# 4
# How systems change: crisis and rift

Demands for paradigm-shift reflect the fact that the reductionist approach we have just described has now reached an impasse. We begin to see a peculiar behaviour that is characteristic of systems which objectively need to change but cannot yet work out how. This is connected with the notion of *bifurcation*: staring at a crossroads, wondering which path to take. Physical systems sometimes hesitate like this, oscillating between possible outcomes, and in one sense human systems do the same. But with human systems there is a crucial difference: the change to a new order won't just 'happen', we must vision it and deliberately bring it into being.

Let us now seek a deeper understanding of how such an impasse is expressed.

## Two views on equilibrium

In our discussion of chemical reductionism we used a perspective of thermodynamic flows, viewing systems through the resources which flow into them and the waste they excrete. In this perspective, we would see entropy as 'untucked loops'. This is an important definition, but a bit limited: we also need to understand what is going on *within* the system, essentially its processes of organisation. Fundamentally, the two perspectives converge, in that low entropy permits self-organisation, and vice versa: thus, 'The entire fabric of life on Earth requires the maintaining of a profound and subtle organization, which undoubtedly involves entropy being kept at a low level.' (Penrose, 2010, p.77). However, there are interesting differences of emphasis, notably on how we regard equilibrium, and therefore 'rift'.

Let us first consider the good side of equilibrium. For example, in the soil system there are three loops: nutrient input/release; soil erosion/production; and carbon sequestration/emission. In an undisturbed natural setup these are kept in balance and the result is no erosion (Amundson, et al., 2015). With the arrival of industrial society, however, things were disrupted, leading to linear flows with many untucked loops (c.f. De Rosnay, 1979), of which erosion is one expression. To set things right, we can strive to restore balance – a realisation which led von Liebig to remark: 'Can the art of agriculture be based upon anything but the restitution of a disturbed equilibrium?' (von Liebig, 1844). Another example is the natural equilibrium between insects that might damage our crops ('pests') and their natural predators, an equilibrium destroyed by chemicals. When the author was obliged to leave his plot unattended for a whole month during the growing season, a natural ecology took over: in response to a surfeit of slugs (*Arion hortensis*) lurking in overgrown grass paths, toads (*Bufo bufo*) took up residence. Some Mexican scientists were recently astounded to find that, when a certain farmer stopped using pesticides, a natural ecology stepped in to do the job (Entomological Society of America, 2016); they then invented the term 'autonomous pest control' for something which nature and traditional farmers have been doing forever! Even built systems, as we will see later, can be redesigned, through biomimicry, around loops and flows.

In all these ways, we could say the goal is for things to be integrated and harmonious. Conventional attempts to connect Marxism with general systems theory have tended to focus on this particular angle of thermodynamic flows (for example Burkett and Bellamy Foster, 2006; Martinez-Alier, 2011), and accordingly, in eco-Marxist literature, 'what went wrong' with the advent of capitalism is often expressed in the notion of 'metabolic rift'. This term was developed particularly by Bellamy Foster (2009), who chose to translate Marx' term *Stoffwechsel* (Marx and Engels, 1968, p.198) as 'metabolic interaction' (Bellamy Foster, 2009, p.177) in place of the more usual 'exchange of matter' (Marx, 1954 [1887], pp.183–4).

The above argument, though important, is, however, only partial: the downside is to over-emphasise the *desirability of equilibrium*, and therefore perceive the sense of 'rift' as something bad. That is why we should complement this with the complexity perspective where, in a sense, instead of looking at the flows entering and leaving a system, we focus on what happens within it: self-organising processes.

In this perspective we encounter a different angle on entropy: *too much* equilibrium.

Thus 'We now know that simplicity and stability are exceptions', beyond which we encounter '*an unexpected intrinsic structure of reality*...' (Prigogine and Stengers, 1985, p.216; italic original). The beauty of a system far from equilibrium is that it attains this realm of creative self-organisation where it self-generates structure. This is closely linked to complexity, in that 'A universe in equilibrium cannot be complex, because the random processes that bring it to equilibrium destroy organization' (Smolin, 2013, p.202). In the pre-Socratic Greek philosophy, which strongly influenced the origins of general systems theory in the twentieth century, change and flux are the only absolutes. Therefore, unchangingly stable systems don't achieve much; rather, what counts is the equipment which allows them to regulate their instabilities (c.f. Wallace, 2015). It follows that, when a system's stability veers towards stagnancy, what it really needs is disruptive forces.

This implies a duality in the notion of 'rift'. In the sense of losing touch with nature and, more specifically, of breaking the loops which recycle the waste from one process as an input to another, rift is bad, but, where it means ripping apart a static and outmoded equilibrium, it is good. Imbalance and unpredictability should be accepted as expressions of the dynamic character of systems but, of course, the environmental justice dimension is to avoid their ill-effects being shunted onto the poor and vulnerable.

The juxtaposition of these conflicting definitions of entropy, equilibrium and rift helps explain why the progression of a system through time is not gradualist or smooth, but instead lumpy and marked by qualitative leaps: during some phases stability prevails, at others, disturbance. We notably find such a view central to the work of ecologist C.S. Holling (b. 1930), who showed how systems explore the potential of a particular phase until it is exhausted, whereupon an intense disruption ushers in a new phase (Holling, 2001). The process is cyclical in that such phases alternate in succession, as they do in evolution where environmental rifts often trigger rapid bouts of diversification; evolution is definitely *not* gradualist (Gould and Eldredge, 1977, p.141). Indeed, Holling and colleagues interestingly remark that the image of a nature in delicate balance is *actually Malthusian*; in refuting this argument, they say: 'natural ecological systems have the resilience to experience wide change and still maintain the integrity of their functions' (Holling, et al., 2002, p.19). Indeed, in a sense, the resilient capacity of any system can itself be considered a *product* of the disturbances it faces and surmounts.

## Regime shifts and the role of feedback

Although the alternance of order-disorder repeats itself cyclically, the character of each new phase is specific and unlike previous ones. To represent such specificity, we often use the terms 'regime' or 'state' in the particular sense of a 'mode of organisation'.

Let us briefly take the climate issue (to which we will return in more detail in Chapter 9) to illustrate issues of regime-shifts (state-shifts). 'It is now well documented that biological systems on many scales can shift rapidly from an existing state to a radically different state' (Barnosky, et al., 2012) and, of course, we know that 'It is possible that anthropogenic climate change will drive the Earth system into a qualitatively different state . . .' (Higgins and Scheiter, 2012).

Clearly the kind of state-shift to avoid at all costs is the tipping-point of runaway global warming (our strategies to avoid this are what we call 'mitigation'). However, there are other state-shift thresholds which it is too late to prevent, and which we simply must adapt to . . . notably the greater frequency or severity of extreme events. In this respect, it is probable that we have fairly recently (i.e. within a generation) embarked on a new era. For instance, with regard to hurricanes, regime shift seems to have occurred in the late 1990s: there are either *more* major hurricanes (Holland and Webster, 2007) or, perhaps, they are less frequent but more extreme (Kang and Elsner, 2015). Such climate regime shifts are now entrenched: thus it has been said that 'Over the next century, all models show a continued trend for more extremes in the temperature-related extremes indices' (Tebaldi, et al., 2006, p.206), while it is increasingly demonstrable that the phase-shift to a warmer climate provides an overarching logic linking seemingly unrelated extreme events (Committee on Extreme Weather Events and Climate Change Attribution, 2016).

The relevance of the above for farming does not need any emphasis. For instance, a threshold has been crossed whereby record-breaking rainfall events, often impacting agriculture, have qualitatively increased since the 1980s (Lehmann, et al., 2015). The empirical confirmation of phase-shift for the author, who has practised food-growing over the past decade and a half, is that there is no longer what we could meaningfully call 'normal' weather.

Here, a crucial point arises. Humanity has always shown a creative capacity to respond to challenges. Traditional farming systems embraced disturbance because it strengthened them, an argument which draws upon the role of immune systems. This is ingrained in our being, because of the way evolution tested us across past ecological difficulties. In this sense, what is commonly seen as an adaptation *problem*, we could more positively view as a challenge to embrace the *opportunities* of a new era, one which demands the kind of resilient, modular, distributed and networked structures/institutions which would be beneficial to society in any case, and make life generally more interesting.

## Introducing 'panarchy' – how systems are ruled

Even ecological disasters have historically been harbingers of progressive agricultural change, both technical and institutional, as shown in the research of Thirsk (Thirsk, 1997). However, if possible, we want to avoid major disasters *and this is precisely the reason for embracing lower-level disturbance*. In other words, either we embrace 'normal' disturbance as a trigger for immunity, or we try to block it, in which case it becomes catastrophic. This is an extremely important point.

Berkes and Folke explain the theory behind this when they praise traditional Amazonian swidden-fallow land-management approaches which mimic natural fine-scale perturbations and thus 'avoid the accumulation of disturbance that moves across scales and further up in the panarchy' (Berkes and Folke, 2002, p.131). Let us unpick the meaning of this, because it harbours an interesting duality. On the one hand, 'panarchy' means that a system's site of 'rule' *is situated at the level of the system itself* ('pan' = all) – this is the dimension of holism. On the other hand, the reference to 'further up' draws upon a particular usage of 'hierarchy' (different to that which we might employ to describe a society like feudalism): the panarchy is a set of *nested* subsystems (Holling, 2001), and the point is that if we attempt to stifle disturbance while it is still at a manageable level it will only reassert itself at another, more threatening, level.

So what can we draw from the above to help us understand 'what went wrong'? If we try to control a system too much, *and in particular make it too simplified and predictable*, if we fail to embrace the creative face of chaos, if we homogenise and smooth things out in the interest of predictability . . . then the system becomes fragile and vulnerable to a more general crisis. '[S]implified intensively managed systems become more inflexibly "brittle" and thus more prone to erratic behaviour (including systems collapse) . . .' (Rees, 2010, p.2). If we aim for predictability of short-term benefits in ecosystem management, the result will be greater long-term fragility (Carpenter, et al., 2015).

This takes us to the essence of the contradiction within what is conventionally called 'food security'.

In relation to livelihoods, an aspiration to predictability is meaningful and legitimate. People have a right to secure employment, lodging etc. and, in the same way, need to be confident that there will be enough to eat, so in this sense you wish things to be as predictable as possible. That is all fine. But the problem is, if you try to *achieve* this by making the system simple, uniform and standardised, it will have the reverse effect. The Green Revolution and globalisation (which we address in more detail in Chapter 10) perfectly illustrate the wrong approach: in the Green Revolution, you grow only a few crops and a few strains of each, with no variability at all in height or appearance. You still see the legacy of this in the EU's regulations on seed, which distrust traditional varieties because they lack what is called 'stability'. In globalisation, you create an expectation that every vegetable (at least in Northern supermarkets, which form the end-point of global value chains) should be available 365 days a year, and of a standard size and blemish-free. Such false attempts at predictability heighten alienation, distorting how the world really is: vegetables *should* be seasonal, they do not all look the same, and each year is different in terms of which crops grow well. Although the predictability of the Green Revolution/globalisation type *can* be achieved, it comes at an immense and unsustainable cost. Partly this is measured in the physical inputs required: fertiliser, water, herbicide, pesticide; and, more importantly still, in the loss of resilience suffered by any homogenised system. Thus, 'the diversity of responses to environmental shocks is closely related to resilience' (Carpenter, et al., 2015, p.5).

What you lose in the approach which over-emphasises uniformity is the most precious treasure of traditional approaches, which made a virtue of variety, preserving all possible strains of a particular crop (c.f. Shiva, 1988) for the reason that evolved characteristics possessed by each might save humanity in the face of some unpredictable threat. It is precisely the variability of traditional strains, *the fact that they are not 'stable' but keep evolving,* which provides this robustness. Inevitably, the unpredictability which modern reductionist approaches sought to banish returns to haunt us today at systemic level. The very inputs which were supposed to make things more secure now trigger (in the shape of greenhouse gases, nitrogen runoff etc.) a regime of intensified ecological stresses and extremes which a simplified system cannot withstand.

The above perspective, which would enrich political ecology, relates in a subtle way to the more obvious *political* manifestations of control: if we assume the flows of command in a system to be linear and deterministic, with one variable governing the rest, then obviously *political control will be easier*. Again, we see the relevance of Gramsci and Foucault (see Chapter 2): we should always look for the ways in which power over people functions *through control over systems*.

## Phase-change: under capitalism and beyond

An interesting paradox arises here: capitalism, while seeking to impose an impossible stability on nature, is, in its *internal* workings, much more keen to embrace disturbance. It has indeed forged its own parody of how systems develop though successive phases or regimes (Figure 4.1), in which we discern a clear analogy with Holling's ecosystem model. Here too, we encounter phase-shifts opening up a new potential, which is then explored for a period until it is exhausted. There follows an episode of stagnancy and decay, followed by an intense disruption, as prelude to a new phase of order, and so forth. In this way, capitalism has its own 'ecology' but, unlike in previous societies, this is divorced from, and antagonistic to, the natural one.

As a representation of this disorder-embracing faculty, Schumpeter coined the term 'creative destruction' (Schumpeter, 1976). And though I happen to find Schumpeter's own exploration of this notion rather weak and unsatisfactory, the concept itself – which is in fact very much in the spirit of Marx (c.f. Schubert, 2013) – has great potential.

The successive phases in the political economy find a specific expression in the food system (Figure 4.2). Such phases can be seen as 'food regimes'. Thus, as with regime shifts more generally, the development of food regimes is not produced either purely out of structure itself or out of agency (c.f. Potter and Tilzey, 2005), but through some interaction between the two.

In today's situation, we often speak of crisis, but how should we understand this? Perhaps at three levels:

[1] *Business-cycle* or boom/bust (*conjoncture* in French). This relates to the fluctuation which occurs within any given accumulation regime. Such instability is 'business as usual' for capitalists, but consequences for working people may be dire – notably in food security terms;

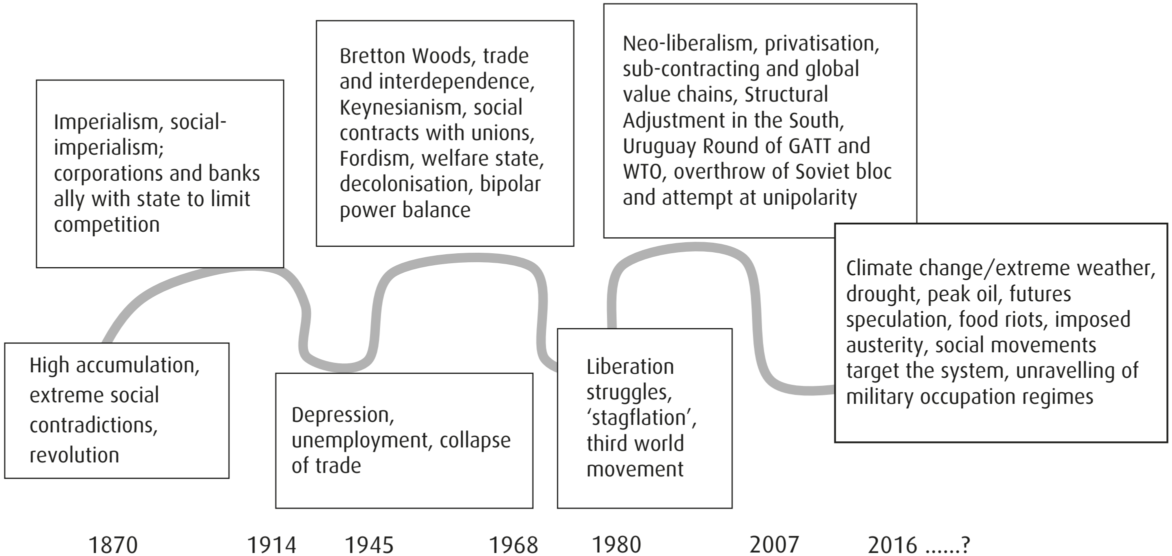


**Figure 4.1** A succession of structural regimes in the international political economy, punctuated by phases of low order

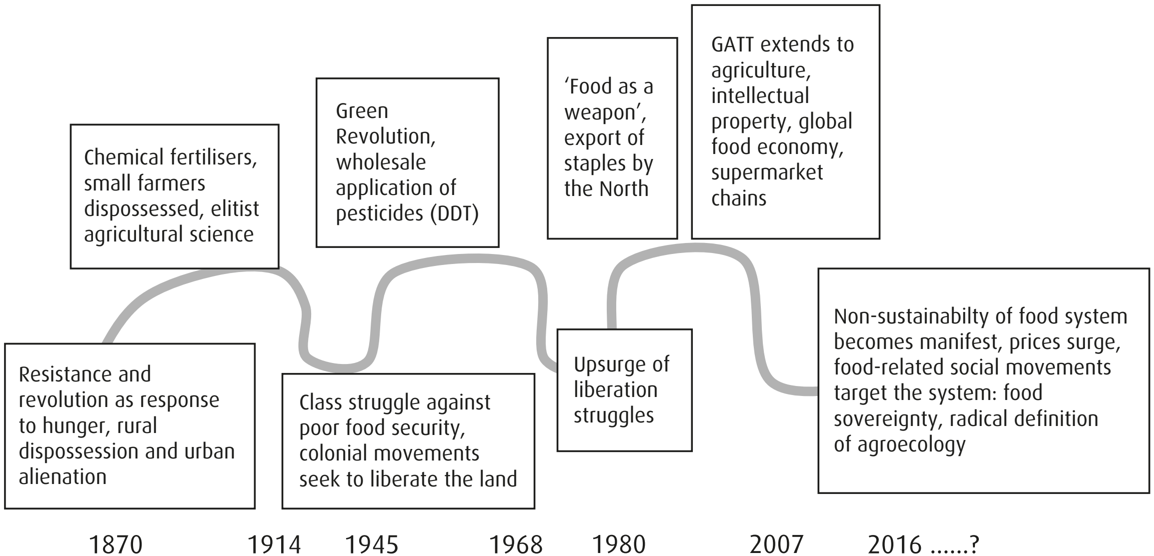


**Figure 4.2** A succession of 'waves' in the capitalist political economy of food, punctuated by phases of crisis

[2] *Structural*, in which an entire regime of accumulation comes unstuck. At such periods, it may for a while be hard to see anything 'creative' in the destruction, and even the ruling order is severely troubled;

[3] *Systemic*, in which the whole mode of production is called into question.

The difference between [2] and [3] is not so clear-cut. If we take the case of 1914–45, it was not clear at the time how capitalism would recover at all, and food issues were very much part of this. In Britain, for example, the strong official promotion of allotments extended throughout the *whole* of this period (Acton, 2011) – not just during the Second World War as is often supposed – and can be considered a response to the threat of social unrest from an impoverished and food-insecure working class. It could indeed be argued that most structural crises give the impression of being systemic while you are living through them.

Nevertheless, there are strong reasons why today's impasse may be more profound and more systemic than what went before. A fundamental showdown in humanity's relations with nature has been brewing since the origins of capitalism – effectively nature's revenge on a model which thought it could control complex reality in a simplifying way – but in earlier periods this was merely latent. Today it is inescapable. Moreover, the structural crisis of the neo-liberal capitalist regime of political economy *coincides with* a regime shift in nature (the regime of climate extremes), placing the simplified system under intolerable stress. We may therefore be living through the first truly systemic crisis since capitalism's origins.

In its implications, a new food/farming paradigm therefore requires transcending not just a certain phase of capitalism, but actually confronting a much wider existential crisis of civilisation, culture, psychology and every other mode of being. Radical movements (c.f., for example, Morin, et al., 2012; World People's Conference on Climate Change and the Rights of Mother Earth, 2010) clearly sense this fact. Hence a dualism in the stance of ruling bodies: on the one hand, as in the FAO's conversion to something resembling agroecology, they rightly advocate a new paradigm; on the other hand, they inevitably fear the big strategic implications such a shift would unleash, notably on the part of those radical forces which alone could truly bring it to fruition.

Such a systemic crisis may well have special features, different from those encountered in previous epochs.

There are already certain types of rhythm visible in capitalist cycles. Following our classification above, [1] if we take from systems theory the notion that '...fluctuations rather than stable states are obviously the rule' (Scheffer and Carpenter, 2003), this would be obvious in the business cycle; [2] in the alternance of major accumulation regimes, there is another kind of rhythm driven by a peculiar parody of Holling's cycle of order-exploration and order-distruption; [3] arguably, in a *systemic* crisis, the system has become chaotic. In fact, in chaotic systems there is still a kind of rhythm, which may reflect how they keep hurling themselves against their resource limits and rebounding from these (Gharajedaghi, 2006, p.117–8). Such chaotic behaviour may be visible in the behaviour of food prices from around 2007 onwards (Figure 4.3).

From physical systems we learn that, as they approach a point of bifurcation, volatility is indicative of an impending qualitative shift: 'It is remarkable that near-bifurcations systems present large fluctuations. Such systems seem to "hesitate" among various possible directions of evolution...' (Prigogine and Stengers, 1985, p.14). We could make an analogy with oil prices, which also appear trapped between two conflicting tendencies, namely tendencies to both high and low prices, each of which could be bad for the fossil economy (high by encouraging a shift to renewables; low by destroying the viability of fracking, tarsands etc.) and, on this point, Fred Pierce makes an interesting

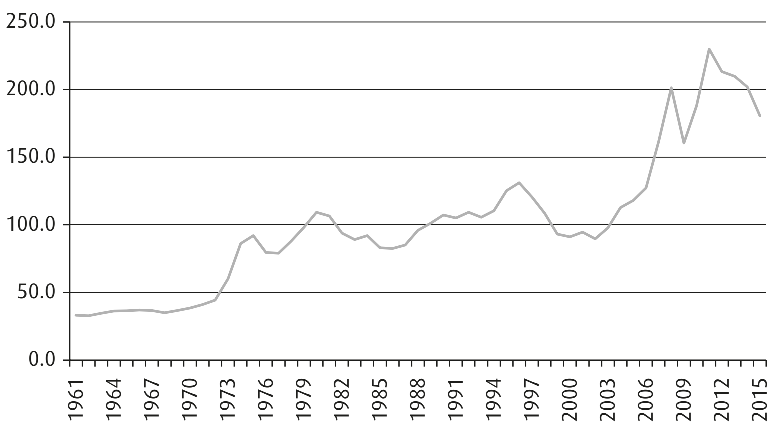


**Figure 4.3** Food price index (2002–4 = 100). Source: the author, data taken from UN FAO on http://www.fao.org/worldfoodsituation/foodpricesindex/en/

observation: 'Maybe we are seeing the death throes of our addiction to fossil fuels' (Pierce, 2015, p.23). So, in a similar vein, we could ask if the chaotic features of food indicators herald the death-throes of chemical/fossil fuel-based farming; and whether this in turn signal a wider paradigm-shift in the organisation of society as a whole.