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LIFE RENATURWAT

The story

Do you want to know how it all started and where we are now?
Read on and you'll find out...

A brief reminder

The general objective of the project is to demonstrate that it is possible to obtain reclaimed water from the effluents of Wastewater Treatment Plants (WWTPs) through the combination of Nature Based Solutions (NBS), such as constructed wetlands, and industrial waste, specifically sludge from Drinking Water Treatment Plants (DWTP), in order to produce high quality water suitable for environmental uses, such as the reclamation and conservation of wetlands.

Genesis

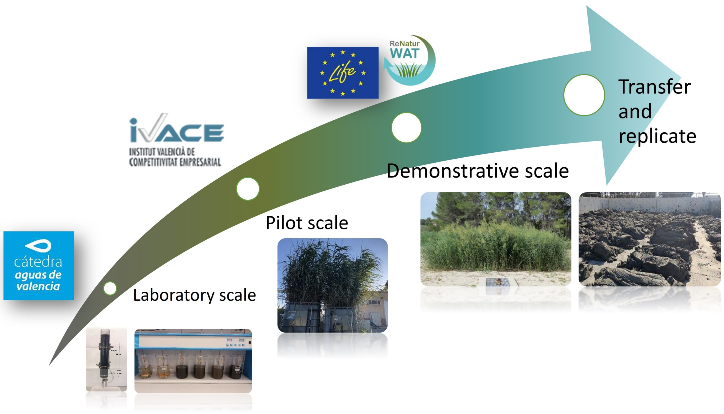
The idea of making use of the sludge generated in the DWTP of "La Presa" arose during a visit to the DWTP by researchers from the Institute of Water and Environmental Engineering (IIAMA) of *Universitat Politècnica de València*, back in 2011. In some silos there was sludge and a good number of cattails had germinated, a helophyte plant typical of Mediterranean wetlands and commonly used in constructed wetlands. Then they thought that this sludge could be a good substrate or filter material for use in constructed wetlands for urban wastewater treatment. They carried out a literature review and saw that a group of researchers who had already done some tests at laboratory and pilot scale (Zhao et al., 2011).

IIAMA proposed to *Empresa Mixta Valenciana de Aguas S.A.* (EMIVASA) to carry out some experiments to see if similar results could be obtained with the sludge generated in La Presa DWTP.

Why to valorise this sludge?

This DWTP sludge is very different from the sludge generated in WWTPs. It is a sludge with a very low organic matter content, basically containing the suspended matter carried by the river from which the water is collected and the remains of the coagulant added in the drinking water treatment process. The coagulant used contains aluminium, which is retained in the sludge formed. This aluminium gives the sludge a very interesting property, the power to adsorb, or in other words, to "trap" phosphorus present in the wastewater. Therefore, this waste could be used to provide tertiary treatment for wastewater and reduce its concentration of phosphorus and other pollutants, which is very important for preventing the eutrophication of the aquatic ecosystems that receive the treated water.

And so began a beautiful and long trajectory...



Experimental stages

We could divide this trajectory into two distinct experimental phases, differentiated by the size of the experiments and wetlands simulated:

1.- Laboratory scale (2016-2019):

01. In this phase, experiments were carried out to determine the maximum phosphorus adsorption capacity of the sludge, for several different grain sizes. These were jar or batch tests, which allowed us to find out how many milligrams of phosphorus each gram of sludge could adsorb. The results were very good, showing a high adsorption capacity, between 11 and 16 mg P/g sludge, similar to commercial manufactured products. The different grain sizes were achieved by manual crushing of the sludge and sieving with different sieve sizes.
02. Other experiments were the tests on filtration-adsorption columns. In this case, the research consisted of reproducing wetlands in miniature. This allowed us to check that the water flowed well through the granulated sludge, i.e. it had good permeability. It also showed that bacteria grew properly and degraded organic matter and ammonia nitrogen. As well as phosphorus retention efficiency was very high, with values above 95% at the beginning, which decreased as the material became more saturated with phosphorus. This is common in this type of treatment system: the efficiency decreases when the material becomes saturated because it has reached its maximum adsorption capacity. Last but not least, it was found that the aluminium present in the sludge was not released into the water and therefore did not increase its concentration in the treated water

2.- Pilot scale (2019-2020). After the experimental laboratory phase, it was decided to take a leap forward and reproduce three vertical subsurface flow wetlands (vertical subsurface flow) at a scale of 1 m^2, using granulated ETAP sludge as a filter medium, instead of the usual gravels usually used in treatment wetlands. In cooperation with the company Global Omnium Medioambiente S.L. (GOMSL), which is specialist in wastewater treatment, together with IIAMA and EMIVASA, two types of operation were tested: continuous and sequential.

In the continuous mode, water was constantly fed from the surface into the wetland, which was also saturated with water, i.e. with a permanent water level. In the sequential mode the wetland was filled, left in contact for about 30 minutes and emptied. This investigation allowed us to evaluate the efficiency of both modes of hydraulic operation at different flow rates. The main conclusions were that the continuous mode achieved a more efficient reduction of phosphorus concentration, but the sequential mode allowed a higher oxidation of ammonia nitrogen (nitrification), so it was decided to propose a hybrid mode for the next phase, in order to combine the advantages of each one. If you want to know the results in more detail, they are published in a scientific article (Hernández-Crespo et al., 2022).

The experimental phases were financially supported by the *Cátedra Aguas de Valencia* and the *Instituto Valenciano de Competitividad Empresarial*.

Demonstrative stage: LIFE Renaturwat (2020-2024)

Thanks to the success of the experimental phases, the companies EMIVASA and GOMSL together with IIAMA undertook the challenge of taking the technology to a higher readiness level, moving on to a demonstrative scale. To this end, they created a multidisciplinary consortium to achieve multiple objectives: to recover a waste, to provide an upgrading treatment for treated water and to improve the biodiversity of the environment of the WWTPs where the project was implemented. It was therefore necessary to have a WWTP where the demonstration wetlands could be built, and what better than two localities in which their managers and owners had already opted for wetland technology to treat their wastewater, *Carrícola* and *Valle Residencial Los Monasterios (Puzol)*, both in Valencia.

The improvement of biodiversity was a fundamental aspect to be addressed in the project, which is supported by the *Fundación Global Nature* and the *Fundació Mediambiental*, as well as the own *Carrícola* municipality, which are also responsible for important dissemination work at a local level. To complete the dissemination of the project and take it to national and multimedia spaces, we rely on the experience and scope of *Agencia EFE,* a communications agency. The consortium is completed by the Water Economics Group of the *Universitat de València*, which is in charge of the business plan, that will show whether the proposed technology is economically and environmentally sustainable. Finally, the company *Aguas de Portugal* is responsible for wide spreading and transferring the technology to other climatic regions.

In order to achieve the objectives, various treatment wetland prototypes were implemented.

Two water renaturation lines were built in *Los Monasterios* urbanisation.

The first line has an intensified vertical subsurface flow wetland (60 m^2), followed by a surface flow wetland (50 m^2), very similar to a natural wetland. The qualification "intensified" is related to the filtering material of the wetland which, instead of the usual gravel, is the sludge generated in *La Presa* DWTP. The purpose of the surface flow wetland is twofold: to improve the biological quality of the water and to generate habitat to improve the biodiversity in the area. Water quality improves both at the microbiological level, as there is an additional disinfection of the water, mainly through photooxidation by solar radiation and predation by filtering aquatic macroinvertebrates (Hernández-Crespo et al., 2022b), and at the macrobiological level, as the system is rapidly colonised by aquatic invertebrates, amphibians, or reptiles (Hernández-Crespo et al., 2022b).

The second line of the renaturation system consists only of a surface flow wetland of the same size and characteristics as the first line, but receiving directly the effluent water from the secondary treatment. The idea of creating both lines is to compare both surface flow wetlands and demonstrate the benefits of reducing phosphorus in the previous subsurface flow wetland.

In the municipality of *Carrícola*, a treatment line consisting of two vertical subsurface flow wetlands intensified with ETAP sludge in series, 20 m^2 each, was constructed.

If you want to know in more detail how they were implemented, we recommend you look over at our Newsletter nº 2.

All this thanks to the financial support of LIFE programme of the European Union.

Next question is...

Are these demonstrative scale wetlands working well?

We tell you about it with pictures and some figures...

Vertical Flow wetland in Carrícola

Vertical Flow wetland in Monasterios

Surface Flow wetlands in Monasterios

Autumn 2022

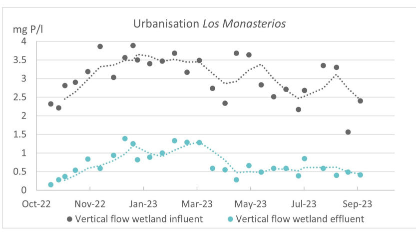
Winter 2023

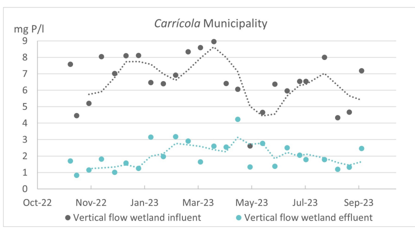
Spring 2023

Summer 2023

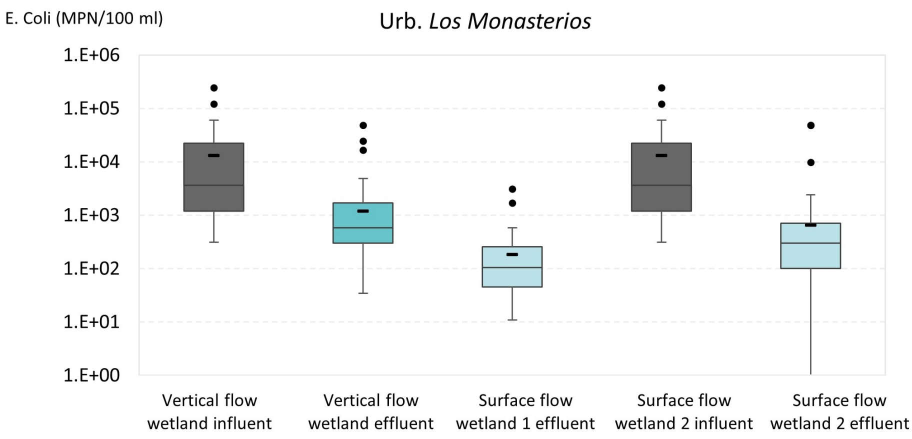
The results for the first year are in line with those found in the experimental stages. The concentration of total phosphorus is reduced by more than 70%, achieving a very significant reduction in the load discharged into the natural environment, especially important in the case of discharge into an area sensitive to eutrophication. The benefits of this reduction are becoming evident in the surface flow wetland that receives the treated water from the wetland with sludge, in which a concentration below of 1 mg P/l is achieved. The water quality, both at physico-chemical and micro and macrobiological levels, in this wetland is better than in the wetland receiving water from the secondary treatment. In the former, aquatic macroinvertebrates indicative of good water quality have been found, such as ephemerals of the genus Baetidae. In addition, the concentration of faecal bacteria is significantly lower, and in the own surface Flow wetland it is further reduced, reaching levels suitable for the reuse of water for various agricultural and environmental uses.

In the following graphs you can see for yourself. The first two graphs show, in grey, the concentration of inflow to the vertical flow wetlands built in the urbanisation *Los Monasterios* and in the municipality of *Carrícola* and, in blue, the effluent concentration.





The third graph shows in grey the input concentration of faecal *Escherichia coli* bacteria (Most Probable Number/100 ml) at the inlet of the vertical flow wetland, at the outlet (blue) and at the outlet of the surface flow wetlands.



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I SUSCRIBE

We remind you of our website and social networks:
There you can find out in more detail what we are doing and will do in the project.

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