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Introduction: Knowing the Land

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Introduction

Land and the use of land provide a key link between human activity and the natural environment. Our use of land is one of the principal drivers of global environmental change, and, in turn, environmental change, particularly climate change, will increasingly influence the use made of land as communities strive to adapt to, and mitigate, the effects of a changing climate. For instance, as farmers and land managers are increasingly positioned as 'carbon stewards' and new environmental bastions in the struggle against climate change, there is growing pressure to adapt land use and land management practices in order to minimize carbon losses, maximize carbon storage (see Smith in this volume) and provide substitutes for fossil fuels. At the same time, a series of long-term trends (such as changing global dietary patterns) and shorter-term 'events' (such as recent poor harvests and the ongoing drought in Australia) have led to constrained global food supply and stimulated pronounced changes in global agricultural commodity prices, putting further pressure on agriculturally productive land.

Consequently, land and food are at the forefront of the domestic policy agenda in the UK to an extent unprecedented since the 1950s. Climate change lies at the heart of the new debate and it was the climate change agenda that prompted the UK environment minister David Miliband to launch a national debate on land use in 2006. 'Food security', until very recently seen as the last refuge of a backward-looking agricultural fundamentalism, has reappeared in the political vocabulary. With scarcely a backward glance at the 'old environmentalism' of multifunctional agri-environments and its emphasis on biodiversity and landscapes, agricultural supply-chain interests have embraced the 'new environmentalism' of climate change with enthusiasm. They proudly proclaim the readiness of the industry to produce both food and bio-crops, and to do so with a neo-liberal confidence in markets to determine the balance between food and non-food crops in land use. For instance, in his speech to the National Farmers Union (NFU) Centenary Conference in February 2008, Gordon Brown stressed the 'core responsibility' of British farmers to 'grow and produce the majority of food consumed by the British people', alongside a 'front line' role adapting and reacting to the challenges and opportunities of climate change and exploiting the potential of farmers to become 'energy exporters'. Farmers and their advisors have been quick to embrace the 'new productivism', with the agricultural consultants Andersons stating that the 'PR battle is being won, and farmers, as producers of food and fuel in a dangerous world, are being valued once again.' (Andersons, 2007).

A recent collection of essays entitled *Feeding Britain*, with a foreword by the government minister Hilary Benn (Bridge and Johnson, 2009), contains papers by representatives of the key sector development bodies, such as the Home Grown Cereals Authority (HGCA) and the Horticultural Development Company, and presents a bullish outlook. For example, Jonathan Cowens, Chief Executive of the HGCA, is emboldened to suggest that environmental cross-compliance measures (modest though these may be in the eyes of most environmentalists) could lead market-orientated cereal farmers to forgo the Single Farm Payment so as to avoid the restrictions. In a SWOT analysis, he identifies 'environmental use of land' as one of the threats to the cereal sector, alongside 'loss of pesticides due to legislation or resistance'.

But policy (and politics), characterized by incrementalism, has not necessarily caught up with these market- and industry-led changes, nor the changing risks associated with new circumstances (see Dunlop in this volume). Agri-environment schemes, organic farming and sensitive river-catchment planning all continue to figure highly within European rural policy. Non-governmental organizations such as the Royal Society for the Protection of Birds (RSPB) initiate schemes to take land out of production to recreate wildlife-rich reserves. Local and slow food movements challenge the logic and ethics of global markets. Moreover, the far-sightedness of the old environmentalists is beginning to challenge some of the assumptions of the new proponents of food security, particularly their inherent 'productivism'. Is it axiomatic, they ask, that agriculture's best contribution to tackling climate change is to grow bio-crops, or invest in anaerobic digesters, or make land over for wind farms? Might not there be an equally important role in maximizing the carbon sequestration or water-holding properties of biodiverse land? Some have even suggested that biodiverse-rich ecosystems allow for maximum carbon sequestration.

This book does not set out to provide definitive answers to these questions. It is too soon to do that and much of the science is too immature. Rather we seek to establish and to explore the contours of the new debate. In no small measure the book emerges from a strong commitment from both of us to interdisciplinarity which has been strengthened and nurtured by the Rural Economy and Land Use (Relu) programme of the UK research councils. Each of us is involved in Relu projects and several of the contributors to this volume are Relu project leaders too. Relu helped to fund a workshop exploring the themes of the book in which most of the contributors participated. We are also committed to policy relevance and application. The Commission for Rural Communities, an advisor to the UK government, co-funded the workshop as part of its climate change work, in which it is seeking to establish both the implications of climate change for rural communities and the 'rural offer' in dealing with climate change.

This chapter, indeed the whole of this book, has three premises. The first premise is that food and energy security issues now occupy centre stage in policy thinking about land use and this is likely to remain the case for some time to come. The second is that this new emphasis on food and energy security will not mean an abandonment of a continued public policy emphasis on multifunctionality and ecosystem services. Indeed this emphasis is likely to continue to grow. The third premise is that there will be 'local' trends that may on occasions seem counterintuitive in a global context.

These three premises need to inform decisions that society makes on how to pose the right questions, determine the right research priorities, collect the right data and conduct the right analysis. These will require normative judgements and will be subject to contestation. We hope that the chapters in this book will collectively help to make the case for putting food and energy security, ecosystem services and localism centre stage not only in the land debate but in the climate change debate too. But first what is our justification for attributing such importance to these three issues?

Food and energy security

For three decades agricultural commodity surpluses in Europe and the developed world contributed to a dominant discourse of 'land surplus' in which set-aside, extensification, alternative land uses, even managed land-abandonment and 'wilding' were totemic terms in debates over land. Quite suddenly all this changed as a consequence of rapidly shifting commodity markets. The era of land abundance and commodity surpluses that dominated policy thinking, at least in terms of the European Common Agricultural Policy, for most of the 1980s and 1990s, is well and truly over. Some would argue that the land surplus debate was, in any case, an artificial construct, emerging out of the peculiarities of European agricultural politics. Indeed, there is a curious mismatch between the Euro-centric policy concerns of the 1980s and 1990s and the concerns of various international agencies and pressure groups over poverty and development. Much of the academic discussion on *global* food and land issues in the 1990s, although cautiously optimistic, was certainly not so sanguine as to assume that land abundance was in any way a global problem. Leading writers such as Gordon Conway (1997) and Tim Dyson (1996) were critical of neo-Malthusianism on the basis that it underestimated the capacity of the human species to adapt and innovate in response to new challenges. But both Conway and Dyson were acutely aware of the challenges of, for example, seasonal weather fluctuations, so that a poor harvest in one part of the world affects markets many thousands of miles away. For example, poor harvests in the Soviet Union and elsewhere in 1972 led to a massive undercover operation to purchase cereals on the international grain markets, an action which, during the Cold War, had major geo-political consequences. The 1974 World Food Conference in Rome was held in an atmosphere of Malthusian gloom about future prospects for world food supplies. Yet just three years later burgeoning production led to world wheat prices lower, in real terms, than at any time since 1945 (Goodman and Watts, 1997). This was not so much an outcome of better weather conditions across the world but a direct result of farmers and nation states responding to market conditions resulting from the cereal shortages in the context of an increasingly international economy. Dyson pins his optimism on this demand and supply response being a recurring pattern. He acknowledges that research, development and investment will be needed and that these cannot necessarily be guaranteed, especially, perhaps, in those parts of the world where they are most urgently required. However, his analysis underplays two trends – first, the impact of climate change itself, both in terms of direct impacts on food production and the potential implications of adaptation and mitigation; and secondly the dependence of agriculture on a finite energy source, oil. It is these concerns that have led to such a powerful re-emergence of food security in the policy arena.

In June 2007, US wheat prices were at their highest for a decade, and in the UK the price of milling wheat doubled during that year. The Food and Agriculture Organization (FAO) Food Price Index for 2007 averaged 157, a 34 per cent increase from 2005, and by May 2008 the index stood at 209, the highest recorded monthly average since the current index started in 1990. Four main drivers of the rapid escalation in food prices have been identified (Nellemann, 2009):

- cyclical factors such as poor harvests due to extreme weather conditions leading to very low global commodity stocks;
- a rapid increase in the share of non-food crops, particularly biofuels;
- high oil prices affecting agricultural input costs, food distribution costs and, ultimately, food prices;
- speculation in food commodity markets.

These drivers have added to the impact of more deep-seated, structural change such as the increased demand for food crops and livestock products from developing and emerging economies. Commentators have debated the relative contribution of the different drivers and, although it is hard to disentangle the impact of new crops compared with other causes of market price increases, what is clear is the emergence of new pressures on land from Amazonian Brazil, where there are reports of a rapid escalation of deforestation, to the European Union (EU), where set-aside was reduced to 0 per cent in 2007/2008, hence its elimination for the first time since its introduction as a voluntary scheme in 1988. Even though agricultural incomes will remain subject to volatility, in their 2008 *Agricultural Outlook* the Organization for Economic Co-operation and Development (OECD) and FAO predicted that the conjoined temporary and structural factors identified above may keep prices above historic equilibrium levels over the next ten years and that this will kindle continuing debate on the 'food versus fuel' issue.

Of course, the global recession has to some extent slowed or even reversed this trend. By the beginning of 2009 the FAO Food Price Index stood at a level similar to that in 2006–07, but this was still above the 2004 index (FAO, 2009). As the director general of the International Food Policy Research Institute, Joachim von Braun, has written in *Nature*:

> the worldwide credit crunch has let some air out of the commodity price bubble, providing a little relief ... But recession also threatens to cut the income and employment of the most vulnerable and undermine investment in agricultural production. The economic bailout and suggested market regulations now being discussed will not protect food prices from future spikes. The world's food worries are by no means over. (von Braun, 2009; see also FAO, 2008a).

In particular, von Braun argues that the economic downturn could have adverse consequences for investment in agricultural research and development (R&D), thereby eventually increasing global food prices beyond the level they would have been without the recession. Moreover, there are some parts of the world, notably China and India, where the recession may have limited impact on long-term structural changes and the rapid pace of economic transformation with its impact on diet. The longer-term population trends are challenging, with world population projected to grow from six to nine billion by 2050. As John Bridge (Bridge and Johnson, 2009) has recently suggested, this growth and, critically, the expected associated changing patterns of demand will require world food production to double. In the context of such predictions, the renewed scholarly and policy focus on food security issues is hardly surprising (see also Ambler-Edwards et al, 2009).

A multifunctional countryside

If we were facing only shortages of food and energy, then a modern-day equivalent of the war-time 'dig for victory' would be the order of the day, and in some quarters, as we have seen already, there is a palpable sense of 'back to business' within the agro-food lobby. However, there are reasons why that is not, nor should be, the case. Politically and culturally, as the chapters in this volume by Dunlop, Lowe et al, Potter, and Ravenscroft and Taylor all demonstrate in different ways, the arguments for seeing the countryside as much more than a site for food production remain powerful. They are deeply embedded in decades of public interest and intervention. A multifunctional countryside in this context encompasses, in particular, recreational, nature conservation and landscape interests. In a society such as Britain – characterized by a high population, a large middle class, a low relative contribution of agriculture to gross value added (GVA), and a deep and well-established tradition of counterurbanization – these interests will not just disappear with increased food and energy demands. They are embedded in public policies and in various expressions of public interest, including pressure group membership. Thus, when speaking to the 2009 Oxford Farming Conference, Secretary of State for Environment, Food and Rural Affairs Hilary Benn stated that 'I want British agriculture to produce as much food as possible' (Benn, 2009) but went on to say that this must be consistent with systems of production that both sustain the environment and safeguard the landscape, as well as producing the type of food that consumers want. If this generalized public interest were not enough, the importance of multifunctionality is massively reinforced by the emerging policy and scientific consensus in the debate on the importance of land management practices for the matter of mitigating and adapting to climate change (even if the precise cause-and-effect relationships have yet to be fully understood).

Although the focus on climate change and land use has so far attracted most popular attention in terms of the potential competition between food and energy cropping (see Karp et al in this volume), there are a number of other potentially significant land use implications of moves to tackle climate change and also to cope with declining availability of oil for fuel and other products once peak oil production is reached. The use of land for flood alleviation is tackled by Morris and colleagues, and Hubacek and colleagues consider the range of ecosystem services provided by upland areas in this context.

Localism

There is a danger that the emphasis on global markets and global environmental change, hugely important though these trends are, can sometimes lead to the neglect of local responses. Local land use trends may run counter to what might be expected from a simplistic downwards extrapolation of macro trends. This is a fundamental point about both the reach of globalization, which although great may not be universal, and the spatially differentiated responses to global trends. In other words the specificities of national, regional and local social, economic, political and cultural contexts will impact on land management practices. These specificities include variations in consumer taste and demand and contrasting regulatory requirements in different places.

Much of this local difference is captured in efforts to make regions and localities competitive even in a globalized context. In other words localism can be seen as the reverse side of the globalization coin. Agriculture's contributory role to landscape and biodiversity and the re-territorialization of food has contributed to the rapidly emerging agenda of regional and local competitiveness. A growing sense of place pervades agricultural and food policy discourses.

What is land?

We have been talking about land as though its defining characteristics are self-evident. But what is land, what are the right questions to ask about it and what are the appropriate data that we need to understand land? This section reviews approaches to understanding the meaning of land. Definitions are important and here we outline the differences between land, land use and land cover: *land* as a physical resource, *land cover* as the bio-physical attributes and human structures of a part of the Earth's surface, and *land use* as operations or activities carried out on land.

'Land cover' and 'land use' are often used interchangeably and/or without clear definitions but it is important to distinguish between the two. Land cover is largely concerned with the bio-physical characteristics of the land and cannot necessarily tell us what the land is used for, particularly if there are multiple uses made of a specific area of land. Also there are feedback effects that cannot be ignored, as land use effects land cover, perhaps permanently. To give an extreme example, the use of land for the production of turf, or even topsoil, clearly has long-term, probably permanent implications on bio-physical properties and therefore on land cover. The specification of any land cover mapping exercise itself reflects policy priorities and the cultural norms of agencies involved, hence the importance of the socio-economic, cultural and the political in any attempt to *know the land*. According to Owens, although land is a resource, 'it's different, it's peculiar, and it's not the same as other resources that support our society and economy. Land provides a material basis for the economy of course, but it also has powerful cultural meanings – it gives us a sense of place, and a sense of history' (Owens, 2007). Hence for Lynch

(1960) land is 'a vast mnemonic system for the retention of group history and ideals'.

This does not mean that we should adopt what Comber et al (2005a) describe as 'pure relativism', rather there is a 'middle way' which accepts that different interpretations of reality are 'meanings' rather than competing truths and that the real world is filtered through such meanings. The implication is that what is thought important to measure about land cover and land use, and the values and interpretation placed on such data will change over time. If we are at the confluence of a set of interconnected drivers relating to climate change and food security, the question that therefore arises is how well equipped are we with the data and information we need in order to judge the land use and land management implications of new and sometimes competing uses of land?

Potentially the land cover/land use distinction is useful and attempts have often been made to preserve it. For example, the standard way in which that most basic constituent of land, the soil, is classified and portrayed attempts to preserve the distinction. The Soil Survey in the UK produces for each locality *two* maps (and corresponding sets of descriptions): one of *soil type* and one of *land use capability classes* based on those soil types. The problem, of course, as indicated above, is that land use may change the underlying edaphic characteristics of the land, thereby often rendering the distinction blurred and problematic. There are many such examples: urban development, rainforest clearance, and the example of turf already given. But one further will suffice here: the British uplands are characterized by various types of heather or grass assemblages of vegetation maintained by grazing. If grazing pressure is reduced, the heather – and ultimately other shrubs – tend to dominate. There is much debate about how long, if ever, it would take, if grazing ceased, for land to return to the mixed oak forest that dominated many such areas before agriculture. The reason for the problem is that the nutrient status of the land has been much reduced after centuries of nutrient removal on the hoof as meat and wool. In short, land use affects the land.

The upland example is useful in another respect beyond that of reminding us that the land use/land cover distinction may be blurred. It also helps us to think about the nature of land as a resource or a factor of production in economic terms. On the one hand, land can be seen as a renewable or 'flow' resource (like water, wind, solar energy). Its productive potential is renewed if managed 'sustainably' – farms and forests as systems that adapt and mimic self-perpetuating ecosystems, yielding a continuous flow of output. But there are ways in which land is more akin to a 'fixed', 'stock' or 'fund' resource, akin to oil or coal. In the upland example, the agricultural use of the uplands has reduced its potential biomass yield. This may not be particularly tragic in this instance where the depletion is very slow and gradual and where grazing, should it be required, is probably sustainable for millennia to come. Moreover, the low-nutrient status of upland soils gives rise to biodiverse vegetation with amenity value. But over-exploitative farming systems can radically diminish the flow resource, using land more as a fund resource.

So land can be seen as flow and as fund. It can also be seen as 'landscape', which brings into the equation the 'values' associated with land that are not directly to do with its use as a resource. As Paul Selman (2006) puts it: 'a landscape is a relatively bounded area or unit; its recognition depends on human perception, which often is spontaneous and intuitive in its identification with a coherent tract of land; and it results from a long legacy of actions and interactions.' Selman suggests that landscape embraces three flows: energy, material and information (perceptions and values). It is these three inter-related but distinct flows which lie at the heart of that fundamental characteristic of land, and such a powerful element in policy thinking – its *multifunctionality*.

Although some writers, notably Wilson (2007), have attempted to construct a broad and a normative conceptualization of multifunctionality, our claim here is less ambitious – for us the key to understanding multifunctionality is the notion of joint production. Joint production emerges from two aspects of production: the physical production process itself and the land/capital context in which production takes place. The ubiquitous nature of joint production in the physical production process – several outputs necessarily emerging from a single production activity – may be linked to the first and second laws of thermodynamics and consequently has been proclaimed as a fundamental economic notion by Baumgärtner et al (2001). Every physical production process is a transformation of energy and matter, which can neither be created nor destroyed (first law of thermodynamics) and must generate a positive amount of entropy (second law of thermodynamics). Classically this leads to low-entropy desired goods and high-entropy waste products (Baumgärtner et al, 2001).

To that extent, agriculture is similar to many productive industries with the negative externality issue at the heart of jointness within the production process itself. But the transformation of energy and matter also takes place in space (land) and large areas of land are required for production. This extensive use of land, which also acts as an environmental, amenity and recreation resource for many people, gives jointness a special significance in agriculture. While this may not be unique to agriculture – buildings occupied by businesses, for example, may be part of an important amenity resource in a city centre – it is important in a way that is hard to imagine for many other branches of economic activity. Thus economists speak of positive economic externalities, in the sense of non-market goods, which arise from multifunctional land use. Policy analysts may speak of public goods and benefits or multiple objectives. We can even look to the post-modernists and invoke Callon's (1998) notion of 'overflowing', arising through 'the production of production' (Adkins, 2005).

Global trends in agricultural land use

The extensive use of land for farming means that agricultural land is now one of the largest ecosystems on the planet, covering some 30–40 per cent of the ice-free land surface (Turner et al, 2007; Foley et al, 2007). Recent decades have seen a significant expansion of the global agricultural area and also a marked intensification of agricultural land use associated with great leaps in land productivity and per capita food availability. Indeed, increases in agricultural output more than kept pace with population growth in the second half of the 20th century (Hassan et al, 2005). Understanding these trends is important, not least because of the growing demand for food, but also because the expansion and utilization of agricultural land is frequently at the expense of the natural environment.

Agricultural land

The global area under agricultural land management has grown steadily over the last four to five decades, and the total value of all agricultural output has roughly trebled in real terms over the same period (FAO, 2007). Agricultural expansion however, has been spatially uneven and has been much greater in developing countries, whereas the trend in developed counties has been for marginal reductions in the area devoted to agriculture. The majority of the Earth's agricultural land (69 per cent) is under pasture of various types (Smith et al, 2007) and the global importance of livestock farming is growing in association with shifting patterns of demand. Moreover, as the single largest user of land, livestock production can have profound implications for environmental management and ecosystem services. The global share of cropland has increased rapidly in recent decades but the rate of increase now appears to be slowing (FAO, 2007). Since the late 1980s Southeast Asia and parts of west and central Asia have experienced significant expansions in cropland, as have parts of East Africa, the southern Amazon Basin and Great Plains of the USA (UNEP, 2007). However, opportunities for the further expansion of cultivated land are thought to be declining given that most land that is well suited to cultivation has already been converted. Consequently, further expansion of cultivated land is likely to occur on marginal land, raising concerns that this will be associated with environmental degradation (Hassan et al, 2005; FAO, 2007). The projected increase in global population (see above) will provide a powerful driver for further agricultural expansion over the coming decades. Much will have to be accommodated through further intensification, although some 20 per cent of the associated increased agricultural production is expected to derive from the expansion of the global agricultural area, most notably in environmentally sensitive and fragile parts of South America and sub-Saharan Africa (FAO, 2007).

Agricultural output

The 40 years to 2004 saw the global output of crops increase by some 144 per cent (Hassan et al, 2005). Cereal crops are particularly important, accounting for over half of the world's harvested area and placing disproportionate demands on inputs of water, energy and agro-chemicals (Hassan et al, 2005), the use of which is likely to come under increasing scrutiny and pressure. Since the mid-1980s, when per capita cereal production peaked, cereal productivity has slowed globally (Hassan et al, 2005; FAO, 2007), while at the same time the production of oil crops has accelerated with growing demand both as feed and food in developing countries (FAO, 2007). Indeed, over the last 40 years it is the expansion of oilseed crops that has driven global cropland expansion (Hassan et al, 2005). For example, on average, global cereal outputs grew by 2.2 per cent p.a. between 1961 and 2005 compared with 4.0 per cent for oil crops (FAO, 2007). As with agricultural expansion, global figures mask significant regional variations in agricultural yields. For instance, in the last 20 years cereal yields have risen by 40 per cent in Latin America, 37 per cent in west Asia, 17 per cent in North America. The result is that whereas in the 1980s each farmer produced an annual average of 1 tonne of food and 1 ha of arable land yielded 1.8 tonnes, by 2007 this had increased to 1.4 tonnes of food per farmer and 2.5 tonnes per ha of arable land (UNEP, 2007). Thus, while the global expansion of the area under agricultural land use has been important in increasing food supply, it is this increase in the intensity of arable production that has been most important in increasing agricultural output.

Diet and food consumption

Changes in agricultural land use and production intensities have contributed to significant progress in increasing per capita food consumption from an estimated average of 2,280 kcal/person per day in the 1960s to 2,800 kcal/person per day by the early years of this century (FAO, 2007). Again, there are considerable regional variations in these figures and, while per capita food consumption in some developing countries has increased quite significantly since the 1960s, little change has occurred in sub-Saharan Africa, with an average of 2,058 kcal/person per day in the 1960s compared with 2,195 kcal/person per day at the start of the new millennium. It is also notable that per capita consumption today in developing countries is still less that that for developed countries in the 1960s (FAO, 2007). As well as the increase in food consumption in developing countries, rising incomes have been associated with a marked dietary change as the share of livestock products (meat and dairy) has increased, often at the expense of previous staples such as roots, tubers and pulses (FAO, 2007; Hassan et al, 2005; Smith et al, 2007). For instance, it has been estimated that in the 30 years to 1997 meat demand in developing countries rose from 11 kg/person per year to 24 kg/person per year (Smith et al, 2007).

The rise of bioenergy

Bioenergy consists of biofuels, biomass and other fuels produced from organic matter:

- Biofuels are liquid fuels derived from organic matter. Approximately 85 per cent of global liquid biofuel is in the form of ethanol with 90 per cent of production occurring in the USA and Brazil. The production of liquid biodiesel is largely centred on the EU (FAO, 2008b).
- Biomass is solid organic matter from crop residues, wood or short-rotation crops such as willow and miscanthus (see the chapter by Karp and colleagues) which is used to provide heat and/or electricity.
- Biogas and/or 'syngas' produced from solid biomass, food and/or animal wastes through the process of anaerobic digestion (see Chapter 5) can be used for heating, energy generation and transport.

In the context of the 'new environmentalism' of climate change mitigation bioenergy production appears to have the potential to perform a totemic role, contributing to energy security, supporting farm incomes and rural development (House of Commons, 2008; Henniges and Zeddies, 2006) and of course contributing to climate change mitigation (although the extent of such a contribution is debated; see The Royal Society, 2008). However, the rapid expansion of bioenergy through biofuel production, competition over the use of land for food production (the so-called fuel versus food debate), and the role of biofuel production in stimulating global increases in food commodity prices means that biofuels have been at the centre of much recent controversy.

As Karp and colleagues explain in Chapter 3, international treaties and national targets and legislation have stimulated the expansion of bioenergy production in recent years. In the USA, expansion of ethanol production has been described as 'exponential' (Westhoff et al, 2007) and policy support both within OECD countries and a number of developing nations means that bioenergy growth will continue, although it seems likely that the contribution of liquid biofuels to energy transport will be limited (FAO, 2008b). Righelato and Spracklen (2007), for instance, report that just a 10 per cent substitution of liquid transport fuels would require 43 per cent of the cropland area of the USA and 38 per cent of that of Europe. Even with much smaller areas under production, there are concerns that liquid biofuels have a significant impact on global agricultural markets and on food security. von Braun (2008) points out that one-third of the US maize crop is now used for ethanol production, with a knock-on effect on agricultural prices. Indeed, it has been suggested that 'biofuels have been the single most significant driver of higher prices' (Evans, 2009, p14). Commentators have also expressed concerns regarding the environmental, landscape and biodiversity implications of bioenergy (House of Commons, 2008; FAO, 2008b). Nevertheless, bioenergy is part of the emerging bio-economy, and technological advances mean that the various forms of bioenergy are likely to become increasingly important in the near future. This raises a number of practical issues and research questions, some of which are discussed in this book.

UK land use data availability and problems

As social, economic, cultural and political imperatives change, so what we want to know about our land also changes. Anyone involved in analysing time-series data about land use – either directly or indirectly – knows this. Comber et al (2005a) illustrate this by contrasting the UK Land Cover Map 2000 (LCM2000) with the earlier 1990 Land Cover Map of Great Britain (LCMGB). The 1990 map was designed to demonstrate the utility of satellite imagery for environmental monitoring, whereas the 2000 map was designed to help meet national and international policy obligations. Consequently, the different objectives of the two surveys – one science led and the other policy driven – lead to very different conceptualizations of land classes that may be nominally similar.

But at least in the case of land cover, as the name implies, a reasonably comprehensive survey of land in its totality may be undertaken and, notwithstanding the definitional difficulties, some knowledge of both the underlying physical characteristics of all land in Britain and its overlying cover is available. The same cannot be said for the use to which the land is put and its function in both physical and social systems. This presents far more tricky issues for the data gatherer and it is at this point that our knowledge of land becomes heavily compromised by two problems: the 'legacy effect' and the 'surrogacy effect'. The legacy effect refers to the long shadow cast by historic policy or science problems and objectives, or earlier data-gathering constraints. In other words, decisions on what data to collect and how, taken decades ago or even in the 19th century, cast a long shadow on what we know of land today. The problem presents a classic methodological challenge to any researchers undertaking time series analysis – the tension between the desire for continuity, on the one hand, and the need for adaptation of data sets to reflect new understanding and new objectives, on the other.

In broad terms, there are at least three main legacy effects (with some overlap) for contemporary land scientists in Britain to contend with. First, there is the importance of collecting so much data for *agricultural* purposes. This is a legacy of either the 19th century, when agricultural and landed interests in politics were so much stronger than today (for example the June Agricultural Census commenced in 1866), or the 20th century and food shortages arising from warfare (for example the comprehensive National Farm Survey undertaken in 1941–43: Short et al, 1999). Secondly, in the 20th-century debate over levels of *planning and urbanization* prompted much academic inquiry and vigorous debate from the 1950s to the 1970s. The warnings of Alice Coleman (1961), a darling of pressure groups concerned with preserving the countryside, were opposed by the more overtly scholarly and less alarmist Robin Best (Best, 1981; Best and Coppock, 1962; Best and Rogers, 1973). In both cases they operated with a rather crude distinction between urban and non-urban land driven by the urbanization debate, but their data sources were different. Best largely relied on analysis of the agricultural census, while Coleman sought to follow in the tradition of Dudley Stamp (1948), whose 1930–38 Land Utilization Survey provided a mapped inventory of every acre of mainland Britain using seven broad classes of land use. Coleman's Second Land Utilization Survey conducted between 1961 and 1968 sadly only ever resulted in 15 per cent of the maps being published, although Coleman did some analysis of the entire data sets to compare with Stamp (see Swetnam, 2007). Thirdly, and more recently, *ecological* data has come to the fore due to widespread concerns, some driven by international treaty obligations, over biodiversity losses. The most obvious legacy here is the range of data sets derived from the Countryside Survey (Carey et al, 2008; Barr et al, 1993).

The *surrogacy* effect comes into play when attempts are made to move from land type to land use or function. The data used for understanding function are frequently aspatial and therefore at best can only serve as a surrogate for spatial land function data. The most ubiquitous example of this is provided by the annual June agricultural survey (formerly census) in which a sample of between 21 per cent and 36 per cent of registered holdings provide information on cropping, stocking, land tenure and so forth. A full census is now only carried out every ten years in fulfilment of EU legislation. The last agricultural census was conducted in 2000. Time and again these data have been translated into spatial data sets at the parish level through use of the parish summaries which may be aggregated upwards to district, county, regional and national levels (see Coppock, 1976). Many are familiar with the national maps produced by the Ministry of Agriculture, Fisheries and Food (MAFF) in the 1960s showing the geographic distribution of farm types. And yet the raw data are not spatial. Famers are not expected to provide any locational information about their holdings. The parish summaries are merely an amalgamation of all holdings with a postal address in the parish. All mapping and spatial analysis of any kind is therefore based on the assumption that farm holding boundaries coincide with parish boundaries which, of course, they do not. Clearly the problem diminishes the larger the spatial unit of analysis, but as farms have amalgamated parish-based analysis has become less reliable. Another example of surrogacy is the use sometimes made of the Farm Business Survey. The FBS has been in operation in roughly the same form since the 1940s, but methods of data collection and the farms covered in the survey change, making it hard to generate accurate time series or spatial data.

Whose land is it anyway? The danger of neglecting property and markets

There is a weakness in the selection of contributions for this book that we fully acknowledge and attempt to partially remedy in this section. Farmers and other managers of rural land are the largest group of natural resource managers on the planet (FAO, 2007). We have said too little about them, therefore we offer two excuses. First, it is rather too soon to offer serious analysis of how farmers are responding to the rapidly changing technological, market and policy possibilities of the new productivism. Secondly, and more prosaically, we have another, as yet uncompleted, programme of research on farmers and the 'social question' in sustainability. In short, it is a topic to which we will return in greater detail in future publications. But it is abundantly clear that many of the possibilities discussed in this book, whether driven by markets, policies or technology, have implications for land occupiers. Maximum benefits for environment and society will accrue only with the co-operation and active engagement of farmers and land managers; and land occupiers' actions are driven by market possibilities (consumer demand), personal aspirations, perceptions and technical abilities, availability of labour and of capital, all in the context of regulatory constraints and possibilities. The literature on these topics is far too voluminous to cover here (but for a recent overview see Brookfield and Parsons, 2007) and in any case these issues are not to do with land per se. We highlight them to avoid any criticism that we have ignored the reality that farmers have agency, that how they manage the land will be determined by what consumers want to consume, what citizens want to regulate, and what they themselves want to do with the land and resources at their disposal.

However, there is one aspect of this complex of social and economic drivers that warrants some closer attention here because it is so intrinsic to the land itself, namely land occupancy arrangements. The nature of land occupancy has such obvious implications for land studies that it is surprising how little research has attempted to explicitly link occupancy to land management practices.

Contrasting tenurial arrangements have implications for the range of social and economic relationships between different groups of people. Thus, Whatmore et al (1990) classified agricultural property rights on a continuum from simple owner-occupation to contract farming with forms of secure and insecure tenancy in between. They identified three main rights to land – ownership, occupation and use – and the distribution of these rights is reflected in contrasting tenurial arrangements. Under simple owner-occupier ownership, occupation and use are all combined within the same firm or person. But as we move along the spectrum landed capital assumes responsibility for certain rights. Under an insecure tenancy, for example, landed capital has some owner and occupier rights with the tenant farmer having some user rights. Under contract farming landed capital retains all land property rights, with the contract farmer responsible only for non-land inputs such as labour and capital.

However, as our own work on tenure has shown (Winter, 2007; Winter and Butler, 2008) such a schema can be misleading as the precise content of a particular arrangement is all-important in determining its nature. There is a danger that methodological problems analogous to those surrounding de jure versus de facto ownership will appear unless the precise contents of tenancy arrangements are analysed very carefully. For example, contract farming may de jure vest all the property rights outside the hands of the farmer, but de facto the terms of the agreement *may* place considerable rights with the farmer. What our work shows is the extent to which unconventional forms of tenure – share farming, contract farming, short tenancies – have arisen which have, as yet, largely under-researched implications for land management practices. For example, contract farming now accounts for nearly 20 per cent of the land area in England's most prosperous farming region of East Anglia.

Currie (1981) has undertaken work that remains helpful in this respect. His distinction between ownership and operating structures gives rise to a classification based on differentiation according to ownership of land, ownership of labour and the provision of entrepreneurship. Currie is particularly interested in the implications of alternative tenurial arrangements for farm decision-making and contends that implications for decisions and management cannot be simply read off from tenure without considering the role of labour and capital. Thus, pure owner-occupation *may* produce highly efficient and productive farming on capitalist principles based on the use of hired labour *or* it may give rise to a form of peasant proprietorship, in which decisions on the allocation of family labour will depend upon factors other than the maximization or even the optimization of profit. It is essential to add a third category to that of capitalist producer and peasant farmer: residential proprietor, whose decisions on agricultural land use are likely to be based on a view of property as an item of consumption rather than production, a positional good, as noted by Offer (1991) for the 19th century as well.

What is the relevance of this rather arcane meander into property rights? First, it is clear that we now have a more and more complex array of actors involved with making decisions about the land. The determinants of land management and the objectives of those engaged in different aspects of land management no longer reside solely with landlord and tenant or owner-occupier. Secondly, shorter-term occupancy arrangements are now more common. This implies an increased risk of environmental asset-stripping as multiple short-term arrangements, whether formal or informal, are not necessarily the best suited to long-term stewardship. It has also been demonstrated that occupancy *change* is often a trigger for management change (Munton and Marsden, 1991) and with shorter-term arrangements this inevitably occurs more frequently. Finally, there is another issue of particular relevance to the increasing tendency to characterize the task of the land manager as the provision of ecosystem services – the fact that occupancy units do not align perfectly with natural units.

Conclusion

In this chapter we have sought to set out some of the key issues that are relevant to the new land use debate and to set the scene for the wide-ranging material presented in this book. We have a commitment to both interdisciplinarity and policy application. The book is essentially about knowledge of the land. But of course there are many different types of knowledge and the book as a whole contains contributions from a range of scientific disciplines that display different ways of knowing land and the issues relevant to the management and use of land. Conceptual unity has been less important to us than the urgent (and prior) need to establish a baseline of evidence and ideas. Following our introduction, the book is divided into two sections. The first section covers a range of new technologies and uses for land that directly or indirectly impinge on the management of land, such as anaerobic digestion (Chapter 5) and energy crops (Chapter 3), as well as ways of using land to manage water (Chapter 6) and provide ecosystem services (Chapters 2 and 7). The aim of the section is to provide state-of-the-art reviews on key issues relevant to the role of the land in climate change adaptation and mitigation. The second section of the book picks up on some of the issues and conflicts that these emerging technologies, capacities and demands give rise to. John Hopkins explores the implications for biodiversity of climate change (Chapter 8) and in Chapter 11 some of the policy aspects of this are also covered. Chapters 9, 10 and 13 serve to remind us of the breadth and challenge of the new land use debate, which encompasses not only the natural and social sciences, but also the arts (Chapter 10) and philosophy and ethics (Chapter 13).

For society as a whole, *what* we 'know' about land is determined in part by *why* we have sought to know some things but not others. The reason for this book is our strongly held perception that the importance of land to our survival as a species cannot be underestimated. As the challenges facing us escalate, so our need grows to take stock of what we know and what more we need to know about land.

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