A model framework to describe growth-linked biodegradation of trace-level pesticides in the presence of coincidental carbon substrates and microbes

Pollutants such as pesticides and their degradation products occur ubiquitously in natural aquatic environments at trace concentrations (μg L⁻¹ and lower). Microbial biodegradation processes have long been known to contribute to the attenuation of pesticides in contaminated environments. However, challenges remain in developing engineered remediation strategies for pesticide-contaminated environments because the fundamental processes that regulate growth-linked biodegradation of pesticides in natural environments remain poorly understood. In this research, we developed a model framework to describe growth-linked biodegradation of pesticides at trace concentrations. We used experimental data reported in the literature or novel simulations to explore three fundamental kinetic processes in isolation. We then combine these kinetic processes into a unified model framework. The three kinetic processes described were: the growth-linked biodegradation of micropollutant at environmentally relevant concentrations; the effect of coincidental assimilable organic carbon substrates; and the effect of coincidental microbes that compete for assimilable organic carbon substrates.

We used Monod kinetic models to describe substrate utilization and microbial growth rates for specific pesticide and degrader pairs. We then extended the model to include terms for utilization of assimilable organic carbon substrates by the specific degrader and coincidental microbes, growth on assimilable organic carbon substrates by the specific degrader and coincidental microbes, and endogenous metabolism. The proposed model framework enables interpretation and description of a range of experimental observations on micropollutant biodegradation. The model provides a useful tool to identify environmental conditions with respect to the occurrence of assimilable organic carbon and coincidental microbes that may result in enhanced or reduced micropollutant biodegradation.

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Swiss Federal Institute of Aquatic Science and Technology
Contributors: Liu, L., Helbling, D. E., Kohler, H. E., Smets, B. F.
Pages: 13358-13366
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 48
Issue number: 22
ISSN (Print): 0013-936X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.58 SJR 2.535 SNIP 1.941
Web of Science (2017): Impact factor 6.653
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.559 SNIP 1.902
Web of Science (2016): Impact factor 6.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.61 SJR 2.546 SNIP 1.838
Web of Science (2015): Impact factor 5.393
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.5 SJR 2.777 SNIP 2.003
Web of Science (2014): Impact factor 5.33
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.52 SJR 2.952 SNIP 2.102
Web of Science (2013): Impact factor 5.481
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes