Environmental benefits and cost-competitiveness of circular fertilisers

Lubos JURIK (SUA Nitra SK/ NENUPHAR)

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This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N° 101060426.

How do circular fertilizers help us replace the use of energy-intensive synthetic fertilisers and protect the health of our soils and the surrounding ecosystems?

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NENUPHAR

New governance models to enhance nutrient pollution handling and nutrients recycling

GA n° 101082169

fer play

Final Conference, Brussels 18-19 Feb 2025

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NENUPHAR

New governance models to enhance nutrient pollution handling and nutrients recycling

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Project review

circe
Creating together

NENUPHAR

New governance models to enhance nutrient pollution handling and nutrients recycling

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Partners:

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NENUPHAR

GOAL

New governance and circular value chain solutions addressing the recovery of N and P from three key waste streams with high nutrient load and widely present in the EU: manure, sewage sludges and dairy wastewaters (DWW).

NENUPHAR developments will be addressing four main innovations:

- Methodology for estimating N/P emissions from the application of a fertiliser on soil to allow a more effective control and monitoring of nutrients pollution.
- New governance models based on a network governance approach.
- Innovative economic and financial incentives for public and private entities.
- Set of enabling technologies to treat the manure, sludges and dairy wastewaters to recover the nutrient loads.

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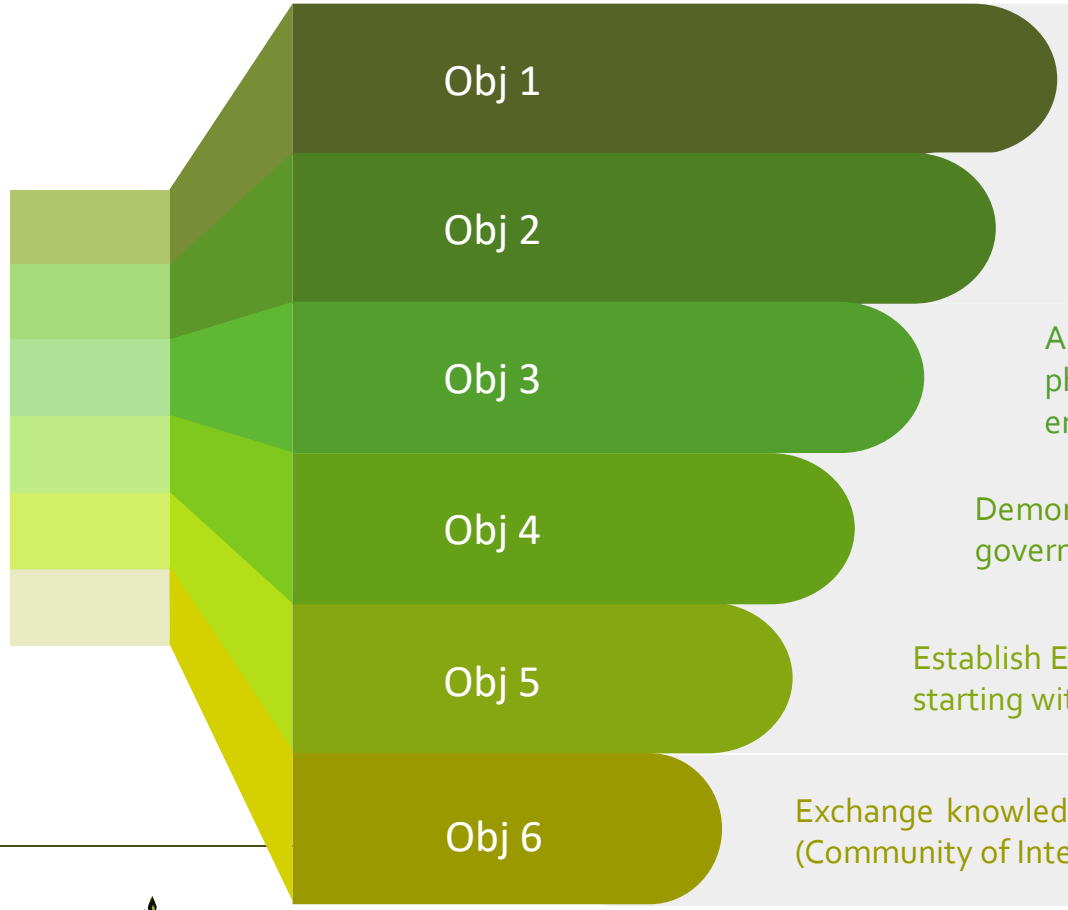
SPECIFIC OBJECTIVES



Foster multi-level stakeholder collaboration and establish enduring governance for effective and circular nutrient flow management.

Map and address nitrogen and phosphorus pollution flows through predictive, monitoring, control, and recovery solutions.

Analyze regulatory, political, and financial aspects of nitrogen and phosphorus emissions management, offering recommendations for enhanced policies and funding schemes.

Demonstrate circular N and P use in three river basins, applying governance solutions and treatment processes at real scale (TRL7/8).

Establish EU-wide community and roadmap for NENUPHAR solutions, starting with the follower clusters in Denmark and Cyprus.

Exchange knowledge with past projects, build a professional community (Community of Interest), and prepare for replicating NENUPHAR insights.

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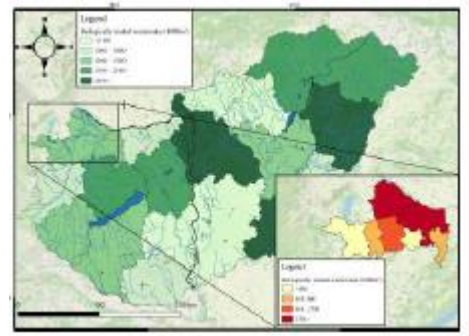
FRAMEWORK

Promising wastes:

Main demo-sites

- animal manures → SPAIN
  - River basin ➔ Ebro
  - Drainage sea ➔ Mediterranean Sea
  - Tech ➔ Ammonia stripping
- sewage waste (sludges) → LATVIA, LITHUANIA
  - River basin ➔ Lielupe
  - Drainage sea ➔ Baltic Sea
  - Tech ➔ Composting
- food chain waste (dairy wastewaters) → HUNGARY, SLOVAKIA
  - River basin ➔ Danube
  - Drainage sea ➔ Black Sea
  - Tech ➔ 1. Membrane with pre-oxidation
    2. Nature-based solution



Followers

- DENMARK → Drainage sea ➔ Baltic Sea; Waste ➔ Sludge, manure and wastewater
- CYPRUS → Drainage sea ➔ Mediterranean Sea; Waste ➔ Sludge and wastewater

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NENUPHAR Teams

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NENUPHAR Project goals

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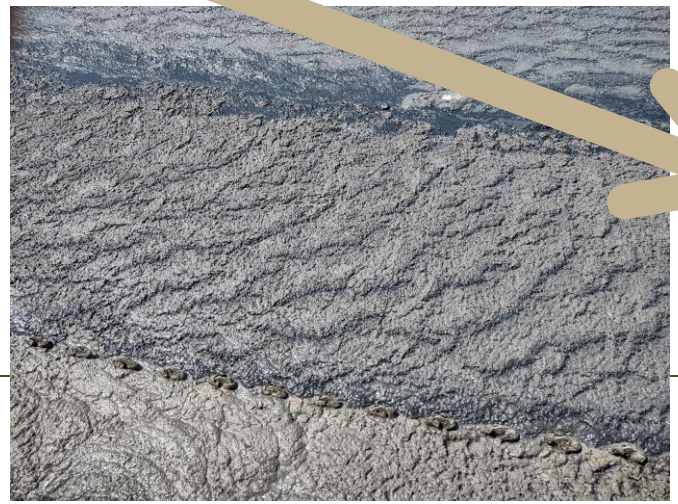
Otputs



The BBFs obtained as recovered N/P

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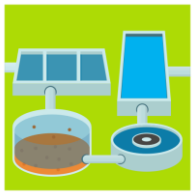
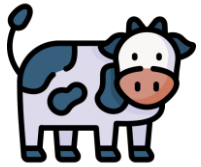
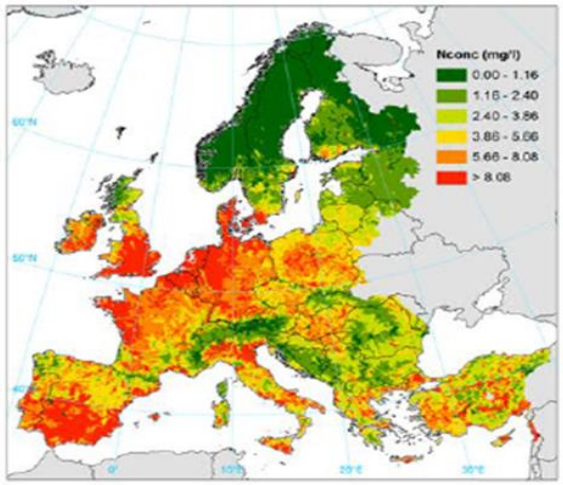
NENUPHAR

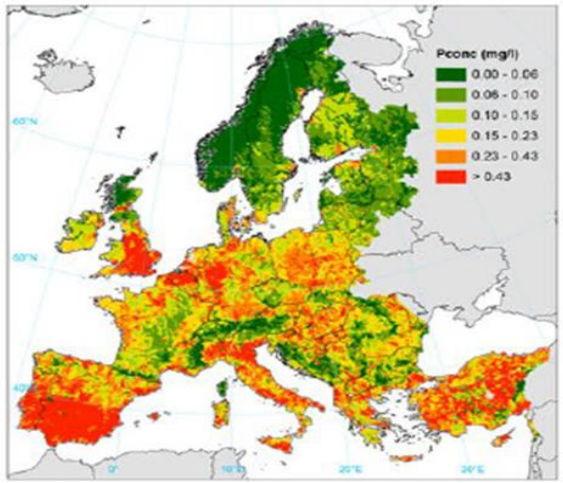
Wastes

- animal manures  → 1,400 million tons per year in EU
- sewage waste (sludges)  → 9 millions tons (dry matter) per year in EU
- food chain waste (dairy wastewaters)  → 926 million m³ per year in EU

2-5 Mt of N

0.6 Mt of P →





Grizzetti, B., Pistocchi, A., Liquete, C. *et al.* (2017) Human pressures and ecological status of European rivers. *Sci Rep* 7, 205.

m the European Union's search and innovation programme under grant agreement N° 101060426.

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Brussels, 11.3.2020
COM(2020) 98 final
COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS
A new Circular Economy Action Plan

For a cleaner and more competitive Europe

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N° 101060426.

A new Circular Economy Action Plan

3.7.Food, water and nutrients

The circular economy can significantly reduce the negative impacts of resource extraction and use on the environment and contribute to restoring biodiversity and natural capital in Europe.

Biological resources are a key input to the economy of the EU and will play an even more important role in the future.

The Commission will aim at ensuring **the sustainability of renewable bio-based materials.**

The Commission will launch the analytical work to determine the scope of a legislative initiative on reuse to substitute single-use packaging, tableware and cutlery by reusable products in food services.

The new Water Reuse Regulation will encourage circular approaches to water reuse in agriculture. The Commission will facilitate water reuse and efficiency, including in industrial processes.

Furthermore, the Commission will develop an Integrated Nutrient Management Plan, with a view to ensuring more sustainable application of nutrients and stimulating the markets for recovered nutrients. The Commission will also consider reviewing directives on wastewater treatment and sewage sludge and will assess natural means of nutrient removal such as algae.

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4.2.Enhancing circularity in a toxic-free environment

A new Circular Economy Action Plan

EU chemicals policy and legislation, in particular REACH, encourage a shift to 'safe-by-design chemicals' **through the progressive substitution of hazardous substances to better protect citizens and the environment.**

However, the safety of secondary raw materials can still be compromised, for instance, where banned substances persist in recycled feedstock. To increase the confidence in using secondary raw materials,

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4.2.Enhancing circularity in a toxic-free environment

the Commission will:

·support the development of solutions for high-quality sorting and removing contaminants from waste, including those resulting from incidental contamination;

·develop methodologies to minimise the presence of substances that pose problems to heatlh or the environment in recycled materials and articles made thereof;

··improve the classification and management of hazardous waste so as to maintain clean recycling streams, including through further alignment with the classification of chemical substances and mixtures where necessary.

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FER-PLAY

With the official title “Multi-assessment of circular fertilisers for promoting local sustainable value chains and clean ecosystems“, FER-PLAY is advancing the use and production of circular fertilisers, supporting Europe in its transformation to a more circular and resource-independent economy while safeguarding ecosystem health.

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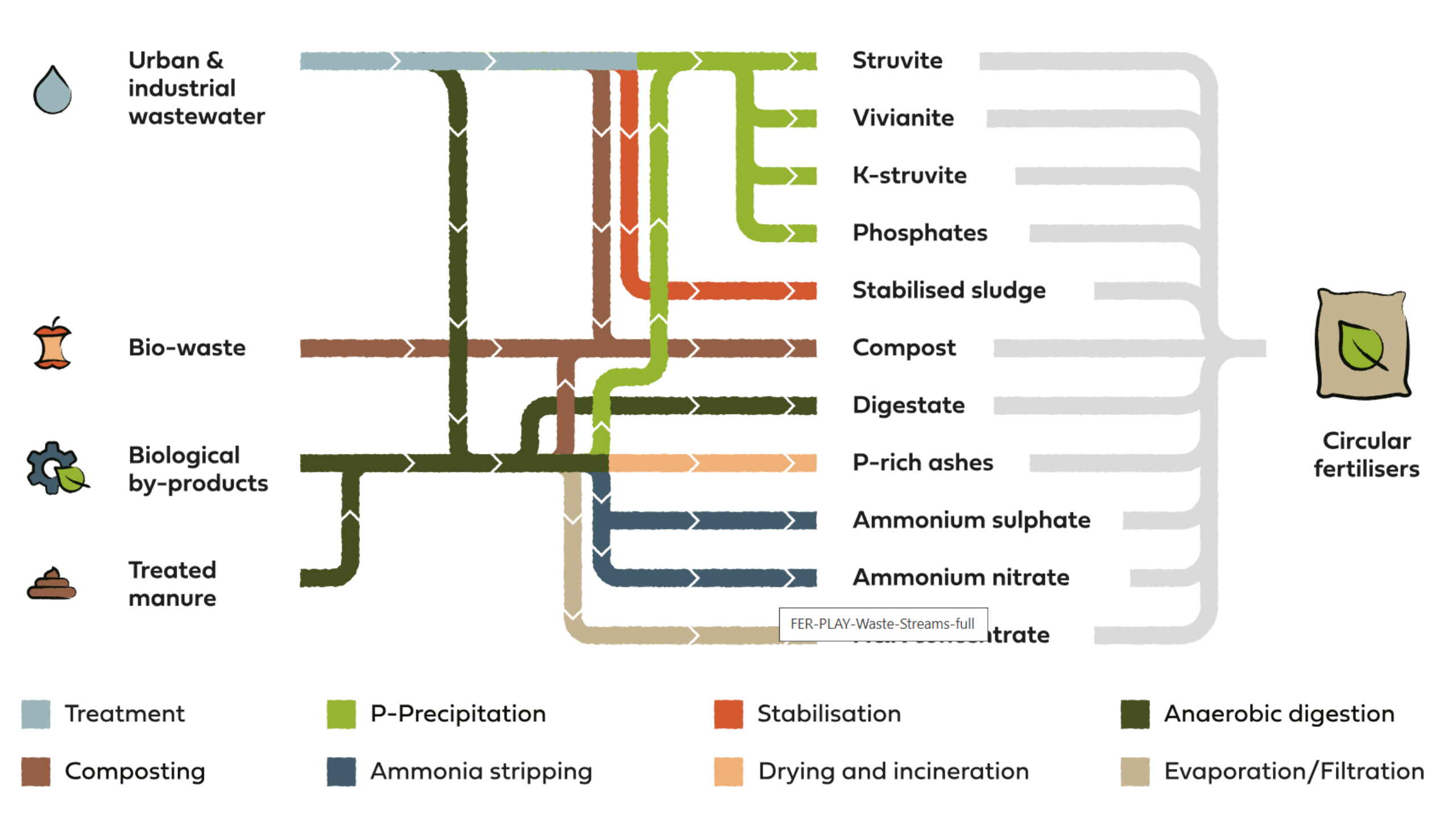
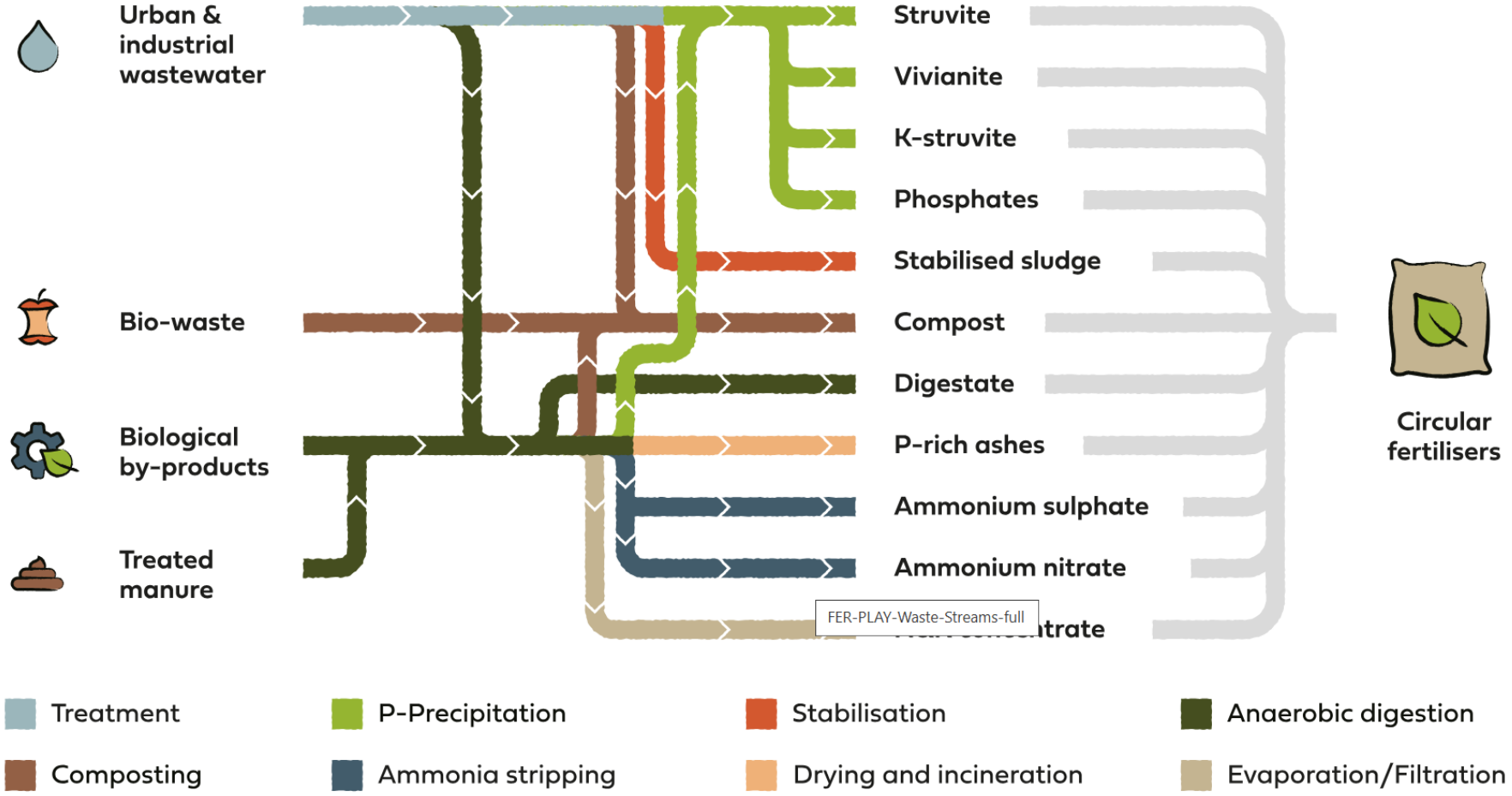

Urban & industrial wastewater
Bio-waste
Biological by-products
Treated manure
Struvite
Vivianite
K-struvite
Phosphates
Stabilised sludge
Compost
Digestate
P-rich ashes
Ammonium sulphate
Ammonium nitrate
Circular fertilisers
FER-PLAY-Waste-Streams-full
Treatment
P-Precipitation
Stabilisation
Anaerobic digestion
Composting
Ammonia stripping
Drying and incineration
Evaporation/Filtration



The Commission will also consider reviewing directives on wastewater treatment and sewage sludge and will assess natural means of nutrient removal such as algae.

In the documents there is a text about sludge, but in the FER - PLAY schemes it is with biomethods - e.g. algae does not consider...

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REGULATION (EU) 2019/1009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 June 2019
laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003

CMC 2: PLANTS, PLANT PARTS OR PLANT EXTRACTS

An EU fertilising product may contain plants, plant parts or plant extracts having undergone no other processing than cutting, grinding, milling, sieving, sifting, centrifugation, pressing, drying, frost treatment, freeze-drying or extraction with water or supercritical CO_2 extraction.

For the purpose of this point, plants include mushrooms and algae and exclude blue-green algae (cyanobacteria).

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ORGANIC FERTILISER

A fertiliser shall be an EU fertilising product the function of which is to provide nutrients to plants or mushrooms. PFC 1(A): ORGANIC FERTILISER

An organic fertiliser shall contain:

- **organic carbon (Corg) and**
- **nutrients of solely biological origin.**

An organic fertiliser may contain peat, leonardite and lignite, but no other material which is fossilized or embedded in geological formations.

Contaminants in an organic fertiliser must not exceed the limit values:

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Screening studies in Europe have shown the presence of hundreds of chemical substances in treated wastewater. For example, 366 substances were detected in waters from 56 European WWTPs (Finckh et al., 2022), and 280 substances were identified in waters from 12 WWTPs in the Danube basin (Alygizakis et al., 2019).

Thousands of compounds were detected in wastewater by non-targeted screening in the study by García-Vara et al. (2023). Of these, 158 substances were identified in a targeted manner and 119 substances were detected in the water at the point of use for irrigation.

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ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE
Fakulta agrobiologie, potravinových a přírodních zdrojů

Treatment of sewage sludge by the method of torrefaction and pyrolysis for their safe use in agriculture
CERTIFIED METHODOLOGY
Pavel Tlustoš et al.

Zpracování čistírenských kalů metodou torefakce a pyrolýzy pro jejich bezpečné použití v zemědělství

certifikovaná metodika

Pavel Tlustoš a kol.

Katedra agroenvironmentální chemie a výživy rostlin, FAPPZ
165 00 Praha-Suchdol
http://www.af.czu.cz

Vydavatelství Česká zemědělská univerzita v Praze

ISBN 978-80-213-3159-4

Praha 2021

Certifikovaná metodika byla zpracována v rámci řešení výzkumného projektu NAZV č. QK1710379

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gramme under

Dry matter and essential nutrient content in sludges (n = 60) collected in 2017–2020

	Sušina	N	P	K	S
	(%)	(g/kg suš.)			
Average	24,6	46,7	27,1	3,8	12,4
Median	23,6	45,4	27,6	3,5	11,7
Min	12,3	20,1	18,2	2,3	7,1
Max	96,0	72,8	40,2	9,1	21,1
Coeff. of variation	44,1	25,3	19,3	30,1	26,6

Pavel Tlustoš et al.

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Content of hazardous elements in sludges collected in 2017–2020 (n = 60)

	As	Cd	Cr	Cu	Hg*	Ni	Pb	Zn
	mg/kg suš.							
Average	11,6	1,80	89,5	364	1,93	49,3	40,6	1038
Median	7,70	1,10	46,1	201	1,50	32,5	28,6	882
Min	3,80	0,25	20,0	77	0,30	14,6	10,6	355
Max	65,9	15,6	1211	2493	14,1	260	343	4313
Coeff. of variation	104	144	198	131	104	107	121	56,0

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Lettuce grown on soil (A: fluvial – Cítov, B: cambium) with additions of pyrolyzed materials in an experiment to verify the transfer of pharmaceutical residues from sewage sludge to biomass

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Drug residue content in lettuce leaves grown (pH (CaCl2) = 7.0) after application (2 wt. %) of dried and pyrolyzed sewage sludge (µg/kg dry matter)

Sloučenina	Kontrola	Kal	Kal	Kal	Kal	Kal	Kal
(µg/kg suš.)	bez kalu	sušený	220 °C	320 °C	420 °C	520 °C	620 °C
Carbamazepin	<MQL	5,3^{b*}	0,1^{a}	0,1^{a}	<MQL	<MQL	<MDL
Ethenzamid	<MDL	1,4^{b}	0,5^{ab}	0,4^{a}	<MQL	<MDL	<MQL
Mirtazapin	<MDL	4,0	<MQL	<MDL	<MDL	<MDL	<MDL
N-desmethyl tramadol	<MDL	0,3^{b*}	0,1^{a}	0,1^{a}	<MDL	<MDL	<MDL
Propafenon	<MDL	3,5^{b*}	0,1^{a}	0,2^{a}	<MDL	<MDL	<MDL
Sertralin	<MDL	4,0^{b}	0,1^{a}	<MQL	<MQL	<MDL	<MDL
Solifenacin	0,2^{a}	1,9^{a}	1,0^{a}	1,1^{a}	1,0^{a}	0,9^{a}	1,2^{a}
Tramadol	0,4^{a}	2,2^{b}	0,5^{a}	0,4^{a}	1,8^{a}	1,6^{a}	1,7^{a*}
Trazodon	<MDL	0,3	<MQL	<MDL	<MDL	<MDL	<MDL
Venlafaxin	<MDL	0,3	<MDL	<MDL	<MDL	<MDL	<MDL

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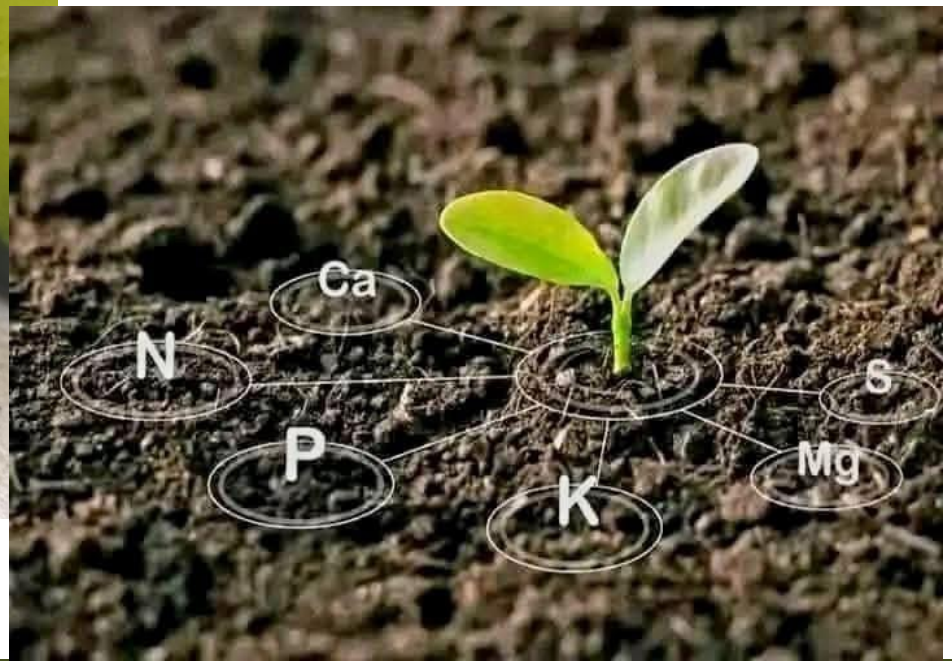
Our research NENUPHAR



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Conclusions and recommendations

Many studies focus on the problem of waste management in urban areas - sewage sludge
Sewage sludge is not only a source of nutrients and organic matter but also a significant source contaminated with heavy metals or residues of hazardous substances
It is necessary to compare the benefits of its use and environmental but especially health risks

Waste from the food industry or processing of other organic substances seems more suitable.

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Thank you for your attention

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