Castilla-La Mancha

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Evaluación de la recuperación del nitrógeno de las aguas residuales urbanas y su valorización mediante la producción de fertilizantes

CENTRO DE REFERENCIA NACIONAL

ENERGÍA ELÉCTRICA, AGUA Y GAS

25 mayo 2022

LA FORMACIÓN COMO PALANCA DE INNOVACIÓN EN EL SECTOR DEL AGUA

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Álvaro Mayor Pillado

Project Manager

Cetaqua

amayor@cetaqua.com

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CETAQUA
WATER TECHNOLOGY CENTRE

Modelo de colaboración público-privada creado para garantizar la sostenibilidad y la eficiencia del ciclo integral del agua, teniendo en cuenta las necesidades locales.

Este modelo se ha consolidado como un referente en la aplicación del conocimiento científico al agua y al medio ambiente, creando productos y servicios en beneficio de la sociedad.

CETAQUA BARCELONA

CETAQUA GALICIA

CETAQUA ANDALUCÍA

CETAQUA CHILE

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ESCUELA DEL AGUA

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www.laescueladelagua.com

- Agbar, con más de 150 años de experiencia, es el grupo empresarial de referencia en gestión de agua y medioambiente en España y Latinoamérica.

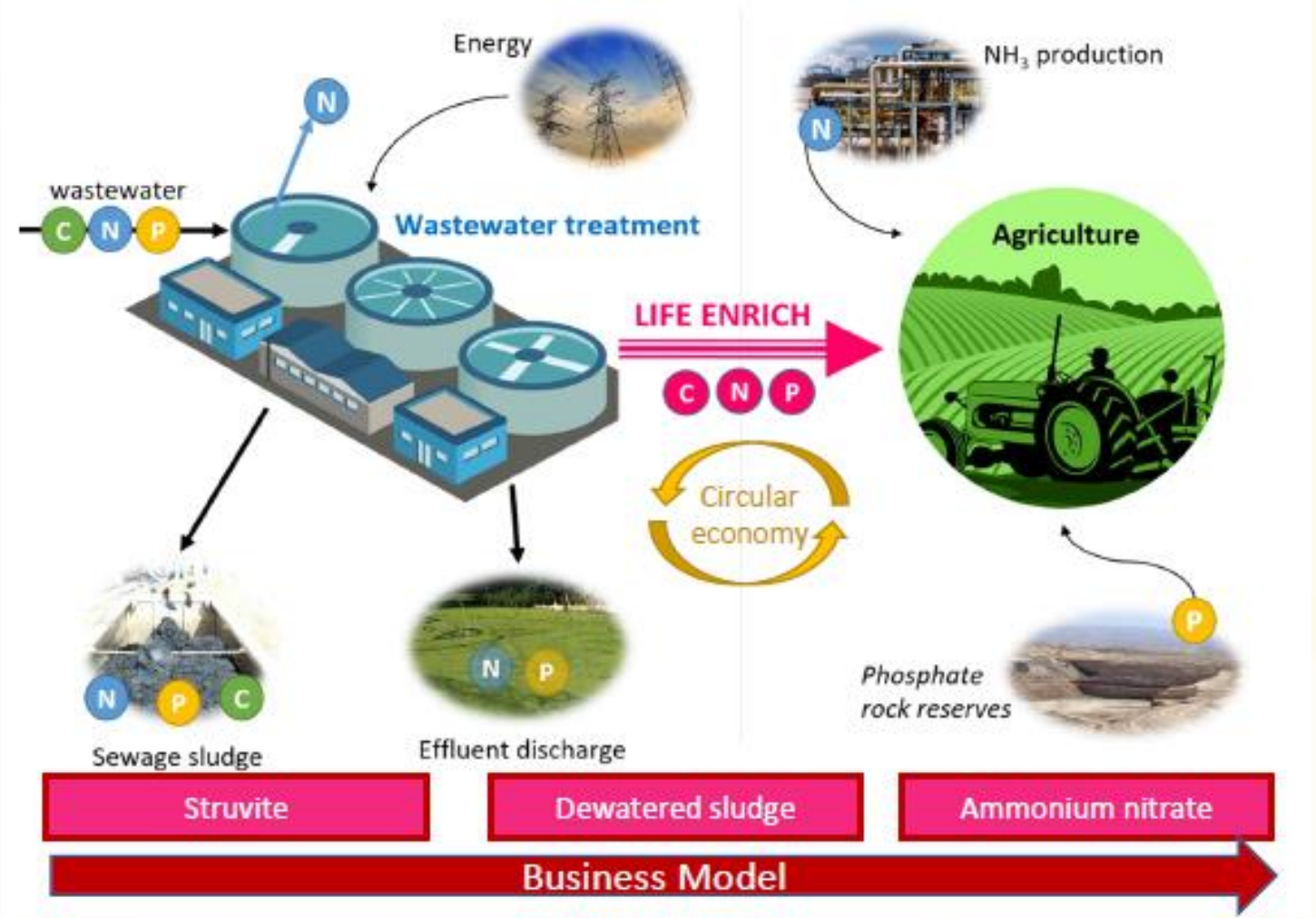
- Escuela del Agua es la institución de Agbar creada en 2012 para compartir conocimiento en materia de agua y medioambiente.

- Su actividad se dirige tanto a la formación para **empresas, administraciones y profesionales** del mundo del agua como a la **ciudadanía en general**, desarrollando desde proyectos de formación y capacitación hasta programas de educación y sensibilización en materia ambiental.

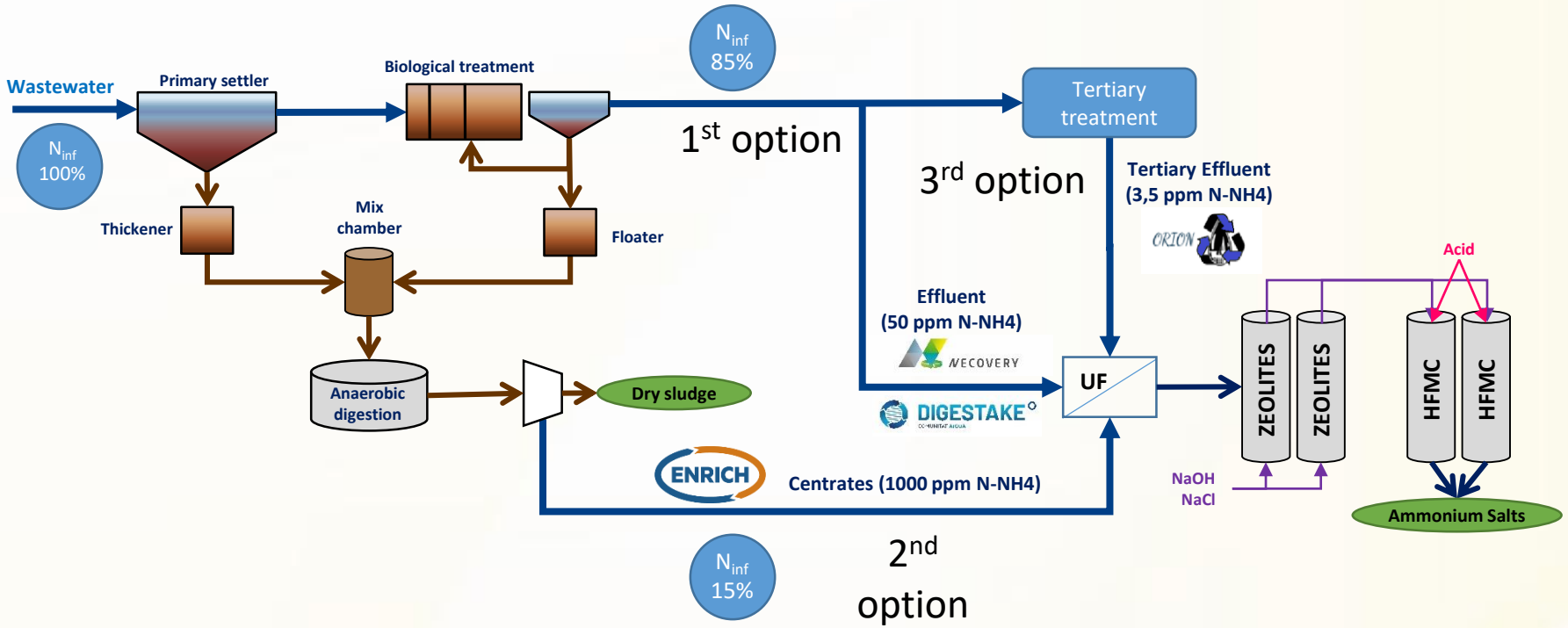
- Los programas formativos **cubren todos los ámbitos del ciclo integral del agua** utilizando **diversas metodologías** presenciales y online, que facilitan una experiencia de aprendizaje única y una **aplicabilidad inmediata** de las competencias desarrolladas a los puestos de trabajo.

Nutrient recovery in WWTPs

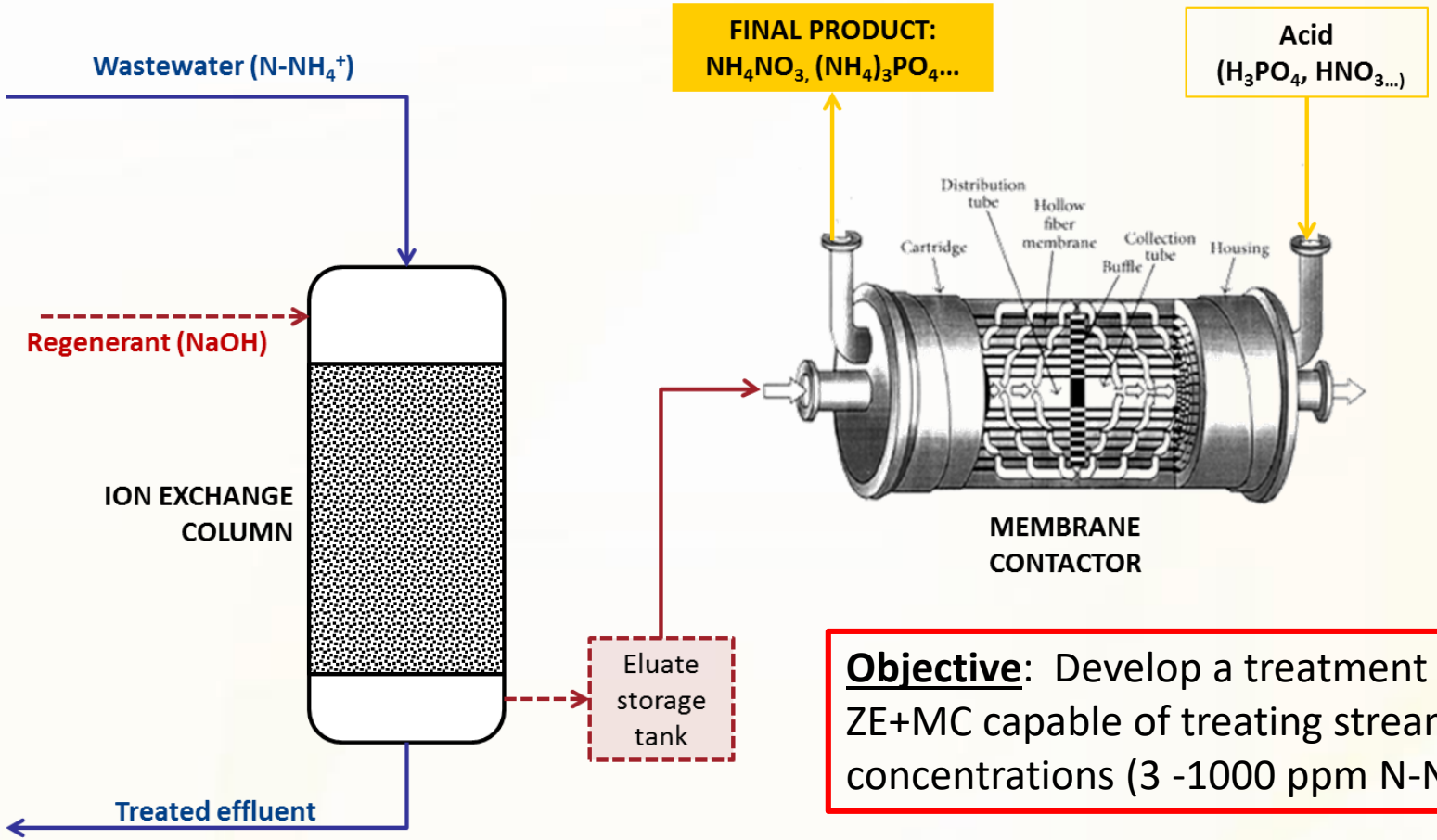
Recovery of nutrients from WWTPs and its **valorization in agriculture**



Nitrogen Recovery

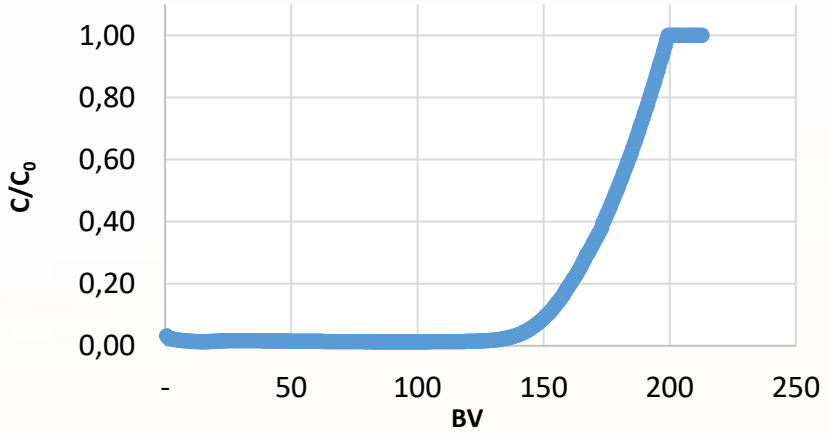


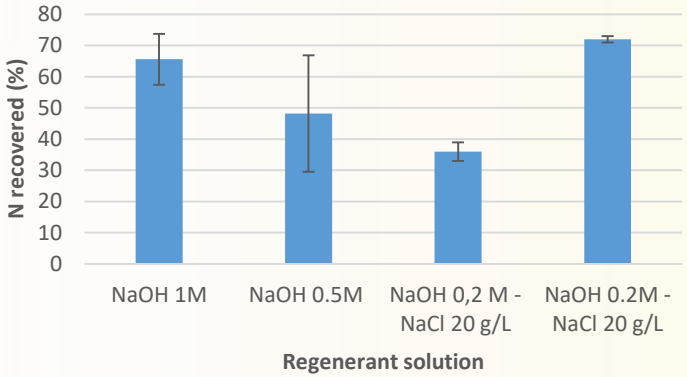
Treatment train



Objective: Develop a treatment train based on ZE+MC capable of treating streams with different concentrations (3 -1000 ppm N-NH4)

Main line results: Zeolites

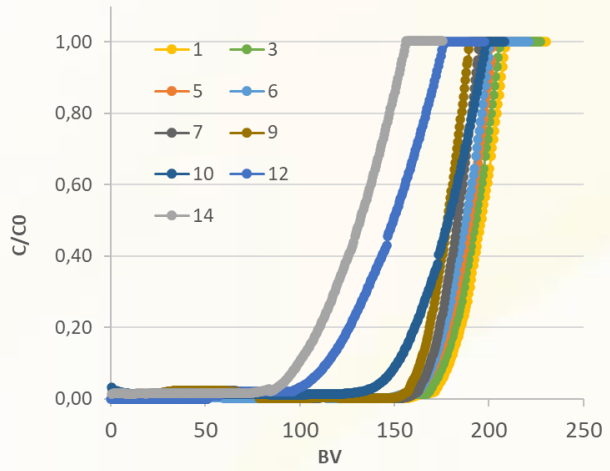




Ultra low N-NH_4^+ concentration (< 1 ppm) in the effluent during adsorption

High recovery capacity in real conditions (>70%)

Average NH_4^+-N influent (mg/l)	54.3 ±10.3
CEC (0,5-1mm) (g N-NH_4 /kg zeolite)	10 ±2.5
CEC (1-2,5mm) (g N-NH_4/kg zeolite)	3.2 ±1.6
Feed flow (BV/h)	7±1



0.5 – 1 mm zeolites increases the process efficiency which implies a 66% cost reduction compared to 1-2.5 mm

Similar adsorption capacities for 10 cycles (0,5-1 mm zeolite). Zeolites reposition may represent 50% of the OPEX

Main line results: Membrane contactors

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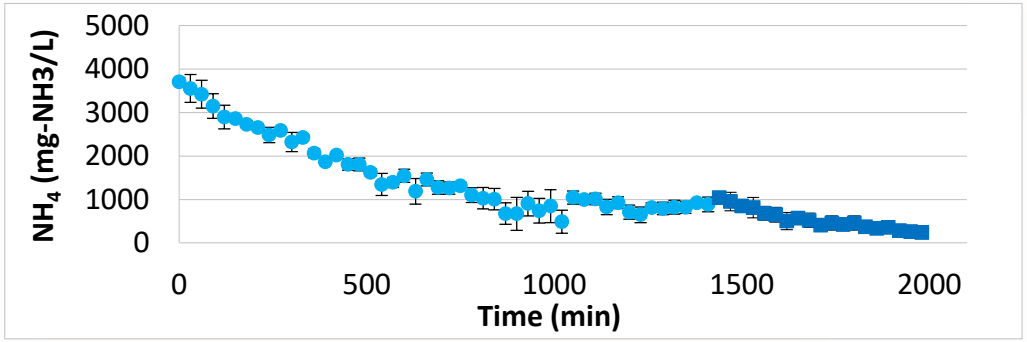
❑ *Effect of two steps*



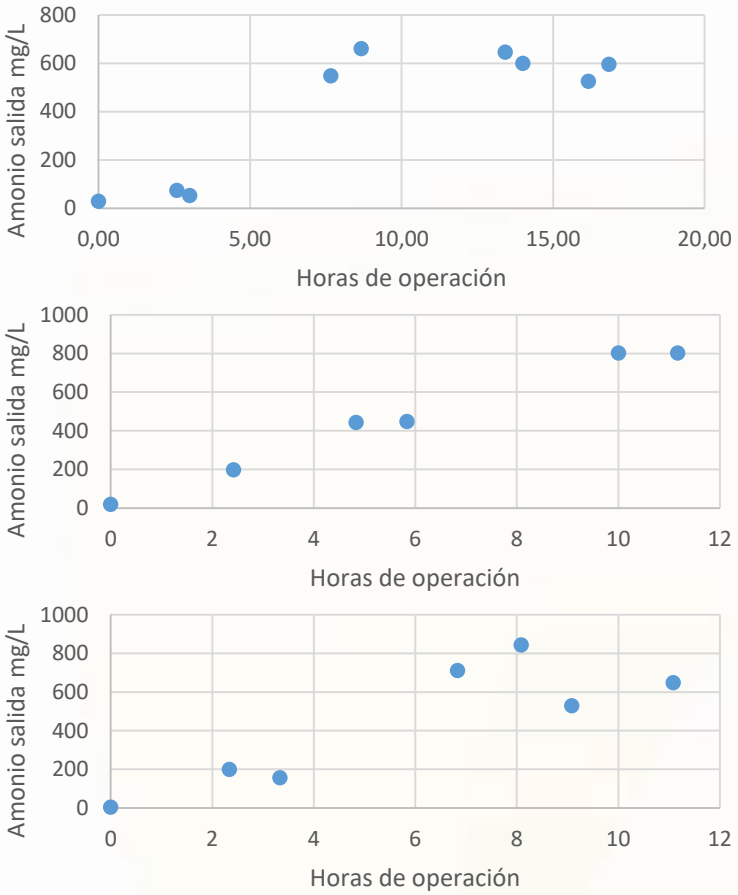
Two steps increase overall removal efficiency but produces a second salt with lower agronomic value

❑ *Examples of acids produced*

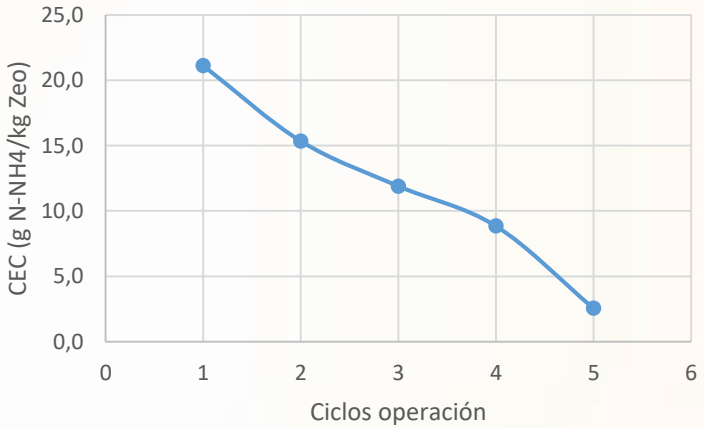
Stripping acid	N-NH4 (%)	N-NO3 (%)	$P\text{-}P_2O_5$ (%)	N-Urea (%)
Nitric	7,7	5,5	-	-
Phosphoric	10,5	-	27,5	-

Possibility to produces fertilizers on demand

Sidestream results: Zeolites

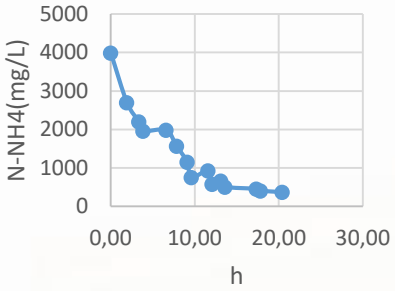


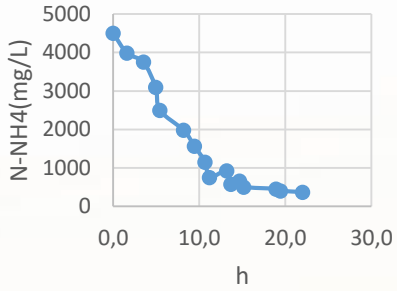
Operating conditions	
Flow (L/h)	450
Regenerant	NaOH 0.2 M
Regeneration (min)	50

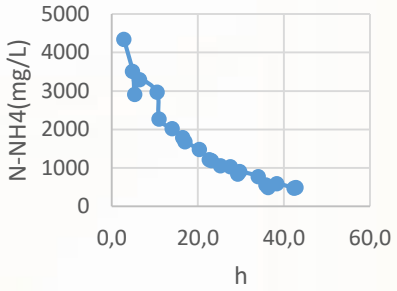


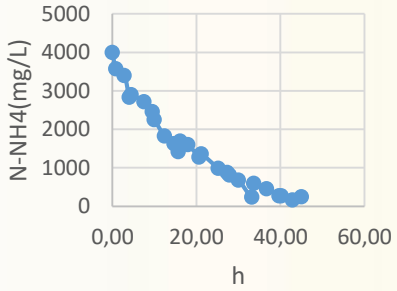
- ✓ Up concentration from 600 mg/L to 4-6g/L (CF between 6-10)
- ✓ Cation exchange capacity= 20-25 g N-NH4/kg Zeolite
- ✓ Zeolites regeneration between adsorption cycles
- ✓ 77% N recovery

Sidestream results: Membrane contactors









Fertilizer	N-NH4 (g/L)	N-NO3(g/L)	Nt (%)	FC (N-NH4)
1	9.7	67.30	7.7	10.8
2	22.6	235.46	25.8	25.1
3	15.3	95.04	11.0	17.0
4	8.2	65.79	7.4	9.1
5	12.4	101.40	11.4	13.7
6	14.4	140.46	15.5	16.0
7	13.2	69.33	8.3	14.7
8	18.4	148.01	16.6	20.4
9	12.3	127.12	13.9	13.7
Target	118	118	23,6	131

- Up to 91% of N-NH4 removed from feed stream
- Evaporation towards NH_3 must be considered
- Critical pH control

Conclussions

- ✓ N recovery efficiency 70% (77% zeolites; 91% membrane contactors)
- ✓ Zeolites regeneration between adsorption cycles
- ✓ Ntot 7-15%w in ammonium nitrate (50% from N recovery)
- ✓ Ammonium nitrate free of metals and micropollutants

Field tests

fertirrigation treatments

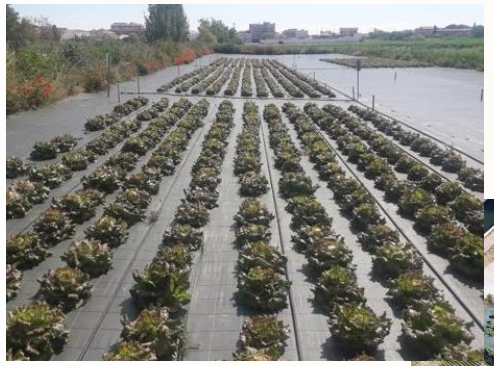
1. STRuvite
2. SANitrate
3. CONtrol

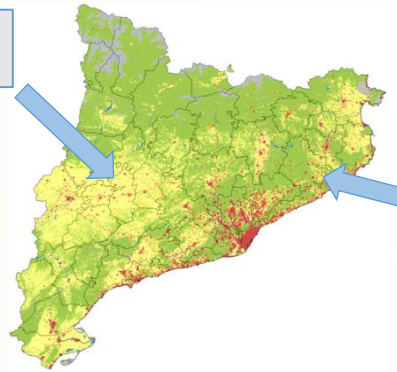
2 growing seasons
Fertigation system
3 cultivated species



Lleida (Agramunt and Castelldans)

Open-air conditions



Cabrils

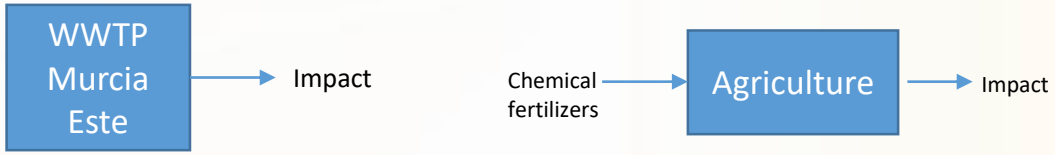
Greenhouse controlled conditions

Perlite

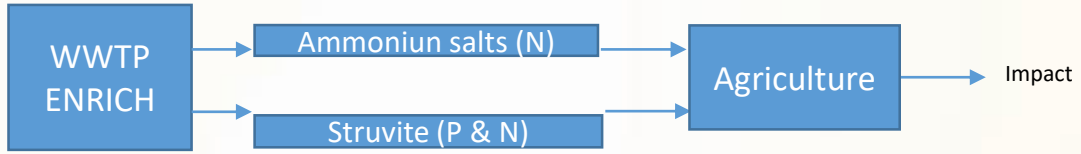
Soil

LIFE cycle Assessment

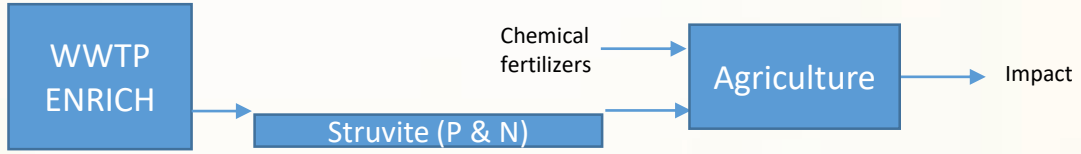
- **Base case:** nutrient removal at WWTP, application of chemical fertilizers



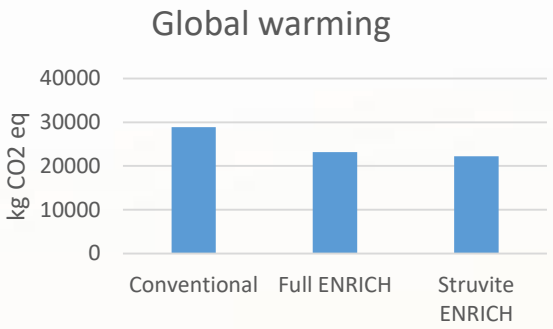
- **Full ENRICH case:** P & N recovery at WWTP through struvite and ammonium salts, full P & N fertilization from recovered fertilizers.

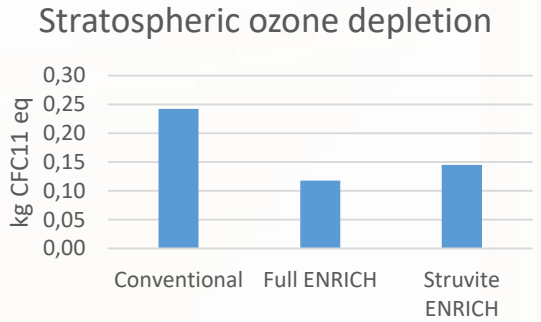


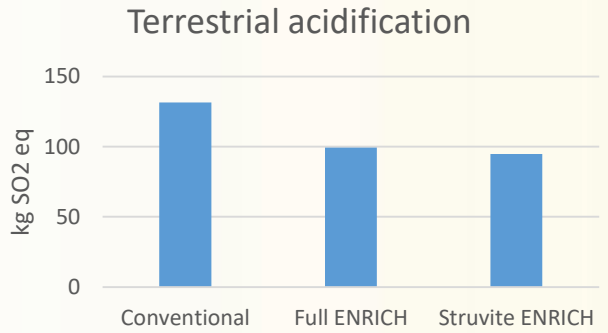
- **Struvite ENRICH case:** P & N recovery at WWTP through struvite. Full P and partial N fertilization from struvite. Partial N fertilization with chemical fertilizers.

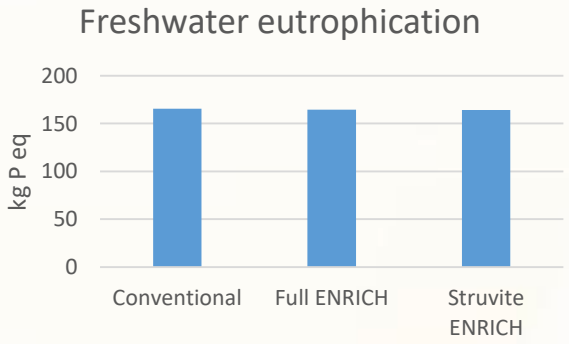


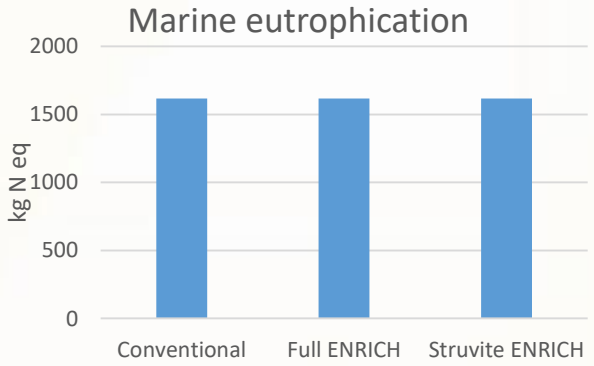
LIFE cycle Assessment

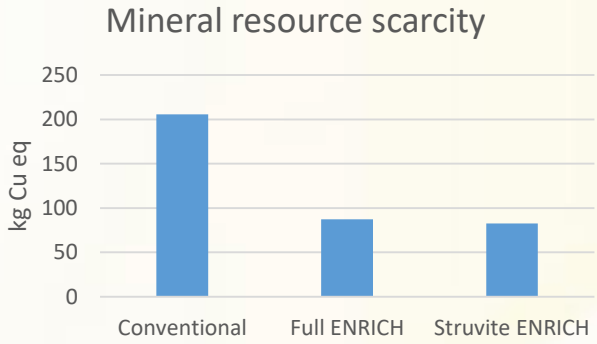












❑ *Zeolites*

Main line

1. Zeolites recovers N in effluents with high efficiency achieving **less than 1 ppm of N-NH_4.**
2. Recovery has a higher cost (**2-4 €/ kg N-NH_4 removed**) than conventional removal N/DN **(1€/ kg N-NH_4 removed)** but provides other benefits.

Sidestream

1. Zeolites may operate at lower cost than Anammox **(0.8-1.5 vs 2.5-3€/kg N removed)**.
2. Pretreatment is required to remove COD and TSS.

Tertiary treatment (polishing)

1. Capacity of zeolites studied at low N concentrations due to it is a critical parameter to stablish economic viability.
2. Lifespan is expected to be improved which will decrease the treatment cost.

❑ *Membrane contactors*

1. It is a promising technology to produce fertilizers achieving marketable N concentration in final product.
2. Flexibility to produce fertilizers on demand just modifying the acid.
3. It can substitute commercial fertilizer or be used as raw material.

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