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# Economics of WFD: Some Preliminary Analysis

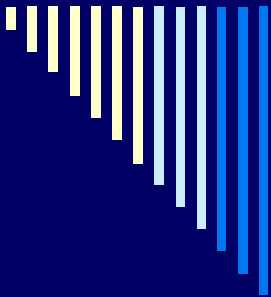
**Reamonn Fealy, Thia Hennessy,  
Stephen Hynes, Cathal O'Donoghue,  
David Meredith, Karyn Morrissey**  
*Rural Economy Research Centre*



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# Overview of Presentation

- Introduction
- Spatial Analysis: Risk of WFD
- IDA → Spatial Regression
- Simulation → Scenario Analysis
- Next Steps



# Introduction



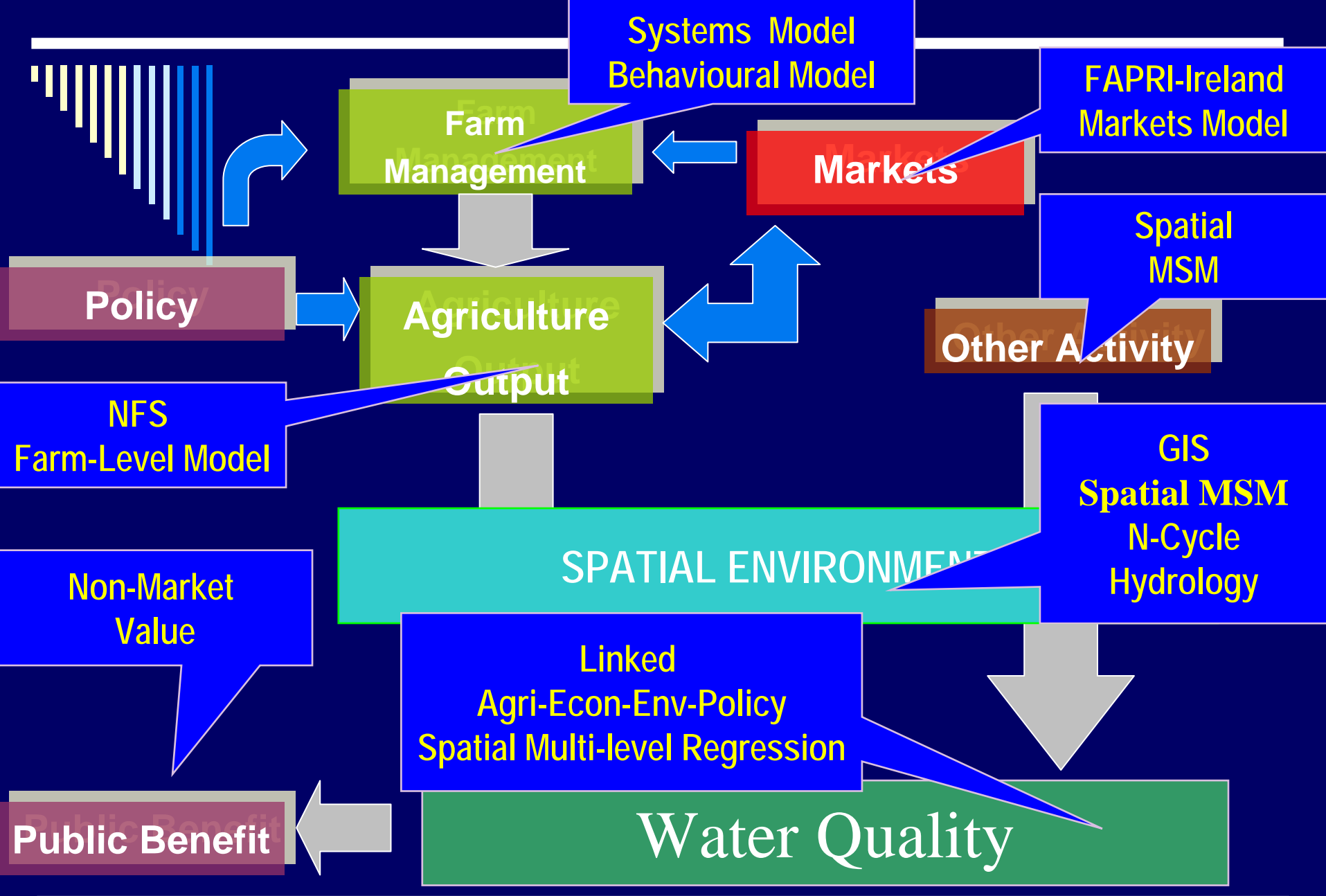
# Introduction to the Directive – Key elements

- **Move from chemical composition to bio-ecological condition.**
- **Good surface water status** (ecological and chemical) to be achieved, as a rule, **by 2015** and prevent deterioration in status; limited exemptions possible
- **Holistic approach:** water quality comprehensively defined in terms of **biology, chemistry and morphology**
- **Integrated water management based on river basins**
- **Broad public participation** by citizens, local communities, NGOs and stakeholders
- **Legally binding** on the objective, but flexible in achieving this objective.



# Economics and the Directive

- River Basin (**Economic**) Characterisation
- Introduction of **full social cost pricing** for water use (operational, capital and environmental)
- Incorporation of **estimates of economic costs and benefits** in catchment management plans.
  - Determination of a programme of **cost-effective measures** to implement the Directive
  - Contribution to whether or not **measures are disproportionately expensive**. In such cases, the WFD allows for a longer time frame to achieve “*good ecological status*” or for a less stringent environmental objective to be met.



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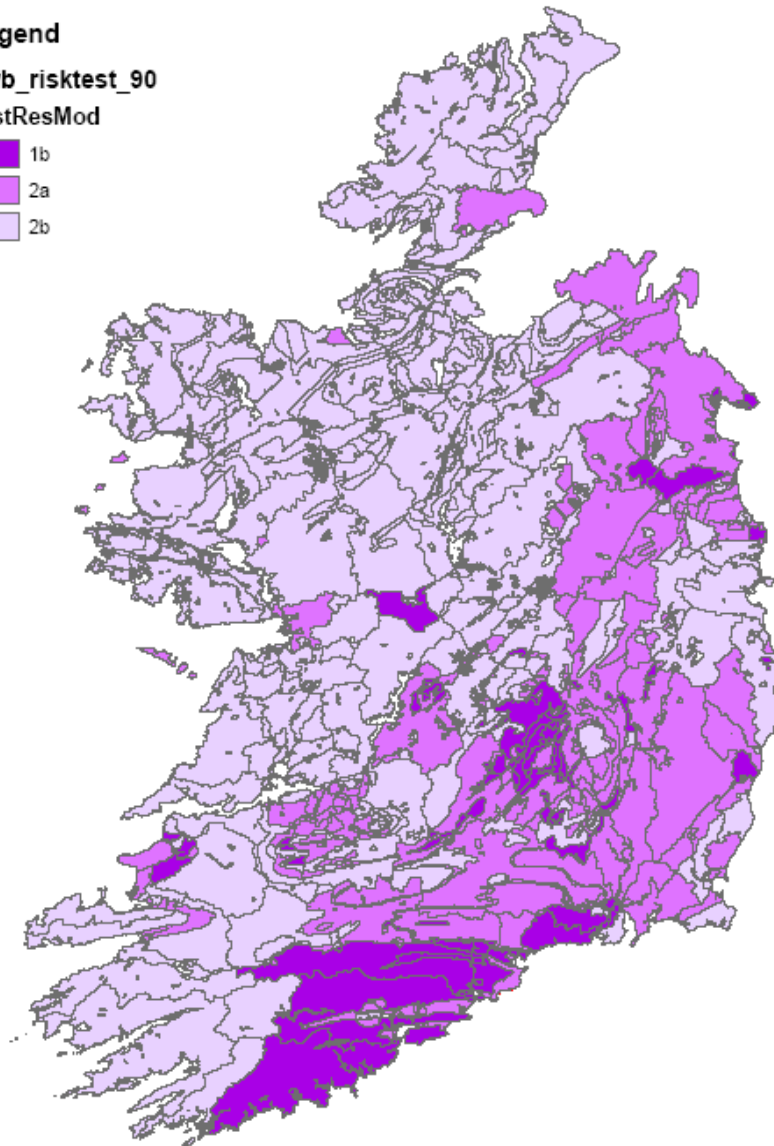
# Spatial Analysis

Legend

gwb\_risktest\_90

TestResMod

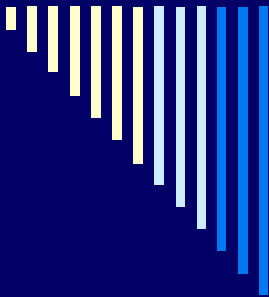
-  1b
-  2a
-  2b



**PATHWAY SUSCEPTIBILITY  
(GWRA3)**

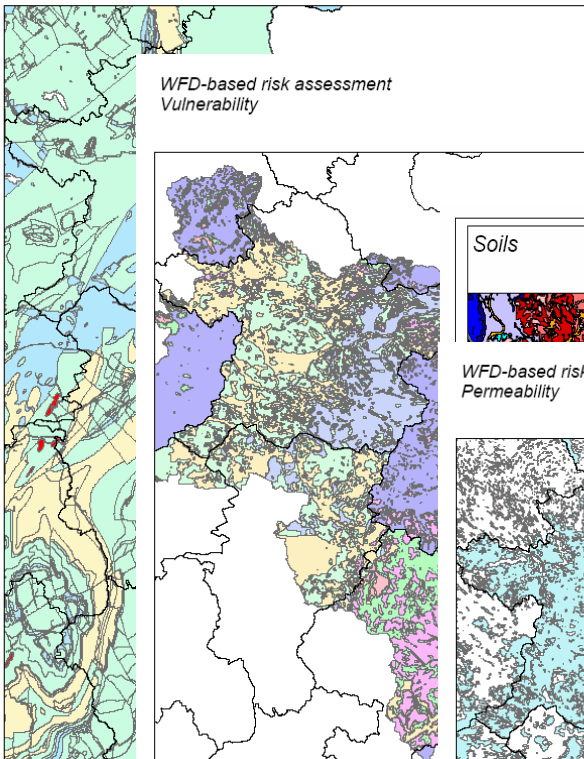
**Flow Regime (Horizontal pathway)**

PATHWAY SUSCEPTIBILITY (GWRA3)			Flow Regime (Horizontal pathway)			
			<i>Karst aquifers</i>	<i>Fissured aquifers</i>	<i>Intergranular aquifers</i>	<i>Poorly productive aquifers</i>
Ve r t i c a l p a t h w a y * *	Soil & subsoil	'Wet' soil	L	L	L	L
		Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	M*
		High	H	H	H	M*
		Moderate	M	M	M	L*
		Low	L	L	L	L
		High to Low**	H	H	H	M



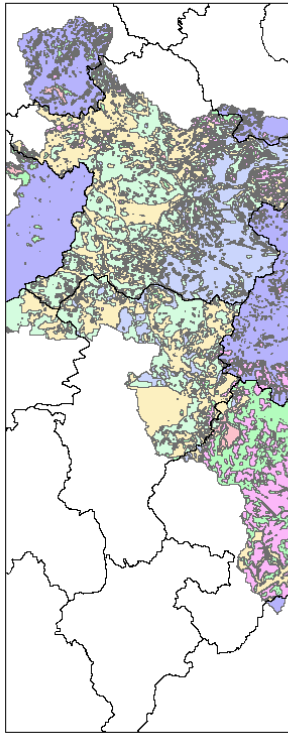
WFD-based risk assessment  
Flow regime

1:641,392



WFD-based risk assessment  
Vulnerability

1:641,392



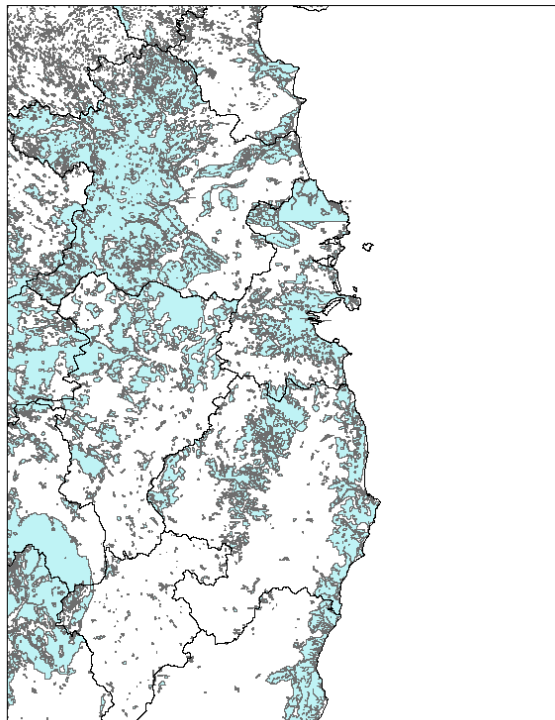
Soils

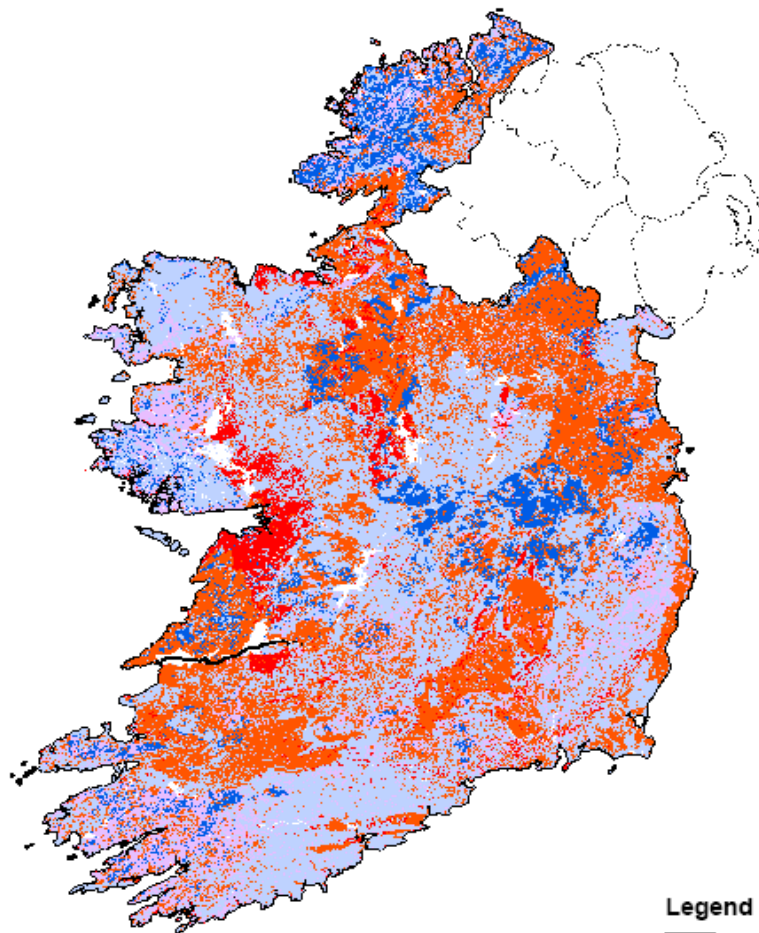
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WFD-based risk assessment  
Permeability

1:641,392



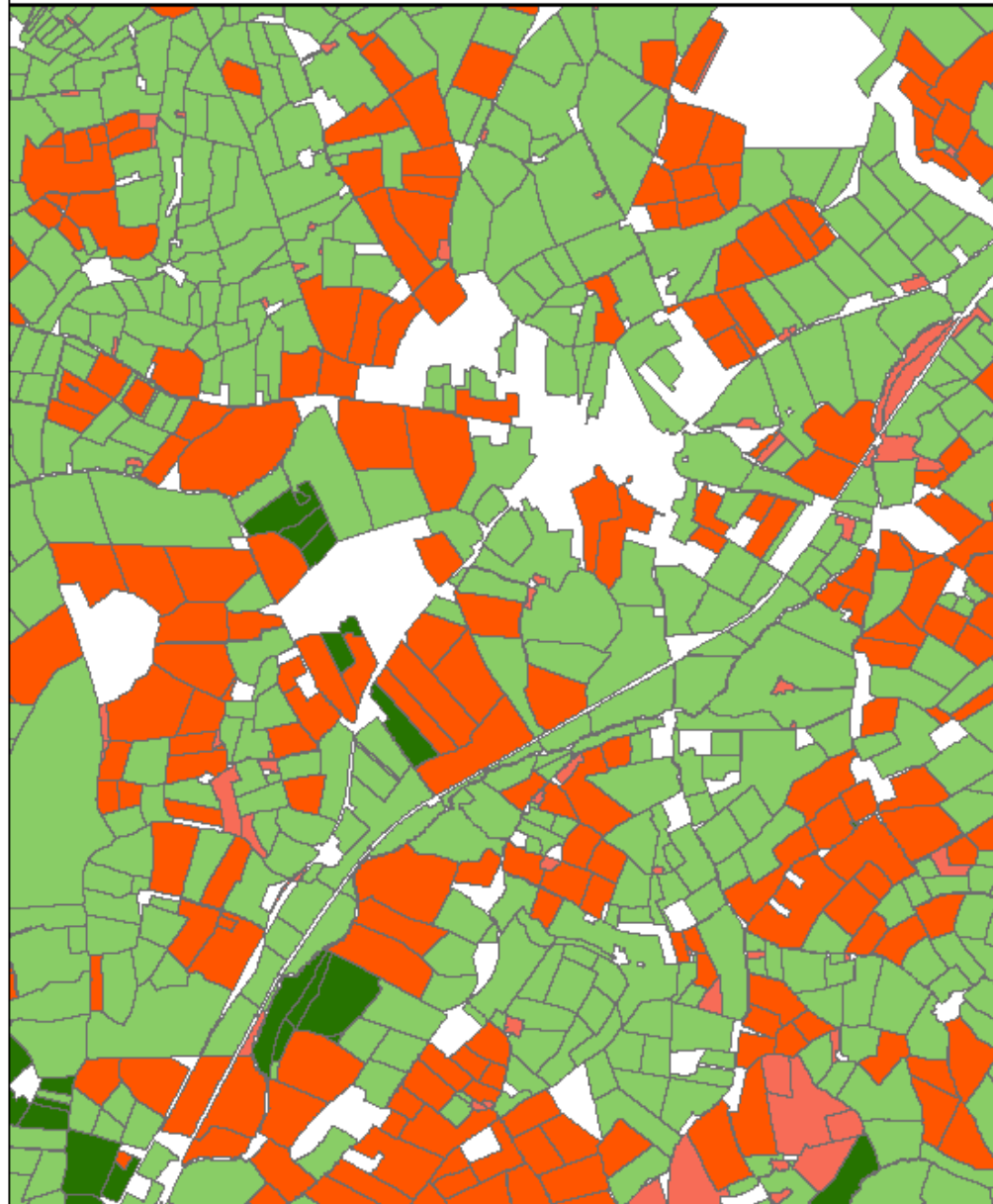


**Legend**

-  Low
-  5
-  8
-  Moderate
-  High
-  Extreme
-  Extreme (Soils)

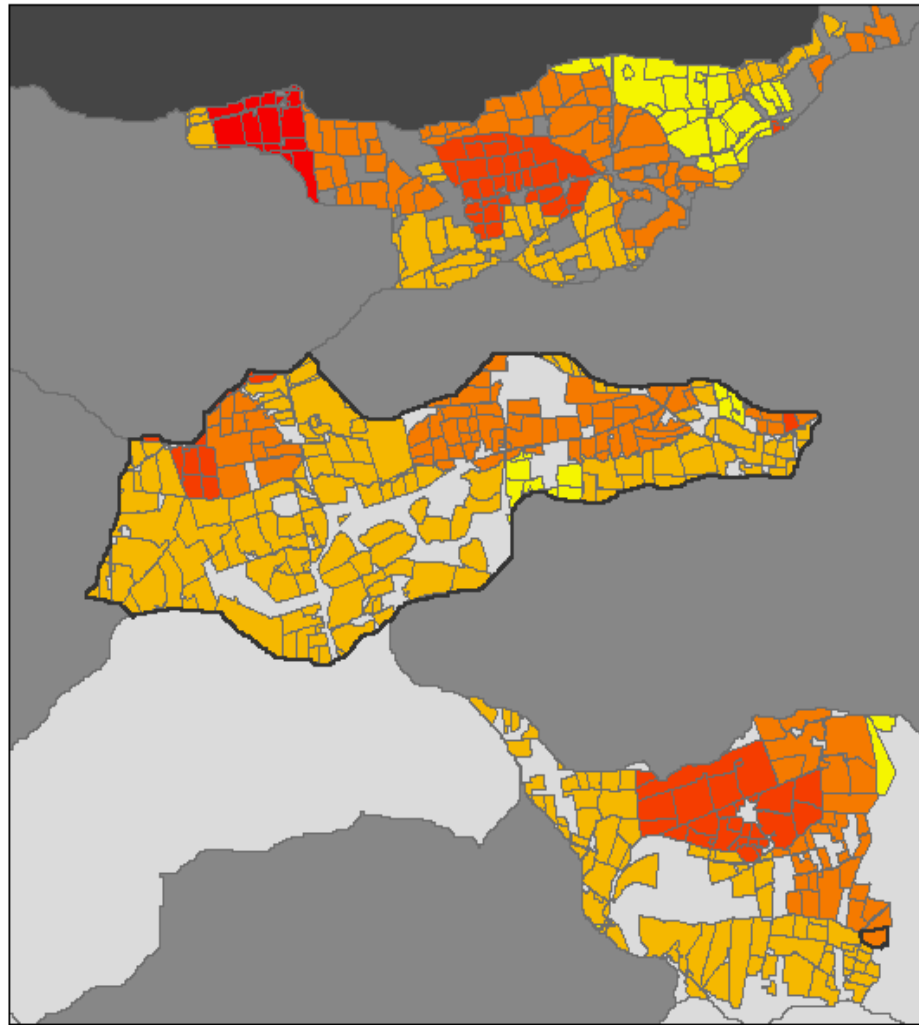
Landuse 2

1:25,000



**RERC**

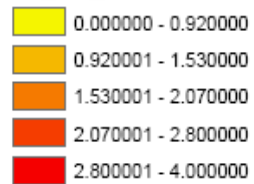




**Legend**

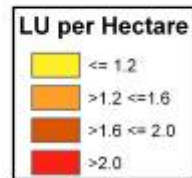
**LPIS\_2006\_MC\_Clip1**

**LU\_Per\_Ha**



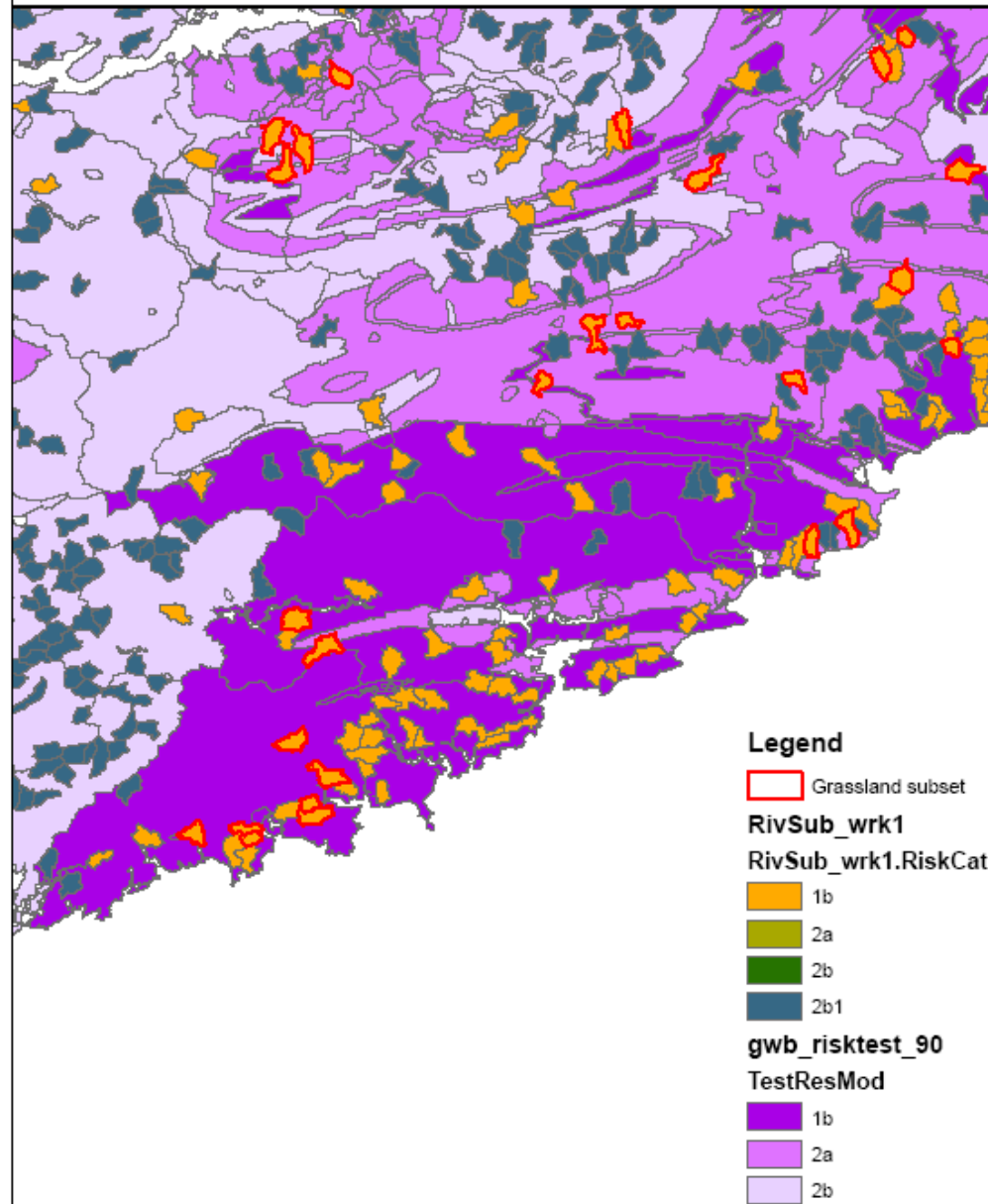
Livestock Density 2006  
(per townland assessment)

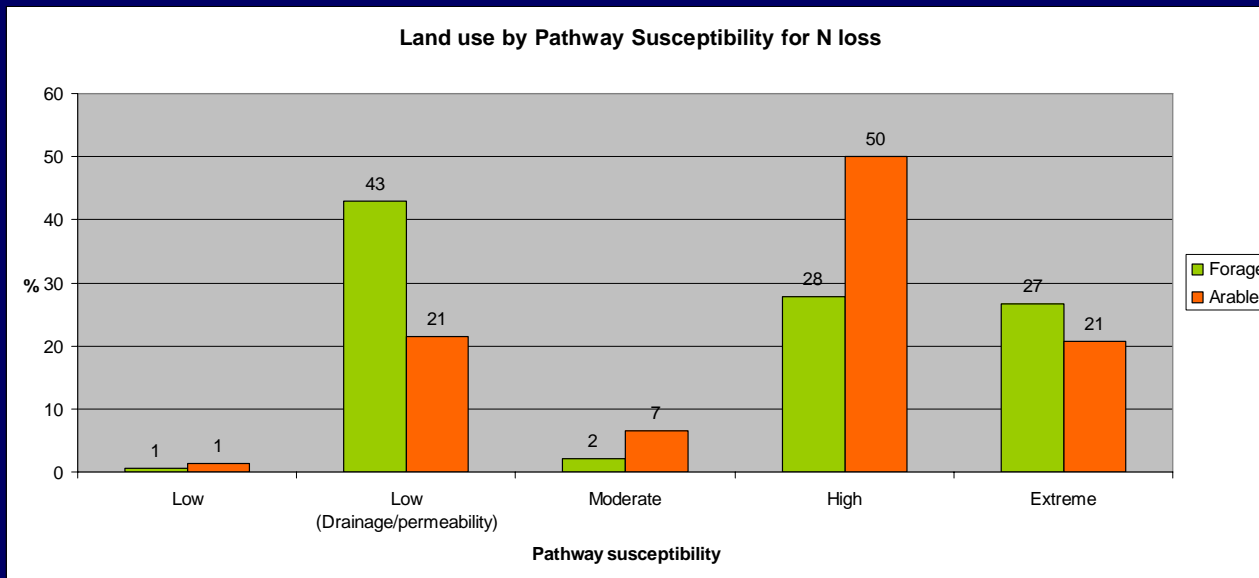
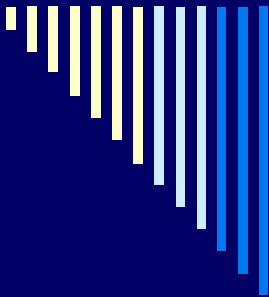
1:2,000,000

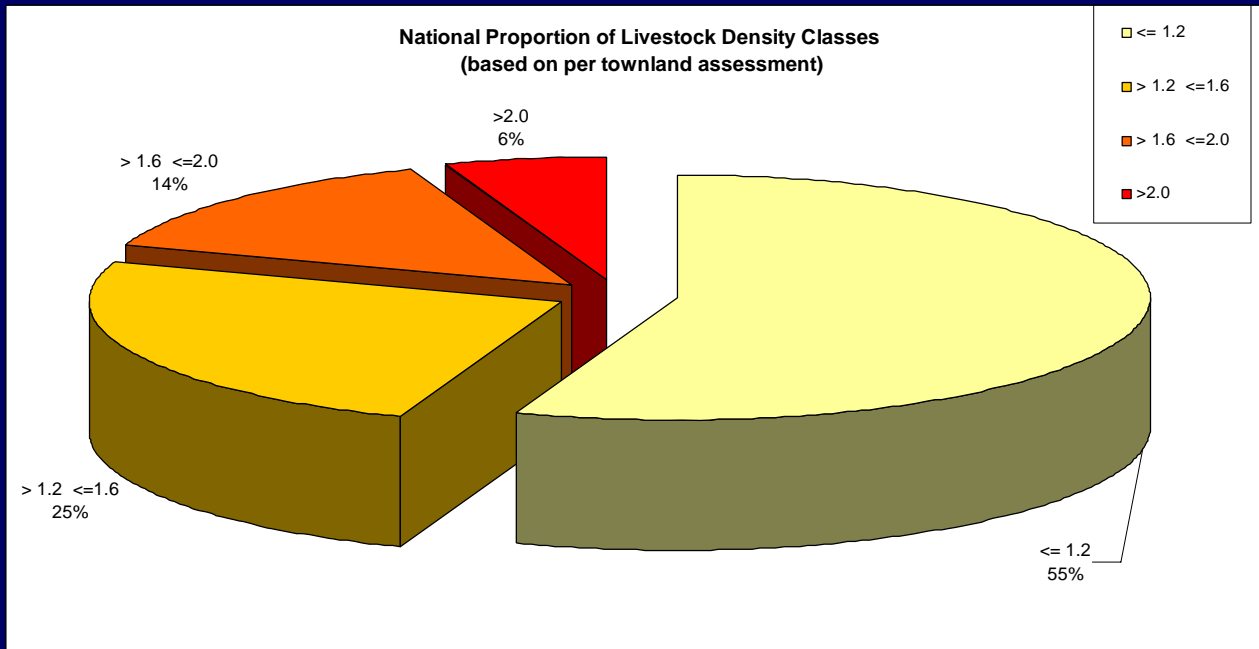
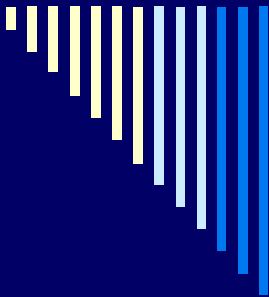


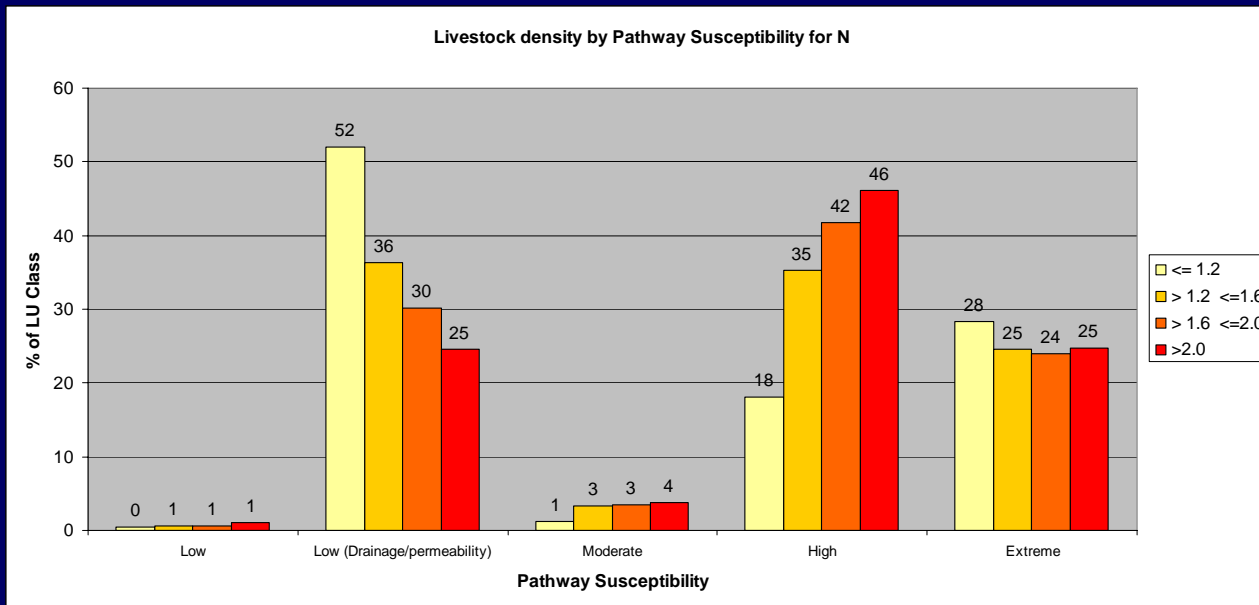
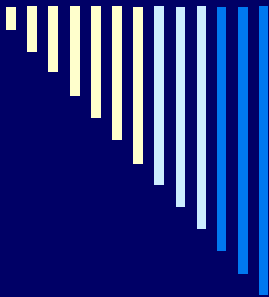
# WFD-based risk assessment

1:751,082



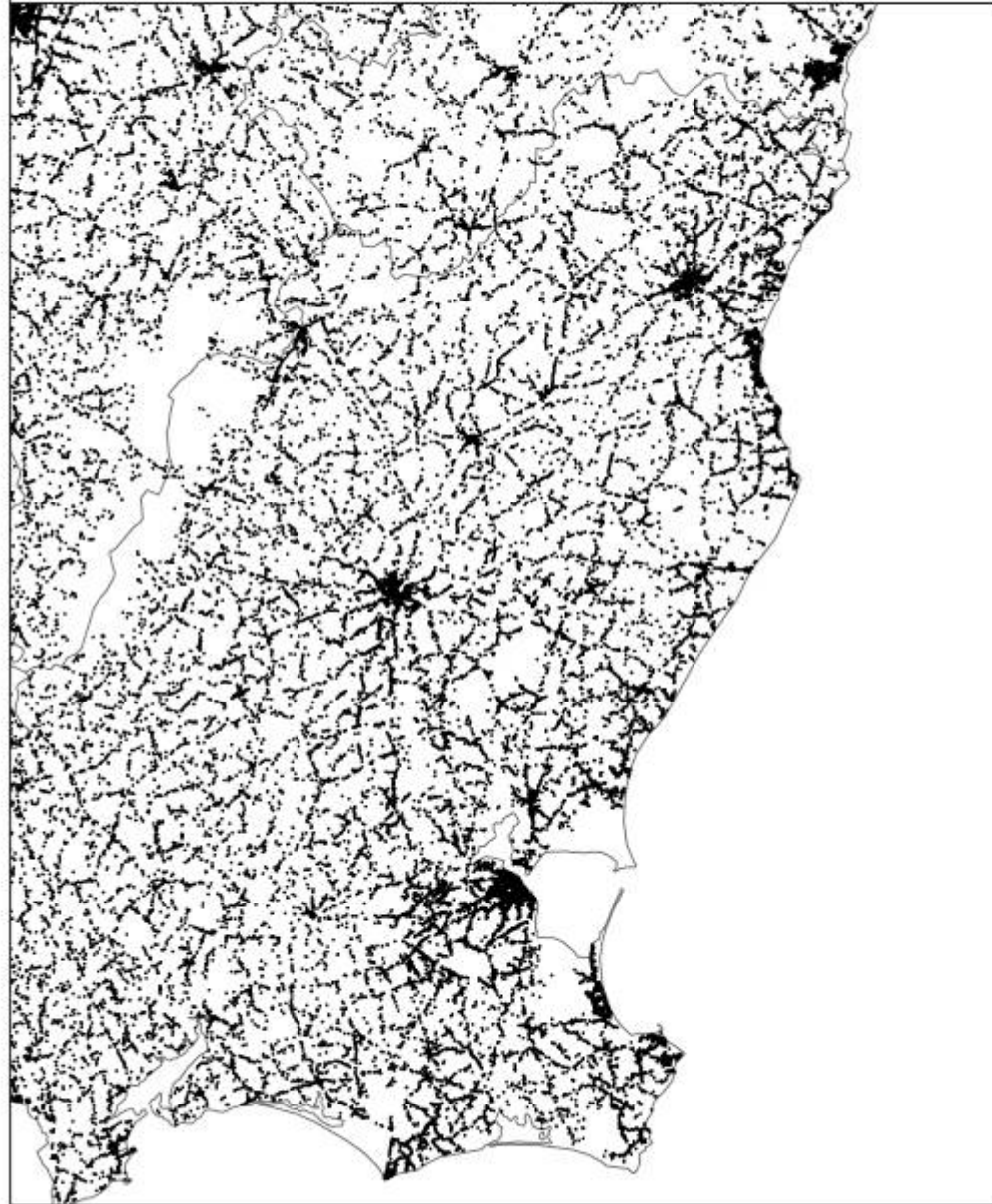






*Housing Density 2006*

1:323,981





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# Spatial Regression



# Previous Work

- Donohue et al. 2006
  - Ecological Status (EPA), Water Chemistry
  - Elevation (GIS) Stocking Density (Census of Ag) , Land Use (CORNE), Rainfall (Met Eireann)
  - Spatial Correlations
    - Negative correlation between Population Density and Stock Density and Water Quality
    - Both significant and similar in sign



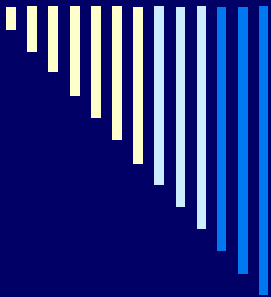
# Extensions

- To simulate cost to agriculture require
  - Multivariate analysis → how factors interact → understand more about why population density and stocking rates impact on water quality.
  - Organic and Inorganic N production (Farm Management and Stocking Density) x Environmental x Other
  - Micro-Data on individual farms in environmental and spatial context
  - Spatial–multi-level model statistical model → incorporate catchment specific and temporal fixed effects
  - Simulation framework → Impact of behaviour change on Water Quality Outcomes

# Spatial Regression (Ordered Probit)

	A	B	C
Dependent Variable	5 point River Quality		
Org N ph	-0.315**	-0.201*	-0.272*
Housing Density	-0.163**		
Septic Tank Density		-0.211**	-0.164**
Construction %			-2.06**
Social Service			-2.558**
Public Admin %			-2.769**

Note: \* Signif. at 10%, \*\* Signif. at 5%



# Simulation



# Previous Studies

- Fezzi et al. (2007)
  - UK Analysis → scenario analysis of potential farm practice changes to meet requirements of WFD
- Hennessy, Shalloo and Dillon (2004)
  - Irish Analysis → Nitrogen restrictions at 170 kg/ha reduce the potential gain from expansion. (80% lose)



# NFS and Farm Level Model

- National Farm Survey
  - Annual Survey c. 1200 farms. Detailed enterprise accounts. Irish component of EU-FADN
- Farm-Level Model
  - Simulation model of farmer response to policy changes
- Heterogeneity of farms
  - Farm size, Location, Technical System
  - Need a micro sample to understand costs to sector
  - Not only mean effects but distribution



# Nitrate Leaching Reduction Measures

- Drawing upon Fezzi et al. (2007)
- Reducing Livestock Stocking Rates
  - Differential margin and stocking intensities
  - Substitution effect important
- Reducing Fertiliser Application Rates
- Reducing Dietary Intake Rates

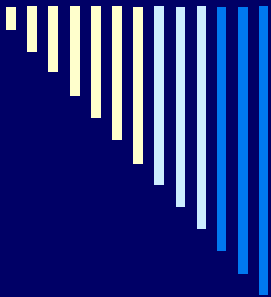
## Organic N production (170 kg ph +)

year	Specialist Dairy	Dairy Other	Cattle	Cattle Other	Sheep	Total
2000	25.2	4.6	1.2	2.3	0	6.2
2001	26.8	11.7	0	0	0	6
2002	23.3	8.4	0	0.3	0	5
2003	25.4	6.6	0	1.5	0	5.4
2004	27.3	7.9	0	0.2	0	5.7
2005	22.5	6.2	1.4	1.5	0	5.3
2006	23	3.9	0	1.3	0	4.4
2007	21	4.9	0.4	0.1	0	3.9



# Cost of Mitigation Strategies (% Change)

	GM	GM + 20% price increase	FFI
90% Fertiliser	1.2	0.6	1.6
80% Fertiliser	2.0	1.0	2.9
Reduce Org N to 170 kg per ha	-1.1	-0.9	-1.5
Reduce Stocking Rate by 20%	-20.0	-20.0	-28.3
Reduce Dietary N intake	-5.4	-4.2	-7.6



# Next Steps



# Next Steps

- ❑ Model at River Catchment rather than ED
- ❑ Improve simulation of organic N → integrate with JC N-cycle
- ❑ Improve farm management modelling → integrate with Farm Systems models
- ❑ Improve understanding of hydrology in river catchments how hydrological factors interact with human (agri. and non-agri. activity)
- ❑ Develop spatial multi-level regression model



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# Thank You

Copies of Reports and Slides can be  
accessed on our website:

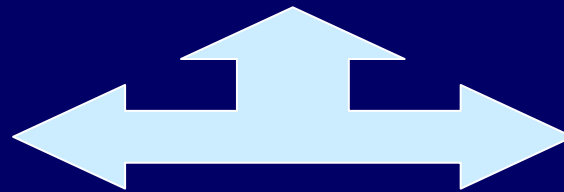
[www.tnet.teagasc.ie/merc](http://www.tnet.teagasc.ie/merc)

# Model Specification: River Attributes Selection

- Ecological Status under the Directive:

**Biological Index= ( fish, fauna, flora)**

**Physico-chemical  
Index**



**Hydro-morphological  
Index**

- Attributes to be considered in the study:

- |                     |        |                       |
|---------------------|--------|-----------------------|
| ➤ Biodiversity      | —————→ | Non-use value         |
| ➤ Recreation        | —————→ | Use value             |
| ➤ Appearance, Smell | —————→ | Use and non-use value |
| ➤ Cost              |        |                       |



# WFD Cost-Benefit Analysis - Benefits of WFD

- Mavra Stithou (RERC), Nick Hanley (Stirling), Stephen Hynes (RERC), Cathal O'Donoghue (RERC)
- Estimate the value of improvements in the ecology of two Irish rivers (Boyne and Suir) due to the WFD, and thus on the non-market economic benefits of moves towards “good ecological status”.
- Comparison between “out and within-catchment” values for the two rivers.
- Other issues: distance decay for use values, the effect of context/information.
- “Scale-up” to estimate national benefit of improved water quality using benefit transfer and micro-simulation techniques