Letter to the Editor

In the current controversy over the potential exploitation of unconventional (shale) gas resources in England based on hydraulic fracturing ('fracking'), the arguments of those opposed to its use have been focussed on three main areas of concern: (i) local groundwater pollution, (ii) disturbances to local communities by increased lorry traffic in the vicinity of drilling sites, and (iii) the further exploitation of new sources of fossil fuels which is contrary to long-term government targets to reduce greenhouse gas emissions. (The current UK government target is a 80% reduction by 2050 from the 1990 baseline). The UK Prime Minister recently expressed his support for fracking in an article in the *Daily Telegraph* : 'We cannot afford to miss out on shale gas' (11^{th} August, 2013).

One feature of the fracking debate which has received no serious attention is the deleterious effects of sealing soil surfaces by establishing numerous drilling pads, and the associated loss of a range of soil functions (food and fibre production, carbon storage, flood protection), which is one consequence of shale gas exploitation. By contrast to the USA where shale gas is currently subject to significant exploitation, the total land area of England (130 000 km^2) is small. Where multiple horizontal wells are drilled from a single well pad (the drilling technology likely to be deployed in England), the area of sealed ground is estimated to be around 1.4 hectares during operations, and around 0.61 hectares after partial reclamation (New York State Department of Environmental Conservation, 2011).

It has been estimated that the Bowland shale, which underlies a substantial proportion of central and northern England, may contain 1329 tcf (trillion cubic feet) of gas (a total gas-in-place estimate; Andrews, 2013). There is currently insufficient information to estimate how much of this could be recovered, or the associated density of drilling pads required to extract it. During shale gas exploitation in the USA, the

density of drill pads is typically around 1 per 1.5 km^2 (New York State Department of Environmental Conservation, 2011). Drill pads at this density in England would lead to sealing of a substantial area of soil; this does not appear to have been considered to date. This is a substantial loss of productive soil resource at a time when global food security is also a serious and growing concern (Blum & Nortcliff, 2013).

The Defra Soil Strategy for England (2009) pre-dates the recent interest in onshore shale gas exploration and it does not consider its implications for soil sealing. It refers to soil sealing in urban areas as an 'unavoidable consequence of development' and cites targets for the increased use of brownfield land for further development. The majority of drill pads are likely to be established on greenfield sites and so will contribute to land take. Although Defra have established a code of practice for the sustainable use of soils during construction, there may also be novel engineering approaches that can help to minimise soil sealing during shale gas exploitation, and to maximise the area of restored land after site closure. This is a challenge that should be addressed by engineers and soil scientists if the shale gas industry develops in the UK. The issue of soil sealing should have greater prominence in the current debate over potential shale gas exploitation and needs to be considered along with the other potential benefits and drawbacks.

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