



Anthropogenic phosphorus input

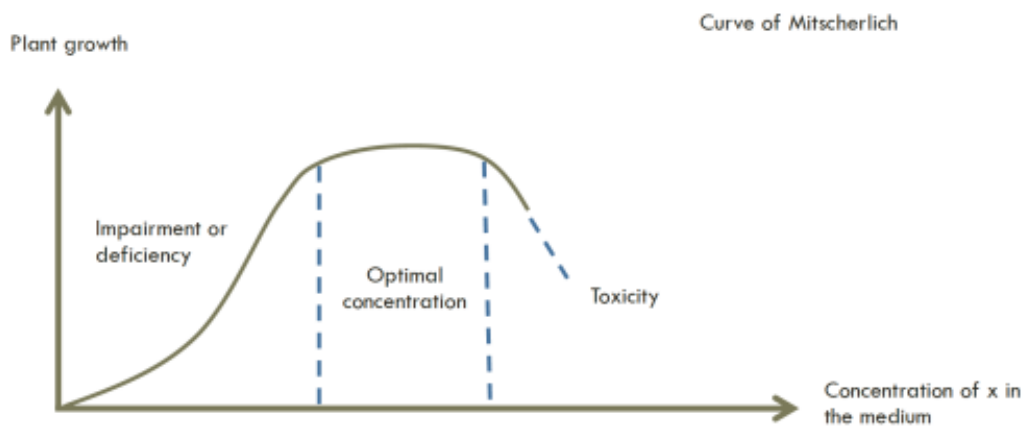
1. Why phosphorus became toxic ?

An ever increasing amount of phosphorus in ocean.

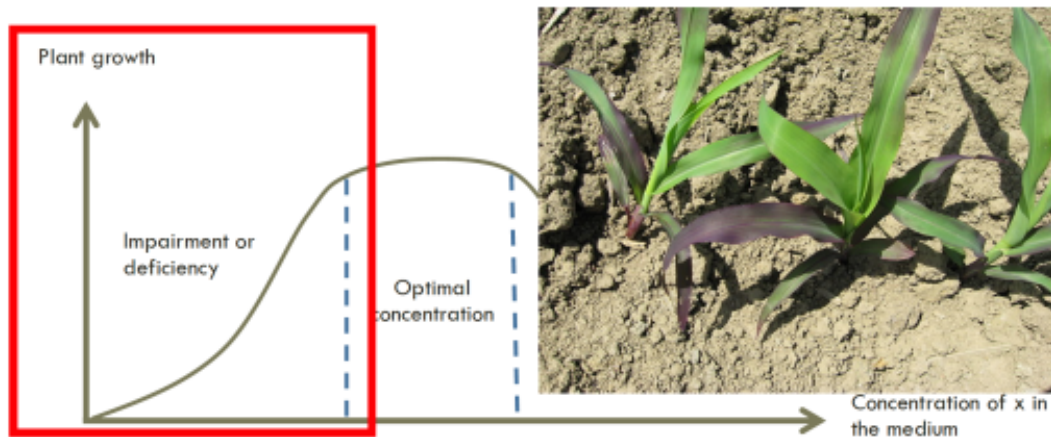
Table 2. Forms of present-day and preanthropogenic phosphorus supply into the World Ocean, Mt/yr (Compton *et al.*, 2000)

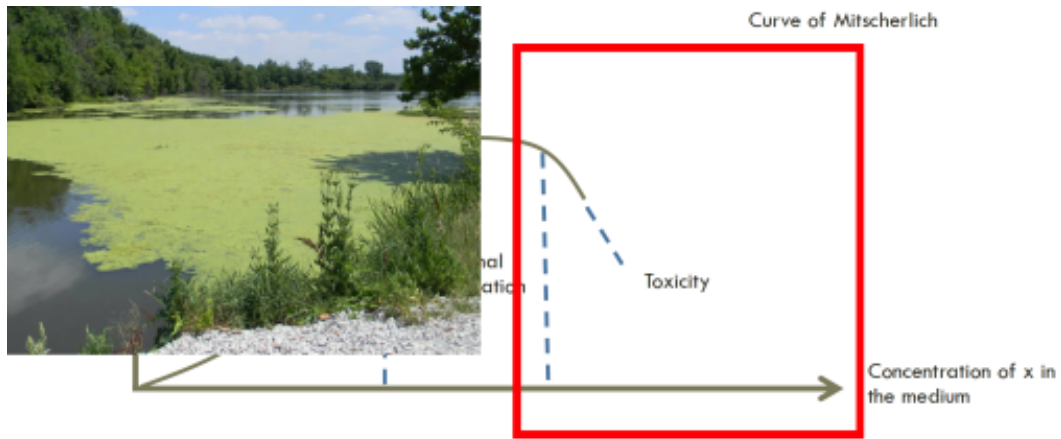
Phosphorus sources and species	Preanthropogenic supply	Present-day supply
1. River runoff		
Dissolved P:		
inorganic	0.3-0.5	0.8-1.4
organic	0.2 (maximum)	0.2 (average)
Suspended P:		
organic	0.9 (maximum)	0.9 (average)
inorganic	1.5-3.0	1.3-7.4
detrital	6.9-12.2	14.5-20.5
2. Eolian	1.0 (including 20% of reactive P)	1.05 (including 20% of reactive P)
Total	10.8-17.8	18.7-31.4
Reactive	3.1-4.8	3.4-10.1

(Baturin, 2003)

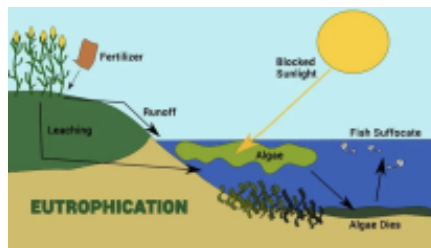


(Gaujous, 1995)





Eutrophication phenomenon



(Pinay, 2018)

Social consequences :

- Crystalization of social tensions
- Agricultural world, local elected officials and environmental protection associations
- Different environment conceptions of public action, social responsibility and scientific knowledge

2. Why is it important ?

According to you, is this phenomenon really important ?

A. I guess, otherwise this course wouldn't exist

B. It is important but there are bigger issues

C. Not important, it is nothing in front of other issues



(Steffen, 2015)

**Ocean Deoxygenation:
Drivers and Consequences**
• Past • Present • Future •

**INTERNATIONAL
CONFERENCE KIEL
GERMANY**
3 – 7 September 2018



SFB 754

Kiel Declaration on Ocean Deoxygenation
Participants of the international conference
"Ocean Deoxygenation: Drivers and Consequences – Past – Present – Future",
3 – 7 September 2018 in Kiel, Germany organized by:
Kiel Collaborative Research Center SFB 754 and Global Ocean Oxygen Network (GO₂NE – IOC-UNESCO)

The ocean is losing its breath

Oxygen in the ocean supports the largest ecosystems on the planet. It is alarming that the ocean is losing oxygen, termed ocean deoxygenation, primarily due to global warming by greenhouse gas emissions, and pollution by nutrients and organic wastes particularly in coastal waters. We call on all nations, societal actors, scientists and the United Nations to:

- (a) Raise global awareness about ocean deoxygenation through local, regional and global efforts, including interdisciplinary research, innovative outreach, and ocean education.
- (b) Take immediate and decisive action to limit pollution and in particular excessive nutrient input to the ocean.
- (c) Limit global warming by decisive climate change mitigation actions.

Both the Paris Agreement addressing Climate Change and the United Nations' 2030 Agenda for Sustainable Development demand conservation and sustainable use of the ocean, seas and marine resources in order to safeguard ocean ecosystems and their current and future societal benefits. These are severely threatened by ocean deoxygenation.

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3. Current phosphorus dependency

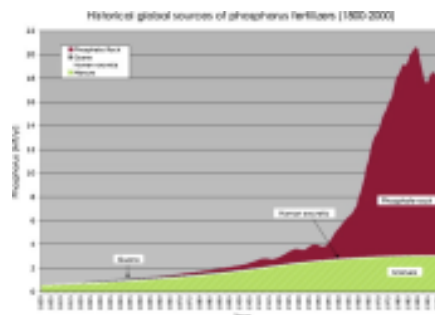
Rapid food demand to rapid population growth

Rectification of phosphorus deficiency of soils

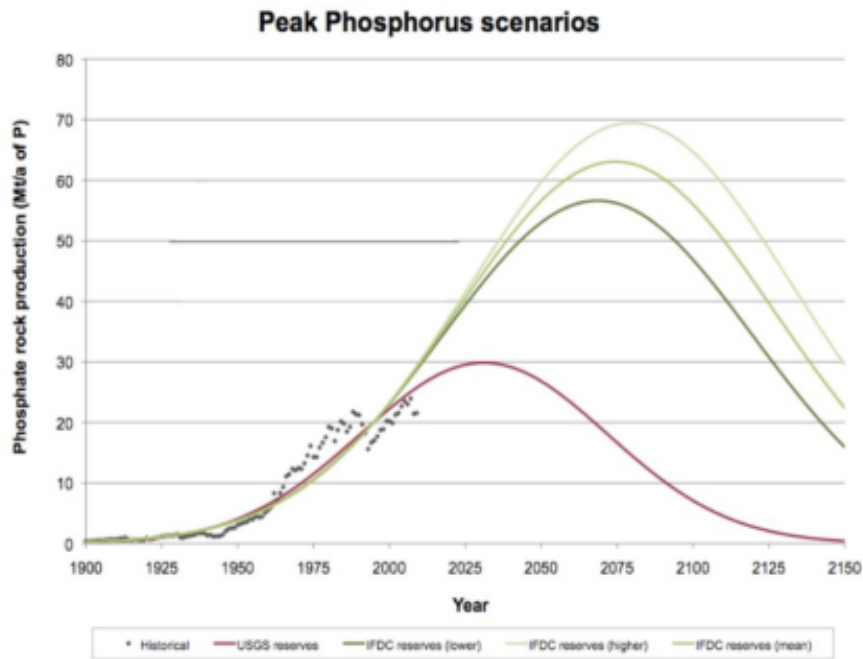
Saving people from starvation

« 90% of global demand for phosphorus is for food production, currently around 148 million tonnes of phosphate rock per year (Smil, 2000a, Smil, 2000b, Gunther, 2005) »

(Cordwell, 2009)



Phosphorus peak



Cordell et al., 2009; 2011

Figure 1. Peak phosphorus curve, indicating that production will eventually reach a maximum, after which it will decline. Red line indicates the original 2009 analysis based on USGS reserve data (Cordell, Drangert & White, 2009), while the green curves were updated with IFDC 2010 phosphate rock reserve data.

(White, s.d.)

4. Prospective of phosphorus demand

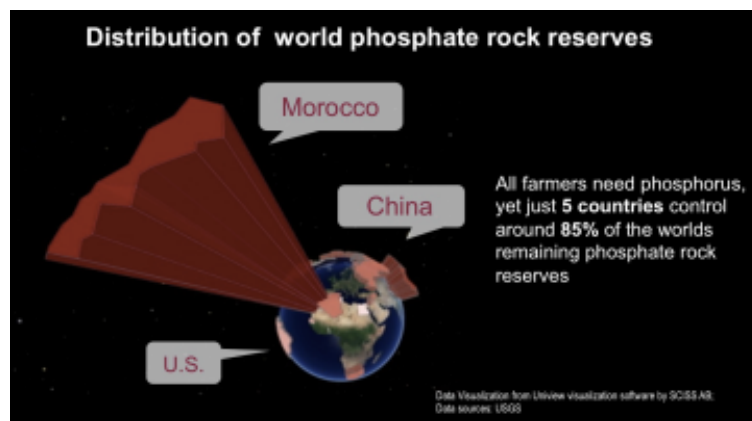
« Following more than half a century of generous application of inorganic high-grade phosphorus and nitrogen fertilizers, agricultural soils in Europe and North America are now said to have surpassed 'critical' phosphorus levels »

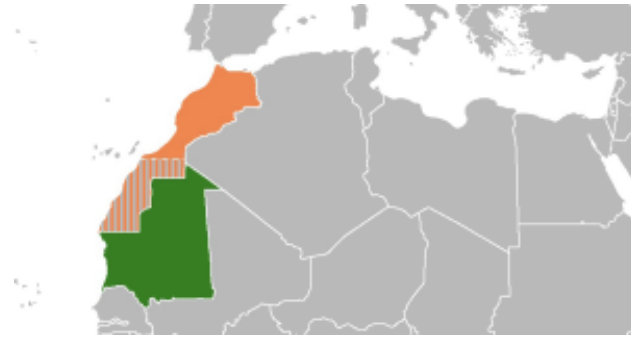
« Consequently, demand for phosphorus in these regions has stabilized or is decreasing. »

« However in developing and emerging economies the situation is different. Global demand for phosphorus is forecast to increase by around 3–4% annually until 2010/11 »

=> high demand and an approaching peak...

5. A new war on phosphorus ?



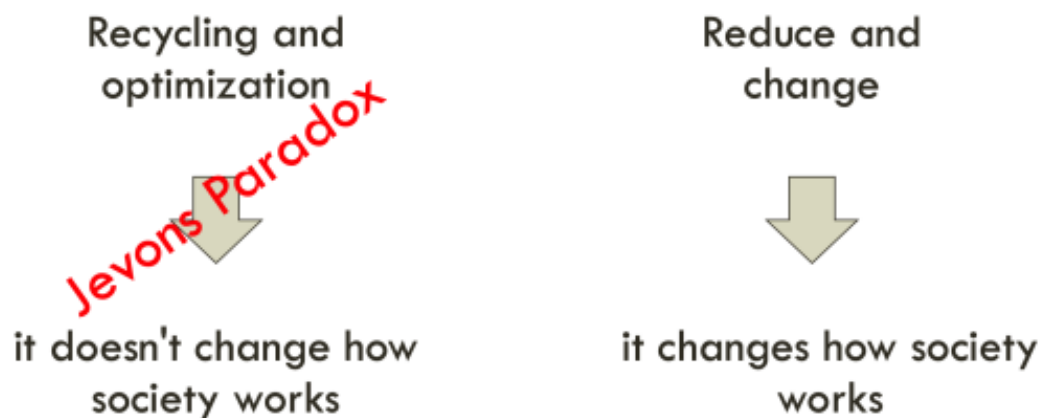


(Wikipedia, s.d.)

6. How can we ensure the safety of phosphate supplies?

Phosphorus security goals might therefore include:

1. "Increase number of people fed per tonne phosphorus input, or, reduce total phosphorus demand while maintaining food/agricultural output;
 2. Reduce dependence on phosphorus imports (to reduce vulnerability to geopolitical dynamics and thereby increasing long-term access to phosphorus);
 3. Ensure healthy soils (no phosphorus-deficiency, no phosphorus accumulation, balanced nutrition and presence of organic matter);
 4. Ensure farmers needs are met (e.g., maintaining or increasing productivity; ensuring access to phosphorus fertilisers);
 5. Reduce losses and wastage where avoidable;
 6. Reduce eutrophication and pollution by preventing phosphorus from the food system from entering waterways."
- 4/5 phosphorus mined for food production never actually reaches the food on our forks
 - Existence of a whole toolbox of phosphorus recycling and efficiency
 - Low tech and high tech phosphorus recovery in the sanitation sector to changing diets



7. Sustainable management of phosphorus

Possible solutions for the management of phosphate nutrition of tropical crops in the context of ecological intensification :

1. Making better use of the diversity of the plant world and genetic resources
2. Greater use of species assemblages in time and space

3. Make more efficient use of mineral and organic inputs
4. Assessing the potential of microbial inoculants and bio-effectors
5. Maintain and promote the activity of the soil's macrofauna
earthworms = ver de terre

(Hinsinger, 2015)