Mechanisms and consequences of tipping points in lowland agricultural landscapes (TPAL)

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Introduction

Concern about abrupt and potentially irreversible ecosystem tipping points is growing rapidly, as they may have significant implications for natural capital and human wellbeing. Evidence indicates that explicitly addressing tipping points leads to improved management outcomes.

What do we mean by a tipping point?

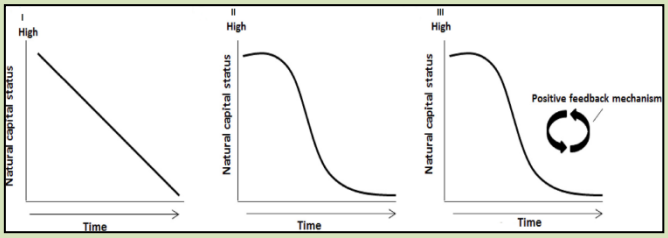

Figure 1: Alternative forms of natural capital status–driver relationships. I. Linear II. abrupt nonlinear III. Nonlinear and strong positive feedback within an ecosystem often leads to hysteresis/irreversible change and is often referred to as a discontinuous threshold or a "tipping point". (Watson *et al.,* 2018. Detecting ecological thresholds and tipping points in the natural capital assets of a protected coastal ecosystem. Estuarine, Coastal and Shelf Science.)

Case Study

The county of Dorset is made up of a mosaic of interconnected ecosystems including farmland, grassland, woodland, urban areas and coastal margins. These broad habitats provide a range of important ecosystem services (ES) to people living within or visiting the area, including the provisioning of food and water, the regulation of air quality, water quality and several cultural services such as an aesthetically attractive landscape and opportunities for recreation.

However, over the past 80 years Dorset has undergone major transitions in land use, which have had significant impacts on its natural capital.

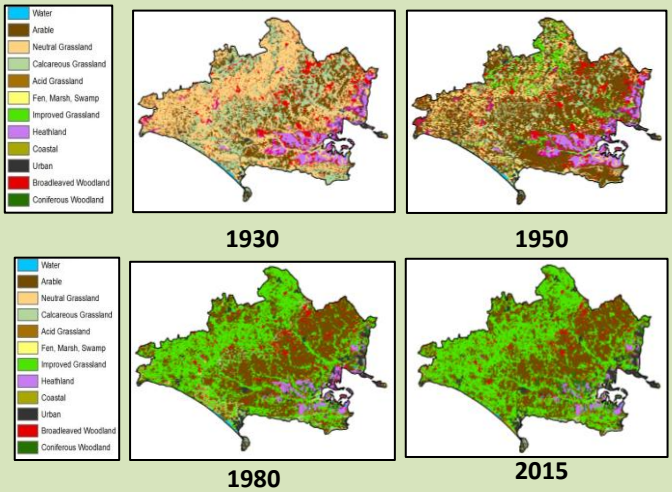

Figure 2 Natural capital asset maps of Dorset based on interpolated LUS maps

Methods

We first digitised, interpolated and classified Land Utilisation Survey (LUS) maps from the 1930's (Jiang *et al.,* 2013), 1950's and 1980's and compared them to the UK Land Cover Map of 2015. All analysis was done using the InVEST modelling tool.

Jiang, M., Bullock, J.M. and Hooftman, D.A., 2013. Mapping ecosystem service and biodiversity changes over 70 years in a rural English county. *Journal of Applied Ecology*, *50*(4), pp.841-850.

Results

Results showed that land use shifted dramatically to more intensive agriculture between 1930-2015 (Fig. 2):

- 97% of all semi-natural grasslands were converted into agriculturally-improved grassland or arable land.
- As were large proportions of the heathlands and rough grasslands (-57%).
- The other important driver of change was afforestation (+25%).
- The larger habitat areas became fragmented, with average fragment size of different habitats falling by 31–94%,
- While connectivity between fragments dropped drastically, by up to 98%.
- Overall, we found significant increases in agricultural provisioning and large losses in biodiversity over the past 80 years, which reflect widespread conversion and intensification of land use, leading to current conflicts in delivery of multiple services and biodiversity.

Further such trade-offs were identified by detailed ES mapping.

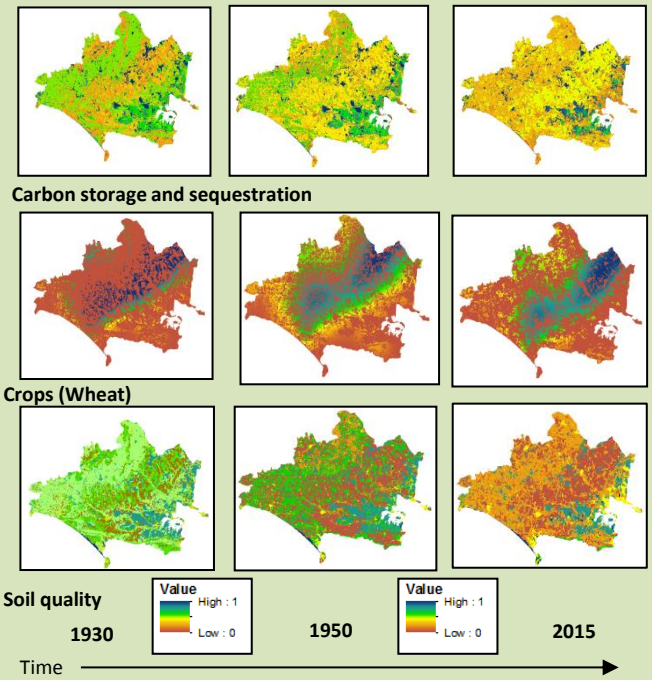

Figure 3 Natural capital hotspot maps of Dorset LUS maps

Conclusions

- Out of 11 different ES mapped 8 showed a marked decline following the changes in lowland land use between 1930-2015. Including : **Carbon Sequestration and Storage, Water Yield , Nutrient Retention, Flood Risk, Soil Quality, Tranquillity (Naturalness) Habitat Quality for Pollinators and Biodiversity.**
- In contrast : **Crops and Livestock**, **Timber Production**, **Visitation and Tourism** all increased.
- **Work is now underway in the project to identify the exact points where tipping points may have occurred in the past and will use modelling approaches (DONC, Dynamics of Natural Capital) to forecast future trends in Dorset's Natural Capital and economy.**