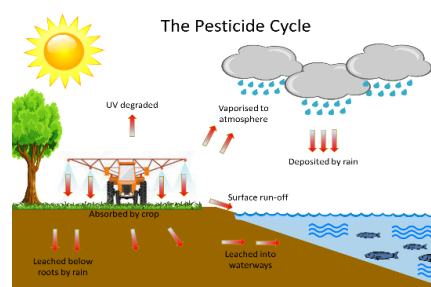


Electroanalysis for monitoring the photocatalytic degradation of the herbicide MCPA



Wesley is a final year PhD student from Queen's University Belfast, based at Atlantic Technological University Donegal. He is funded by The Bryden Centre project which is a cross-border, renewable energy research centre funded by the EU under the Interreg VA programme. His research during the PhD focused on the photocatalytic degradation of organic pollutants while using electroanalysis as an analytical monitoring technique.

MCPA (2-methyl-4-chlorophenoxyacetic acid) is a phenoxy acid herbicide used to control the growth of broad-leaf weeds in arable and horticultural crops. Intensive agricultural practices have led to the increased use of herbicides with the aim to improve crop yields. The herbicide is applied by broadcast spraying and despite regulatory buffer zones, MCPA can frequently enter watercourses. As MCPA is also highly soluble, it can be leached from soil surfaces into waterways especially after rainfall. The presence of MCPA in these watercourses can contaminate natural ecosystems and disrupt biodiversity. Clean water in rivers and lakes is not just important for the ecosystems they support, but also for the supply of clean drinking water for human consumption.



In Northern Ireland, MCPA has been detected in final water sources at concentrations over and above the legal limit of $0.1 \mu\text{g L}^{-1}$. In 2015, a water sample taken from County Fermanagh had a MCPA concentration of $0.8 \mu\text{g L}^{-1}$, which exceeds the limits set out by the European Drinking Water Directive by 8 times. Water remediation processes such as adsorption and coagulation have limitations as they often only concentrate pollutants or simply transfer them to another phase or media, and in doing so, fail to completely remove the threat. Other processes such as filtration and chemical methods are associated with high operating costs as well as the possibility of generating toxic secondary pollutants. Advanced oxidation processes (AOP), due to the generation of highly reactive and a non-selective reactive oxygen species, can degrade problematic organic pollutants. Among AOPs, photocatalytic processes have been considered as a very effective method for the mineralisation of organic pollutants due to its reduced energy requirements, low cost and maintenance and minimal production of harmful by-products.

To ensure the development of photocatalytic technology for water remediation applications continues, it's paramount that the degradation process can be accurately monitored. Monitoring the degradation of MCPA and its main degradation product, 4-chloro-2-methylphenyl (CMP) is usually performed by gas or liquid chromatography. These methods can be costly, time-consuming and/or requiring complicated sample preparation.

Electrochemical sensor technology offers an attractive alternative method for the detection and quantification of herbicides. Electrochemical sensors can offer real time analysis with many advantages over conventional methods. These include the use of inexpensive, portable instrumentation, quick analysis time, minimal sample preparation, while also providing high sensitivity and selectivity to the analyte of interest. The portability aspect of this detection technique offers in-situ monitoring yielding rapid onsite data. This work showed that electroanalytical methods can be successfully utilised for monitoring the photocatalytic breakdown of MCPA and the formation and degradation of its main intermediate product CMP.

