A generalizable integrated natural capital methodology to prioritise investment in saltmarsh enhancement

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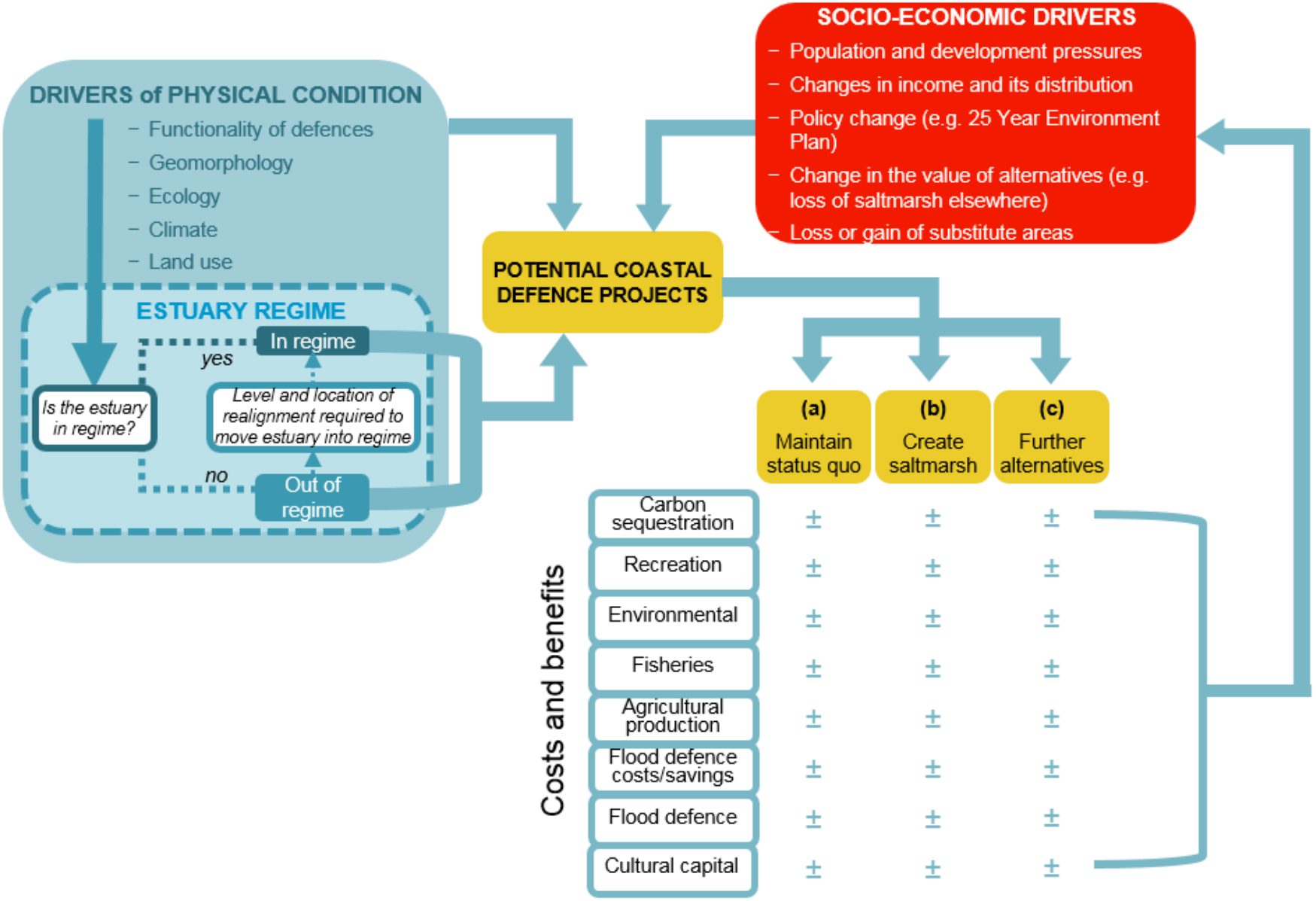

SOCIO-ECONOMIC DRIVERS
– Population and development pressures
– Changes in income and its distribution
– Policy change (e.g. 25 Year Environment Plan)
– Change in the value of alternatives (e.g. loss of saltmarsh elsewhere)
– Loss or gain of substitute areas
DRIVERS of PHYSICAL CONDITION
– Functionality of defences
– Geomorphology
– Ecology
– Climate
– Land use
ESTUARY REGIME
Is the estuary in regime?
yes
In regime
Level and location of realignment required to move estuary into regime
no
Out of regime
POTENTIAL COASTAL DEFENCE PROJECTS
(a) Maintain status quo
(b) Create saltmarsh
(c) Further alternatives
Costs and benefits
Carbon sequestration
Recreation
Environmental
Fisheries
Agricultural production
Flood defence costs/savings
Flood defence
Cultural capital
±

Where are priority areas for managed realignment of saltmarsh: maximise ecosystem services & minimise costs?

Altering coastal/estuarine defences to allow previously protected land to be flooded by the tide

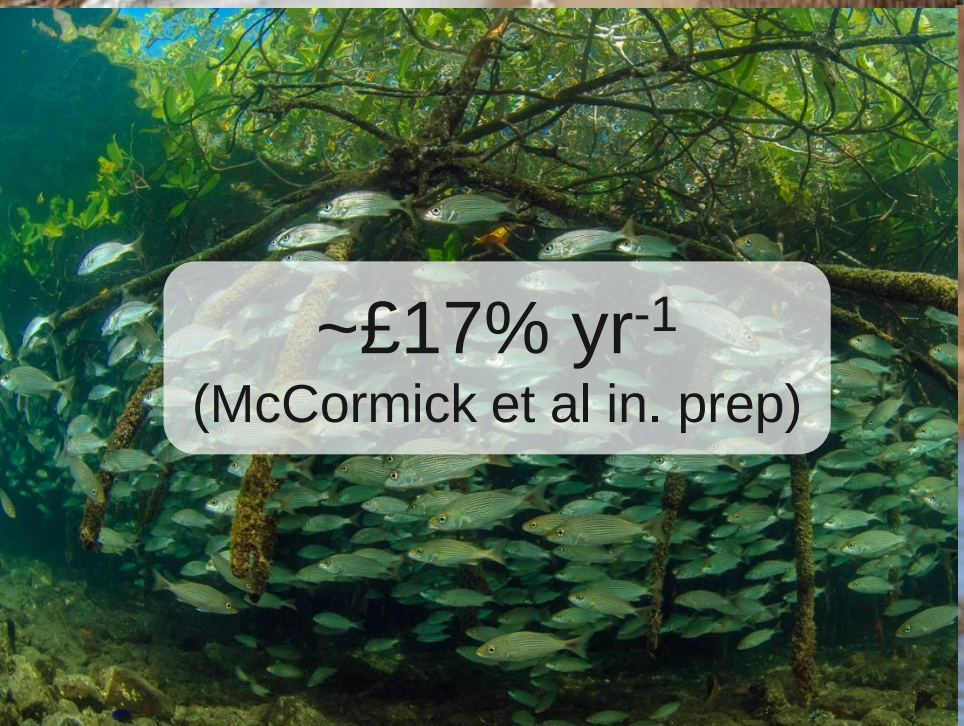
Saltmarsh

- Heavily exploited, threatened ecosystem
- 50% lost worldwide (Barbier et al 2011)
- Declining by ~100ha a year in the UK

Land conversion	Pollution	Land reclamation	Sea level rise	Agricultural runoff

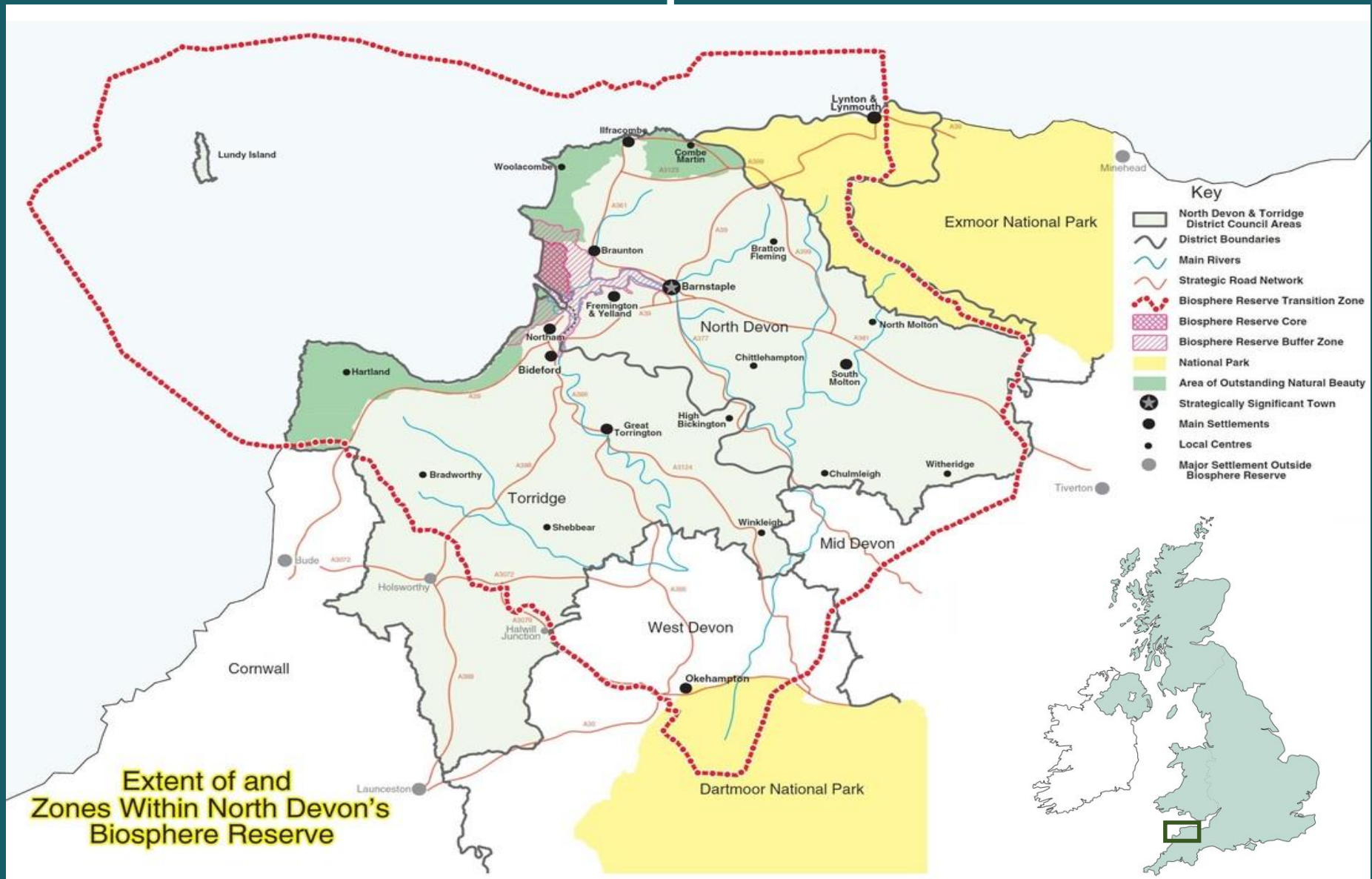

1990 US$159 ha-1 yr-1
(Woodward & Wui 2001)

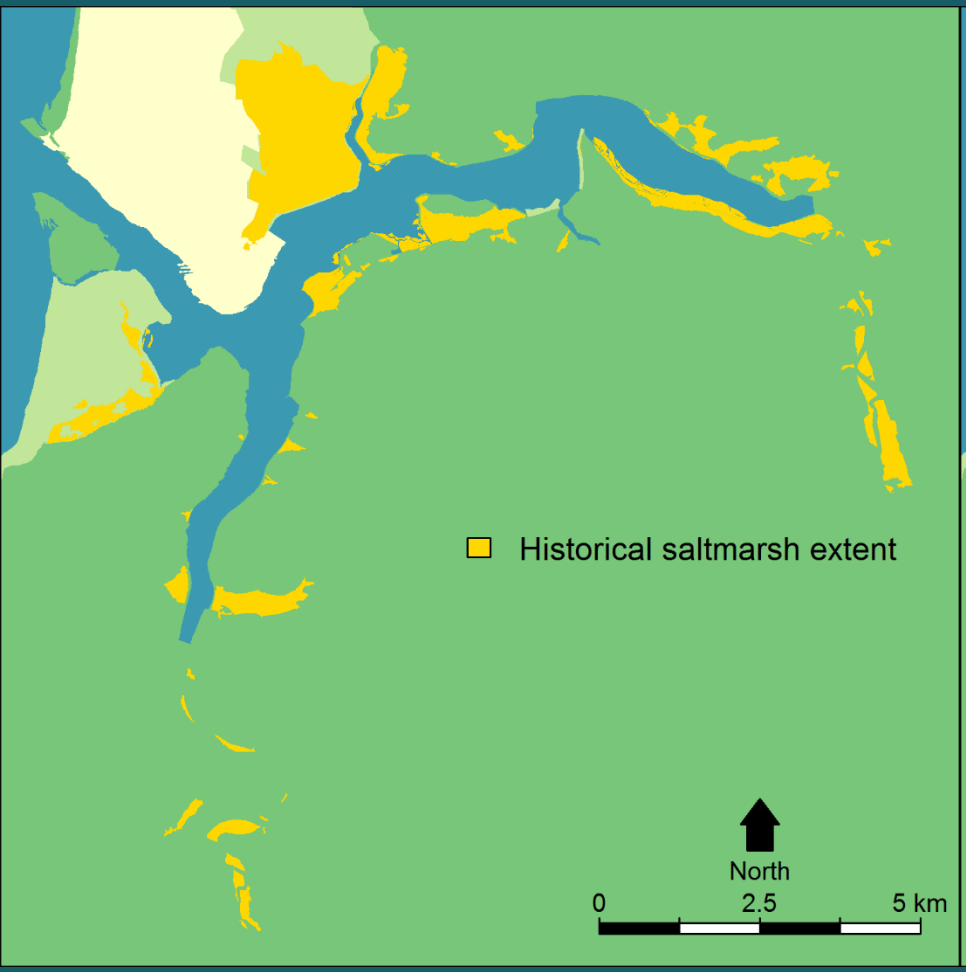

£15.27 ha-1 yr-1
(King & Lester 1995)

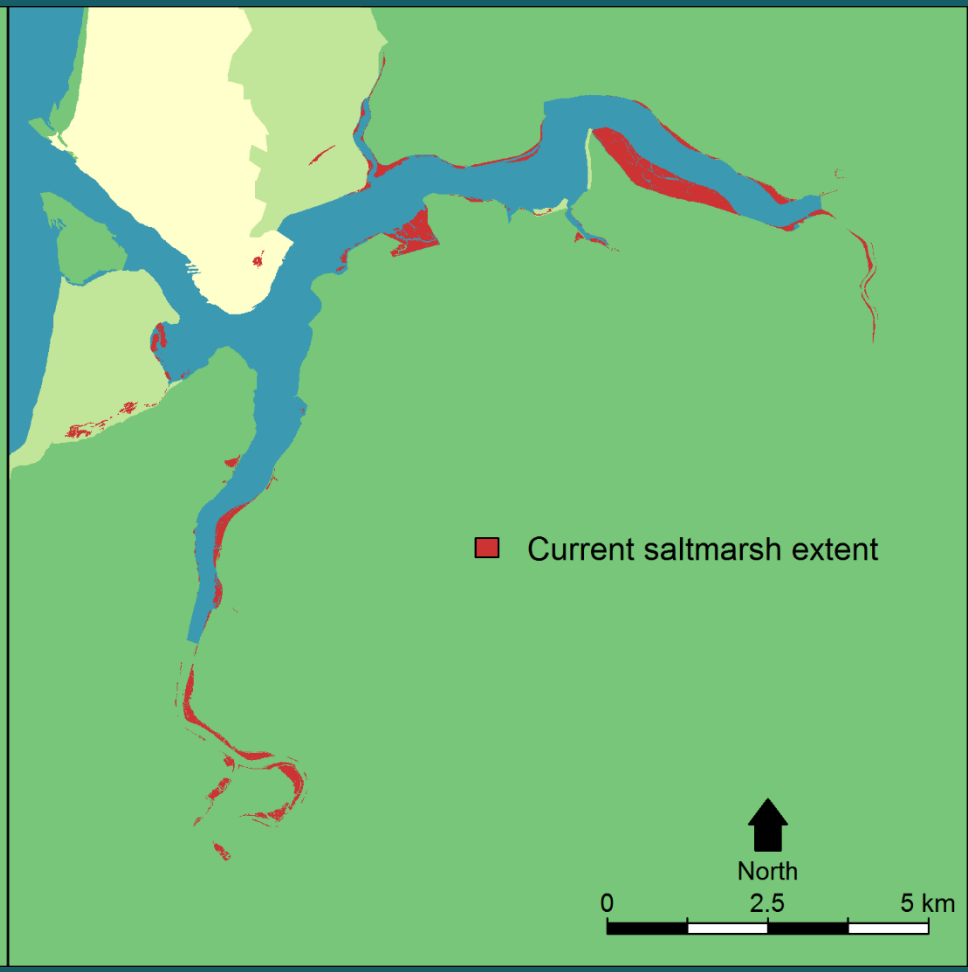

~£17% yr-1
(McCormick et al in. prep)


1990 US$490 ha-1 yr-1
(Woodward & Wui 2001)

Case study: North Devon Biosphere




Historical saltmarsh extent
North
0
2.5
5 km

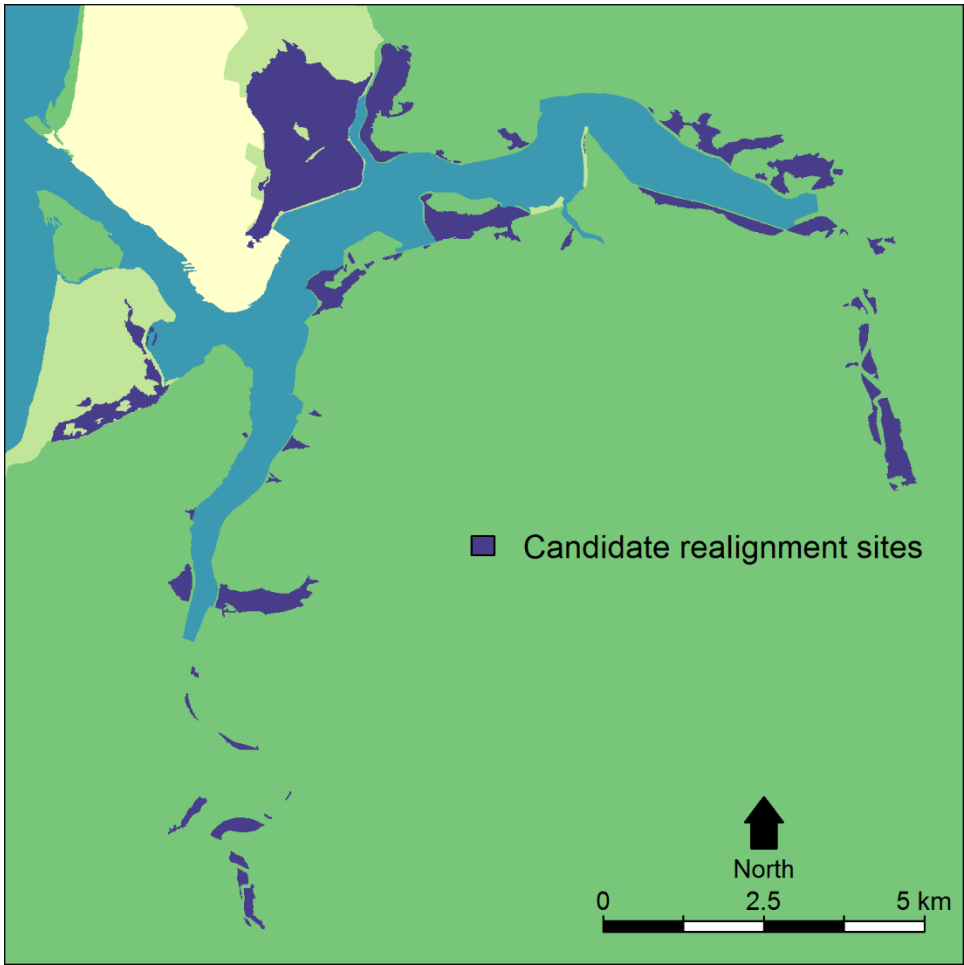

Current saltmarsh extent
North
0
2.5
5 km

What we did

1. Identify candidate managed realignment areas based on LIDAR data
2. Estimate opportunity costs to agriculture
3. Estimate direct costs: property damages and realignment costs (£15,000 per ha, Hudson et al 2015)
4. Estimate recreational and carbon sequestration benefits
5. Identify priority areas for managed realignment

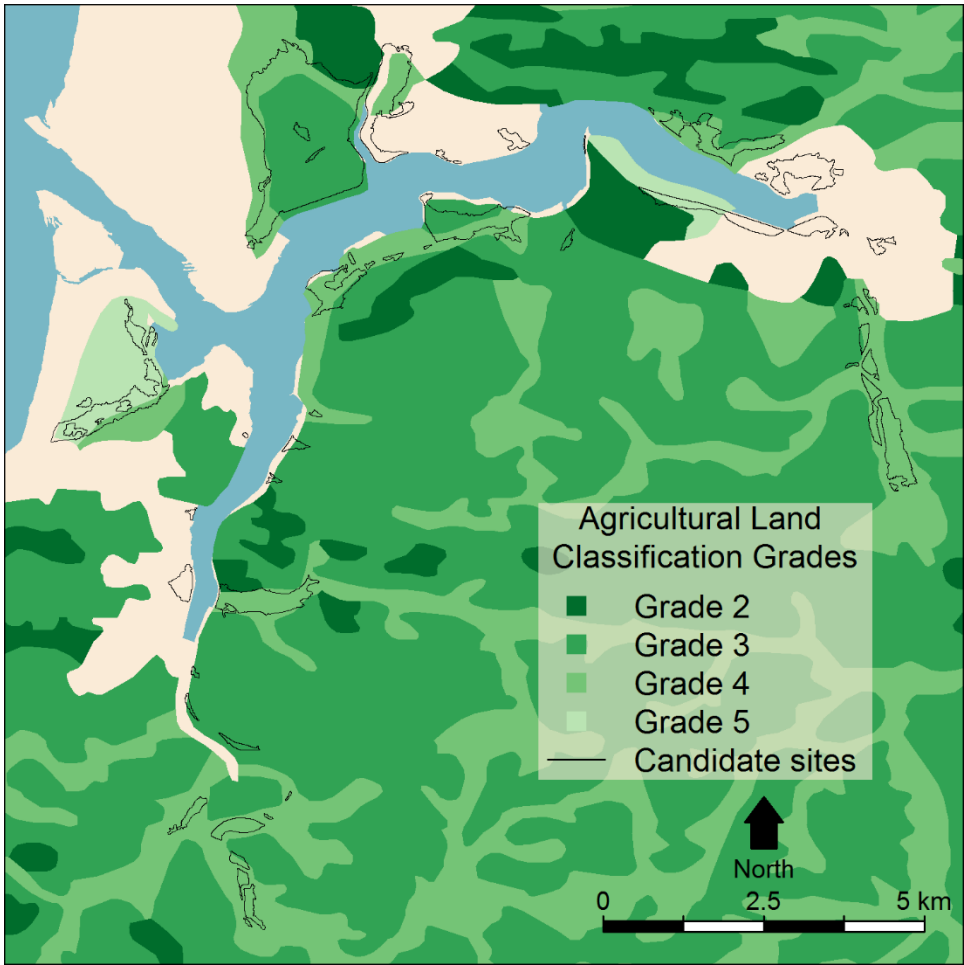
Potential managed realignment sites

Number	57
Average (ha)	15
Median (ha)	2
Min (ha)	0.3
Max (ha)	339



Opportunity costs to agricultural production

- Agricultural Land Classification (1988)
  - Grade 1: excellent
  - Grade 5: very poor quality
- Sale price data (2006)
- Annual stream of benefits (2016 prices)



Property damages

- Scenario 1: Ignore property damages
- Scenario 2: Exclude all sites with properties
- Scenario 3: Incorporate property losses
  - Identify properties within each site
  - Average property value from HM Land Registry for postcode(s)
  - Sum and convert to annual stream of property losses

Spatially explicit recreational benefits

Outdoor Recreational Valuation tool (ORVal)

- ORVal estimates visitation to existing or newly created green spaces
- Derives monetary estimates of the value households attach to the recreational opportunities provided

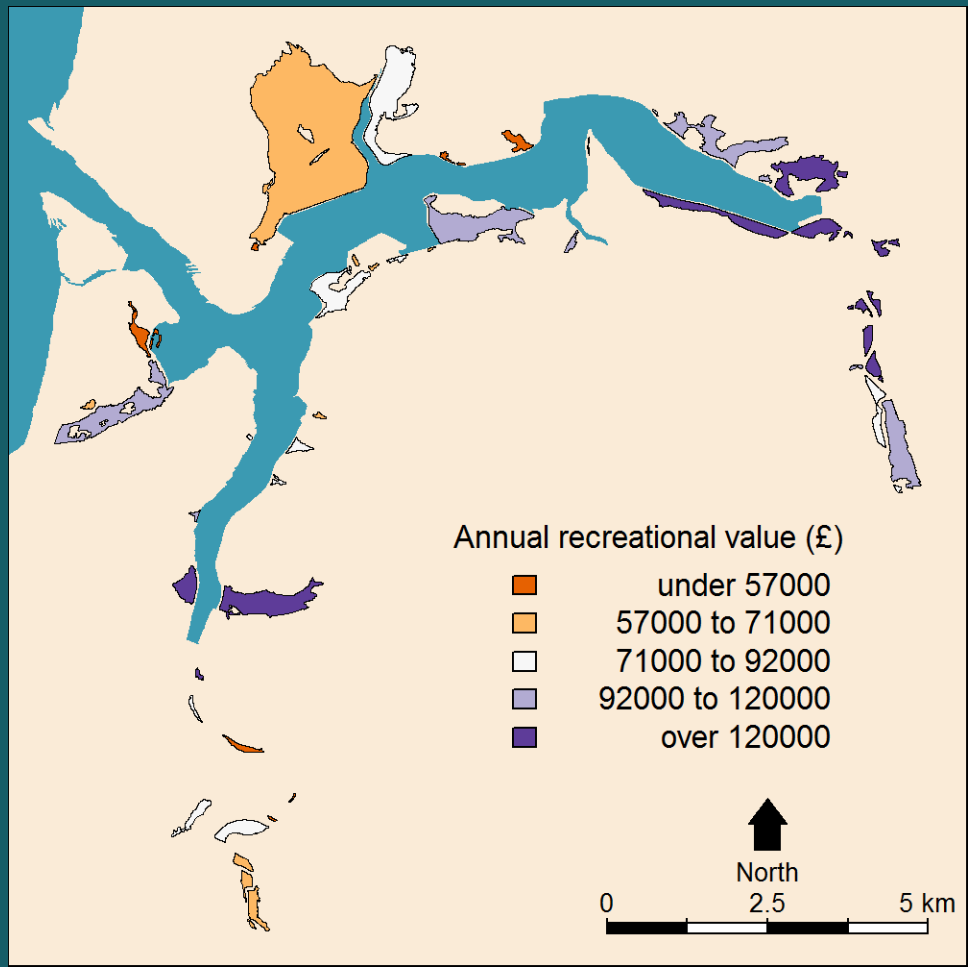
In this analysis:

- Landcover specified as 50% saltmarsh for all new sites (50% agriculture)
- Travel cost: road and path networks

→ Accurate costs for both walking and driving recreation visits

Recreational values

2016 prices (GBP)

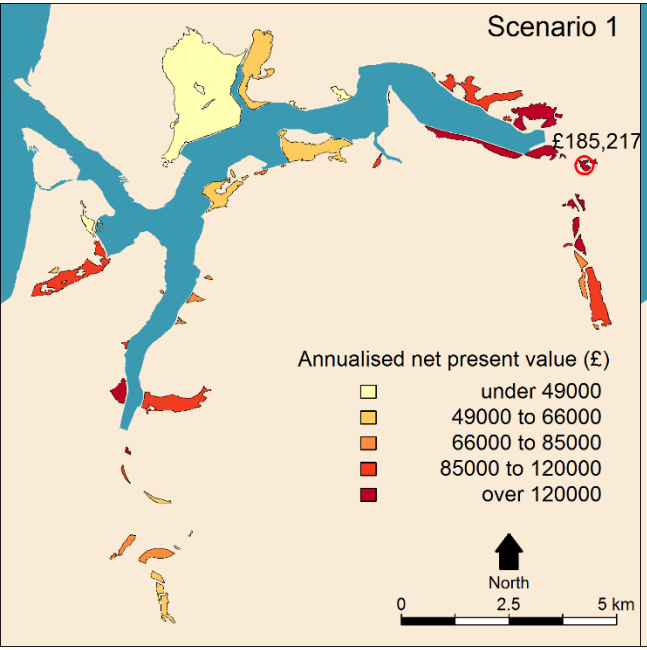


Carbon sequestration benefits

- Sequestration rates: current land use versus vs. saltmarsh
- Assumed saltmarsh-carbon ‘equilibrium’ at 20 years
- Current land use (Bateman et al. 2013)
  - $2km^2$ grid
  - Rough grazing, or temporary or permanent grassland
  - Root crops, cereals, other
  - Emissions: CoolFarm Tool (Hillier et al. 2011)
  - Sequestered carbon stock (Ostle et al. 2009)

- Saltmarsh sequestration rates
  - 0 to 15 years 4 $tCO_2\ yr^{-1}$ (eftec 2017)
  - 15 to 20 years: 2 $tCO_2\ yr^{-1}$ (eftec 2017)
- Marginal abatement costs (untraded) (Bateman et al. 2014)
- Annualised net present value

Results - site



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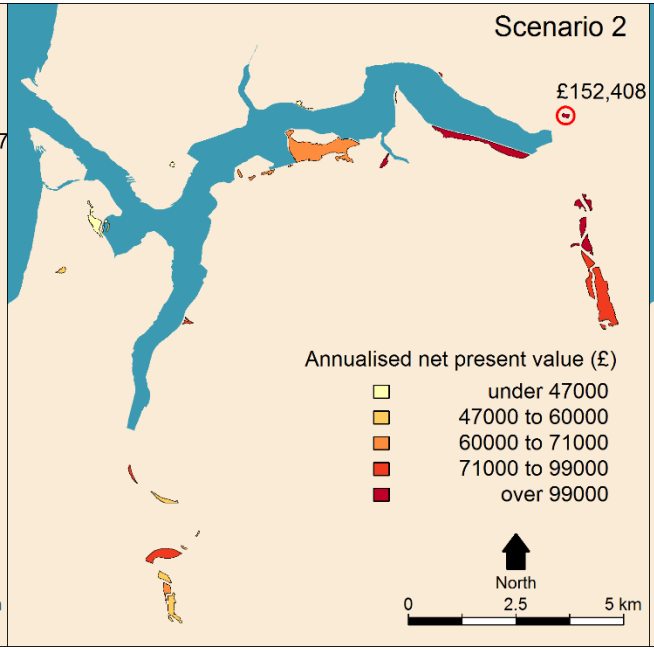

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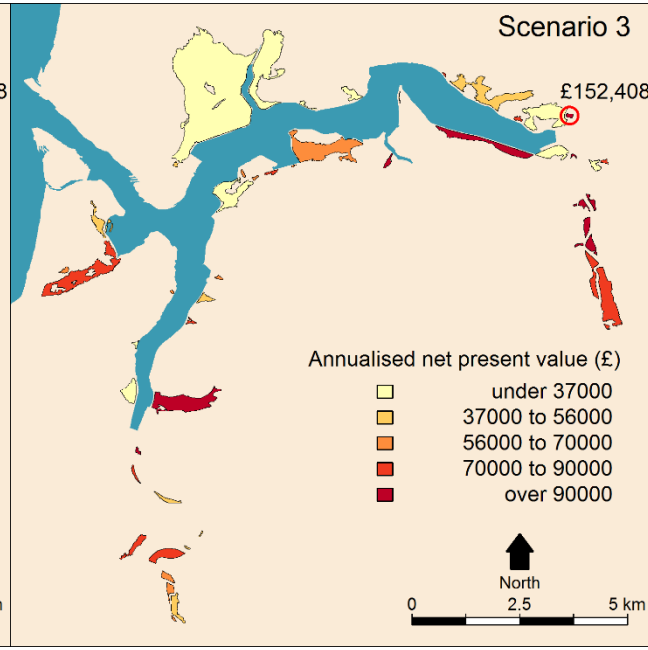
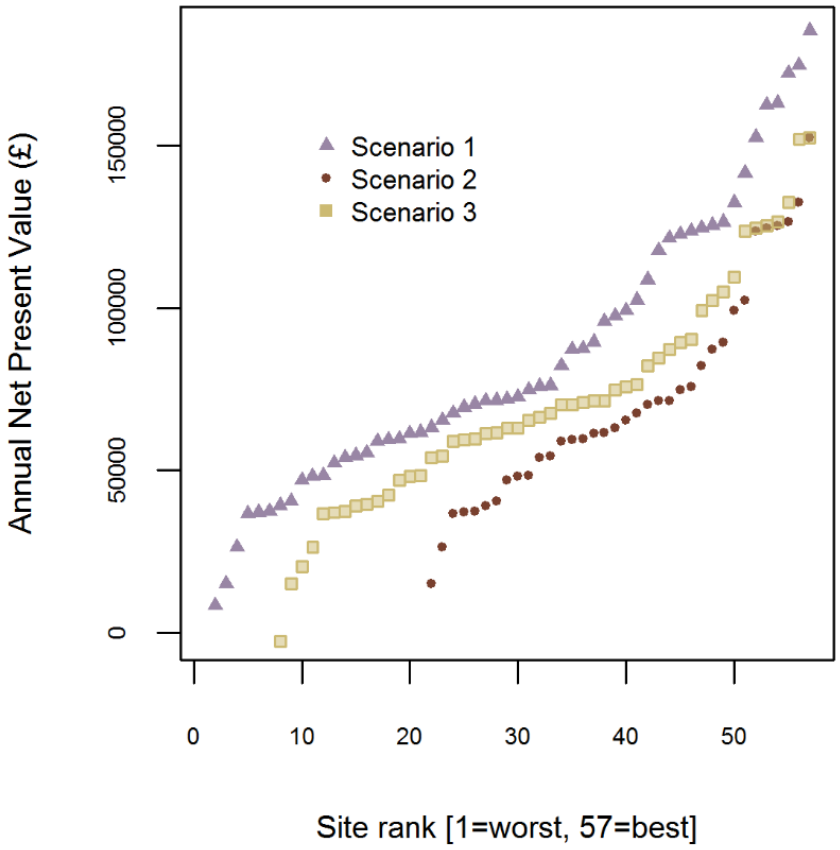
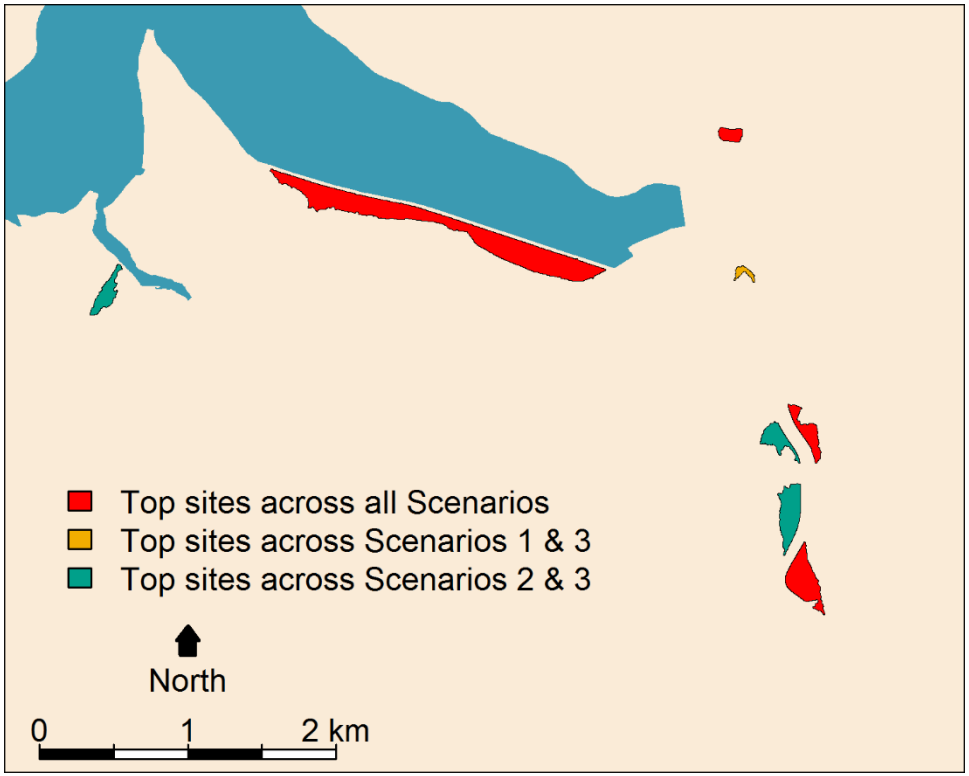


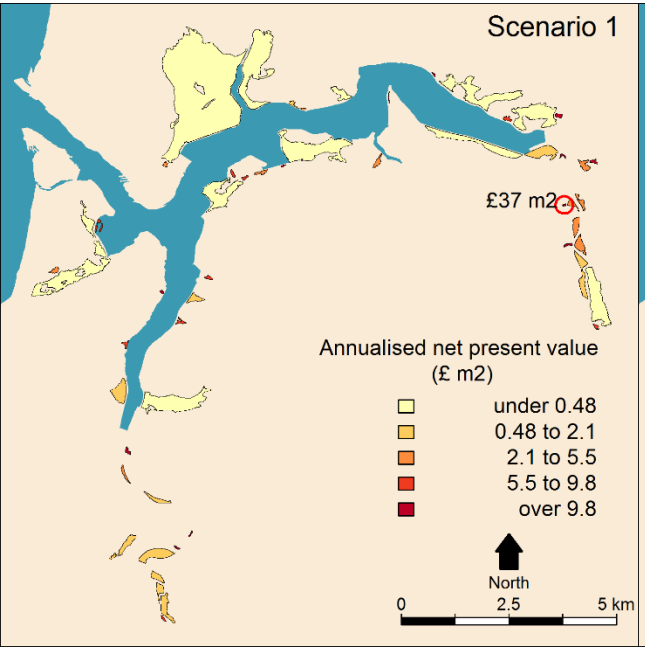
Incorporate

Results - site





Results – per m^2



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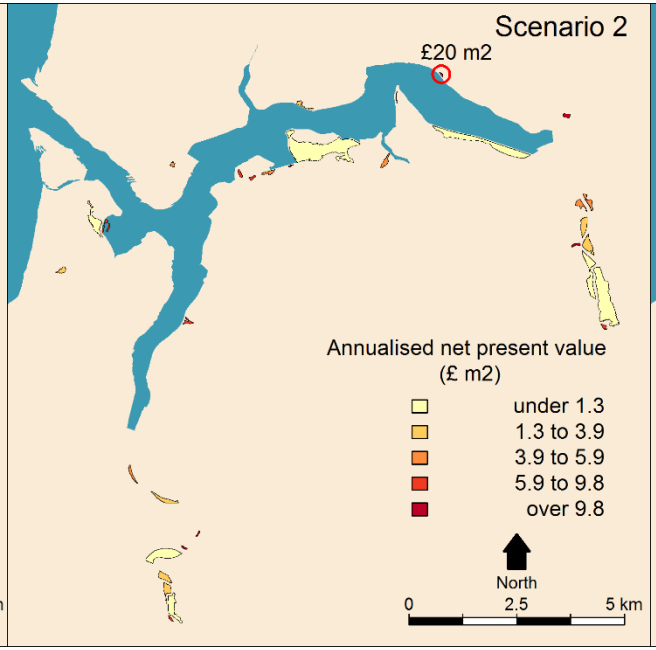

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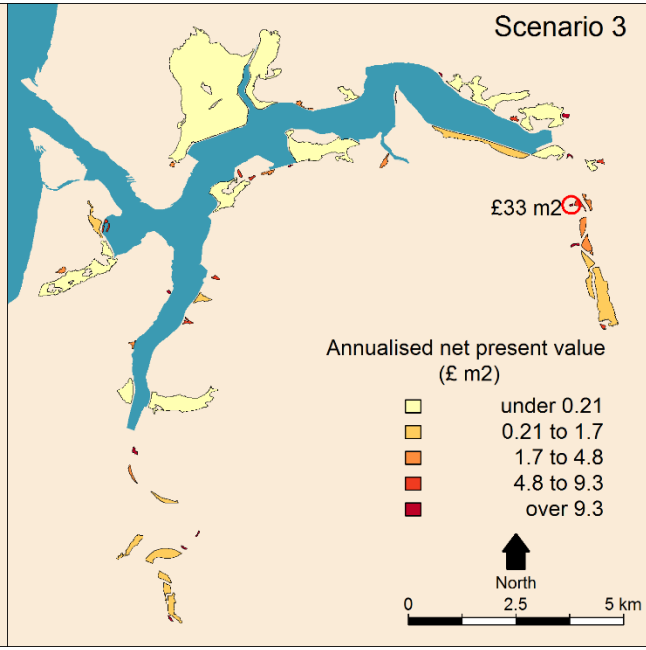

Incorporate

Findings

- Four sites are prioritised for re-alignment across all scenarios
- Annual net present value of re-alignment ranges from £152,408 to £185,217 yr^{-1}
- Recreational values and property damage costs drive prioritisation
- Future: evaluate sites' geomorphology and tidal hydrodynamics

Thank you

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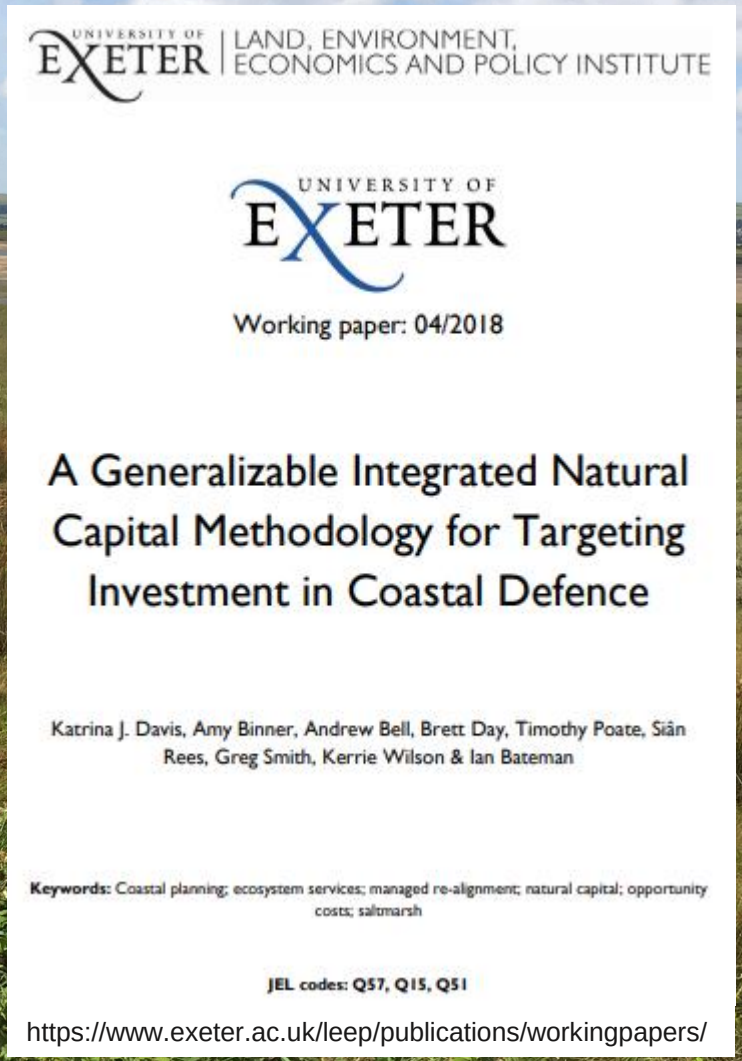

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Working paper: 04/2018

A Generalizable Integrated Natural Capital Methodology for Targeting Investment in Coastal Defence

Katrina J. Davis, Amy Binner, Andrew Bell, Brett Day, Timothy Poate, Siân Rees, Greg Smith, Kerrie Wilson & Ian Bateman

Keywords: Coastal planning; ecosystem services; managed re-alignment; natural capital; opportunity costs; saltmarsh

JEL codes: Q57, Q15, Q51

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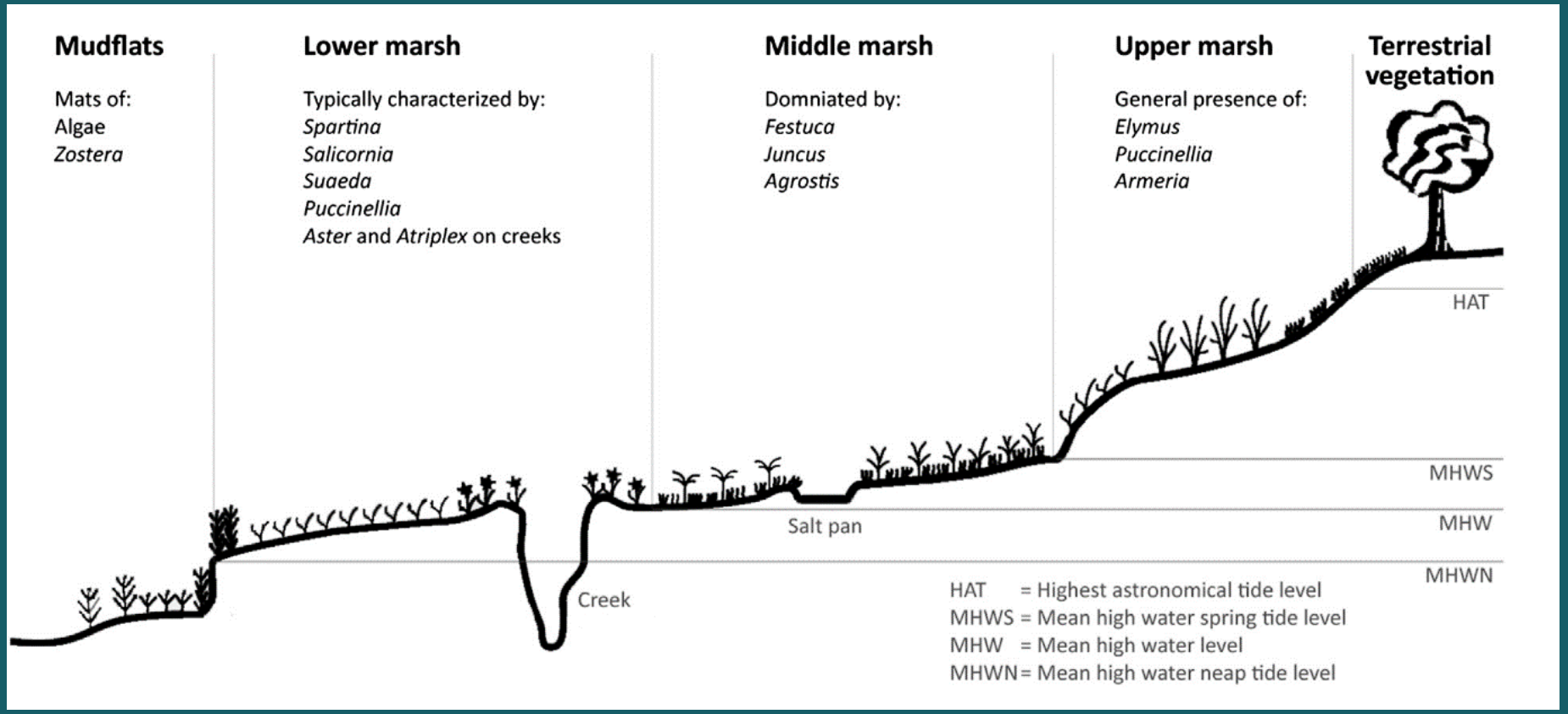
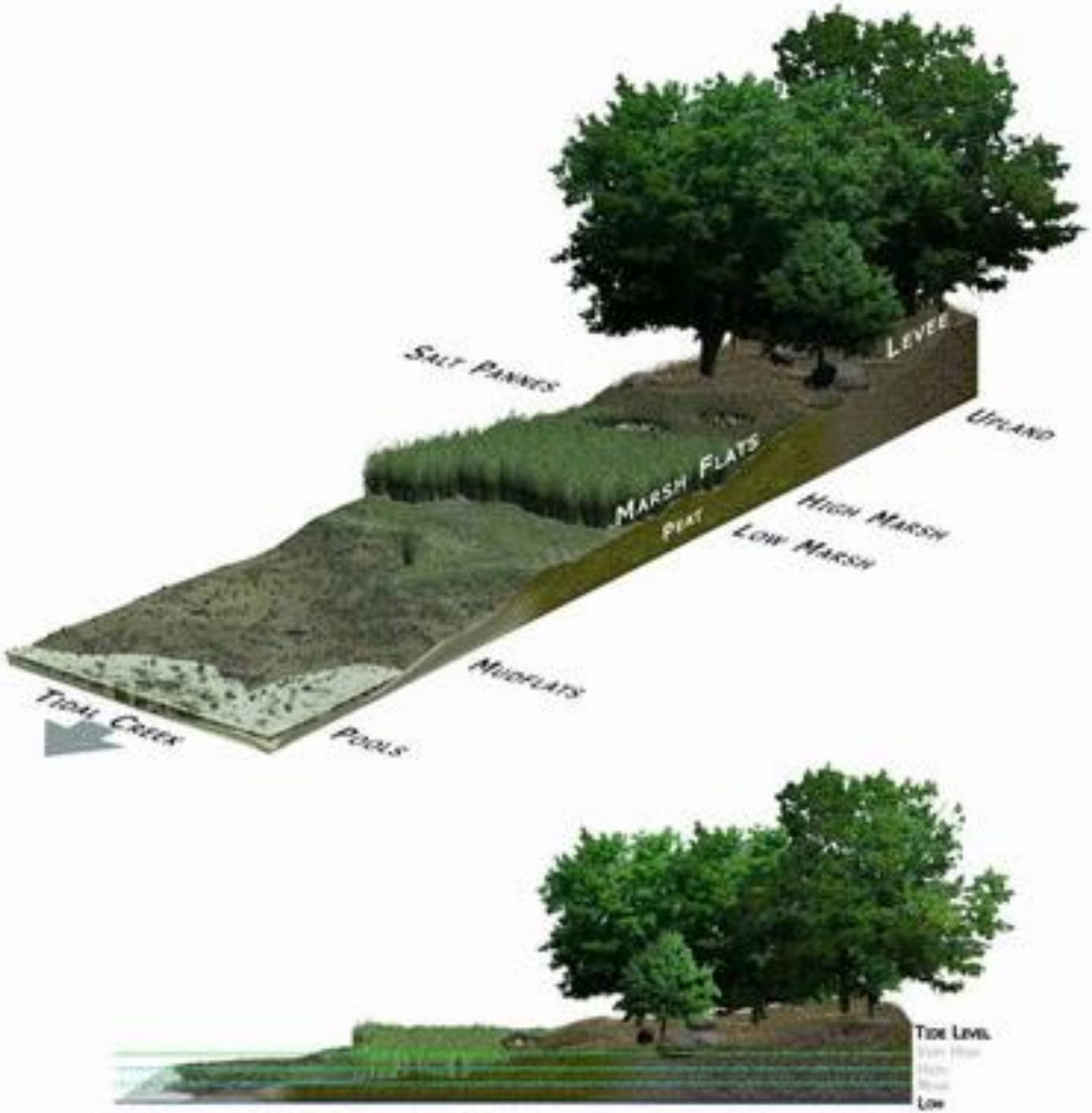
Why do we care about saltmarsh?

Ecosystem services	Ecosystem processes and functions
Raw materials and food	Generates biological productivity and diversity
Coastal protection	Attenuates and/or dissipates waves
Erosion control	Provides sediment stabilization and soil retention in vegetation root structure
Water purification	Provides nutrient and pollution uptake, as well as retention, particle deposition
Maintenance of fisheries	Provides suitable reproductive habitat and nursery grounds, sheltered living space
Carbon sequestration	Generates biogeochemical activity, sedimentation, biological productivity
Tourism, recreation, education & research	Provides unique and aesthetic landscape, suitable habitat for diverse fauna and flora

Adapted from Barbier et al (2011)


Mudflats
Mats of:
Algae
Zostera
Lower marsh
Typically characterized by:
Spartina
Salicornia
Suaeda
Puccinellia
Aster and *Atriplex* on creeks
Middle marsh
Domniated by:
Festuca
Juncus
Agrostis
Upper marsh
General presence of:
Elymus
Puccinellia
Armeria
Terrestrial vegetation
HAT
MHWS
MHW
MHWN
Salt pan
Creek
HAT = Highest astronomical tide level
MHWS = Mean high water spring tide level
MHW = Mean high water level
MHWN = Mean high water neap tide level



Adapted from NOAA

Results - site

	Costs (£)			Benefits (£)		Annual net present value (£)		
	Opportunity costs to Agriculture	Property damages	Direct	Carbon sequestration	Recreational	Scenario 1	Scenario 2	Scenario 3
Min.	0	5,513	150	13	10,933	-124,283	15,112	-2,069,841
1st Qu.	46	11,025	384	45	60,393	54,483	48,296	39,158
Median	138	33,075	909	130	77,553	71,819	64,214	63,020
Mean	1,847	225,030	6,896	773	89,045	81,075	71,942	-1,831
3rd Qu.	752	101,320	4,015	534	120,672	117,592	87,761	84,517
Max.	52,396	2,232,207	152,419	11,165	186,610	185,217	152,408	152,408