Elimination at source of biocidal agents from freshwater environments by TiO2 photocatalysis

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INTRODUCTION

Biocidal agents are used to eliminate or prevent the action of harmful organisms, such as insects, weeds, and microorganisms. Biocidal agents are mostly used in agriculture where these compounds are also known as pesticides. **Pesticides** are classified as priority substances by the EU and SEPA and due to their effectiveness in agriculture for food production, pesticides are widely used worldwide.

Pesticides cannot be treated by conventional wastewater treatment methods and thus are often discharged into natural aquatic environments. In the environment, pesticides can **cause harmful effects** such as:

- Cancer and neurological disorders;
- Disruption of the endocrine system;
- Infertility and birth defects;
- Contamination of waterbodies and accumulation in food chain.

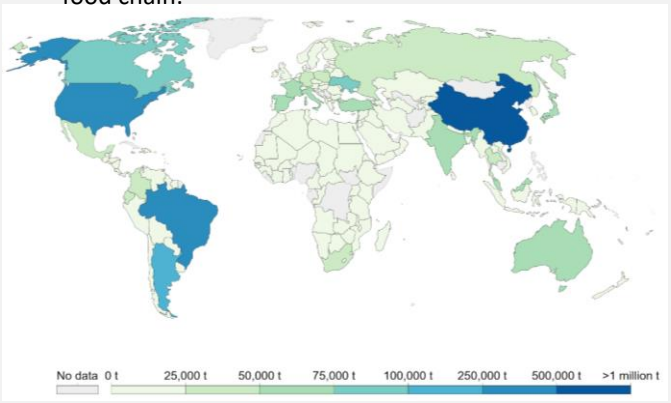

Fig. 1 – Total annual pesticide usage (tonnes) of pesticide during 2017 (UN Food and Agricultural Organization, 2017).

PROJECT OVERVIEW

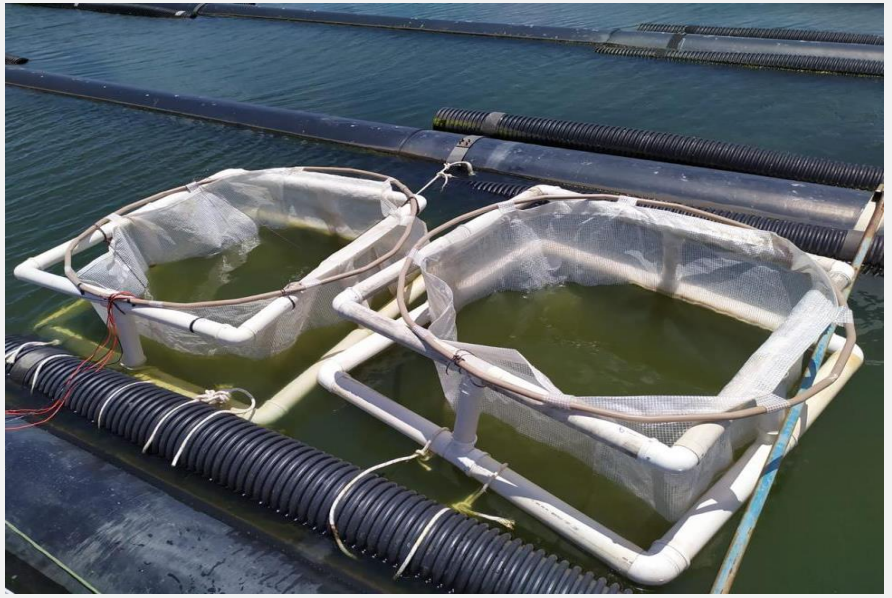

Fig. 2 – (Left) Initial treatment unit prototype proposed for the photocatalytic treatment unit for the degradation of pesticides at source. (Right) Mesocosms structure inside of the Gavião reservoir in Brazil containing photocatalytical treatment units in order to improve water quality and remove cyanotoxins.

The aim of this project is to **develop a novel and economical treatment unit based on TiO_2/C_3N_4 photocatalysis that can be applied at source for pesticide removal from wastewater in farms across Scotland**. Potential deployment locations are wastewater storage tanks, rural SuDS (Sustainable Drainage Systems) ponds, drainage systems and farmyards.

A prototype will be developed and tested for the pesticide removal will be based on a treatment unit used in a pilot-scale study that used titanium dioxide coated glass beads placed in tetrahedral pods within a stainless-steel cylindrical structure. The treatment unit was first developed to remove the common algal toxin microcystins and improve water quality in-reservoir prior to treatment to ease the burden on water treatment plants.

FUTURE WORK

The first step for the application of the treatment unit will be the selection of a panel of representative pesticides commonly encountered in aquatic environments. The pesticides were chosen based on toxicity, prevalence in the environment, persistence, ecological risk and environmental impact. The initial pesticides selected were **diuron, atrazine, dimethoate, 2,4-D, glyphosate and the five neonicotinoids acetamiprid, clothianidin, imidacloprid, thiacloprid and thiamethoxam**.

The **next steps** of the current project will be:

- to develop analytical liquid chromatography methods to quantify biocidal degradation;
- to perform bench-scale experiments using different catalysts and light sources in order to optimize the photocatalytic treatment at source;
- to develop and build a photocatalytic treatment unit that will allow in-situ removal of pesticides;
- to deploy and evaluate photocatalytic reactors in farms across Scotland and refine its design to extend its use;
- to determine the production of transformation compounds after photocatalytic treatment of pesticides and evaluate the toxicity of transformation products.

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