Dealing with **data**

Dr Ine van der Fels-Klerx of RIKILT – Institute of Food Safety, Wageningen University and Research Centre discusses her most recent project, which looks into the impacts of climate change on food safety

To begin, could you detail the main aims and objectives of the 'Effects of climate change on natural toxins in plant and seafood production' (EMTOX) research project?

The main aim of EMTOX is to assess the impacts of climate change on feed and food safety hazards, particularly on mycotoxins in cereal grains and on marine biotoxins in shellfish, considering both the direct effects of change in climate as well as the indirect effects due to shifts in primary production systems (cereal production and algae blooms).

Can you describe the project's focus on natural toxins in cereal and shellfish production that are harmful to human and animal health? Why were cereal and shellfish selected and what are the most severe toxins that they contain?

The focus of the project was on natural toxins including mycotoxins, phytotoxins and phycotoxins (or marine biotoxins). One characteristic of the project was to use all available data and models, bring these together and integrate them such to estimate climate change impacts on these natural toxins, rather than performing new experiments or field studies. So, the project tried to provide estimates based on current state of the art. From the three types of natural toxins, some models or data on weather effects on mycotoxins and phycotoxins were available. Information on phytotoxins was too scarce to use in the current project.

How do you propose to quantify the relationship between climate change and the occurrence of natural toxins?

For mycotoxins, we quantified the relationship between climatic data and mycotoxin levels by developing an empirical model based on historical data for deoxynivalenol (DON) in wheat in north-western Europe. The model was then used to forecast climate change impacts on this mycotoxin in wheat, whilst also considering changes in crop phenology. Furthermore, we brought together weather data and mycotoxin data in different cereal grains from different countries and over two decades. Based on this data, effects of simple climatic parameters on the occurrence of a variety of mycotoxin/grain combinations were assessed.

For marine biotoxins, we used available hydronamicecological model suites which were run with climatic data. These results were then qualitatively linked to marine biotoxins.

Could you discuss the state-of-the-art phytoplankton models that you are using? How established are these models and what properties do they offer?

The phytoplankton models used in this project result from many years of development in collaboration with other scientific institutes and have been used quite extensively to assess the ecological quality of the North Sea within the Oslo-Paris (OSPAR) Commission with respect to the implementation of the Water Framework Directive. The results of several studies in which these models were used have been published in peer-reviewed scientific journals.

These models rely primarily on modelling the nutrient cycle in the water and sediments, and the interaction with phytoplankton (consumption of nutrients to grow and release nutrients through mortality). In practice, only the four most common groups of phytoplankton are actually modelled, but this already allows us to quantify fairly accurately the phytoplankton biomass in a system like the North Sea. Quantitative models for marine biotoxins were not available and, therefore, relationships between phytoplankton and these toxins were derived from statistical analyses of historical data.

What simulation technologies have you utilised and how can they help to explore natural variability and toxin projections?

For mycotoxins, we used two different global/regional climate models (GCM/RCMs) to assess the effect of different climate change modelling approaches. Both models produce a series of 50 years to assess natural variability.

With respect to marine biotoxins, numerical models were used for a series of 20 years and accounted for different climatic conditions. Key variables here were wind and amount of sun, as well as levels of freshwater from rivers running into the North Sea. In this way, inter-annual variability was introduced in the system. In practice, the analysis of individual years clearly shows inter-annual variability in the amount of phytoplankton produced, and thus in biotoxins, but the 20-year series is long enough to identify climate-related trends.

Have you attained any conclusive results to date? What has been the greatest success of your research to date?

We did not get quite as far as we would have liked in terms of gaining estimates of the impacts of climate change on different combinations of cereals/mycotoxins. This is because available models and data were lacking. However, we succeeded in applying the integrated approach of using climate change data, wheat phenology models and a predictive model for DON contamination of wheat in north-western Europe. Results indicate an increase in DON.

Regarding marine biotoxins, we were able to apply the integrated approach for climate change data through harmful algal bloom (HAB) nutrient models. However, information on the relationship between HAB and marine biotoxins was scarce.

Climate change and food safety

Climate change poses a threat not only to our atmosphere but also to food production and safety. The **EMTOX** project has investigated impacts of climate change on primary production and natural toxins – which, if found in our food products, can have an adverse impact on our health

CLIMATE CHANGE HAS evolved in the global consciousness to become one of the most critical issues for the future of our planet. Since 1850, the global average temperature has increased by 0.76 °C. This warming is set to accelerate, with estimations of an average increase of 1.8 °C by 2100. According to the 2007 EU green paper, 'Adapting to climate change in Europe: Options for EU action', Europe has warmed faster than the global average this past century.

With increases in global average air and ocean temperatures, widespread melting of snow and ice and a rising global average sea level, the effects of climate change can no longer be ignored. These effects are expected to have great impacts not only on the possibility of natural disasters but also on food production, security and safety. In particular, climate change threatens the safety of feed and food products arising from primary plant and marine production systems, specifically due to the expected increased occurrence of natural toxins such as mycotoxins and phycotoxins.

THE IMPORTANCE OF PREVENTION

Emerging feed and food safety hazards need to be identified as early as possible so that appropriate risk management actions can be applied. Following this method, potential hazards can then be prevented from becoming actual threats to animal or human health. Some scientific literature has already been published that suggests the contamination of feed and food production is likely to increase due to climate change. However, these works mainly consist of review studies rather than modelling studies that assess the impact of climate change effects on contamination from toxins. Appreciating this gap, Dr Ine van der Fels-Klerx from RIKILT – Institute of Food Safety, Wageningen, The Netherlands, together with co-workers from European countries, set up the project, 'Effects of climate change on natural toxins in plant and seafood production' (EMTOX), focusing on estimating the impacts of climate change projections on the occurrence of feed and food safety hazards in primary plant production and marine systems in north-western Europe. This project has a focus on natural toxins, including several key mycotoxins in cereal production and phycotoxins in shellfish production.

A CLOSER LOOK AT TOXINS

Mycotoxins form a group of highly toxic chemical substances that can contaminate our feed and food products. They are produced by naturally occurring fungi that grow on many agricultural products such as cereal grains. One of the major influences on fungi growth and their mycotoxin production is local weather, including rainfall, relative humidity and temperature. Thus, changes in climatic conditions are expected to heavily affect mycotoxin contamination of cereals.

In fact, ecosystems can be so sensitive that even the smallest changes in climate may cause significant effects, and this is especially true in plant production. During the last two decades alone, there has been recorded expansion in mycotoxins.

Phycotoxins, or marine biotoxins, are toxic chemical compounds that can be produced by microalgae in coastal waters. Shellfish like mussels, oysters, and scallops consume plankton-rich diets and can accumulate these toxins. By eating certain shellfish, we are exposed to these phytotoxins which can potentially lead to adverse health effects, including Paralytic Shellfish Poisoning (PSP) and Diarrheic Shellfish Poisoning (DSP).

EMTOX concentrates its projection techniques on the estimation of how climate change impacts on the occurrence of food toxins by running specific case studies. These studies look in detail at deoxynivalenol (DON) in wheat in the terrestrial

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area of north-western Europe, and Dinophysis spp. abundance in the coastal areas. In order to provide evidence for the cause-and-effect relationships between climate change and toxins, van der Fels-Klerx's team analysed many different databases and datasets. The modelling looked at both direct and indirect effects from changes in production systems, and has resulted in the development of maps of Europe with estimated changes of wheat growing, DON contamination and algae blooms up to 2050. Other mycotoxins and phycotoxins are evaluated historically.

THE BENEFITS OF NETWORKING

To prepare effective projections, the project takes a multinational and integrated approach. Van der Fels-Klerx brings together expert knowledge and networks from distinct disciplines by involving and linking models and projections from institutes around north-western Europe. As a result of the analyses, the EMTOX network produced climate change projections for the years 2031-50. For both the marine and plant production system, statistical data analyses also focused on using existing national datasets from the study area. Results indicate an increase in DON and Harmful algal blooms.

FINDING SUCCESS

Due to a lack of available data and models, van der Fels-Klerx and co-workers were initially unable to attain sufficient data and models on different combinations of cereals and mycotoxins. However, EMTOX has succeeded in using climate change data, wheat phenology models and a predictive model for DON contamination in wheat in north-western Europe, obtaining results of climate change impacts on this toxin. In addition, the project team has been able to study climate change data regarding marine biotoxins through the use of harmful algal bloom (HAB) models and qualitative estimates on the relationship between HAB and marine biotoxins.

EMTOX presents results from its projections in the form of Geographical Information System (GIS) maps and is currently writing a series of scientific reports to be published in the journal, *Food Additives & Contaminants*. The team presented their first set of project results at the World Mycotoxin Forum in 2010 whilst further results related to mycotoxins in cereal grains were presented at EuroCereal in late 2011. This year, van der Fels-Klerx plans to run a workshop with stakeholders and other policy makers in The Netherlands to further discuss EMTOX's results.

Van der Fels-Klerx believes the increased insights into the climate change impacts on food safety will prove valuable to risk managers in Europe as they can support decision-making processes on implementing measures to keep European feed

INTELLIGENCE

EMTOX

IMPACTS OF CLIMATE CHANGE EFFECTS ON NATURAL TOXINS IN PLANT AND SEAFOOD PRODUCTION

OBJECTIVES

To project the impact of climate change on the occurrence of feed and food safety hazards in both terrestrial primary plant production and marine seafood systems in north-western Europe. The project focuses particularly on natural toxins in cereal and shellfish production that are harmful to animal and human health, including mycotoxins and phycotoxins.

PARTNERS

Plant Research International, Wageningen UR, The Netherlands • **Deltares**, The Netherlands •**State General Laboratory**, Cyprus • **Danish Climate Centre, Danish Meteorological Institute**, Denmark • **Research Centre Foulum, Aarhus University**, Denmark • **National Environmental Research Institute, Aarhus University**, Denmark • **Institute of Marine Research**, Norway • **Bioforsk – Norwegian Institute of Agricultural and Environmental Research**, Norway • **Norwegian University of Life Sciences**, Norway • **MTT Agrifood Research Finland**, Finland • **Lantmännen**, Sweden

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