Future Parks in Future Climates – Scalable Solutions

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Abstract

Britain's 15 National Parks cover about 10% of Britain's land area, rising to 20% in Wales, which rises to 25% when you add Wales' 5 Areas of Outstanding Natural Beauty, the sister designation to National Parks. Their size, geographic spread and range of altitudes from the highest mountains to the lowest floodplains and coastlines, the climatic extremes experienced, combined with their low economic base and small population size mean that they are especially vulnerable to the twin challenges of climate change and Peak Oil.

As Category V Protected Landscapes they have been designated with people in mind to conserve and enhance the natural beauty, wildlife and cultural heritage there by managing the interaction of people and the environment and enabling people to understand and enjoy the special qualities that this has produced. The National Park Authorities charged with these purposes must fulfil them in a way that supports the communities living there.

This paper explores the options open to National Parks to develop a new, nationally important role in addressing the twin challenges through landscape scale management, soil carbon management, water management, renewable energy generation and localised food production. The paper argues that significant additional investment is required to support this expanded remit and what is possible in National Parks should be possible anywhere.

The Current Role of National Parks in Britain

National Parks are a significant land asset designated on behalf of the Nation to conserve their natural beauty, wildlife and cultural heritage, enable people to enjoy and understand the special qualities of these landscapes and through achieving this to support the communities living there. The history of their designation can be summarised as being done to safeguard these inspiring and spectacular landscapes so that they remain unblemished by urban or industrial development forever and to provide the space and freedom for everyone to enjoy them, provided the visitors do not damage what they come to enjoy.

In an era when most of the developed world's population now live within an urban settlement, designating National Parks is proving to have been most providential.

In Britain, they are especially designated under a globally recognised category [1] that supports the interaction of people and the environment, most notably farming but also forestry, water management and environmentally sustainable tourism.

Despite Britain's upland National Parks being co-incident with the Less Favoured Areas (areas of rural

economic deprivation and lower farm economic potential), the National Parks have been very successful in supporting the local economy through these statutory purposes. For example, a range of reports about the environmental sector in Wales have demonstrated that it generates over £6 billion of annual GDP, accounts for 1 in 6 of all jobs in Wales and over £1.8 billion of annual wages across all environment sectors [2]. Breaking this down further by way of illustration for the coastal and marine environment sector, which is vital to the Welsh economy overall (a large proportion of the Welsh population lives along the coastal plains), it provides 92,000 jobs and generates £2.5 billion of annual GDP [3]. Although this has not been done, it would be possible to extrapolate this sort of contribution to all Britain's National Parks that are wholly or partly coastal, i.e., the Pembrokeshire Coast, Snowdonia, Norfolk Broads, New Forest, South Downs, North York Moors, Lake District and Loch Lomond and the Trossachs National Parks.

(This could be further extrapolated by including the coastal AONBs and Heritage Coasts too.)

The 3 National Parks of Wales, provide 12,000 jobs, generate a total annual income of £177 million and contribute £205 million to the annual GDP [4]. Within the Brecon Beacons National Park, this disaggregates further to £49 million of annual income, £59 million of annual GDP and 3,300 jobs [4].

10% of all employment in the Welsh environment sector is within National Parks and the rate of environmental job dependency within National Parks is double that of elsewhere in Wales [4].

Despite these impressive figures however, Wales' National Parks contribute only about 9% to Wales' total GDP and only account for 10% of total Welsh environmental employment [4], by comparison with the 20% of the land area they occupy. Whilst this partly reflects the sparse populations (especially in the Brecon Beacons and Snowdonia National Parks), it might also be symptomatic of the lack of sufficient environmental investment made within National Parks, given the much larger strategic role that they can play in mitigating and adapting to climate change and developing rural economic bases that are resilient to the energy descent following Peak Oil.

Whilst there is much more that can be achieved for the employment and tourism sectors through eco-tourism [4], there is still more that can be achieved through investing in large scale integrated land management schemes to provide more than just food from the land, i.e., to increase the rate of environmental employment within National Parks to achieve direct benefits to the environment. This is discussed further in The Future Role of National Parks in Britain below.

Developing this new or enhanced role for National Parks is vital. Collectively, their geography and topography expose them to the extremes of the British climate, from the coldest winds to the deepest snows to the strongest storms and surges to the hottest and driest droughts. Given the projections being developed by the UK Climate Impacts Programme [5], which can be summarised as longer, drier, warmer summers overall and stormier, wetter winters overall, the National Parks and the biodiversity they support as well as the farming and tourism livelihoods on which biodiversity and the local economies depend, will experience the most extreme effects of climate change. Being less 'adulterated' by urban and industrial development than elsewhere in Britain, they are therefore likely to give a clearer picture of what actually is happening to terrestrial and aquatic environments in the absence of human interference, i.e., they can serve as strategically important barometers of change, early warning systems.

Yet paradoxically, with their lower economic base and sparse populations, especially their ageing and declining hill farming populations, they might be less capable of adapting and mitigating to climate change than they might have been in the past; there might be less economic and industrial resilience than is required to make the changes. The age profile of upland farmers (including those in National Parks) is high, meaning that risk aversion is prevalent and innovation is scarce [6].

This paradox is important: alongside other responses, Britain needs to develop large scale landscape-based solutions to mitigate the worst effects of climate change such as increased flooding and drought risk. National Park Authorities are uniquely placed in Britain to achieve this given their remit, given the evidence that they are already probably net contributors to greenhouse gas emissions and that together with other upland areas they generate a significant volume of the surface runoff that can flood areas downstream. With relatively low populations and small industrial sectors creating a lower overall energy demand, they are also well positioned to meet most if not all of their energy needs through locally generated renewable energy schemes and improve on energy efficiency too. Examples of how this is being achieved are outlined below in The Future Role of National Parks in Britain.

The Welsh Assembly Government has stated in its National Parks Policy Statement [7], "*They are places that experiment with new approaches in sustainable development and environmental conservation, providing exemplars of best practice for wider Wales, and helping to shape and lead future rural policy and practice*." Yet National Parks need assistance and investment to live up to this vision and to meet the challenges ahead.

A related and parallel challenge is the per capita ecological footprint in National Parks. Measured as global hectares per capita, the biological ecological footprint (i.e., the amount actually available on the Earth per person) is 1.8 global hectares per capita [8]. The actual figure for the USA is 9.6, for China 1.6, for Brazil 2.1 and the global average is 2.2. For Wales it was 5.16 in 2003 and rose (at a 1.5% annual rate in line with trends elsewhere in Britain) to 5.25 in 2005 [8]. This rise was in line with increases of gross economic activity over the same period, giving the lie to the phrase "sustainable economic growth."

Tal-y-Llyn railway station ca. 1960 in the Brecon Beacons National Park, since closed with all other railways in the Park following the Beeching Review. (From Around Brecon, compiled by Mike Davies and Gwyn Evans 2000, Tempus.)

Applying this analysis to the 3 Welsh National Parks (though Dawkins et al. gives figures only per county rather than per National Park), both Snowdonia and the Brecon Beacons National Parks (both predominantly uplands Parks) record ecological footprints of 5.3 – 5.46 global hectares per capita, whilst the Pembrokeshire Coast National Park was in the range of 5.18 – 5.29. So all the Welsh National Parks were at or above the Welsh average, especially the most remote and least populated upland Parks. This is explained by a higher reliance on road transport for travelling and for nearly all goods and services, further journey distances, older and less energy-efficient housing stock, poorer connection to the National Grid, higher energy dissipation from point of transmission to point of consumption and poorer communications technology.

Conversely, other more densely populated parts of Wales have lower ecological footprints, with one Welsh county having the lowest footprint in the UK. So whilst the Welsh Parks might have lower energy demands, which might more easily be met in future through small scale renewable technologies for example, achieving this sort of objective would produce a dramatic switch in this portion of their ecological footprints. The important point is that the high quality environmental image that people may automatically associate with National Parks does not yet stand up to closer scrutiny in terms of the lifestyles led (though much effort is underway to help change this); whilst the per capita availability of and access to high quality environments might lead observers to believe that life is more sustainable there, there are significant per capita lifestyle obstacles to overcome in order to make this a reality.

In summary, the vulnerability of National Parks and the rural economy to the effects of climate change and Peak Oil, coupled with the obvious roles that National Parks can play in meeting these challenges, sends up a strong signal that their role needs to be modernised and the right investment made to achieve this. Recent economic growth has been in eco-tourism and activity-based tourism (neither of which are defined here), which use the landscape and demonstrably generate significant revenue, some of which might be usefully re-invested, and amongst which many tourism businesses are making the ‘green switch’ (for example the Brecon Beacons National Park Authority is the first in Britain to be awarded the European Charter for Sustainable Tourism). However, whilst leisure activities have a direct impact on the landscape, its businesses are, on the whole, not directly involved with land management. This remains in the farming and forestry domains, which like tourism are vulnerable to the effects of rising fuel prices but differs from tourism because any consequential economic decline or stagnation will have a direct impact on the management of National Park landscapes, i.e., on the primary purposes of the designation.

Therefore in order to develop the necessary economic, social and ecological resilience in National Parks, as well as fulfil the strategic role that they can undoubtedly play, direct investment is required to increase the integrated environmental management needed, thereby increasing the level of environmental employment and contribution to overall GDP, whilst GDP itself needs to be modernised to measure the value of sustainably managed natural assets.

The Future Role of National Parks in Britain – Providing Solutions

Air, soil, water, carbon and nitrogen are essential to nearly all visible life and certainly to human life, agriculture and biodiversity. Until recently, conservation land management in Britain has overlooked the importance of these building blocks, which provide the ‘infrastructure’ for the living world. Since the 1980s, air quality has been improving steadily in Britain as industries and regulators have understood the damaging effects of air emissions on air and water quality, for example acid rain deposition, and progressively stringent statutory limits have been imposed on emissions [9]. Soil conservation is also now a high priority in Britain and Europe, given that we now understand how important soil organisms and nutrients are to sustaining food and nutrient chains on which we all depend. To this effect, a Framework Soils Directive is being drafted by the European Commission [10], to which national soil strategies are emerging in response. Today, grazing management, woodland management and water management are the keys to the sustainable management of these essential resources.

The geography of National Parks and their expanses of mountains and moorland, forests and grasslands, caves, coasts, rivers and wetlands and the diverse wildlife that depend upon them are especially vulnerable to the impacts of climate change. They are also well positioned within Britain to provide test beds for ecosystem-led responses to climate change, that is, managing all the processes throughout the landscape that enable an ecosystem to function properly, rather than just looking after wildlife in reserves or tucked away in farmland corners. Given their geographic location, range of habitats, species and ecosystems and the climatic extremes that they experience, Britain’s National Parks can make a significant national and regional contribution to mitigating and adapting to climate change through flood control, water conservation, carbon conservation, woodland expansion, biodiversity conservation and sustainable farming. They provide montane (areas above the natural tree line (ca. 610m) supporting alpine and sub-alpine flora and fauna), upland, lowland and coastal barometers of the ecological changes taking place and the space for rural responses to the changes ahead.

For example, a recent report (the “ECOSSE Report”) [11] has confirmed that tracts of deeper peat exist in Wales than were hitherto identified. Organic soils cover about 20% of Wales, containing 50% of the country’s soil carbon. Within Wales, soils hold nine times more carbon than does vegetation (including forestry), with over 80% of this soil carbon in upland and grassland soils [12]. In other words, 40% of Wales’ soil carbon is in upland and grassland soils.

Welsh soil carbon is estimated to amount to 340Mt (million tonnes), comprising 126Mt organic soils (including peat), 183Mt mineral soils and 31Mt unclassified soils [13]. The ECOSSE report has increased this estimate to 410Mt. In the UK as a whole the soil carbon is estimated to be upwards of 9,800Mt, which is 64 times the volume of annual UK CO_2 emissions, with the largest proportion of this is in upland organic soils [14]. Already vast tracts of these soils within National Parks are severely degraded by erosion, overgrazing, trampling, poor burning management practices and acid rain deposition.

A 1% loss per year of soil carbon would increase net Welsh carbon emissions by 25% [12] and where upland moorlands are already severely degraded or where large tracts of eroding peat are exposed, soil carbon is already being washed or evaporated out. Conversely, re-establishing the accumulation of organic matter and growth of moorland shrubs and grasses could restore the carbon sequestration function of these soils and could therefore be a positive contribution to mitigating climate change. A healthy upland bog accumulates carbon at around 2,500 kg C per hectare per year (0.7 Mt per year for the UK as a whole [15]).

Evidence suggests that increases in annual average soil temperatures have caused increasing losses of soil carbon [16] and that these losses have been greatest in upland soils. Further evidence is seen in the increased concentrations of dissolved organic carbon in rivers [17, 18, 19]. Elevated atmospheric CO_2 levels might also produce a shift from *Sphagnum* mosses (peat-forming mosses) to vascular plant-dominated communities, leading to increased oxidation and decomposition of soils (reversing the peat formation processes) and therefore further carbon losses from soils [20]. On the other hand, *Sphagnum* mosses will also respond positively to enhanced CO_2 levels (increased rates of photosynthesis), which in turn might lock any soil nutrients away again as new peat is laid down. In other words, peat accumulation in the uplands (and lowland raised bogs and fens), which has relied for millennia on *Sphagnum* mosses, might be altered in ways that we don't yet understand fully.

Dissolved organic carbon (DOC) in Welsh rivers has increased by 90% since 1988 [21]. By the mid twenty-first century, DOC from bogs released subsequently into the atmosphere as CO_2 could match CO_2 emissions from the burning of fossil fuels, thereby undoing any improvements made in domestic and industrial CO_2 emissions [21].

Collectively, Britain's organic soils and peatlands hold more carbon than the forests of Britain and France together and Britain's National Parks hold most of them. However, chronic and ongoing erosion and soil compaction, historic overgrazing, increasing soil temperatures and reduced summer rainfall mean that these natural carbon stores have become significant carbon sources, contributing to greenhouse gas emissions, potentially on a scale that dwarfs technical and industrial efforts to curb greenhouse gas emissions in other sectors. "*The world's peatland stores of carbon are emptying at an alarming rate. It's a vicious circle. The problem gets worse and worse, faster and faster,*" (Chris Freeman University of Wales Bangor [21]).

As well as these large tracts of peatlands and other wetlands, Britain's National Parks also include river sources and coastal ecosystems the poor ecological condition and management of which contribute to lowland flooding and, together with high rates of abstraction, water shortages too. Restoration of wetland extent and ecological function is an integral part of conserving water resources, restoring carbon sinks and alleviating lowland and coastal flooding. The recent Pitt Review [22] recommended that wetland management be included in flood management systems.

Within National Parks the wider countryside is on the whole less fragmented than elsewhere, as demonstrated by their larger share of national and international protected sites. Only at this landscape scale is it possible to provide the space to achieve these benefits and to enable biodiversity to flourish. National Parks have the space and land-based industry in farming and environmental management to develop national and regional responses but need help to achieve this owing to their small populations and low economic base. Managing National Parks relies upon the co-operation and viability of farming, forestry, water resource management, development control and realistic investment in the costs of landscape conservation.

How is biodiversity affected in National Parks? National Parks are at risk from a wide range of impacts including:

- Loss of snow (which affects alpine flora and moisture availability for insects and birds);
- Reduction in freezing and seed vernalisation;
- Decline in heather and other dwarf shrubs;
- Increased winter survival of heather beetle;
- Increase in bracken encroachment;
- Dry moorlands and increased incidence of wildfires;
- Increased survival of agricultural pathogens and parasites;
- Increased erosion, run off and flash flooding;
- Low river flows during summer;
- Coastal squeeze, accelerated coastal erosion and coastal and inland flooding;
- Saline intrusion into freshwaters;
- Increased leisure demand on natural resources;
- Risk of lost income to habitat-related enterprises (shooting, angling, water recreation, farm-based tourism);
- Decay and loss of limestone features.

The decline and loss of alpine flora, the decline in condition and extent of habitats such as blanket bog, raised bog and snow bed vegetation, the potential decline in distribution of species such as the large heath butterfly (*Coenonympha tullia*), red grouse (*Lagopus lagopus scotticus*), black grouse (*Tetrao tetrix*), ptarmigan

(*Lagopus mutus*), Atlantic salmon (*Salmo salar*), stiff sedge (*Carex bigelowii*), least willow (*Salix rotundifolia*) and dwarf willow (*Salix herbacea*) to name just a few are not parochial issues but matter to everyone because their decline or loss would signal a decline in the capacity of natural resources available within National Parks to mitigate the impacts of climate change; if this occurs in Britain's most protected landscapes, what hope for biodiversity and environmental quality elsewhere?

Faced with this scale and extent of decline on the one hand and the need to respond on a very large scale and draw attention to what is being done and what needs to be done on the other, how are the National Parks measuring up to this challenge? Examples of current projects underway include:

- Exmoor National Park's Mires Restoration Project, a partnership project between the Environment Agency, Natural England, South West Water and the Exmoor National Park Authority, which to date has restored 129 hectares of degraded mire at a cost of £603.00 per hectare.
- Dartmoor National Park's Blanket Bogs Restoration Project and also a research studentship on behalf of a partnership involving the Duchy of Cornwall, the National Trust, Natural England, the Universities of Plymouth and Exeter and the Dartmoor National Park Authority.
- Cairngorms National Park's range of projects including a climate change knowledge transfer and research project involving the UHI Millennium Institute, Macaulay Land Use Research Institute (MLURI) and the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER); a demonstration sites project for sustainable flood management involving the River Dee Catchment Management Partnership, MLURI, the Scottish Environmental Protection Agency and land managers; the Clim-ATIC project involving the UHI Millennium Institute, Forestry Commission Scotland and the European Commission's Northern Periphery Programme to explore the potential for the rural peripheral communities to adapt to climate change; and a green farms project involving the Scottish Agricultural Organisation Society Ltd, to enable farmers and food producers to take action to live with climate change and to develop market advantage and added value as a consequence of it; the Cairngorms National Park Authority is a partner in all of these projects.
- Peak District National Park's Moors for the Future Project, the largest upland moorland habitat restoration project underway on eroded peatlands in Britain, also involving research and development on carbon sink management and the value of moorland restoration, development of education resources, habitat restoration tool kits and PR.
- Brecon Beacons National Park's peatland restoration project at 2 sites on separate Sites of Special Scientific Interest, where a combination of catastrophic fires, acid rain deposition and overgrazing has destroyed the moorland vegetation, exposing large areas of bare and eroding peat.

Extensive bare eroded peat undergoing restoration at Waun Fignen Felen within the Brecon Beacons National Park.
Photograph: Paul Sinnadurai

Whilst these projects are all laudable and valid, clearly they are not of a sufficiently large scale to do more than scratch the surface of upland peatland management across the 10s of thousands of hectares required.

A better scale can be achieved by involving the right organisations, for example the water utilities, some of which own very large tracts of upland moorland and some of whom are considering how they might re-direct their capital expenditure more judiciously to benefit not only water quality and supply but also biodiversity, carbon sinks and the wider rural economy. For example, a new water treatment works to remove sludge and discolouration might cost a water utility in the region of £15m to £20m, with annual maintenance and periodic renewal costs plus the electricity costs to power them on top of this capital outlay. Within 20 years or so this plant might need significant overhaul, at additional expense. How much better would it be to invest this capital 'upstream' within the landscape instead, so that rather than allow the sludge and discolouration to arrive at the treatment plant, it is instead held within the moorlands where the surface erosion, compaction and overgrazing that would otherwise give rise to these pollutants have been reversed, across a large area, through an agri-environment project with the local farmers, at a fraction of the cost? For example, the Welsh agri-environment scheme Tir Gofal pays farmers £50.00 per hectare to graze heather moorland in an environmentally sensitive manner. Although a simplification, at these prices, a £15m to £20m project over 10 years would pay for 30,000 to 40,000 hectares per year to be grazed, an area in the right order of magnitude to be effective at the right scale.

If the vegetated moorland surfaces are allowed to recover so that the plants send down deeper roots and send up a wider leaf surface area, they will intercept more rainfall which in turn will infiltrate deeper into the soil rather than rush off across the surface carrying sludge and discolouration, as well as vital nutrients, with them. Better infiltration will also mean better water retention, thereby militating against water shortages during the drier seasons and against excessive surface runoff that contributes to floods. This also achieves better water quality, conservation and supply and a wider distribution of the benefits to the local economy rather than just to built infrastructure.

These beneficial effects are already being observed on a very small scale at Waun Fignen Felen in the Brecon Beacons for example, where there is clear evidence of better water retention, vegetation restoration and cleaner water percolating down through the underlying rock strata.

What about Peak Oil? The National Parks are also addressing this challenge through supporting sustainable transport and increasing self-sufficiency in local food production and consumption but most significantly through support for small-scale renewable energy projects such as farm-based or village-based hydro-electricity, biomass boiler systems, small-scale wind turbines, ground source heat pumps, solar-thermal, photo-voltaic installations and more recently anaerobic digestion plants. For example the Brecon Beacons National Park has recently calculated that it is technically feasible and, provided the right planning applications come forward with the right investment, highly probable, that a handful of private or community-owned combined heat and power plants could generate up to 5.35 megawatts of electricity, enough to supply 6490, or 63.5%, of the Park's households, generating additional income of about £4,686,600 per year. In addition, it is technically feasible to generate 244 kilowatts of hydro-electricity to supply 405, or 2.7%, of the Park's households, generating additional income of about £213,744.

Analogous calculations have also been made for the installation of small-scale wind turbines, the point being that the technology exists and the energy demand is low enough but the investment needs to be made and people need to be encouraged to develop their projects. So, whilst technology alone won't solve climate change and the energy descent following Peak Oil, it is potentially quicker to achieve and easier to measure the benefits than land management, which is on a much larger scale but might actually be cheaper to achieve, over a longer timescale.

Conclusions

National Parks are nationally and internationally important assets, for their natural beauty, wildlife and cultural heritage and for leisure and recreation. Management is principally through the interaction of people and the environment but the perception and understanding of what this means needs to expand beyond farming, forestry, leisure and tourism to include carbon, soil and water management and moving as close as possible to self-sufficiency in food and energy. Owing to their small populations and low economic base, as well as the ageing demographic of the hill farming population, this needs new investment.

Britain's climate change agenda appears to be fixated on technological solutions, which are measurable and achievable and which of course can generate income. Some of these, for example renewable energy, are technically feasible within National Parks even to the point of near self-sufficiency. However, technology alone won't be enough to meet the challenge of climate change. As Albert Einstein is attributed with saying, "*The world won't move beyond its current crisis by relying on the same thinking that created the situation*." Technology and industry have given us human-induced climate change, so by Einstein's maxim, they won't solve it, though of course they can help. The scale of the climate challenge is beyond technological solutions and a larger part of the solution lies in landscape management and in changing people's perceptions and behaviour.

Also, it might be more cost-effective and benefit a wider section of society to expand the effort into the landscape too, and if it's achievable in National Parks, it should be achievable anywhere.

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