You are kindly invited to attend a lecture by

Colin Sage

visiting professor at AUR and Senior Lecturer, Department of Geography, University College Cork

The global food system, nitrogen and the metabolic rift: Farming - and eating -within planetary boundaries

Tuesday January 30, 2018 - 4:00PM

Italian Geography Society – Aula "Giuseppe Dalla Vedova"

Palazzetto Mattei in Villa Celimontana

Via della Navicella, 12 - 00184 Roma

The development of the global food system has utterly transformed the volume and variety of foodstuffs made available for purchase to consumers in many regions of the world. The application of science and technology to seeds, other agricultural inputs and to farming practices has resulted in extraordinary productivity in primary production. Yet the supply of cheap food commodities from all over the world to those with the means to buy them has come under increasing scrutiny across a number of fronts. Food security and health specialists highlight the triple burden of malnutrition (continued hunger & insufficient intake; mal-consumption and obesity; and micronutrient deficiencies). Meanwhile, environmental scientists draw attention to the growing ecological costs arising from the industrial agricultural model that is responsible for driving land-use change and loss of biological diversity (from plant genetic resources to entire habitats); the depletion and contamination of surface and groundwater resources; the degradation of ecosystem services, including pollinators; and a significant and rising contribution to climate change.

The framework of planetary boundaries as set out by Rockstrom et al (2009a, 2009b) and by Steffen et al (2015) draws our attention to nine key Earth system processes each of which are being affected by human activity. The framework attempts to establish critical thresholds that represent limits to a safe operating space for human societies. For three of the nine processes – climate change, biodiversity loss, and nitrogen and phosphorous flows - the initial formulation indicated a clear breaching of their respective boundaries. While climate change has arguably become the single most important issue *de nos jours* and one around which there is probably greater scientific consensus of a boundary limit (350-450 ppmv C), other processes are less easily quantified or may be less directly connected to specific drivers. One that can be attributed to anthropogenic activity, not least because it has come to underpin the survival of the species through food production, is that of the biogeochemical flow of nitrogen.

The development of the Haber-Bosch process early in the 20th century to synthesise atmospheric nitrogen (N_2) into the form of fertiliser and thereby provide a source of reactive nitrogen (N_r) that could be taken up by crops has had an utterly transformative effect on the world. Together with the subsequent development of fertiliser-responsive high yielding seeds, it has been argued that without the Haber-Bosch synthesis only about 40 percent of the world's current population could be fed (Smil 2002). Yet it has also been estimated that only 47 percent of the reactive nitrogen applied to cropland worldwide is converted into harvested products and that more than half is lost to the environment. The global alteration of the N cycle leads to many different, cascading effects on human and ecosystem health but arguably it is one that has least recognition amongst the general public.

Globally, humans currently ingest c. 20 Tg N yr-' in their food, most of which subsequently enters the environment. A further 100 Tg N yr-' involved in food production but which never enters a human mouth is also released to the environment. Such figures demonstrate how significant is the contribution from food production and consumption (Galloway et al 2002). Moreover, the continuing expansion of animal feed cultivation to satisfy rising demand for meat is accelerating this problem not least due to the inefficient conversion of vegetal to animal protein such that animal food production contributes c. 63% of reactive N losses (Lassaletta et al 2014a). A further dimension of this problem is the separation of feed production from animal rearing such that we see marked regional contrasts. For example, around three-quarters of Europe's protein-rich animal feeds are imported from South America making attribution of environmental burdens – GHG emissions, land use change as well as biogeochemical flows – more complex.

These planetary scale processes, especially those that are approaching – or even transgressing – limits, capture something of the 'metabolic rift' as originally conceived by Karl Marx. Given his concern for the robbing of soil fertility by capitalist agriculture, it seems apposite to consider the way in which the apparently successful 'solution' has served to disrupt a key global nutrient cycle. In this lecture, I will develop and extend the metaphor of metabolic rift by focussing upon the nitrogen cycle and the ways in which its global disequilibrium has resulted from an industrialised global food system that has reshaped agriculture around the world. If we are to recover and restore planetary balance in this particular area, then it becomes clear that we must examine the potential for transition towards an agroecological model of food production that makes greater use of local nutrient cycling pathways.