Evolutionary Resilience and Adaptation to Climate Change in European Coastal Systems

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Structure

- The idea of Evolutionary Resilience (ER)
- ER as a theory to inform deliberation and planning in situations of high uncertainty
- Climate Change Adaption Planning
- Applying ER to Broads, UK and Rotterdam, Netherlands CC Adaptation Plans
- Conclusions, links to ARCH project

Towards Evolutionary Resilience

Davoudi identifies three types of resilience:
- Engineering
- Ecological
- Evolutionary (also known as 'socio-ecological')

(Davoudi, 2012, Davoudi *et al.*, 2013)

The concept of resilience has shifted, as its objects of attention have shifted, from simple engineering entities, to bounded ecosystems, through to open socio-ecological systems.

It has expanded to incorporate aspects of all three phases, emphasising awareness of their interplay, in a context of complex socio-ecological systems undergoing a range of interacting transformations, in tandem with the human potential for steering these towards more desirable outcomes

Engineering Resilience

"Bounce-back"

The Millennium Bridge, Arup Foster and Caro, 2000-2002

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Engineering Resilience

- an ‘asset’
- being robust, stable
- *bouncing back*
  to a prior state,
  before a disturbance,
  emergency
  or crisis

- **Persistence**

“Stability [...] is the ability of a system to return to an equilibrium state after a temporary disturbance” (Holling, 1973:17)

Ecological Resilience

"Tipping points"

Liberty Lake, WA, with summer algae blooms

Ecological resilience

- **Adaptability**
- Bounded systems, ‘Bouncing forth’ to a new state
- ‘Tipping points’:
  systems flipping between
  one stable state and the
  next (Gunderson, 2000)

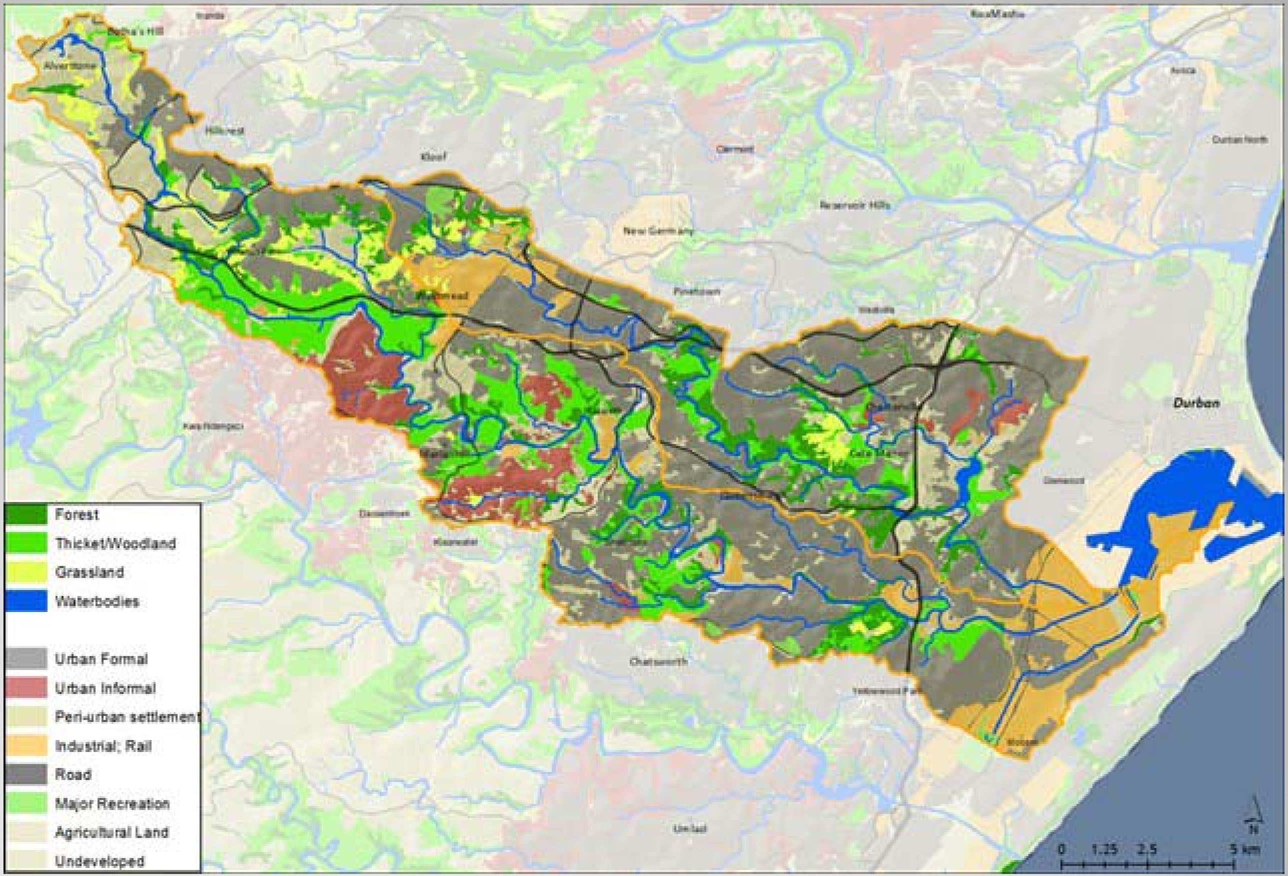
“Resilience … is a measure of the ability of these systems to absorb changes [...] and still persist” (Holling, 1973:17).

Later called ecological resilience (Walker *et al.*, 1969; Holling, 1996).

Evolutionary resilience

"Dynamic interplay"

A watershed system around Durban, SA

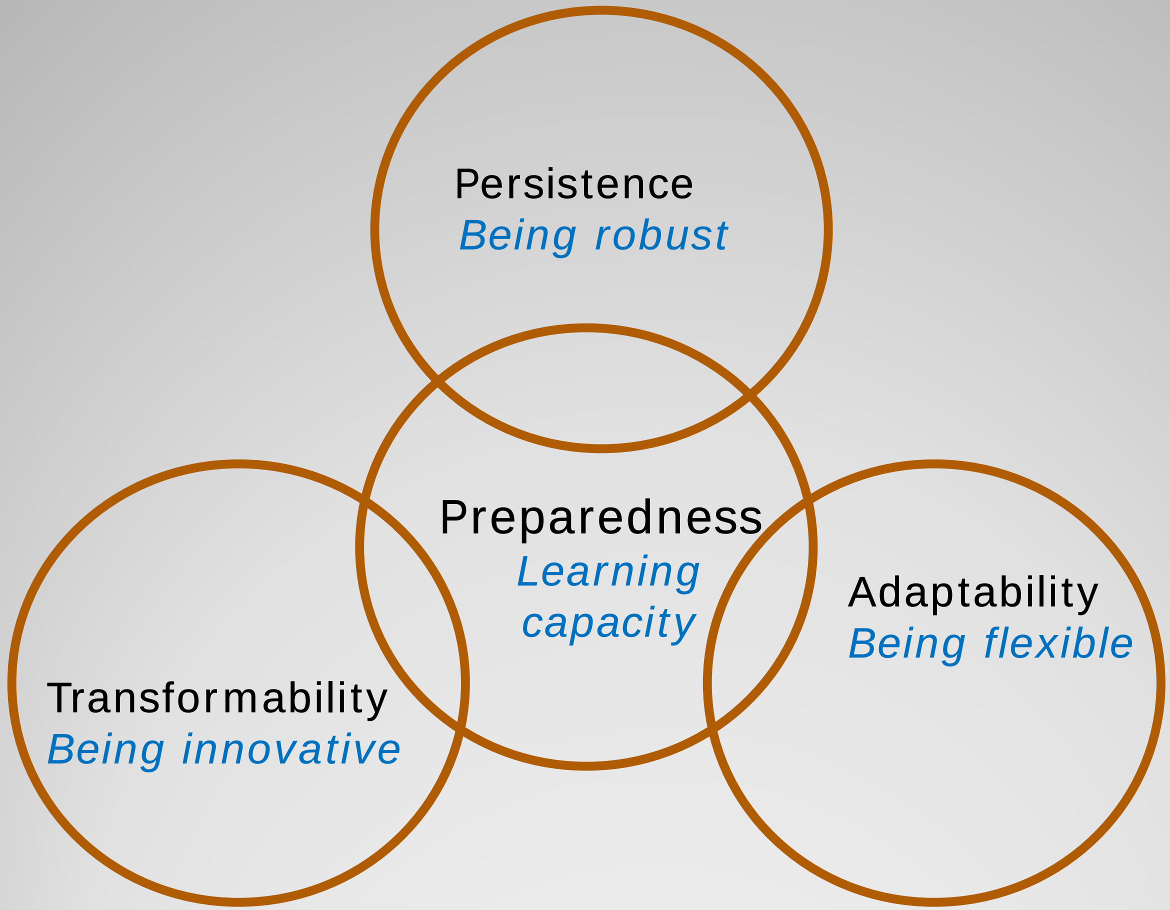


Evolutionary resilience

- Emergent: not an asset but a process of change
- People and nature as interdependent systems

  (Folke et *al.*, 2010)
- multiple scales and timeframes (‘adaptive cycles’ and ‘panarchy’)
- dynamic interplay between *persistence*, *adaptability* and **transformability**

Evolutionary resilience



Applying the idea of Evolutionary Resilience

- Identifying a manageable number of components and subcomponents
- Primary mapping of their relationships
- Applying this model to plan evaluation
- Most applicable in cases of high uncertainty e.g. for Climate Change adaptation

Climate Adaptation Planning

- Rising on the European Territorial Agenda (2007→2011)
- Climate Change Act in UK; Dutch National Adaptation Strategy in Netherlands
- Both nations show high degrees of integration between climate change adaptation and spatial planning
- Lower integration with other transformation agendas:
  - demographic shift
  - energy shift (Grieving and Fleischauer, 2012)

CC adaptation and local scale

- Climate change impacts are very different between local areas in one region
- Unlike mitigation, interventions and impacts are most relevant at local scale
- People have more trust in local government
- Expenditure on adaptation comes partly from local budgets - more politically acceptable when balanced with gains – e.g. increased land values
- Yet, much Coastal Protection Planning and Marine Spatial Planning (windfarms, marine protected areas etc) is decided at National scale.

The case studies: A) Rotterdam, The Netherlands and B) The Broads, UK

UK and climate risk

- Country as a whole is 139th on World Risk Register
- East Anglia's clay and sandstone coastal areas are some of the fastest eroding in Europe
- The Broads are 'the front line' for climate risk in the UK - particularly vulnerable in terms of flood and salinization
- Broads coast sea level rise estimated at 54cm by 2100
- Vulnerable include elderly populations, pattern of ex-urban migration in mid to later life, coastal areas are England's most ageing areas

UK in World Risk Report, 2012

(Env. Degradation and Disaster Focus)

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of coping capacities	Lack of adaptive capacities
116.	Italy	4.82 %	13.85 %	34.78 %	16.05 %	54.84 %	33.44 %
117.	Australia	4.57 %	15.05 %	30.38 %	14.39 %	41.87 %	34.88 %
118.	Bulgaria	[illegible]	[illegible]	39.11 %	16.90 %	59.31 %	41.11 %
119.	Samoa	[illegible]	[illegible]	[illegible]9.58 %	27.91 %	73.83 %	47.00 %
120.	Ireland	[illegible]	[illegible]	[illegible]0.54 %	14.98 %	42.26 %	34.38 %
121.	Equatorial Guinea	[illegible]	[illegible]	[illegible]4.37 %	26.40 %	85.65 %	51.06 %
122.	New Zealand	[illegible]	[illegible]	[illegible]8.77 %	16.13 %	39.79 %	30.39 %
136.	Kuwait	[illegible]	[illegible]	41.03 %	13.27 %	65.98 %	43.84 %
137.	Slovakia	3.69 %	[illegible]	36.13 %	13.82 %	56.98 %	37.58 %
138.	Czech Republic	3.67 %	[illegible].82 %	33.96 %	14.33 %	51.85 %	35.71 %
139.	United Kingdom	3.65 %	11.60 %	31.49 %	15.53 %	46.40 %	32.53 %
140.	Poland	3.53 %	9.79 %	36.05 %	17.23 %	55.45 %	35.48 %
141.	Latvia	3.51 %	9.26 %	37.94 %	20.98 %	58.05 %	34.81 %

UK is relatively low on Risk Register (139) but also in the danger zone for Exposure

Netherlands and Climate Risk

- 51st on World Risk Register 2012
- 60% of Netherlands is below sea level
- Sea level rise along Dutch coast line between 65 and 130cm by 2100 – threats of both flood and salinization
- Since mid-20th century, many canals have been filled in – less space for flood, drier dry land
- Peatlands shrink when they dry out – rivers behind dikes can be higher than land – 'the reverse bathtub effect'
- Standards for water defences only introduced in 2004
- By 2011, one third of water defences not up to standard

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Netherlands in World Risk Report, 2012 *(Env. Degradation and Disaster Focus)*

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of coping capacities	Lack of adaptive capacities
1.	Vanuatu	36.31 %	[illegible]	[illegible]	34.17 %	81.19 %	55.78 %
2.	Tonga	28.62 %	[illegible]	[illegible]	27.91 %	81.31 %	46.11 %
3.	Philippines	27.98 %	[illegible]	[illegible]	33.92 %	83.09 %	43.03 %
4.	Guatemala	20.75 %	[illegible]	[illegible]	37.28 %	81.18 %	53.04 %
5.	Bangladesh	20.22 %	[illegible]	[illegible]	43.47 %	86.84 %	61.03 %
6.	Solomon Islands	18.15 %	[illegible]	[illegible]	43.96 %	84.26 %	53.42 %
7.	Costa Rica	17.38 %	[illegible]	[illegible]	21.59 %	65.63 %	35.19 %
8.	Cambodia	17.17 %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
48.	Suriname	8.62 %	[illegible]	[illegible]	30.01 %	73.27 %	39.53 %
49.	Guinea	8.55 %	[illegible]	71.05 %	58.08 %	90.16 %	64.91 %
50.	Kyrgyzstan	8.50 %	[illegible]	51.10 %	27.54 %	77.79 %	47.98 %
51.	Netherlands	8.49 %	30.57 %	27.76 %	13.89 %	39.14 %	30.26 %
52.	Mauritania	8.43 %	12.47 %	67.55 %	49.04 %	86.54 %	67.07 %
53.	Nigeria	8.28 %	12.06 %	68.70 %	55.46 %	88.00 %	62.63 %
54.	Malawi	8.18 %	12.34 %	66.25 %	56.28 %	85.31 %	57.15 %
55.	Bhutan	8.17 %	14.81 %	55.14 %	35.06 %	77.31 %	53.05 %
56.	Algeria	8.15 %	15.82 %	51.48 %	22.50 %	78.46 %	53.48 %
57.	United Republic of Tanzania	8.11 %	12.01 %	67.52 %	67.34 %	83.49 %	51.73 %
58.	Ecuador	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Netherlands is 51st on Risk Register, mainly due to Climate Exposure

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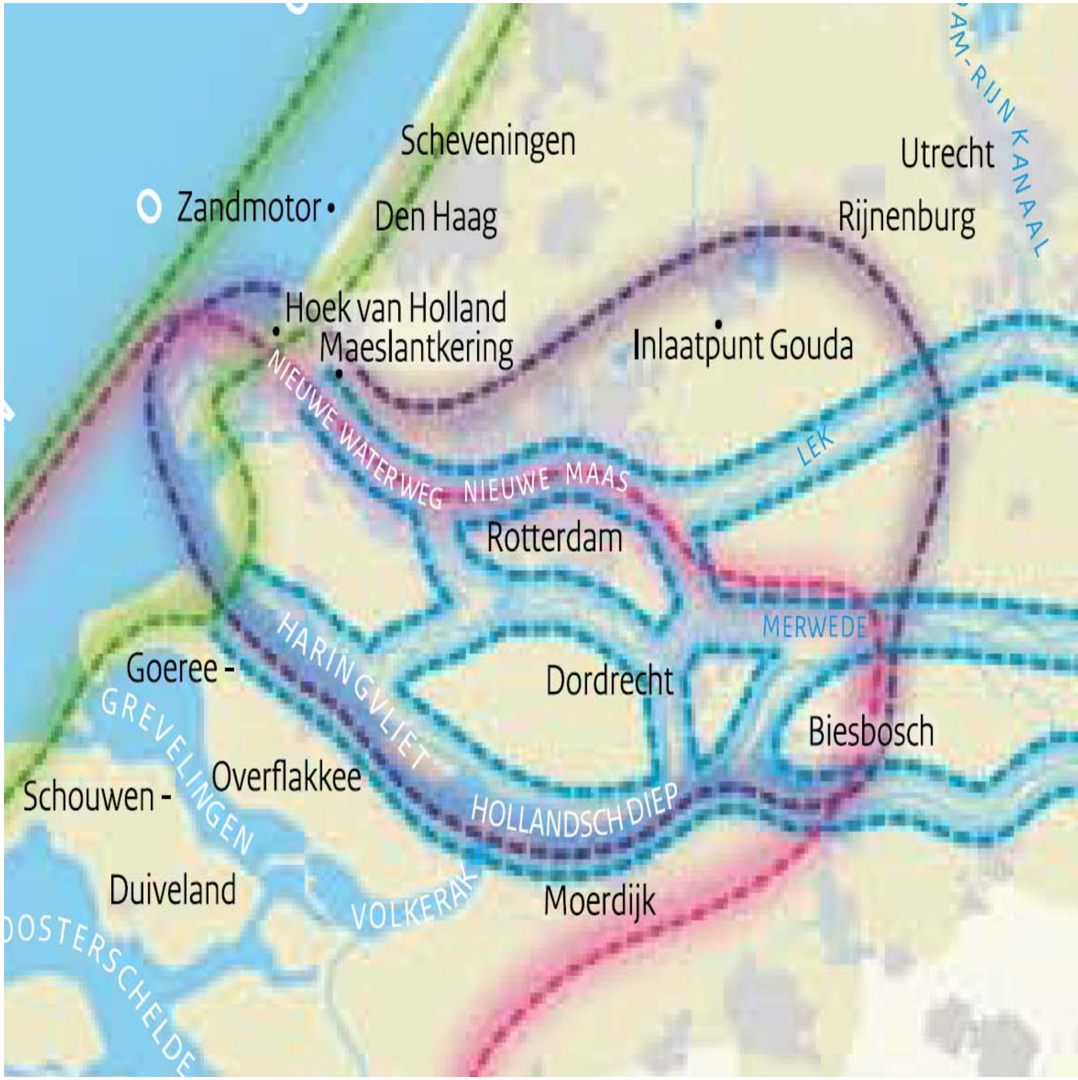
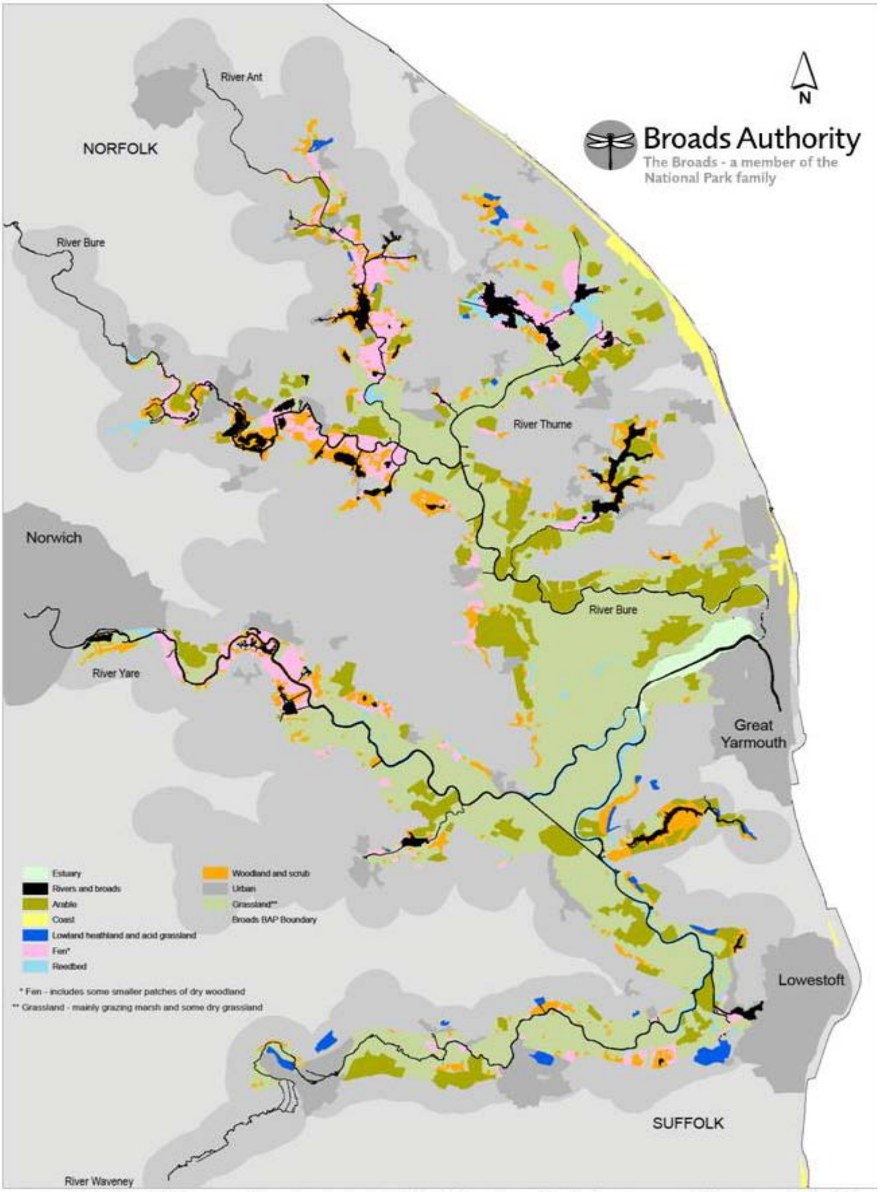
• **Rotterdam**'s vulnerable position within the network of Dutch Delta rivers

• The purple outline is the Rhine-Drechtsteden area: one of six Netherlands areas designated for improved water management through the Dutch Delta Programme



A) Rhine-Drechtsteden area around Rotterdam



Main types of land in **The Broads**

- Fenland
- Reedbeds
- Woodland
- Arable land
- Grassland

Rivers and Broads are in black, urban areas are dark grey, mid grey is the boundary

B) The Norfolk and Suffolk Broads

Broads and Rotterdam Case Studies – Contrasts and *Commonalities*

The Broads, UK	Rotterdam, Netherlands
Rural	Urban, densely populated
In UK ‘National Parks’ family – a planning, harbour and navigation authority	Metropolitan authority linked to ‘mainport’
303 km^2	314 km^2
6,000 population	600,000 population
Biggest CC challenges: flood and water quality	*Biggest CC challenge: flood and water quality*
Flood threats: North Sea and rivers	*Flood threats: North Sea and rivers*

CC Adaptation Plans Compared

The Broads, UK	Dimension	Rotterdam, Netherlands
A planning body, within National Parks family	Nature of governing authority	Metropolitan Authority
Public bodies and NGOs: Natural England, the Environment Agency, local authorities, the National Farmers Union and the University of East Anglia, Broads Authority and Broads Forum	Bodies participating in CC Adaptation process	Mainly public and business interests: Rotterdam municipality, Port of Rotterdam, DCMR Environmental Protection Agency Rijnmond and Deltalings
2020/2050/2080	Timescale/Milestones	2025
Conformative	Spatial planning system	Performative
Conserve protected areas, public enjoyment of these	Broad aim	Increase city's prosperity and aesthetic appeal

Plans compared/continued

The Broads, UK	Dimension	Rotterdam, Netherlands
Tourist industry and agriculture emphasised	Economy	Economic growth is one of the twin goals of the strategy
Major focus	Biodiversity	Barely mentioned
Discussion and deliberation with regard to acceptability of climate adaptation options	Involvement of public	'Informative and Marketing' interventions to the public
Integrated with mitigation plans; unclear whether taking into account population ageing; unintegrated with energy shift	Integration with other strategies and transformation agendas	Weak – adaptation projects are high-carbon footprint (and carbon capture is main mitigation strategy)
Choices for flood management to be agreed by stakeholders (lose agricultural land)	Typical example of approach	Bringing back water in terms of water plazas, embankments (increase population)

Broads Authority Climate Change Adaptation Approach

- Balancing agricultural, ecological and tourism interests, therefore delicate!!
- 77% of land under Broads Authority is privately owned (inc. by NGOs)
- Approach initiated by and generalisable across the body of National Parks:
  - Technical; Step-by-step; Identifies climate risks; Develops adaptation options
- Once identified, adaptation options opened up to a lengthy, deliberative consultation process with local stakeholders

Slow-paced process, emphasises (end-phase) dialogue

Rotterdam Climate Initiative

- Initiated by International Advisory Board for Rotterdam *(advises on economic dvpt)*
- Aim: "Making the city even more attractive and economically prosperous"
  - 'Bringing in water' to make city more attractive and provide place for floodwater
  - Positioning as flagship climate adaptation pioneer, selling knowledge, innovations and expertise globally
- Growth oriented despite climate risk – e.g. new housing development outside dikes is planned
- Citizens are to be kept informed about the plans

Emphasis is on engineering water back into the city

Resilience	Sub-dimensions		Rotterdam CC Adaptation plan
Persistence			**√** Protecting and improving economic performance of city and population, reversing outmigration
Adaptability	Flexibility		**?** Not clear how wide involvement of concerned organisations goes – and how/if they are networking together towards adaptation aims
	Resource-fulness	*Efficiency*	**X** Lack of integration with other transformation agendas (mitigation, demographic shift, energy shift)
		Rapidity	**X /√** Smart flood defences but… downplaying emergency and evacuation planning – in line with Dutch national picture
		Diversity	**X** Dependence on mainport for economy (plus building/construction). Mainport continuous expansion, reducing the resilience benefits of redundancy
Transform-ability			**X** Engineering style resilience: focus on engineering to reintroduce water, but without a shared or more holistic vision of new role of water in city e.g. transport
Prepared-ness			**X** 'Informative and marketing' approach to public participation does not engender wider social learning and preparedness

Resilience	Sub-dimensions		Broads Draft Adaptation plan
Persistence			Envisages overall persistence of function, tempered with potential for negotiated adaptation – e.g. flooding agricultural marshlands downstream
Adaptability	Flexibility		**√** Existing extensive networking through Broads Forum, inclusive CC strategy building wider social networks, raises potential for negotiated adaptations
	Resourceful -ness	*Efficiency*	**√/X** Integrated with climate change mitigation planning and with other regional adaptation plans; low recognition of demographic and energy shift
		Rapidity	**?** Local authorities in UK required to have emergency plans (Civil Contingencies Act, 2004) but unclear whether there has been any attempt to make these compatible with adaptation plans
		Diversity	**?** Assumes continuing agri and tourism/boating economy (i.e. not diversification measures to adapt to salinisation, reduced water flow scenarios)
Transform-ability			**X** Shift to new trajectory not considered – e.g. where Broadlands reverts to agriculture, integrates saline agriculture or fen plant biomass production
Prepared-ness			**?** Deliberative consultation process aids social learning but is constricted by organisational remit and rigid linear process predetermining adaptation options.

Conclusions

- Rotterdam broadly exemplifies an engineering resilience approach - ‘bounce back’
- The Broads approach is between engineering and ecological resilience, mobilising stakeholders to facilitate system shift if necessary
- Neither plan contemplates transformability
- Institutional and historical factors main factors behind the strategies’ limited conceptions of resilience

Some Questions….

- How much would a more defined operationalisation constrain the flexibility inherent in ER theory?
- Can the theory have any face validity for localities prior to encountering any significant (negative) climate impacts? (Collingridge dilemma)

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Evolutionary Resilience

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