Environmental stress enhances the effects of pollutants

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The UFZ researchers based in Leipzig use an experimental facility consisting of 47 gutters in order to quantify the effects of agricultural chemicals on lifelike ecosystems and to validate their mechanistic models for risk assessment. Credit: UFZ/André Künzelmann

Each and every organism on Earth is exposed to the influence of various

environmental conditions and of other living organisms. These factors can trigger stress and make the living organism more vulnerable to external influences. A team headed by researchers from the Helmholtz Centre for Environmental Research has now succeeded in using aquatic organisms to demonstrate that the presence of environmental stress multiplies the effects of pollutants on organisms. Furthermore, they have developed a model that makes it possible to use the intensity of the environmental stress as a basis to predict the increased impact of pollutants. They published their findings in the *Scientific Reports* journal.

Animals and plants are simultaneously exposed to a multitude of natural and man-made ("anthropogenic") stressors. These may arise, for example, from the lack of water associated with competition for food, infestation with parasites or confrontation with environmental chemicals such as pesticides. It is known from all fields of ecology that such simultaneous effects of a variety of stressors can have great implications for plants and animals within an ecosystem, while, individually, the stressors trigger virtually no discernible effects.

As now demonstrated by the findings of the research team from the Helmholtz Centre for Environmental Research (UFZ), the University of Koblenz-Landau and the Bundeswehr University, Munich, the presence of environmental stress can multiply the effects of pollutants by a factor of up to 100.

In order to devise measures aimed at preserving biodiversity in a more effective and targeted manner, the ability to predict what impact a combination of different stressors has on individual populations is really important in any case.

It therefore comes as a surprise that, despite a large number of research papers centring on this topic and the awareness of the impact of individual stressors, there is, to date, no universal approach to such

predictions of their effects as an entirety.

Thanks to these research findings, it will now be possible to make predictions of this kind, confirms Prof. Dr. Matthias Liess of UFZ who headed the study: "We have developed a model that allows us to calculate the overall quantitative stress exerted on an organism. We achieved this by determining the interrelationships among the individual stressors and also taking account of individual stress capacity in this context." This factor does vary considerably between the organisms contained in a population; most of them have a medium level of stress capacity, some cannot cope with even a low level of stress, and others stand up to high levels of stress without any problems.

The study is based on data from scientific investigations performed in the last 15 years that address the combined effect of pollutants such as pesticides and heavy metals and at the same time examine the effect of environmental stressors – such as lack of food, predator pressure and UVB radiation – on living organisms. On this basis, over the last three years the researchers succeeded in identifying universally valid patterns of the combined effects on vertebrates and invertebrates in aquatic systems and formalise them in a model. This model (SAM – Stress Addition Model) has now made it possible to predict the combined effect of stressors on populations of insects, crustaceans and amphibians.

The researchers anticipate that they will be able to refine their model over the coming years in such a way that it will be applicable to all combinations of stressors in the future. Furthermore, Matthias Liess believes that it is not inconceivable that its field of application can be extended beyond the aquatic habitat examined so far: "The correlation between the intensity of the environmental stress and the effects of pollutants seems to be of such a universal nature that it probably also applies to terrestrial systems and humans."

More information: Matthias Liess et al. Predicting the synergy of multiple stress effects, *Scientific Reports* (2016). DOI: 10.1038/srep32965