Professor: **Frederi Viens, Chair, Department of Statistics and Probability**

Project: **Africa's Great Oasis: Attribution of Lake Chad's Variability to Human & Environmental Factors**

Subject Areas: **Computational Bayesian statistics, environmental science, agro-ecosystem services, paleo-climatology, historical analysis of primary sources, policy recommendations**

Project Description:

Prof. Viens has been leading a group of scholars and students since 2013 to understand interactions between the complex hydrology of Lake Chad in the Eastern Sahel, its potential for ecosystem services, the impact of smallholder farmer irrigation in its basin, and the possible connections to global climate change. A short broad-audience summary can be found in his article in The Conversation, published in April 2019:

https://theconversation.com/data-statistics-and-hydrology-can-reveal-key-truths-about-lake-chad-110907

Viens's team has established **preliminary results suggesting that global climate change is not directly linked** to variability in Lake Chad's hydrology, and that **farmer irrigation activities are very unlikely to have any negative consequence** on the lake. More work is planned in this direction, including an investigation of **historical rainfall patterns** and their relation to climate change, to solidify or mollify the conclusions, and provide policy **recommendations on agriculture development in the basin**. Many hypotheses remain to be tested. One is whether the lake in **a relatively low state provides an optimal set of ecosystem services to fishermen, pastoralists, and farmers**. Another is whether population growth and economic gains in the region may **drive the lake's resources into unsustainability in the coming decades**. The African Futures early-career scholar would engage with Viens and colleagues on all these research aspects, and would **help coordinate work by undergraduate, MS, and Ph.D. students at MSU and other institutions**.

The project's main analytical tool is **computational Bayesian statistics, a form of supervised machine learning** which has its roots in the 18th century, and has taken off in the last 20 years thanks to improvements in computing. Any scientific scholar with mathematical training at the level of an undergraduate degree, and with some programming experience, will be capable of mastering the basic data science tools. This includes **classical linear Bayesian hierarchical modeling, and its numerical implementation using the so-called Gibbs sampler** and other Markov-Chain Monte-Carlo techniques.

The Bayesian paradigm leaves open a number of **theoretical questions, about statistical uncertainty quantification**, which are relevant to Viens's Lake Chad project, and which would satisfy the desires of a mathematical scientist to dig deep into theory, if that is a desired direction for the Scholar. The African Futures Scholar will also have an opportunity to engage in a highly original project on **analyzing primary-source historical data to reconstruct the last thousand years of Lake Chad's climate**. Another possibility for the Scholar lies in an **environmental study of the globally significant Hadejia Nguru wetlands, which lie in the Lake Chad Basin, to understand how human activities affect this delicate ecosystem**; this would be in collaboration with scholars from a Nigerian forestry institute.

The AAP priority areas covered by this project include: 1. Agri-food systems; 2. Water, energy and environment; 6. Nutrition and health. Other priority areas could also be included, if needed.

Beyond the computational data analysis and coordination work summarized above, the early-career researcher will also help Viens with **writing publications as a lead- or co-author, composing grant applications, and will have opportunities to participate in other Africa-centric data-science activities**.