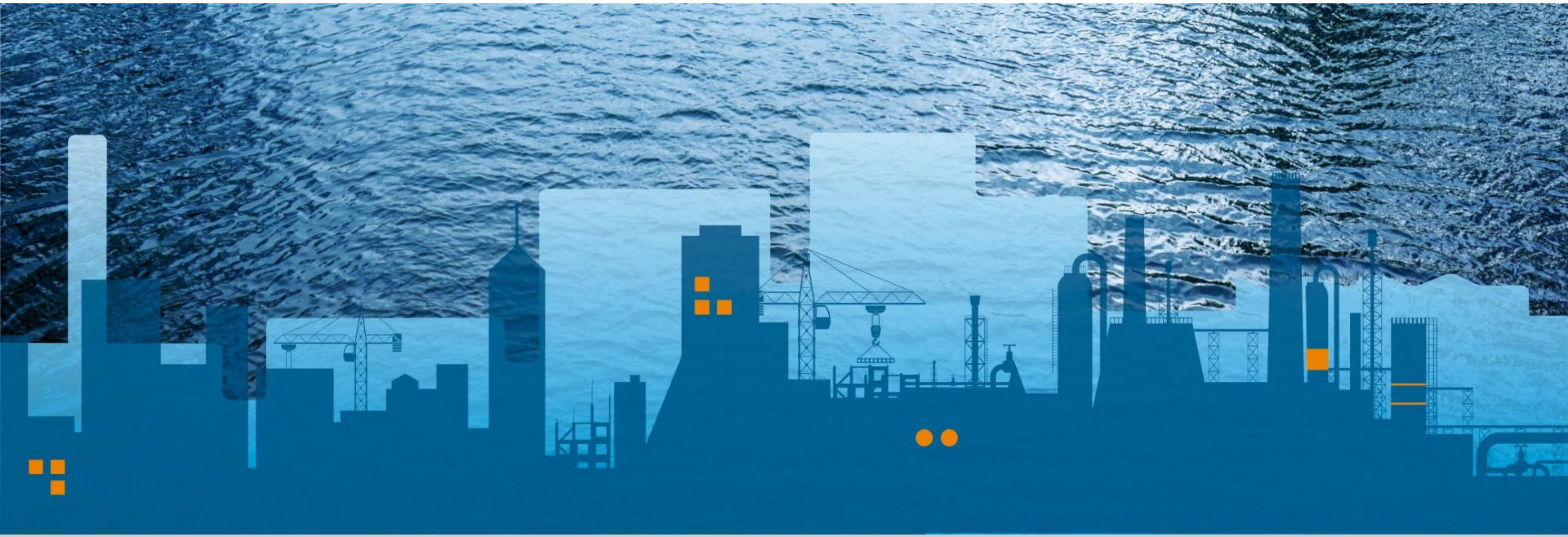
Phosphorus recovery from wastewater: strategies and technologies

Overview of driving forces and challenges



Event / Date
Gdansk/ 12.6.2018

Organisation John Nurminen Foundation
Contact Marjukka Porvari

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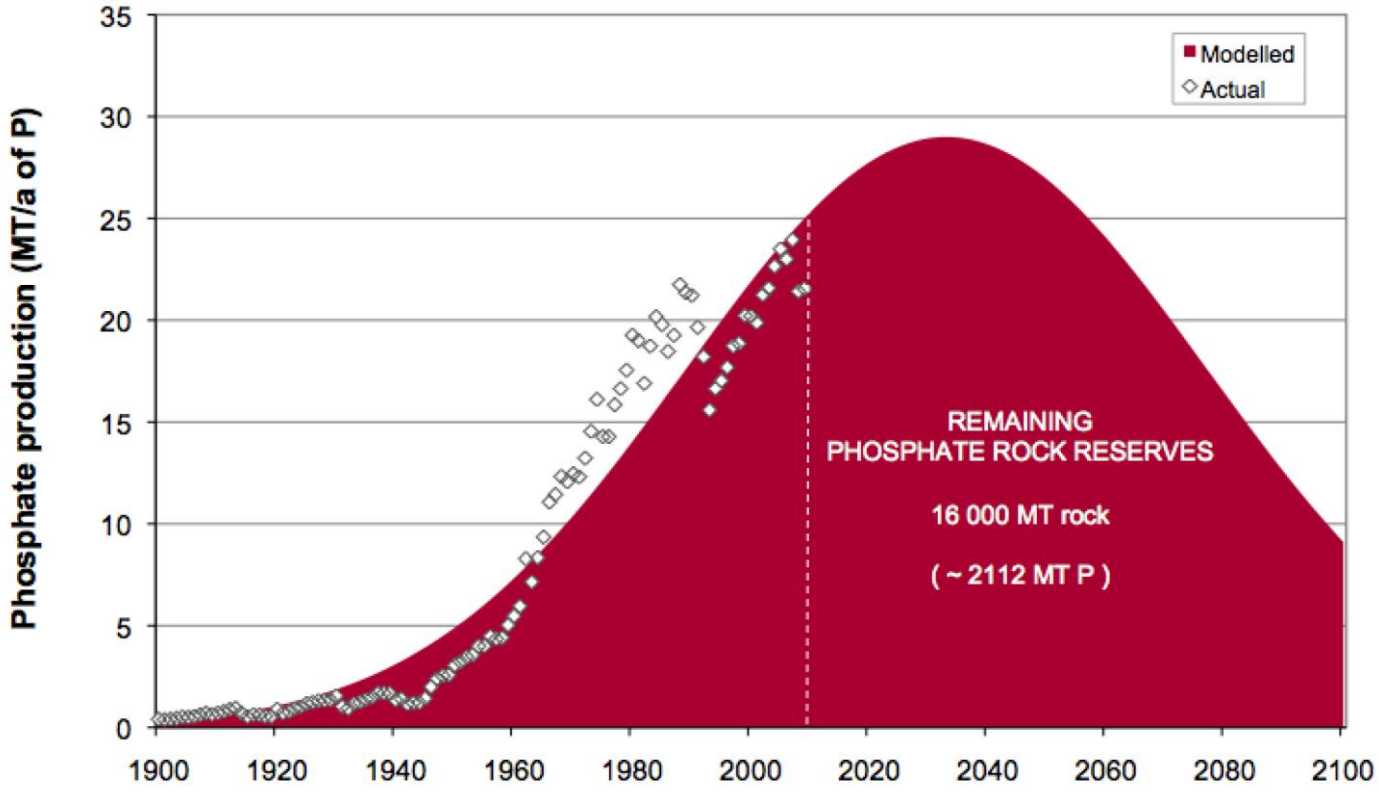
GLOBAL PHOSPHORUS RESERVES?



Source: http://www.mdpi.com/2071-1050/3/10/2027/htm

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NUTRIENT IMBALANCE IS A GLOBAL PROBLEM

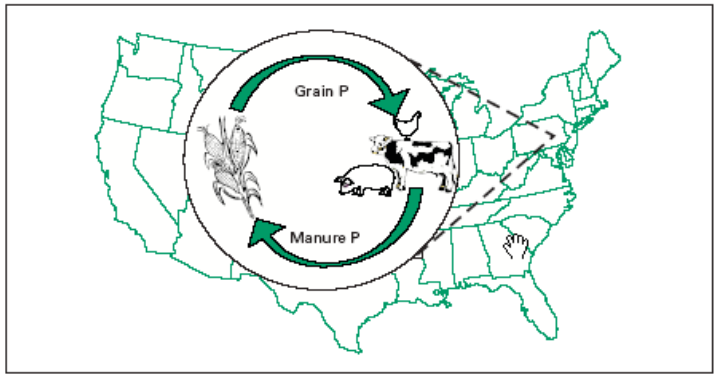


Figure 34-6. Before World War II, nutrient cycling was localized and sustainable within watersheds.

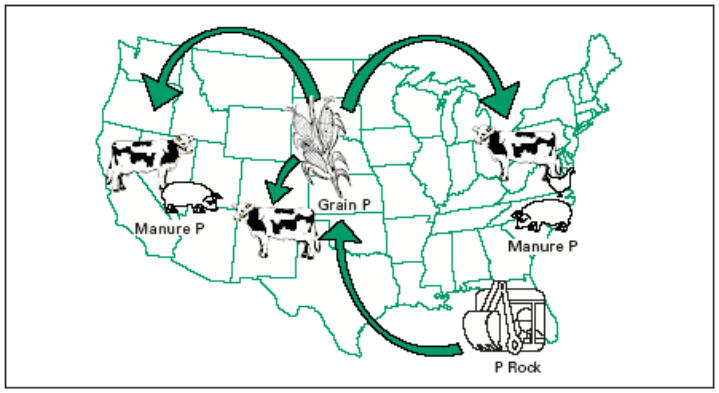
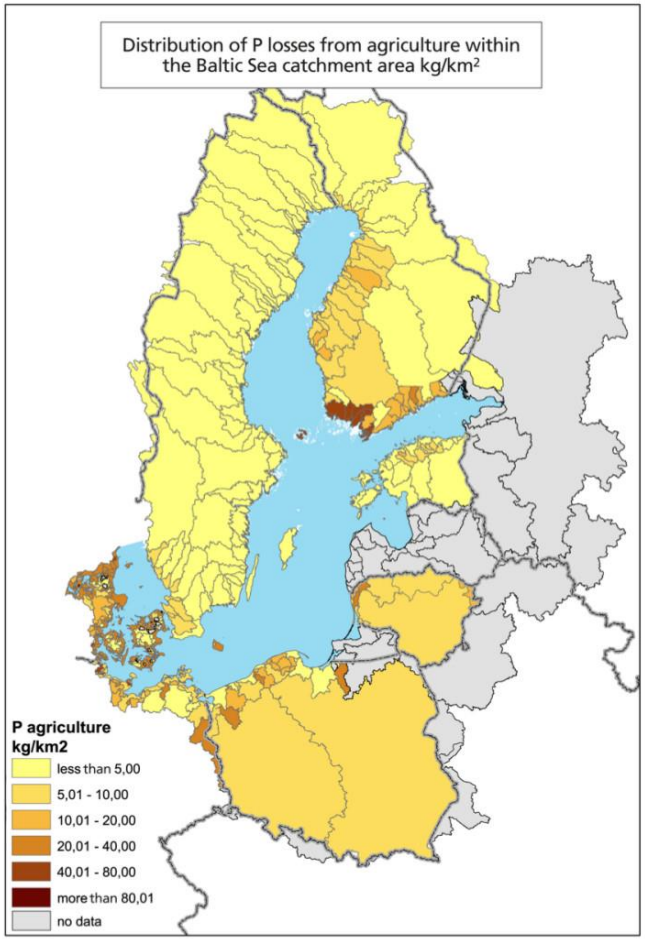


Figure 34-7 Since World War II, the nutrient cycle has been broken on a national level, with P tending to move from areas of grain production to areas of livestock production.

Source:http://www.lpes.org/Lessons/Lesson34/34_4_Phosphorus_Increase.pdf



Source: HELCOM PLC-6

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OVERABUNDANCE AND REGIONAL ACCUMULATION OF PHOSPHORUS

PHOSPHORUS USE EFFICIENCY VARIES GREATLY AROUND THE BALTIC SEA

	Outputs	Inputs			
Tons P	Crop harvest	Fertiliser	Livestock excreta	PUE*	Human excreta
Belarus	36 400	69 400	46 300	0,3	5 400
Denmark	45 400	11 200	55 200	0,7	7 200
Estonia	6 400	3 000	3 800	0,9	1 400
Finland	21 600	12 200	15 600	0,8	6 600
Germany	55 000	19 200	34 100	1	6 500
Latvia	12 700	7 100	5 900	1	2 300
Lithuania	25 300	14 400	12 200	0,9	4 100
Poland	165 100	170 300	154 000	0,5	45 000
Russia	4 500	2 600	16 800	0,2	13 200
Sweden	34 000	10 500	22 700	1	11 800
Total	406 400	319 900	366 600	0,6	103 500

Source: Stockholm University/Baltic Sea Centre. Policy Brief, Nov. 2017

MARKET FORCES ARE NOT YET THERE

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WWT SLUDGE IN AGRICULTURE - CHALLENGES

- Heavy metals: e.g. cadmium, chromium, mercury and lead from industry, copper and zinc from households
- Organic compounds such as polybrominated flame retardants and pharmaceuticals coming from households
- Microplastics an emerging issue

- Perception and fears of food industry, farmers and consumers

DIFFERENCES IN REGULATIONS AND RISK PERCEPTIONS OF WWT SLUDGE UTILISATION

Country (substance analyzed)	Cd	Cr	Cu	Hg	Ni	Pb	Zn	
FINLAND *(in sludge)*	3	300	600	2	100	150	1500	
SWEDEN *(in sludge)*	2	100	600	2.5	50	100	800	
DENMARK *(in sludge)*	0.8	100	1000	0.8	30	120	4000	
GERMANY *(in sludge)*	10 (5)*	900	800	8	200	900	2500 (2000)*	
EU Directive 86/278 *(in sludge)*	20-40	-	1000-1750	16-25	300-400	750-1200	2500-4000	

Source: Project PURE sludge handbook

PHOSPHORUS RECOVERY METHODS

aqueous phase	sewage sludge [SS]	sewage sludge ash [SSA]
REM-NUT®[1] [2; ion exchange, precipitation]	**Gifhorn process**[7] [4.1; wet-chemical leaching]	**AshDec® depollution**[12] [5; thermo-chemical, ash depollution, Cl-source: e.g., $MgCl_2$]
AirPrex®[2] [3.1; precipitation/crystallization]	**Stuttgart process**[8] [4.1; wet-chemical leaching]	**AshDec® Rhenania**[13] [5; thermo-chemical, Rhenaniaphosphat, Na_2SO_4]
Ostara Pearl Reactor®[3] [3.2; crystallization]	**PHOXNAN**[9] [4.2; wet-oxidation]	**PASCH**[14] [5; acidic wet-chemical, leaching]
DHV Crystalactor®[4] [3.2; crystallization]	**Aqua Reci®**[10] [4.2; super critical water oxidation]	**LEACHPHOS®**[15] [5; acidic wet-chemical, leaching]
P-RoC®[5] [3.2; crystallization]	**MEPHREC®**[11] [4.3; metallurgic melt-gassing]	**EcoPhos®**[16*] [5; acidic wet-chemical, leaching, P-acid production]
PRISA[6] [3.2; precipitation/crystallization]		**RecoPhos®**[17] [5; acidic wet-chemical, extraction]
		Fertilizer Industry[18*] [5; acidic wet-chemical, extraction]
		Thermphos (P_4)[19*,**] [5; thermo-electrical]

Source: L. Egle, H. Rechberger, J. Krampe , M. Zessner 2016: Phosphorus recovery from municipal wastewater: An integrated comparative technological, environmental and economic assessment of P recovery technologies. Science of the Total Environment.

PHOSPHORUS RECOVERY - CHALLENGES

- Costs much higher than in traditional usage of sewage sludge in agricultural fields
- Quality of end products:
  - P content varies, low in some methods
  - Hazardous substances: heavy metal contents high when recovering P from ashes, the amount of micropollutants often unknown
  - Plant availability of P may be low in some methods
- Technological maturity: most processes still in piloting phase

THANK YOU!

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