

Spatial modelling of the energy-land-water nexus: challenges and opportunities

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The challenge of decarbonising future energy system pathways needs to be met whilst also safeguarding the value of natural capital to ensure the continued flow of ecosystem goods and services. Although both objectives emphasise benefitting from natural resources, efforts to connect the valuing nature and energy systems research communities are currently only at a preliminary stage.

The UK is a world leader in modelling, mapping and valuing the flows of ecosystem services generated by stocks of natural capital. These efforts connect myriad policy, climate and economic drivers of change to impacts on biophysical processes and the resulting supply of ESs and value of derived goods and benefits, noting that such interactions are highly spatially and temporally dependent. However, beyond measuring a subset of greenhouse gas (GHG) flows, they rarely incorporate or respond to potential changes in UK or global energy systems (e.g. increased offshore wind, solar or biomass production, switches across fossil fuels, improvements in energy storage etc.). Such technical and infrastructure developments can have substantial impacts on natural capital and ESs, including through reduced natural capital stocks, changes in land use (especially through the adoption of above-ground renewables) and impacts on water resources, landscapes and biodiversity.

A parallel, but separate, literature explores potential strategies to meet emissions reduction targets by decarbonising the UK energy system while delivering reliable, affordable energy to consumers. Energy system models (e.g. UK MARKAL, TIAM-UCL) have been applied to a range of future UK energy scenarios, characterised by various requirements for decarbonisation, resilience and assumptions regarding global energy prices, technological advancements (especially carbon capture and storage) and policy parameters (emissions targets). However, the treatment of natural capital and ESs within these models is limited and could be greatly enhanced by integrating them with the spatially and temporally explicit models developed in initiatives such as the National Ecosystem Assessment Follow-On Phase.

Making such an integration is central to the new ADVENT project (Addressing Valuation of Energy and Nature Together) which has been funded by the NERC Valuing Natural Capital in Low Carbon Energy Transitions programme. To assess the potential trade-offs and synergies between energy and natural capital objectives will require a particular focus on the spatial detail, because this is central to appreciating the conflicts or complementarities involved in different uses of land or water. This paper will set out the objectives and proposed methodology of ADVENT, particularly to address the challenges of linking models operating at different spatial and temporal scales.