Analysis of the mixture toxicity burden in 17 rivers in north eastern Australia - implications for the Great Barrier Reef.

The Great Barrier Reef (GBR) is a protected ecosystem, listed as a UNESCO World Heritage site since 1981. It runs for approximately 3000km along the coastline in north-eastern Australia. A total of thirty-five major river basins discharge to the GBR and many transport large loads of pesticides, suspended sediment, nutrients from agricultural land. Over the past 6 years an extensive program has been conducted by the Queensland Government to monitor concentrations of 51 pesticides and their breakdown products in 17 rivers that discharge to the GBR. To explore the potential impact that the pesticides pose to the riverine environments and to the GBR we analysed the risk posed by the individual pesticides and their mixtures. Australia currently does not have water quality guidelines for 17 of the 38 pesticides detected. For those, we calculated ecotoxicity thresholds using a simplified version of the Australian methodology for determining water quality guideline values, based on species-sensitivity distributions. In all rivers, multiple pesticides were routinely detected at concentrations greater than their level of reporting. All rivers had at least one sample where the combined toxicity was greater than 1 toxic unit (TU), i.e. exposure situations where the total pesticide concentration exceeded acceptable levels. In a number of rivers more than 50% of samples had a combined toxicity greater than 1 TU. Average TU’s per river ranged from 13.47 to 0.10, with substantial fluctuations over the seasons but without clear trends between years. The patterns indicate that specific events such as severity of wet/dry seasons and cyclone events impact the combined toxicity found. We also found land use patterns affected the combined toxicity in the river ecosystems. In each of the rivers, 90% of the expected mixture toxicity was caused by only between 2 and 6 pesticides, although the individual pesticides that dominated the combined toxicity differed between rivers.
Analysis of the Pesticide Mixture Toxicity Burden in 17 Australian Rivers that Discharge to the Great Barrier Reef

Francis D. Spilsbury, Dept of Biological and Environmental Sciences, Linnaeus of Gothenburg, Sweden. Contact: gugust@student.gu.se
Michael St. J. Warne, Centre for Agroecology, Water and Resilience, Coventry University, U.K. Contact: michael.warne@coventry.ac.uk
Thomas Backhaus, Dept of Biological and Environmental Sciences, University of Gothenburg, Sweden. Contact: thomas.backhaus@bioenv.gu.se

1. The Great Barrier Reef Catchment Loading Monitoring Program (GBRCLMP): Pesticide concentration data were analysed from an environmental monitoring program conducted in Queensland, Australia from 2011 – 2016. 13 Rivers that discharge to the Great Barrier Reef. 2. Data treatment for ETV estimation and the consideration of Non-Detects. - Australian national guidelines use Species Sensitivity Distributions (SSDs) to determine ecotoxicological risk from pesticides. - Median number of pesticides detected per sample was 5. - 81.3% of samples contained a mixture of 2 or more pesticides.

2. Risk of individual compounds and pesticide mixtures of samples calculated as the sum of risk quotients (RQ) for each pesticide.

3. Comparisons of Limit of Reporting (LOR) vs. ETV for 95% Species Protection.

4. Relative contributions to mixture toxicity. - Pesticides were ranked by relative contributions to the total pesticide mixture risk, calculated for 966 “at risk” samples with a mixture toxicity of ETV > 0.25 (73.7% of all samples).

5. Impacts for different taxonomic groups and risk profiles of pesticide mixtures for individual rivers.

6. Land use patterns and river pesticide profiles used to identify priority pesticides, land use categories and rivers.

Acknowledgements: The generosity and support of the Great Barrier Reef Catchment Loads Monitoring Program of the Queensland Department of Environment and Science who supplied the pesticide monitoring and land use data used in this study. Background photo: Bush plains from the southwest Reef, 2015 (credit: Australian Broadcasting Cooperation).