Water and Urban Sustainability Research

Professor David Butler

Centre for Water Systems
University of Exeter, UK
d.butler@exeter.ac.uk

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Urban Futures ReVISIONS AIA EXETER

Introduction

- An introduction to three current UK research consortia working in the area of **urban sustainability**, all with a significant water component
- All three projects are multidisciplinary and funded by the Engineering & Physical Sciences Research Council EPSRC within their Sustainable Urban Environment (SUE) programme
- **Urban Futures**: sustainable regeneration - from evidence-based urban futures to implementation
- **ReVISIONS**: Regional Visions of Sustainable Infrastructure Optimised for Neighbourhoods
- **AIA**: Ashford's Integrated Alternatives

Urban Futures ReVISIONS AIA EXETER

The Urban Futures Project

- 4 year project (May ‘08 to April ’12)
- Funded by EPSRC as part of SUE II
- 4 university partners and many collaborators
- Aim in brief: envisioning the future to make more sustainable decisions today

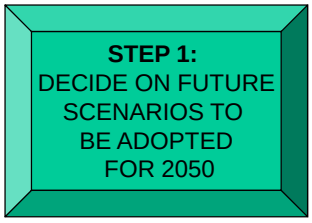
Sustainable Regeneration: From evidence-based urban futures to implementation

Research Areas

1: Biodiversity
2: Air Quality
3: Water and Wastewater
4: Sub-Surface Built Environment (infrastructure and utilities)
5: Surface Built Environment and Open Space
6: Density and Design Decision Making
7: Organizational Behavior and Innovation
8: Social Needs, Aspirations and Planning Policy

The 3 main linking elements of this research are ***urban regeneration, sustainability,*** *and* ***futures scenarios***

… overarching work consists of ***5 key steps***



Sustainable Regeneration: From evidence-based urban futures to implementation

Future Scenarios to be Adopted

UF is **not** about predicting the future...

...and goes beyond **trend analysis**

... allowing for creative thinking

"This just isn't doing it for me. Could we go back to using the crystal ball?"

Future Scenarios to be Adopted

- UF is **not** concerned with how we get there from here;
- UF is **not** creating new future scenarios;
- UF **is** about adopting future scenarios that are**:**
    - *well-cited within academic literature;*
    - *amenable to all work packages (allowing for cross fertilisation of research findings);*
    - *sufficiently distinct from each other;*
    - *wide ranging (from probable to plausible)*

STEP 1:
DECIDE ON FUTURE SCENARIOS TO BE ADOPTED FOR 2050

STEP 2:
DERIVE URBAN FUTURES TOOLKIT

Step 2: Deriving Urban Futures Toolkit

Includes a mix of …

- ***Contextual Indicators,*** and
- ***Sustainability indicators***

… which are relevant ***now*** and in the ***future***

… for 8 Work Packages (WP) … and in themed areas,

… for example

Themes for WP3 (water) toolkit

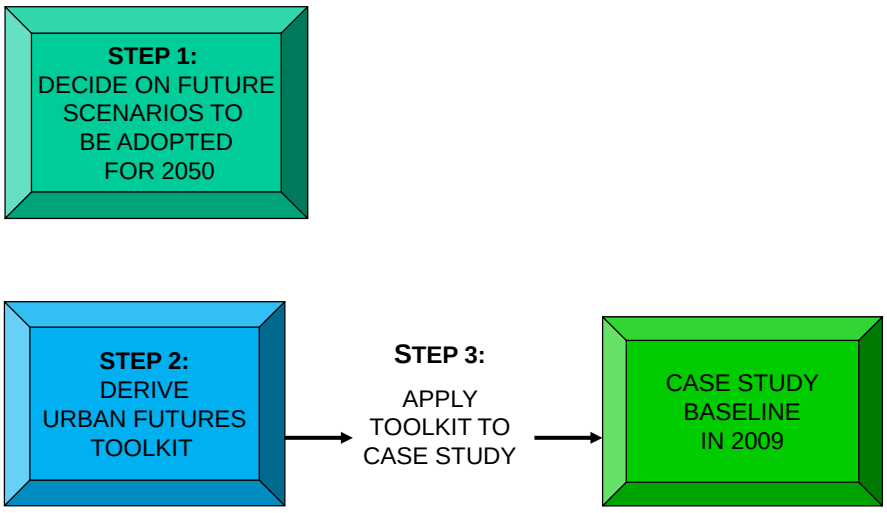
2: DEMAND

1: SUPPLY

3: DISPOSAL

4: CLOSING THE LOOP

Sustainable Regeneration: From evidence-based urban futures to implementation

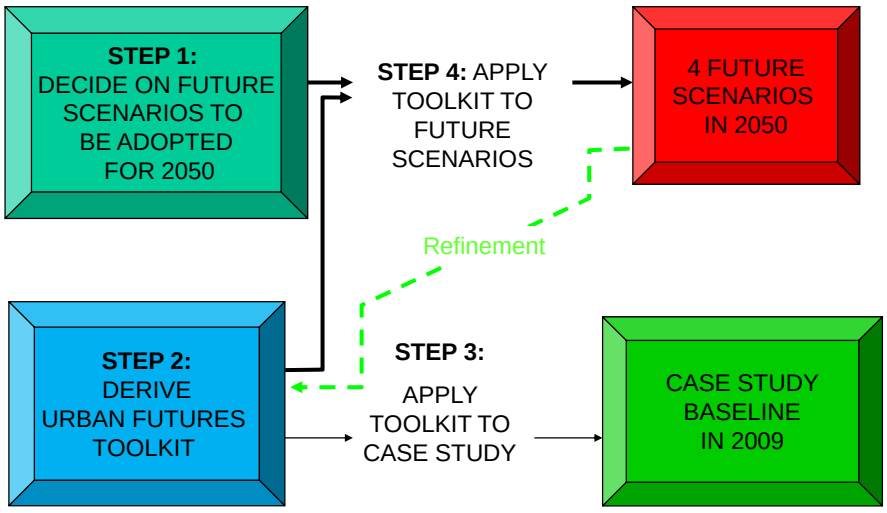


National Case Studies

- Birmingham Eastside
- Lancaster and Morecambe
- Worcester

International Case Studies

- Singapore
- India
- Brazil
- Republic of Ireland

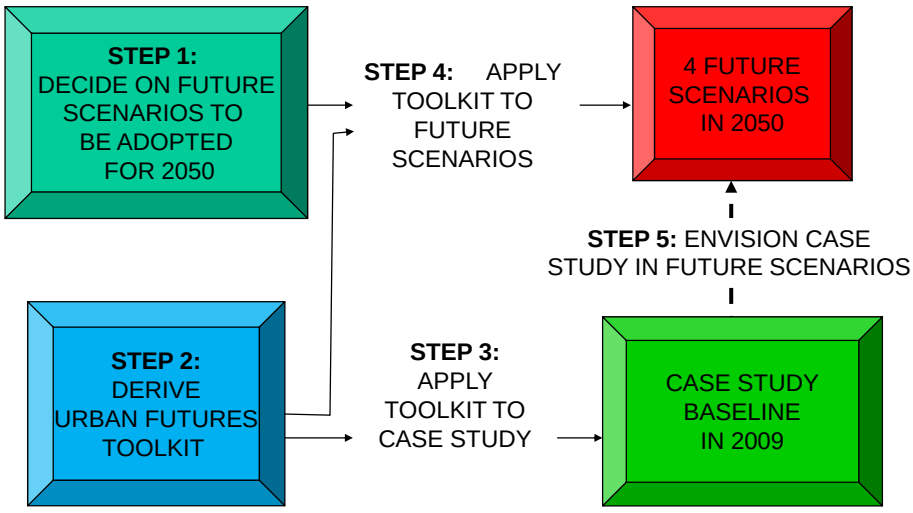


Step 4: Apply Toolkit to Future Scenarios

- Application of the toolkit across 4 future worlds enables:

  … ***pressure testing*** of toolkit
  … ***refinement*** of toolkit
  (may need to re-apply Step 3)
  … derivation of ***internally consistent*** answers
  … derivation of new questions

- Ultimately, by repeating this process, a generic UF toolkit (for each work package) will have been derived



Step 5: Envision Case Study in Future Scenario

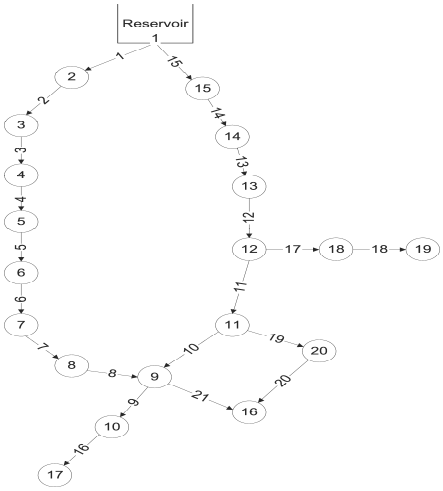
At Step 5 all of the pieces should be in place thereby providing sufficient information to allow each WP to envisage the case studies within all 4 future scenarios

… in so doing it should allow for 'optimisation' of today's solutions in order they remain relevant, no matter how the future develops

… several discrete studies will be conducted in each work package as part of the UF research

Sensitivity of current water infrastructure performance to different futures

- Sensitivity analysis of a benchmark water distribution system (NY tunnels)
- **Population** and **demand** changes under four futures
- **Cost**, **quality** and **pressure** indicators are used to compare the performance of the benchmark infrastructure with the new future



Population and demand changes

Future	Population change	PCC change
PR	35%	-20%
MF	45%	5%
FW	20%	-10%
NSP	25%	-30%

Sustainable Regeneration: From evidence-based urban futures to implementation

Pressure head at critical nodes

Designed for	Demand Change	0.88	1.00	1.08	1.20	1.25	1.35	1.45	1.52	Design Scenario
		Implication of ... on Lowest Peak Head (ft of Water)								
		NSP (Population & Demand Change)	Existing demand	PR and FW (Population & Demand Change)	FW (Population Change)	NSP (Population Change)	PR (Population Change)	MF (Population Change)	MF (Population & Demand Change)	
NSP (Population & Demand Change)	0.88		-12.04	-20.78	-34.95	-41.23	-54.44	-68.51	-79.24	0.24
Existing demand	1.00	5.97		-6.89	-18.07	-23.02	-33.44	-44.54	-53.01	0.00
PR and FW (Population & Demand Change)	1.08	8.82	3.66		-9.42	-13.69	-22.68	-32.26	-39.57	0.06
FW (Population Change)	1.20	12.08	7.84	4.87		-2.82	-10.15	-17.95	-23.91	0.06
NSP (Population Change)	1.25	13.36	9.47	6.76	2.35		-6.87	-14.21	-19.81	0.02
PR (Population Change)	1.35	15.07	11.67	9.29	5.43	3.72		-4.65	-9.34	0.12
MF (Population Change)	1.45	16.55	13.56	11.47	8.08	6.57	3.41		-3.62	0.05
MF (Population & Demand Change)	1.52	17.46	14.72	12.81	9.71	8.34	5.45	2.37		0.02

Water age at critical nodes

Designed for	Demand Change	0.88	1.00	1.08	1.20	1.25	1.35	1.45	1.52	Design Scenario (hrs)
		Implication of ... on Water Age (hrs)								
		NSP (Population & Demand Change)	Existing demand	PR and FW (Population & Demand Change)	FW (Population Change)	NSP (Population Change)	PR (Population Change)	MF (Population Change)	MF (Population & Demand Change)	
NSP (Population & Demand Change)	0.88		29.3	26.4	23.6	22.5	21.2	20.1	19.4	33.8
Existing demand	1.00	42.8		35.9	32.5	31.1	28.4	25.8	24.3	38.4
PR and FW (Population & Demand Change)	1.08	45.0	40.4		34.5	33.2	30.7	28.1	26.1	37.9
FW (Population Change)	1.20	43.9	39.4	37.0		32.3	29.7	27.0	25.1	33.6
NSP (Population Change)	1.25	44.1	39.6	37.1	33.7		29.8	27.1	25.3	32.4
PR (Population Change)	1.35	44.6	40.1	37.6	34.2	32.9		27.7	25.8	30.3
MF (Population Change)	1.45	45.5	40.8	38.3	34.9	33.6	31.1		26.6	28.5
MF (Population & Demand Change)	1.52	51.4	45.1	42.3	38.8	37.5	35.0	32.7		31.1

ReVISIONS

Regional Visions of Integrated Sustainable Infrastructure Optimised for Neighbourhoods

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The ReVISIONS Project

- 4 year project (April '08 to March '12)
- Funded by EPSRC as part of SUE II
- 6 university partners and many collaborators

- Aims to provide the knowledge and evidence base to aid the **planning of regional spatial development** together with **infrastructure** for transport, water, waste and energy in a more coordinated and integrated way so as to:
  - **reduce impacts** on the environment and resources,
  - improve **economic** competitiveness
  - allow households to live more **sustainably**, with a socially inclusive and enhanced quality of life.

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Research Areas

- Environmental modelling and overall assessment
- Water services
- Energy conversion and supply
- Water demand modelling
- Waste management
- The building stock and building energy demand
- Health
- Transport

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Research Areas

- Key idea is to find more sustainable **combinations** of infrastructure measures for various spatial **planning options**
- What can be done at the local (neighbourhood) level to 'optimise' performance at the regional planning scale?
- Based on a core **Land Use-Transport Integrated model (economic)**
- Currently takes no account of either the demand for **infrastructure services** or their supply

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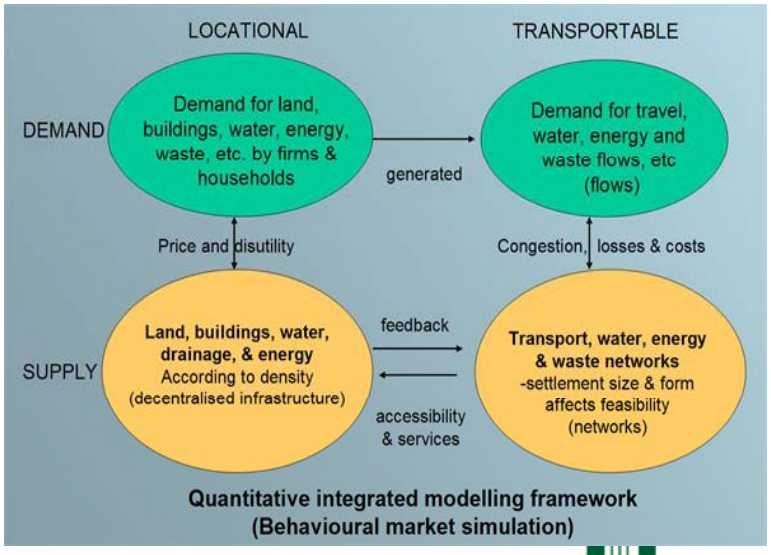
Integrated framework



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Case studies

- The South East region
- The East of England region
- The North East of England
- International case studies
  - Beijing, China
  - Sao Paulo, Brazil
  - Southern California, USA

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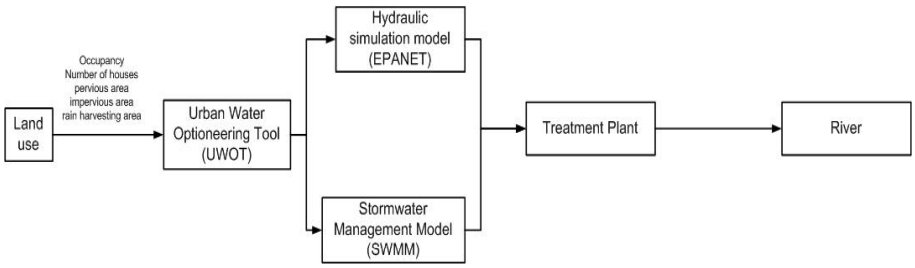
Water service implications of alternative urban forms and densities



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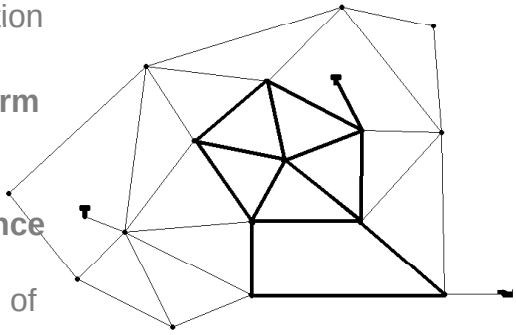
Sensitivity of current water infrastructure performance to different urban development

- Sensitivity analysis of a benchmark water distribution system (Anytown)
- **Population** and **urban form** changes at various timescales
- **Cost**, **quality** and **resilience** indicators are used to compare the performance of the current system with planned changes



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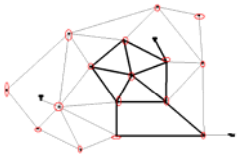
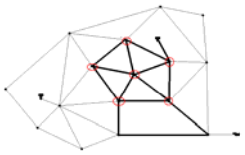
Alternative expansion options

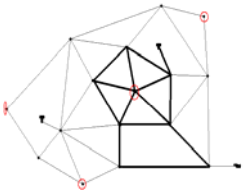
- **Uniform**



- **Monocentric**

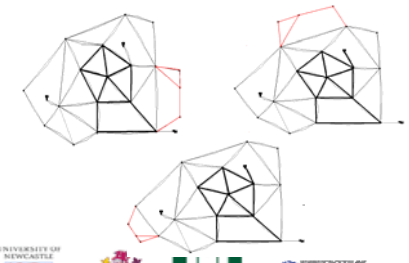


- **Polycentric**



- **Edge development**

9 options



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Technology scenarios

Scenario: per capita consumption	Existing homes (lcd)	New homes (lcd)
1	150	120 Water eff.
2	120 Retrofit w.e.	120
3	120 Retrofit w.e	80 Recycling

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Scenario 2 results

Urban Forms	expansion nodes	35%			50%		
		Total Cost ($)	Water Quality (hours)	Network Resilience	Total Cost ($)	Water Quality (hours)	Network Resilience
No expansion	None	8,579,372	52	0.18	8,579,372	52	0.18
Uniform expansion	all	9,894,287	46.2	0.21			
Monocentric expansion	13,14,15,16,18,19	11,287,672	44.7	0.2	12,713,353	40.8	0.19
Polycentric expansion	3,9,11,19	12,781,570	38.88	0.18			
Edge expansion	1-2	10,154,408	45.56	0.16	11,115,597	42.6	0.196
	2-3	10,758,097	40.47	0.17	11,918,489	34.23	0.148
	3-4	10,846,757	41.86	0.2	12,587,577	37.88	0.17
	4-8	10,465,646	37.66	0.19	12,324,740	41.26	0.20
	8-9	11,924,030	38.9	0.15	13,496,761	41.60	0.16
	9-10	11,863,444	35.56	0.166	14,410,322	45.99	0.15
	10-11	11,726,879	35.8	0.165	13,681,282	37.70	0.16
	11-12	11,899,287	44.35	0.2	12,827,267	36.07	0.21
	12-1	9,352,206	47.18	0.26	11,116,313	36.72	0.18

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Ashford's Integrated Alternatives (AIA)

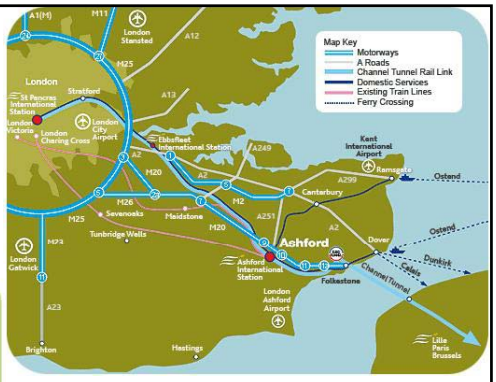
UNIVERSITY OF EXETER Cranfield UNIVERSITY Imperial College London BUSINESS SCHOOL UNIVERSITY OF SURREY UNIVERSITY OF BRADFORD MAKING KNOWLEDGE WORK

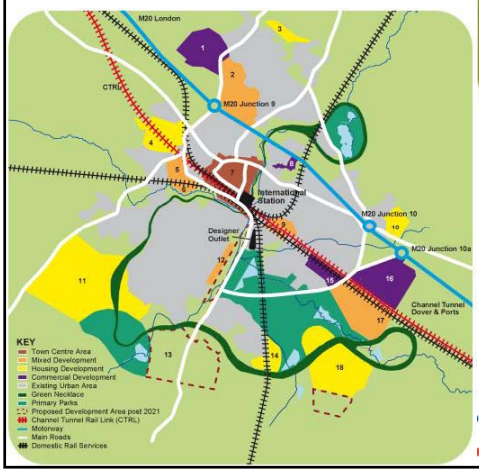
The AIA Project

- 2 year project (April ‘09 to March ’11)
- Funded by EPSRC as part of SUE II
- 5 university partners and many collaborators

- Aims to explore the feasibility of more integrated urban utility service provision as a way to improve the sustainability of urban development.
- This will be achieved by researching issues of scale, integration and delivery to potentially reduce resource use, limit emissions, manage innovation and improve the quality of life in the case study of Ashford, Kent.

Ashford



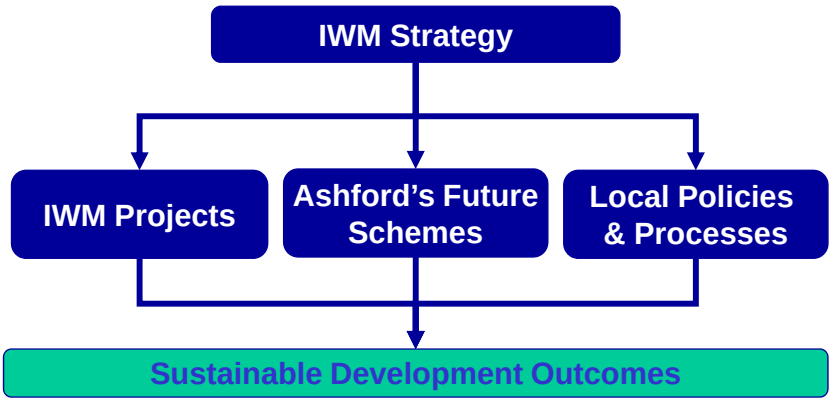


Ashford’s development

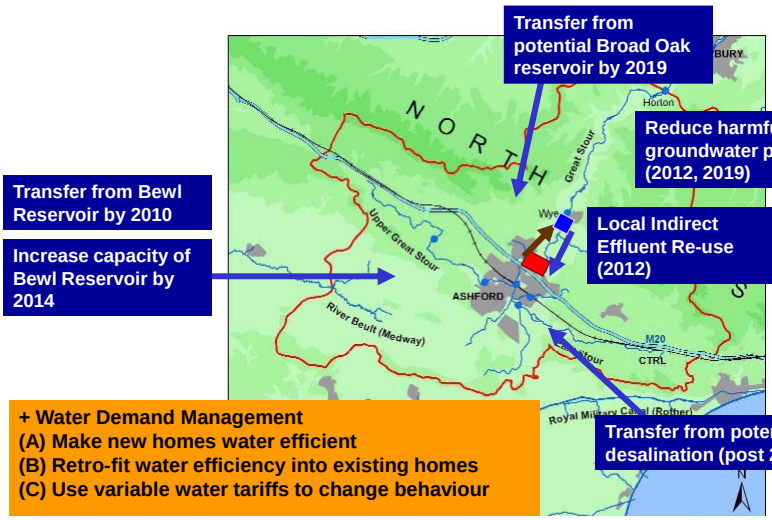
Key Topics

- Sustainable development
- Utility integration: **water & energy/carbon**
- Scale issues
- Decision making and stakeholders
- Delivery processes
- Identification of benefits & best practice
- Case study (Ashford) and stakeholder focus

Ashford Integrated Water Management Strategy (AIWMS)

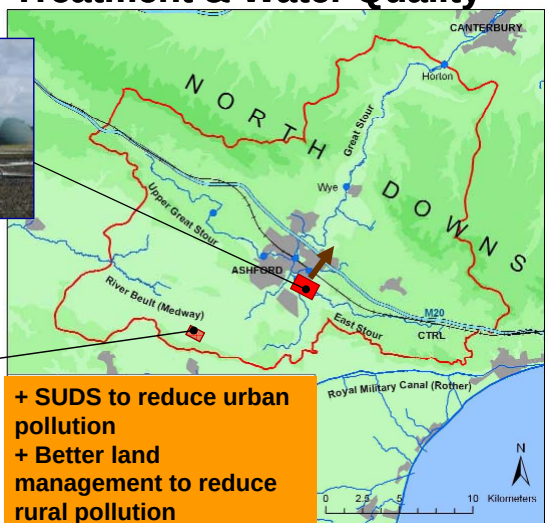


Main AIWMS findings: Water Resources & Supply



+ Water Demand Management
(A) Make new homes water efficient
(B) Retro-fit water efficiency into existing homes
(C) Use variable water tariffs to change behaviour

Main AIWMS findings: Wastewater Treatment & Water Quality



Expand existing Ashford Wastewater Treatment Works

Reserve land for future southern works (2031+)

Create wetlands to polish effluent quality

+ SUDS to reduce urban pollution
+ Better land management to reduce rural pollution

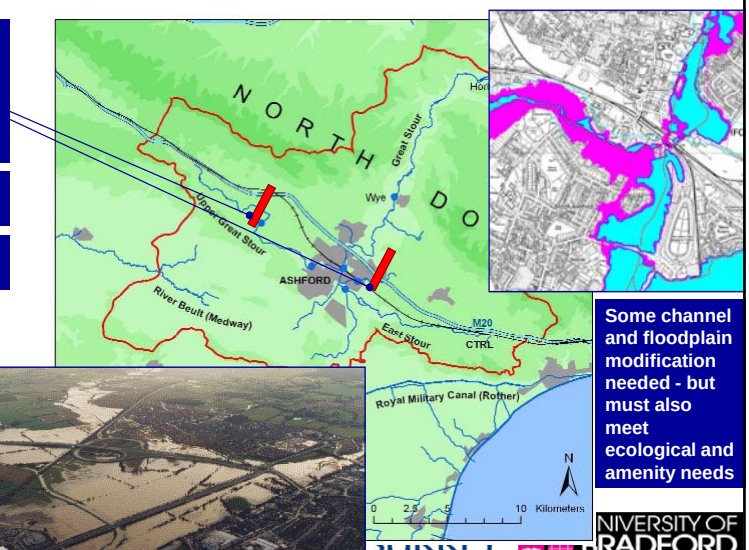
Explore uses for treated effluent, e.g. biofuel coppice

Main AIWMS findings: Flood Risk & Drainage

Ashford defended by 2 upstream flood storage reservoirs - limited opportunities for improvement

SUDS on all development

SUDS to over-attenuate runoff



Some channel and floodplain modification needed - but must also meet ecological and amenity needs

Main AIWMS findings: Ecology & Biodiversity

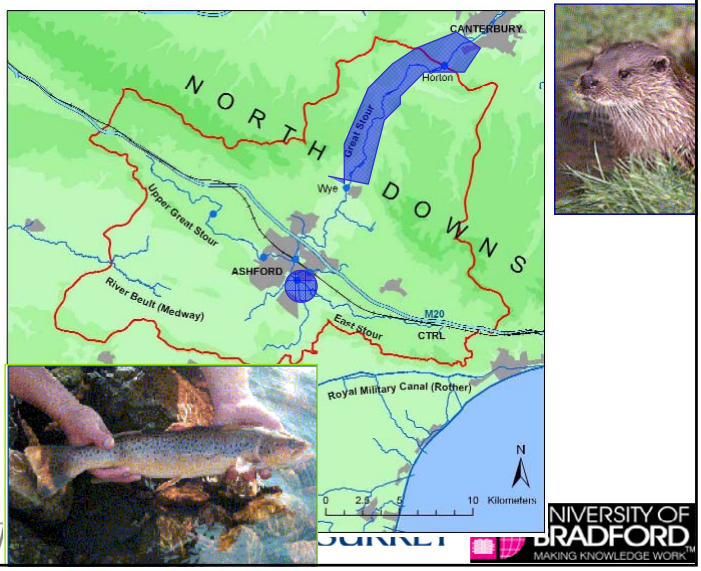
Best results come from:

- improving river flows

- improving water quality

- making the most of what is already there

There is potential to create or improve habitats in urban river corridor - linked to SUDS designs



Benefits of integration

- Solutions with **multiple benefits**:
  - Re-using treated effluent is a reliable resource that could reduce the impact on the Chalk stretches of the Stour
  - Sustainable drainage to reduce flood risk and pollution
  - Wetland areas for landscape, habitat and water quality improvement
- Building strong **partnerships**:
  - Kent Water Demand Management Group is taking water efficiency forward
  - Regular consultation is critical to approaching uncertainty and resolving conflict

University of Exeter · Cranfield University · Imperial College London Business School · University of Surrey · University of Bradford – Making Knowledge Work

Conclusions

Three projects – one goal:

More sustainable development

Water and Urban Sustainability Research

Professor David Butler

Centre for Water Systems
University of Exeter, UK
d.butler@exeter.ac.uk

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