

Assessing Resilience and Adaptive Capacity of Developing Industrial Ecosystems: A case study in the South Humber Bank, United Kingdom

Alexandra Penn, Frank Schiller, Lauren Basson, Angela Druckman, Amy Woodward and Nigel Gilbert

The South Humber Bank (SHB), situated on the Humber Estuary in the UK, is a large, active industrial area comprising a diverse set of industries ranging from fish processing to oil refining and chemical and bio-chemical production facilities. The attached ports of Grimsby and Immingham are the UK's largest by tonnage, whilst the estuary provides infrastructure for 20% of national gas landing and 27% of UK oil refining capacity. The region is also the source of 23% of the UK's CO₂ emissions. The estuary is of national biodiversity and conservation importance, with flood risk management issues. Neighbouring communities face significant socio-economic problems including unemployment and fuel poverty. Development of the region is affected by, and affects, linked biophysical, industrial, economic, social and governance systems, populated by many diverse actors. SHB faces significant new challenges and opportunities with transition to a low carbon economy and national energy security as current key and potentially controversial policy issues. It is one of the UK's most important energy hubs, with strategic energy generation facilities and infrastructure, significant potential for carbon capture and storage and new investment in large-scale renewable energy technologies from offshore-wind to biofuels. The system's resilience (in social, economic and environmental dimensions) plus capacity to adapt to changing economic and environmental conditions have an impact locally, nationally and globally.

SHB was also one of the first focal areas of the UK's industrial symbiosis programme and is thus an ideal location in which to study the development of an industrial 'ecosystem' and how such local co-operation and synergy affect system resilience. Industrial ecology considers complex interactions and interdependencies between firms as 'ecosystems' which may be improved in regards to their sustainability via biologically-inspired design (after certain properties of biological ecosystems perceived as desirable). The creation of such an 'ecosystem' via industrial symbiosis (sharing of materials, energy, assets, logistics and expertise between organisations) in Humber-side was identified as a means to promote context-sensitive economic development, efficient use of resources, reduction in environmental impacts, job creation and the alleviation of fuel poverty through use of excess industrially-generated steam for district heating. We present preliminary analysis of the ongoing development of the SHB industrial ecosystem, identifying and characterizing its structure and dynamics and discuss various measures of the system's resilience and adaptive capacity in economic, social and environmental terms. This work explores both how resilience thinking can be applied to functioning industrial ecosystems and how resilience measures may alter and be used as the system undergoes substantial change. Determining how to manoeuvre through this transition in the context of potentially conflicting goals of different stakeholders with regards to different dimensions of sustainability will be crucial in decision making for the region and forms part of our broader project providing complexity-based tools useful for decision-makers aiming to 'steer' towards policy-relevant goals. The region's development through this period therefore, not only provides us with a system of study, but also the opportunity to integrate resilience thinking into new tools with real world application for UK climate impacts.