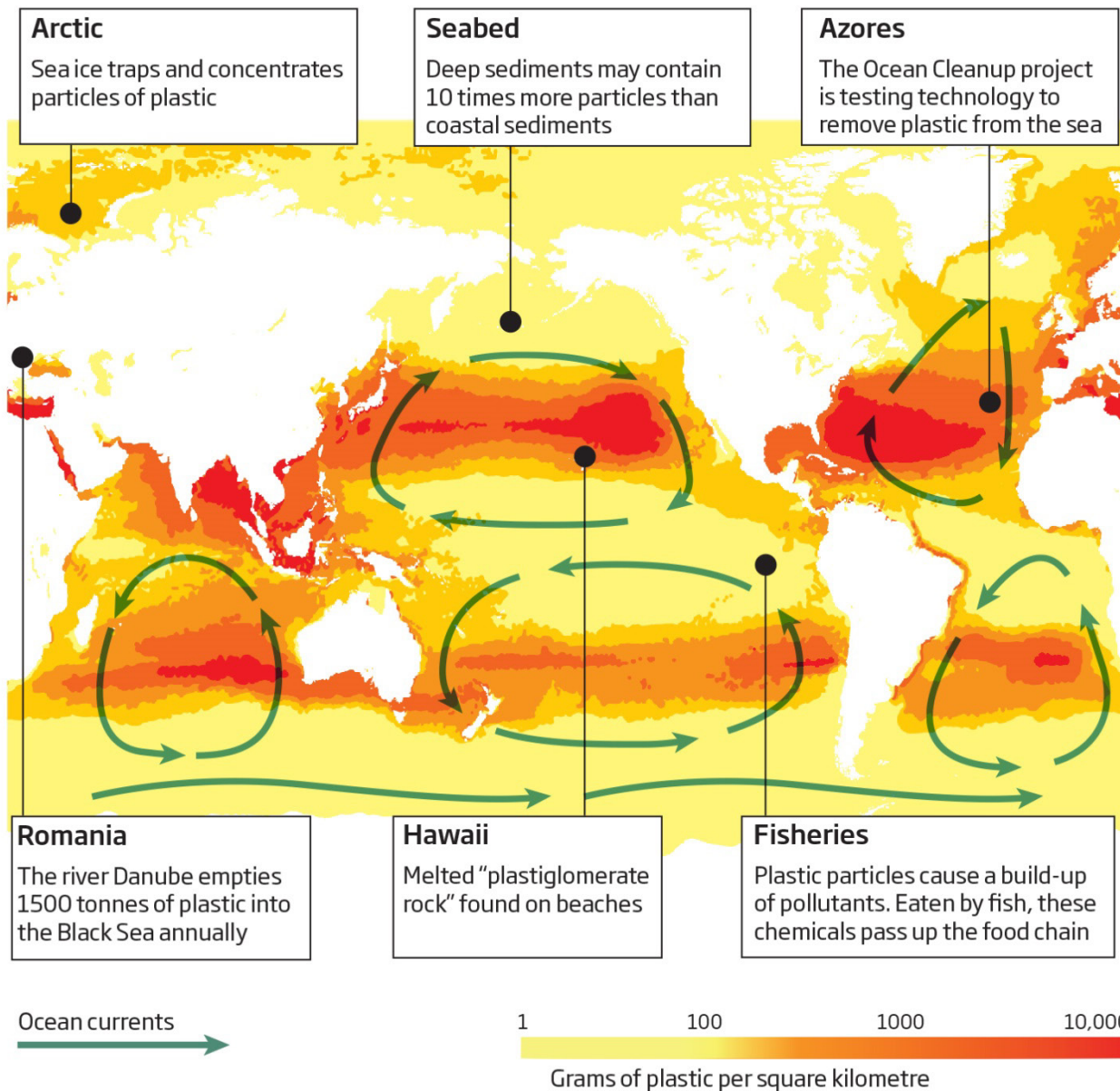
Most plastic accumulates on beaches (1), in coastal waters and their sediments (2), and in the open ocean (3). Dark blue arrows depict wind-blown litter; grey arrows water-borne litter; orange arrows vertical movement through the water column, including burial in sediments; and black arrows ingestion by marine organisms.

Growing plastic production

- include thermoplastics, polyurethanes, thermosets, elastomers, adhesives, coatings and sealants, and polypropylene fibres. PET, PA and polyacryl fibres are not included

Global garbage dump

Much of the ocean's plastic waste is found near heavily populated coastlines, but farther out, it is concentrated in five "gyres" in the Atlantic, Pacific and Indian oceans. Where most of it ends up is unclear



Místo zmizelého boeingu našli nový "kontinent". Tvoří jej tuny plastového odpadu

Je to křídlo, nebo kus sedačky? Otazník vznášející se nad zmizením malajsijského boeingu obrací zájem veřejnosti k dalším otázkám - tentokrát ekologickým. Pátrání potvrzuje předpoklad, že oceán z hromadícího se odpadu začíná formovat "nový kontinent".

Čtěte více o: [Pacifik](#) | [oceán](#) | [ekologie](#)

ČTK

ČLÁNEK

DISKUSE (115)

Je to už téměř měsíc, co záchranáři několika států pátrají po zmizelém letu MH370, bohužel neúspěšně. Hledání pohřešovaného malajsijského letadla zatím vedlo jen k objevení velké spousty trosek a různých plovoucích předmětů. Bohužel o žádném z nich nebylo možné s jistotou říct, že patří k hledanému Boeingu 777 společnosti Malaysia Airlines.

Značné množství odpadků pohupujících se na hladině oceánu dělá ze sisyfovského hledání zmizelého letadla ještě komplikovanější úkol. Ve vodách plují zbytky



Obrovskou masu odpadků v Tichém oceánu přináší mořský proud ze všech břehů.

foto: Reuters

THIS WEEK

EDITORIALS

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WORLD VIEW End the unfair racket of academic jobs for the boys p.427



DECEPTION Orchid shape and smell fools amorous wasps p.429

In the name of beauty

The ugly truth is that the plastic microbeads found in many skin scrubs and other personal-care products are a serious pollutant of the marine environment. They should be phased out rapidly.

A beautiful woman comes into focus. What makes her skin glow so? Why, she says, she uses Aveno's Positively Radiant skin-brightening daily scrub for "naturally beautiful results".

What is not clear from this advertisement is that the "gentle exfoliators" in the product promoted by Jennifer Aniston are minuscule beads of plastic. When Aniston, or those she inspires to follow her, rinse the scrub down the drain, many of the beads end up in the sea, where they will persist indefinitely. This is unnecessary, damaging and must stop.

Others agree, and the face scrub, along with hundreds of other products, including toothpastes, may not be long for this world. On 10 September, the California Legislature sent a bill (AB 888) to the state's governor, Jerry Brown, that would ban the inclusion of spheres of polyethylene, polypropylene and other plastics less than 5 millimetres across in personal-care products after 2020.

If signed into law, the bill will prevent trillions of plastic beads from being rinsed down the drain. Not all of these make it to the sea — wastewater treatment plants can sift out 90% of them — but the problems caused by the remaining millions are considerable. (Meanwhile, beads trapped in 'sludge' at the plants do not disappear. Plenty are sprayed on crops, from where they escape to rivers and lakes.)

In a paper published on 3 September, aquatic-health researcher Chelsea Rochman at the University of California, Davis, and her colleagues estimate that 8 trillion microbeads per day are emitted into

While bans and phase-outs slowly take effect, the Beat the Microbead campaign, funded by Dutch non-governmental organizations the Plastic Soup Foundation and the North Sea Foundation, has created an app for consumers who want to avoid contributing to the problem. A few clicks can confirm whether the tempting scrub in the pharmacy aisle contains the beads. This is helpful in the short term, but ultimately the onus of responsibility should not be on the consumer.

"No luminous complexion is worth the wholesale pollution of Earth's oceans."

Microbeads are not the only source of microplastic in the oceans. Tiny plastic pellets used in making plastic items spill into the sea; plastic bags and bottles break down over time. On almost any beach on Earth, the sand carries tiny, bright grains of plastic.

And macroplastics remain a serious problem. A study published last month estimated that around 90% of seabirds have plastic in their bellies (C. Wilcox *et al. Proc. Natl Acad. Sci. USA* <http://doi.org/7dv>; 2015). Some birds mistake shopping bags for jellyfish; others confuse cigarette lighters and pen caps with prey and fly home to feed them to their chicks.

The consequences of this ubiquitous plastic for marine species, marine ecosystems and human health remain areas of active research. But the public and policymakers need not wait for detailed results before taking action. Banning microbeads will not solve the plastic-pollution problem, but it is an easy start. Jennifer Aniston and the



Oázy života

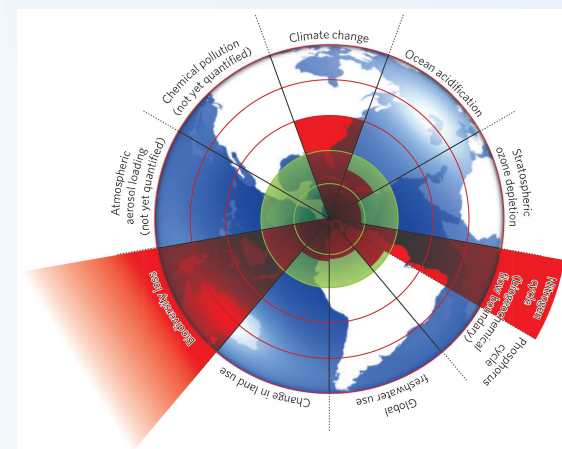
„For some microbes, plastic is the equivalent of a hotel buffet table. Any hard surface in the ocean becomes a collection plate for nutrients...“



X. Emise atmosférických aerosolů

Earth System process	Control variable	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis	Disruption of monsoon systems. Human-health effects. Interacts with climate change and freshwater boundaries.	To be determined	1. Ample scientific evidence. 2. Global threshold behavior unknown. 3. Unable to suggest boundary yet.

Boundary: Not yet identified



Emise atmosférických aerosolů - důsledky

- 1) **Ovlivnění klimatického systému**
- 2) **Škodlivé účinky na lidské zdraví**

ad 1) globální koncentrace aerosolů je od prům. rev. dvojnásobná
aerosoly ovlivňují:

- radiační rovnováhu planety
zvýšeným odrazem do vesmíru
- hydrologický cyklus změnou
mechanizmu tvorby srážek
- **cirkulaci asijských monzunů**
 - aerosoly nad Indo-Ganžskou plání více zahřívají
atmosféru, zatímco dochází k ochlazení povrchu
 - dochází tak k posunu srážek do oblasti Himalájí a
změnu časového rozvržení



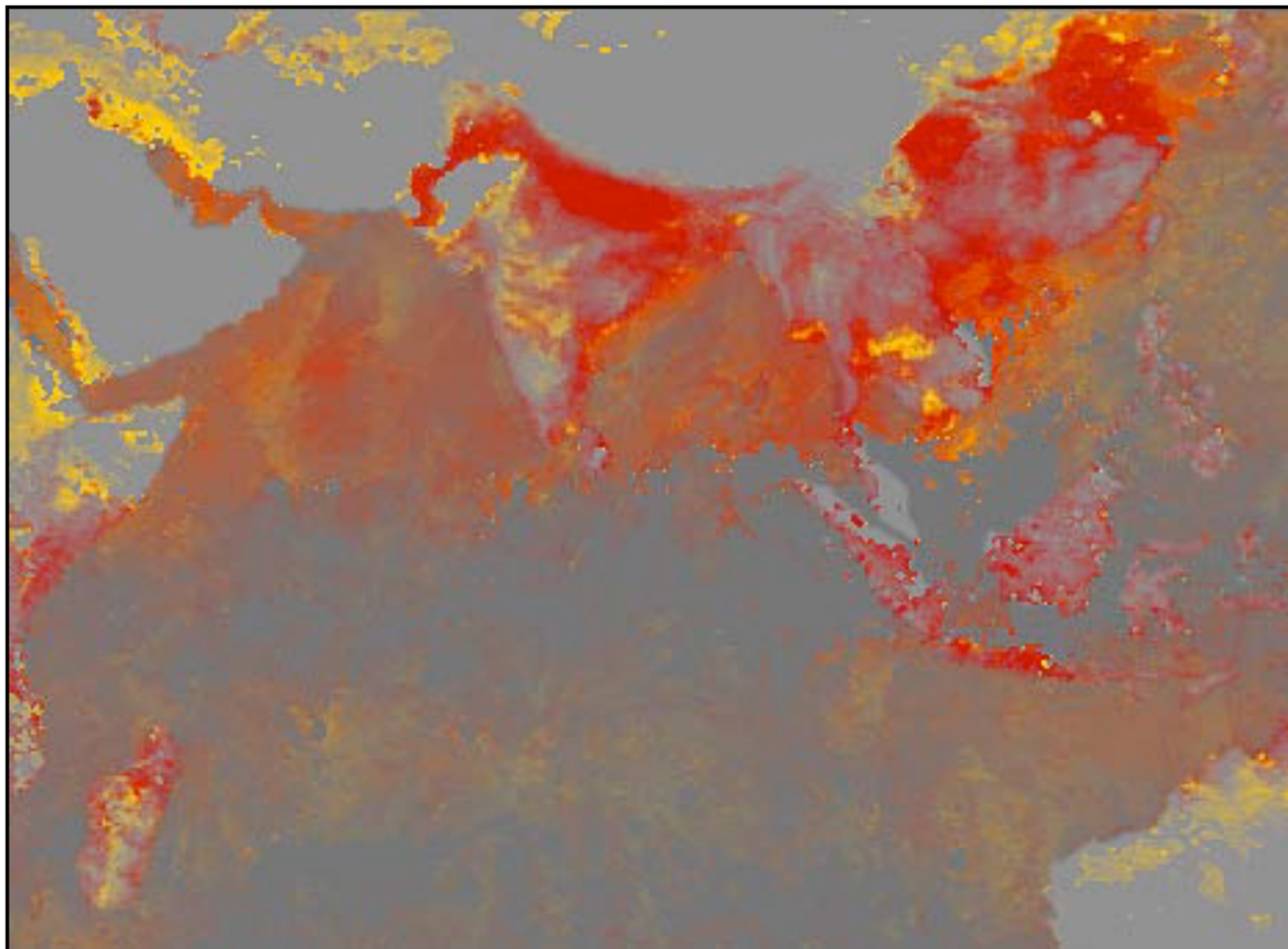
The screenshot shows the NewScientist website's 'Environment' section. The article title is 'Air pollution is stunting India's monsoon', dated 12:16 30 September 2011 by Michael Marshall. The article text discusses how air pollution is contributing to the drying out of India and the weakening of the monsoon. It quotes Yi Ming of Princeton University, who states that the summer monsoon provides up to 80% of total annual rainfall in south Asia and supports 20% of the world's population. The article also mentions that the monsoon is brought by large-scale wind patterns that transport heat between the northern and southern hemispheres.

Znečištění atmosféry nad indickým oc.

8-12.12. 2004

zlatá barva – větší částice (písek, soli)

červená barva – menší částice (spalování fosilních paliv či vegetace)



Znečištění atmosféry pod Himalájemi

7.11.2007

smog nad Pákistánem a Indií



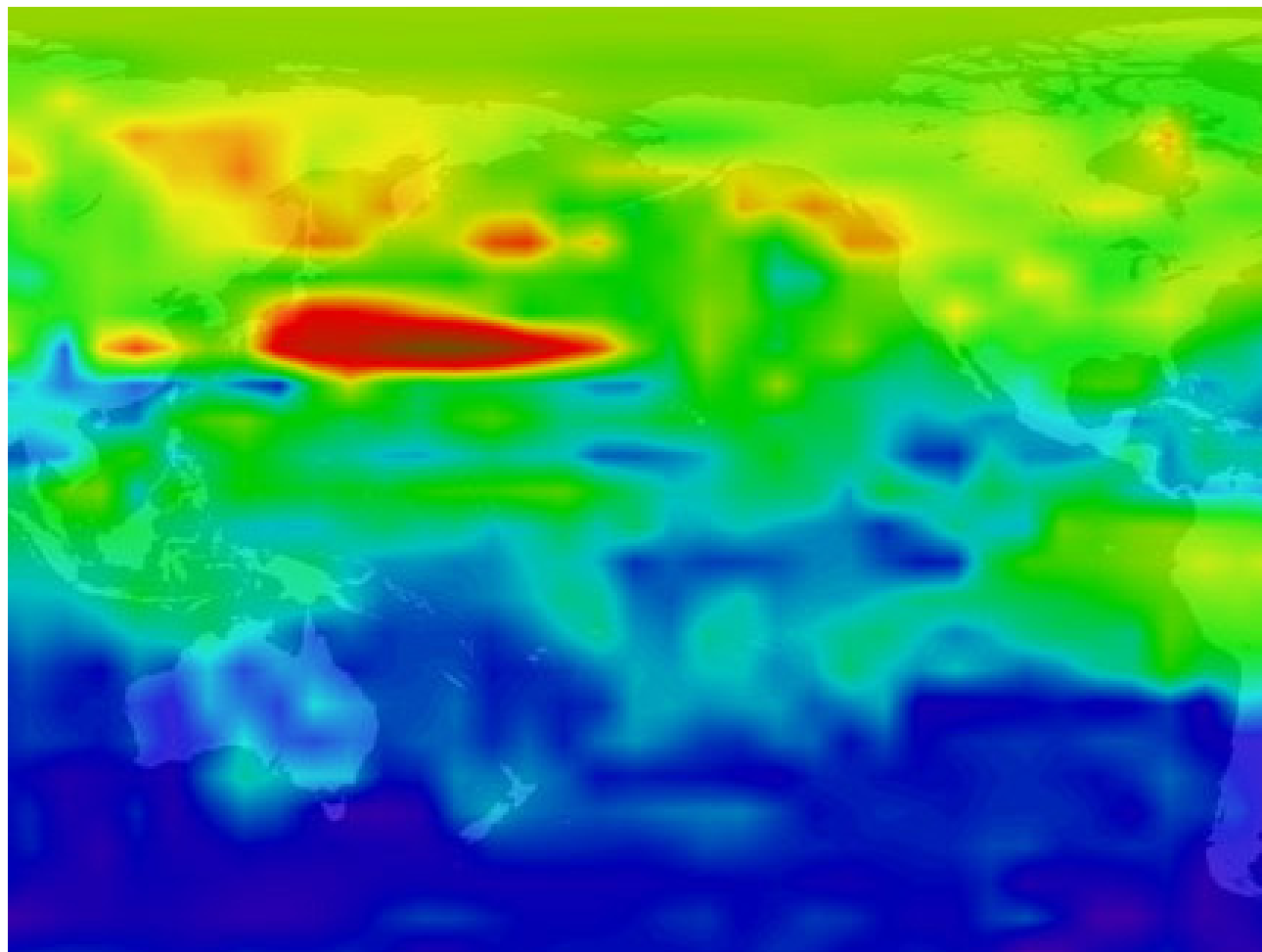
16.12.2004

smog nad tokem Gangy



Globální přenos znečištění

přenos oblaku CO z Číny do USA – květen 2000



(b) March 12, 2000

Emise atmosférických aerosolů - důsledky

1) *Ovlivnění klimatického systému*

2) *Škodlivé účinky na lidské zdraví*

ad 2) částice PM_{2,5} zodpovídají za:

- 3 % úmrtí na kardiovaskulární choroby
- 5 % tracheální, bronchiální a plicní rakoviny
- 1% úmrtí akutních respiračních onemocnění dětí

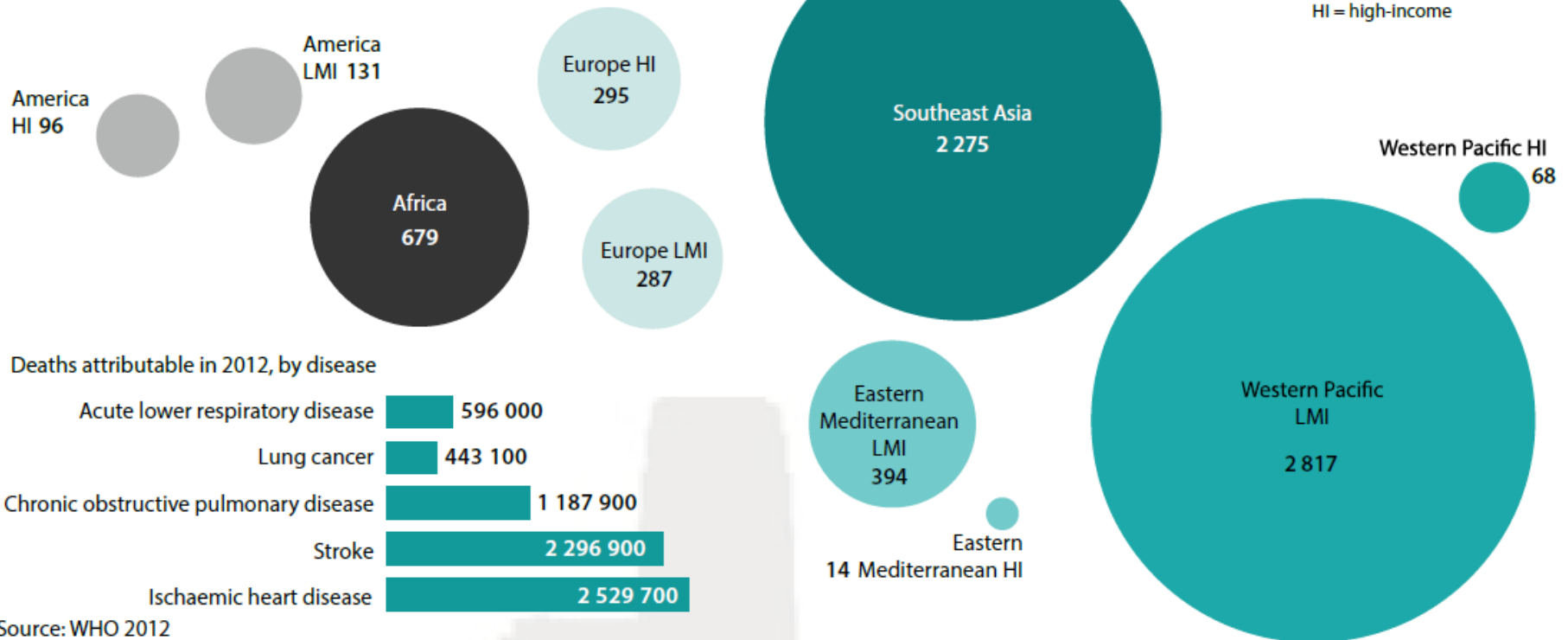
- $0,8 \cdot 10^6$ předčasných úmrtí/rok kvůli průmyslovému zneč.
- $1,6 \cdot 10^6$ předčasných úmrtí/rok kvůli vnitřnímu zakouření
- $0,3 \cdot 10^6$ předčasných úmrtí/rok prašností v povolání
 - většina případů v rozvojových Asijských zemích

UNEP Year Book 2014 emerging issues update

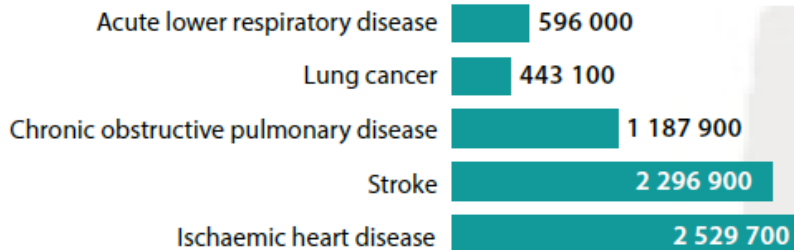
Air Pollution: World's Worst Environmental Health Risk

Choking to death

Deaths attributable to the joint effects of household and ambient air pollution in 2012, by region ('000)



Deaths attributable in 2012, by disease



Source: WHO 2012

Jak se k této situaci postavit?

