

# Food security in a transforming system of global environmental change (GEC)

The world's food system is undergoing an unprecedented transformation: not just from the significant impacts of global environmental change (GEC), but also from the rapid expansion of transnational agribusiness. The food system is now a globalised, interconnected socio-ecological system and the global South is increasingly being integrated into this new, interconnected, efficiency-driven model.

There are three key outcomes of a well-functioning food system: food security, social welfare and environmental welfare (see Figure 1) yet, our current system has so far failed to provide these for the planet's poor. How, then, will the future food system respond to the challenge of providing food security whilst

also adapting to issues of rapid environmental and sustainability issues – most notably climate change? Developing a system of adaptive governance to meet these challenges is clearly an important area for research, but it requires an understanding of the complexity and uncertainty inherent in such measures.

Countries in the global South face this uncertain future with a current mandate of poverty reduction and sustainable development. Yet reconciling these two obligations requires a new method of engaging with the complexity of an interconnected and unequal global system. As such, this piece examines the use of a complex adaptive systems (CAS) approach for understanding the multilevel relationships

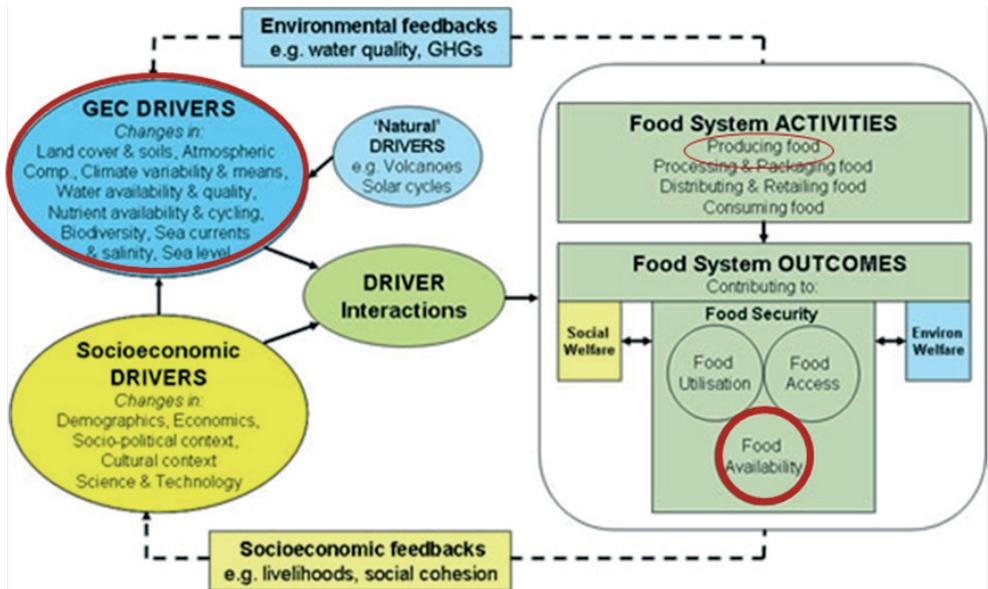


Figure 1: Drivers of change in the food system with the areas that are currently the focus of research in GEC studies circled in red (Adapted from Ericksen 2008).

between the social and ecological components of the food system. This, in turn, requires acknowledging that many GEC processes are non-linear; that inherent uncertainties constrain decision-making; and that since the food system comprises many different actors, it is important to include a range of viewpoints in decision-making. GEC pressures can pose a real threat to sustainability and food security, but this policy brief explains that it could also provide an opportunity to transform the food system through positive engagement with a variety of stakeholders.

### The problem: GEC studies in the food system

Despite the existence of holistic<sup>1</sup> frameworks through which to conceptualise processes of change in the food system, most global environmental change research focuses on

how changes in environmental processes (usually climate, but also soil nutrients, lack of water etc.) impact on food production and how this translates into reduced food availability. However, as Figure 1 illustrates, these processes form only a very small part of the total system that determines food security and the social and environmental welfare associated with a well-functioning model. In fact, the most recent concerns surrounding food security relate to the elements of access and utilisation. Recent hikes in food price from 2008 onwards have dramatically affected the affordability of food for much of the world's poor, reversing the progress that had been made towards meeting the first Millennium Development Goal of halving hunger by 2015. Food affordability is not only linked to the price of food, but also to the income of those attempting to buy it in the first place.

The impact of the 2008 food price crisis was less severe on food security in the developed world when compared to the developing world, with many countries such as Haiti, Madagascar and Mozambique reduced to rioting (Headey and Fan 2008, Berazneva and Lee 2011). This is because in general, people in the developing world spend a higher proportion of their income on food compared to their counterparts in the developed world (FAO 2010). Part of the solution could therefore be to focus on job creation to raise household income streams, but given other macro-trends such as deagrarianisation and urbanisation (especially in Africa), there is uncertainty whether to focus development on rural or urban areas – considering people’s diversifying livelihood strategies (Bryceson 2002; Pereira et al, under review). The situation is understandably complex and policy-makers must learn the full range of possible scenarios before targeting funds towards one plan over another.

Utilisation is another element of food security, which is often ignored. This is exacerbated by a focus on the main staple crops of maize, soybean, wheat and rice and livestock, leaving out ‘orphan crops’ like sorghum and millet that are often more important for food security (Easterling et al 2007; Lobell et al 2008). We are facing an unprecedented situation in our history in which national populations can be simultaneously obese and malnourished (Pollan 2008) and where, as well as having just under a billion people who are undernourished (FAO 2010), there are even more who suffer from the ‘hidden hunger’ of micronutrient deficiencies<sup>2</sup>. Previously diverse diets from around the world have shifted dramatically towards the ‘Western diet’ to the exclusion of previous, more culturally acceptable and environmentally sustainable alternatives that made full use of what the local environment could provide – whether it

was eating the whole chicken (including its feet and not just its breast meat), making beer from sorghum (an African indigenous crop that is drought-resistant), or only eating fruits in season (and not growing them in greenhouses). The loss of such dietary tradition is also coupled with the unsustainable use of the environment to cultivate the very crops making up this new cuisine, which is derived from extensive and intensive mono-cultures of maize and soybean cultivation (Pollan 2008, Godfray et al 2010). Identifying the tools that will allow policy-makers to address these issues holistically rather than in a piece-meal fashion- constrained within disciplinary approaches- is critical for addressing processes of environmental change.

Considering all of the above, the questions, which ought to be addressed by researchers are as follows:

- How are current changes and processes in the food system affecting food system outcomes?
- How will environmental changes (GEC) affect these in the future?
- What does this mean for countries’ development agendas and food governance strategies?

Overall, the food system remains a complex and capricious menace, requiring a research method that will enable us to deal effectively with such characteristics. To aid in analysing these challenges, this policy brief proposes the use of complex adaptive systems (CAS).

## **Complex Adaptive Systems theory in practice**

Below are the five main attributes of complex adaptive systems (CAS):.

- Non-linearity is demonstrated through disproportionate relationships between system states over time. According to Berkes et al (2003), complex systems organise around one or several possible equilibrium states and when conditions change, the system's feedback loops tend to maintain its current state, but if it is at a threshold, the system could change rapidly and flip: this process is rarely predictable and forms the cornerstone of maintaining resilience in a system, i.e. building sufficient adaptive capacity in a system so that it does not cross a threshold.
- Uncertainty arises precisely from the inability to predict which of the multiple states will occur.
- Emergence is the term for when a system's properties emerge from the interaction of its components. This means that merely understanding the individual components themselves is insufficient for understanding the behaviour of the entire system.
- Self-organisation means that open systems will reorganise at critical points of instability. The process of self-organisation after a disturbance will draw from temporal and spatial scales above and below it (Folke 2006).
- Panarchy: complex systems are never just one system, but a nested set of systems or 'panarchy' (Gunderson and Holling 2002). When coupled, they create feedbacks and therefore need to be analysed simultaneously at different scales and across different levels. Yet it can be problematic to analyse social and ecological systems together as they often operate across different temporal, spatial and other scales (Young et al 2006).

Using these characteristics to understand the food system provides us with a novel lens through which to view the system's complexity. Below, the policy brief uses CAS theory to discuss processes of change in the food system and the possible governance mechanisms that become

apparent when the underlying characteristics of the system are understood.

## Uncertainty and flexibility

How uncertainty is internalised by decision-makers is the fundamental starting point for using CAS theory to meet food security challenges. As a core property of a complex system, uncertainty must be viewed as a permanent feature of the food system rather than a problem that needs to be minimised through forecasting or predictive modelling. The non-linearity and sensitivity to initial conditions that define complex systems make it nearly impossible to predict the future accurately – something unexpected is certain to arise. Accepting that we face an uncertain future does not necessarily constrain our response options, but ought to urge us to become more flexible in how we govern the food system. Dealing with such uncertainty requires “learn(ing) to manage by change rather than simply react(ing) to it” (Folke 2006: 255) and this, in turn, requires learning how to make good decisions without full knowledge (Polansky et al 2011). In order to cope with this uncertainty, decision-makers need to learn how to take unpredictability and surprise as matters of course, learning to juggle shifting objectives (Holling 2001). Adapting to GEC in the food system will therefore require flexibility in our governance systems to respond to changing conditions. Together with this, we need to increase the system's resilience to unexpected shocks by building functional redundancy (rather than streamlined efficiency – see below on MNCs) and by building up stocks (e.g. from national grain reserves to Accumulated Credit and Savings Associations) (Homer-Dixon 2006: 283). This already occurs to some extent as people respond to situations of uncertainty (e.g. keeping national grain reserves), although in many cases these have been abandoned in favour of liberalised efficiency. There needs to be a stronger research focus that identifies

these practices and builds on them, learning what does and does not work along the way and why. These findings can then be incorporated into policy that makes the food system more resilient rather than efficient.

## Self-organisation and Diversity

The expansion of multi-national corporations and their consolidation of power is one example of a complex process in the food system. This process can be seen as self-organisation by these actors across multiple levels to achieve efficiency (if not resilience) by reducing redundancy. It has resulted in a few, large companies having control over the food system: from what is produced (by providing seeds and their sourcing policies) to what is consumed (what is available on the shelf for purchase). Through this process of monopolisation, much of the flexibility and redundancy that was previously in the food system has been lost. Therefore by making themselves more resilient through increasing their own capital, market share and access to the means of production, such multi-national corporations have, consequently, reduced the resilience of the food system as a whole.

Addressing this phenomenon from a CAS perspective would require that some redundancy is built back into the system through fostering diversity. The concept of diversity as a means of building resilience (by creating redundancy in a system) has been incorporated into governance literature. Stark (1999) argues that the challenge to governance is to maintain this diversity of principles because they form the basis of organisational adaptability. Recognising the need for diversity echoes Berkes et al's (2003) statement that complex systems rely on a multitude of perspectives. This is similar to the ecological idea that increased biodiversity will develop resilience by affording the system greater capacity to absorb different shocks

through increasing the variety of responses available (Folke 2006). A diversity of opinion offers functional redundancy that means if a component fails for whatever reason (e.g. exposure to a stress) there is sufficient overlap to ensure that the whole system does not break down. Creating redundant structures through maintaining diversity can therefore be a form of adaptive capacity.

Calling on a systems approach and in particular the idea of needing a multiplicity of perspectives in order to understand a problem also has implications for concepts of fairness and equality.

“Wicked problems reflect the coalescence of social, technical and political dilemmas that cut across boundaries of communities, organisations or nations... therefore decisions impacting on such multifaceted issues being made through a single-issue lens will give rise to conflict between multiple stakeholder groups affected by cumulative impacts or unintended consequences [thereby] compounding systemic volatility of already turbulent environments.” (Alahi 2010: 224).

Using a CAS approach to appreciate a diversity of actors, then, can increase resilience and help to deal with uncertainty. From an equality perspective, participation of multiple perspectives creates shared values that can serve as a common ground – thereby facilitating stability (not equilibrium) (Emery and Trist 1965). Having a common ground in turbulent environments creates a climate of cooperation and social adaptability that in turn should result in a positive response underpinned by shared values in understanding the problem (Alahi 2010).

Applying this concept to the food system, it becomes evident that much of the research

looking at food systems under environmental change leaves out a vast array of actors – or, at least, does not look at how they interact with each other. Agronomic research in the developing world has recently been critiqued for its lack of a critical appreciation of the political and contextual dynamics underlying various agricultural projects aimed at improving the lot of poor people (Sumberg et al 2012). We are all end consumers of food, but there are a variety of other important roles that are undertaken in the food system and even a cursory acknowledgement of these can lead to a more holistic appreciation of where specific actors fit into the greater whole. For example, consumers can be individuals buying produce from a supermarket, restaurants, fast food outlets, street vendors, celebrity chefs or a fisherman harvesting their dinner directly from the sea. Each of these actors would have their own opinion on what the food system should be, and in adapting to stresses in the food system, it is necessary to reflect these differences and reach an informed compromise rather than simply following the easiest or most efficient solution.

This process is even more important in a developing world context where there are many marginalised and unheard voices that do not get a chance to be recognised as important actors in decision-making processes and yet they are often the foundations upon which the rest of the system is built. The ‘panarchy’ or adaptive cycle heuristic has already been applied to understanding issues of power in transforming systems in Mexico (Pelling and Manuel-Navarrete 2011). However, addressing issues of power and the inclusion of marginalised voices remains a major challenge that will benefit greatly from case studies that analyse how equitable engagement is or is not achieved. Any policy addressing food security issues needs to

ensure that marginalised voices are recognised and included in the decision-making process.

In the South African food system, there has been a recent recognition of the strategic importance of multi-stakeholder engagement for addressing the complex governance challenges that the country’s food system faces. The development of partnerships between food companies and NGOs as well as local communities and to a certain extent, with government is one example of this (see Pereira and Ruysenaar 2012). Many of these initiatives are still in their infancy and it remains to be seen whether they effectively achieve what they set out to do. However, one issue that must be highlighted is that in most cases, local communities are often seen as the recipients of the benefits of these multi-stakeholder dialogues rather than equal participants in the discussion. The question of agency (and its associated power dynamics) within multi-stakeholder engagement is a major constraint that needs to be recognised and addressed if truly equitable consensus is to be attained. Mosse (2004: 663) refers to the ‘mobilizing metaphors’ of participation, governance etc. “whose vagueness, ambiguity and lack of conceptual precision is required to conceal ideological differences.” In order for concepts like participation to become more than rhetorical devices, the value of the system’s diversity needs to be recognised and it is here that CAS theory is most useful- in identifying the multiple actors whose interactions result in the emergent properties of the overall system. Two immense challenges then remain: one is that, once identified, how best to bring these voices around the table in a way that ensures equitable participation and the second is then to reach sufficient consensus that decisions can be made and actions taken.

The conclusion is that recognising a diversity of actors in the food system can provide a

different and nuanced understanding of problems and an array of possible responses. It also provides a platform for increased awareness about the inclusion of marginalised groups and acts as a first step towards increased fairness and equality in the food system. This will not necessarily result in consensus- in fact it is often the opposite that is true. However, without the inclusion of diverse opinions and ideas, whether they agree or not, the system would become so path-dependent that it would lose all flexibility to respond to uncertainty.

## Emergence

Understanding that the food system is more than the sum of its constituent parts is one of the most challenging requirements of CAS theory. At a simple, and yet extremely important level, how we as consumers engage with the food we eat needs to recognise this emergence more explicitly. Food has been conceptually reduced to calories in the form of carbohydrates, proteins and lipids with some vitamins and minerals that are needed for disease prevention – nutritionism (Pollan 2008). And yet, each new diet fad advocates a different combination of these in order to be healthy. On top of this, certification and labelling of our food has added an extra layer of considerations to the food we eat, e.g. 'is that coffee not just tasty, but is it also ethically acceptable, socially fair or environmentally sustainable?' More importantly, 'is it safe to eat?' (e.g. does it meet the WTO's Sanitary and Phyto-sanitary requirements?) Growing, buying and eating food has never been more complicated.

As well as being a means of acquiring nutrition for survival, food has cultural and social significance. It creates opportunities for interaction and celebration, but many of these relationships are being lost in contemporary society. Perhaps, rather than reducing the

complexity of food, our relationship with it as consumers and its role in our society, there needs to be an attempt to understand food as emergent - more than the sum of its nutritional parts. The best example is of the food that is eaten on traditional and religious holidays. The turkey on Thanksgiving is more than a combination of protein and fat, but has cultural significance where the cooking and eating of it is as important as the nutritional value of the meal. Similarly, special foods are consumed at religious festivals and on special occasions; from lamb at Easter to the sumptuous meals that are cooked for Eid al-Fitr and the slaughtering of a goat or sheep in honour of special visitors in some African cultures. These foods are not merely a means of acquiring nutrition, but emerge as significant and relational elements of the food system. At the very least, re-conceptualising food not merely as nutrition may aid consumers in coming to terms with the complexity that we constantly encounter when dealing with food, and will help policy-makers in developing appropriate policy for its governance.

## Key policy issues

This policy brief has briefly explored the unique contribution that CAS theory can make towards understanding the challenges to delivering food security in a transforming food system. The key issues that it highlights are:

1. The need for researchers and policymakers to come to terms with the complexity inherent in the food system.
2. How policy must reflect the inherent uncertainty in the food system by building institutions that are more flexible to change.
3. That it is necessary to take into account a diversity of opinions and their associated power dynamics in order to offer a variety

of responses and avoid unsustainable path-dependence.

4. That we need to re-appreciate that our food has emergent properties and cannot be understood through its components in isolation.

Such an understanding of the food system under GEC provides a new lens that can be employed to address the many challenges in this field. For developing countries, it advocates systemically sustainable development over attempting to combine environmental goals under business-as-usual development that does not take into account the complexity of the system as a whole. Importantly, a systemic approach will help avoid some of the pitfalls of more disciplinary solutions that could have negative feedbacks on other parts of the system. A research agenda that acknowledges systemic complexity is likely to be far more effective in the long-term and will go a long way towards realising adaptive food governance that can meet the food needs of everyone on the planet. However, a research agenda that cannot translate into policy will have very little real impact on improving people's lives. A complex systems approach is starting to be more widely applied by researchers addressing problems like natural resource management, but it has yet to be employed to inform policy on issues like food security. The critical aspect is thus to start moving CAS from the realms of academia to where it can start influencing policy. It will by no means be easy, but it is a challenge that needs to be met because the status quo is untenable for millions of people around the world.

#### End Notes

<sup>1</sup> Here, holistic refers to frameworks that do not focus on one disciplinary aspect of the food security problem, but include multiple factors such as health, gender, culture, economics and agronomy.

<sup>2</sup> Date from the World Health Organisation's (WHO) VMNIS (Vitamin and Mineral Nutrition Information System) database shows the prevalence of micro-nutrient related diseases: the prevalence of anaemia in the general population is estimated at 24.8%, 35.2% of the general population is estimated to have insufficient iodine and 33.3% of pre-school children and 15.3% of pregnant women are estimated to be at risk of Vitamin A deficiency (WHO 2012).

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