Water Quality: Rural Diffuse Pollution

Andy Vinten

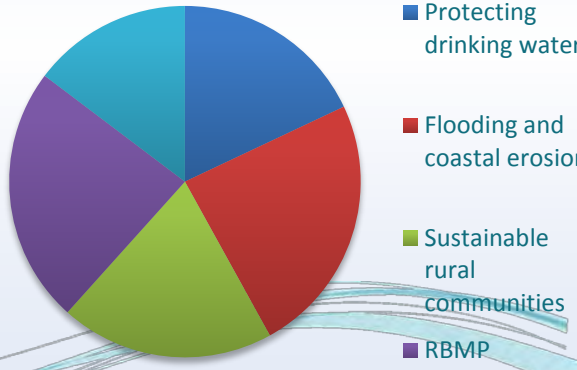
The James Hutton Institute

Research landscape

crew
centre of expertise for waters

Current projects (RBMP)

- Impact of soils and drainage on water quality and flood risk
- Catchment management and drinking water costs
- Indicators to assess the effectiveness of measures
- Innovative monitoring techniques
- Measures for septic tanks
- Source estimates of ecologically important P
- SRDP – evidence base, targeting, guidance



crew
centre of expertise for waters

Draft tender to RESAS on Water Resources & Flood Risk Management

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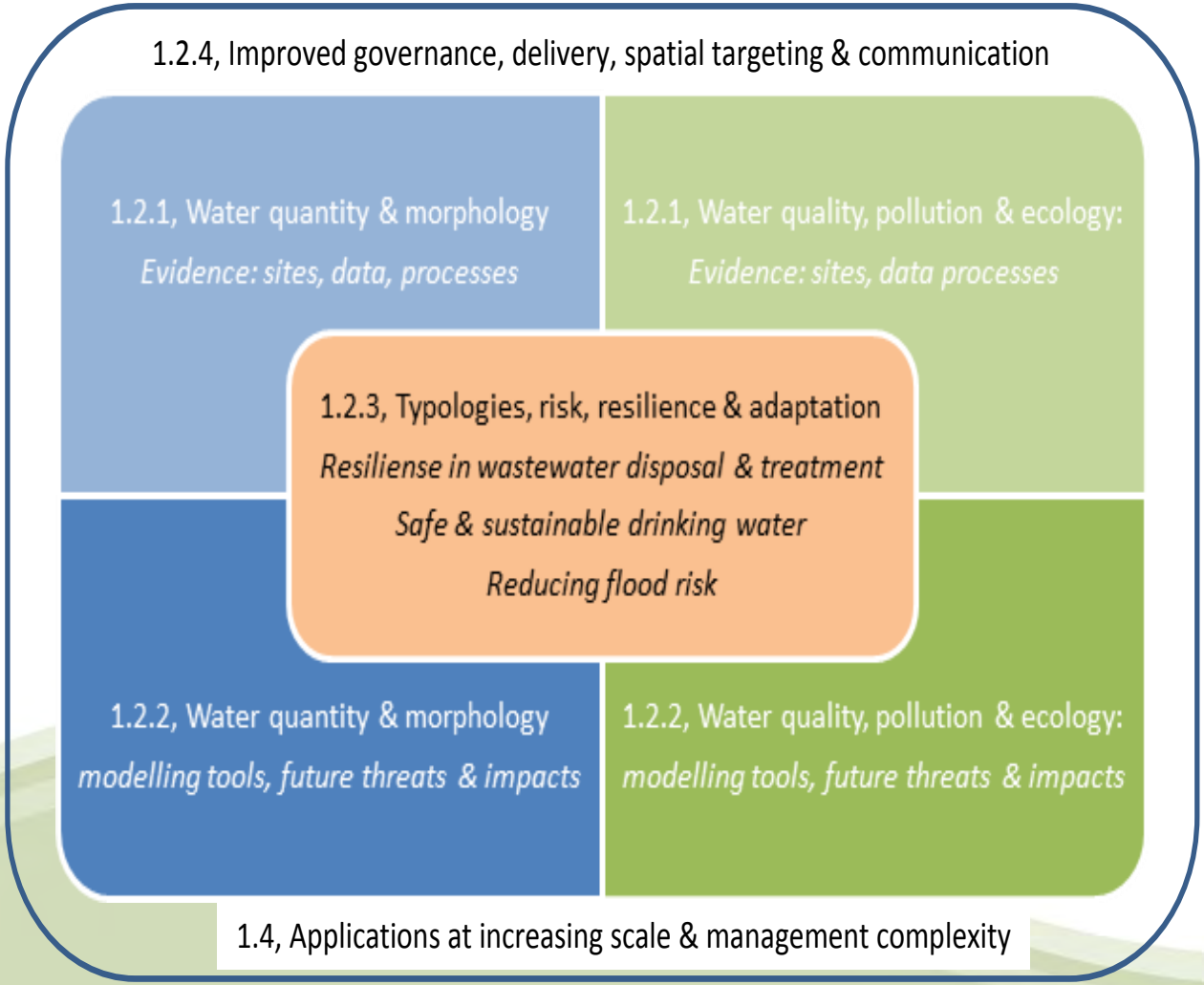

Changing emphasis for diffuse pollution:

fine sediment
Pathogens
Urban sources

Increased emphasis for:

Extreme flows
Morphology
Resilience
Governance
Communication

Catchment citizenship - a key “here and now” need

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- Understanding different perspectives
- Achieving shared values
- Mitigation of real issues
- Living with uncertainty

Catchment citizenship barometer

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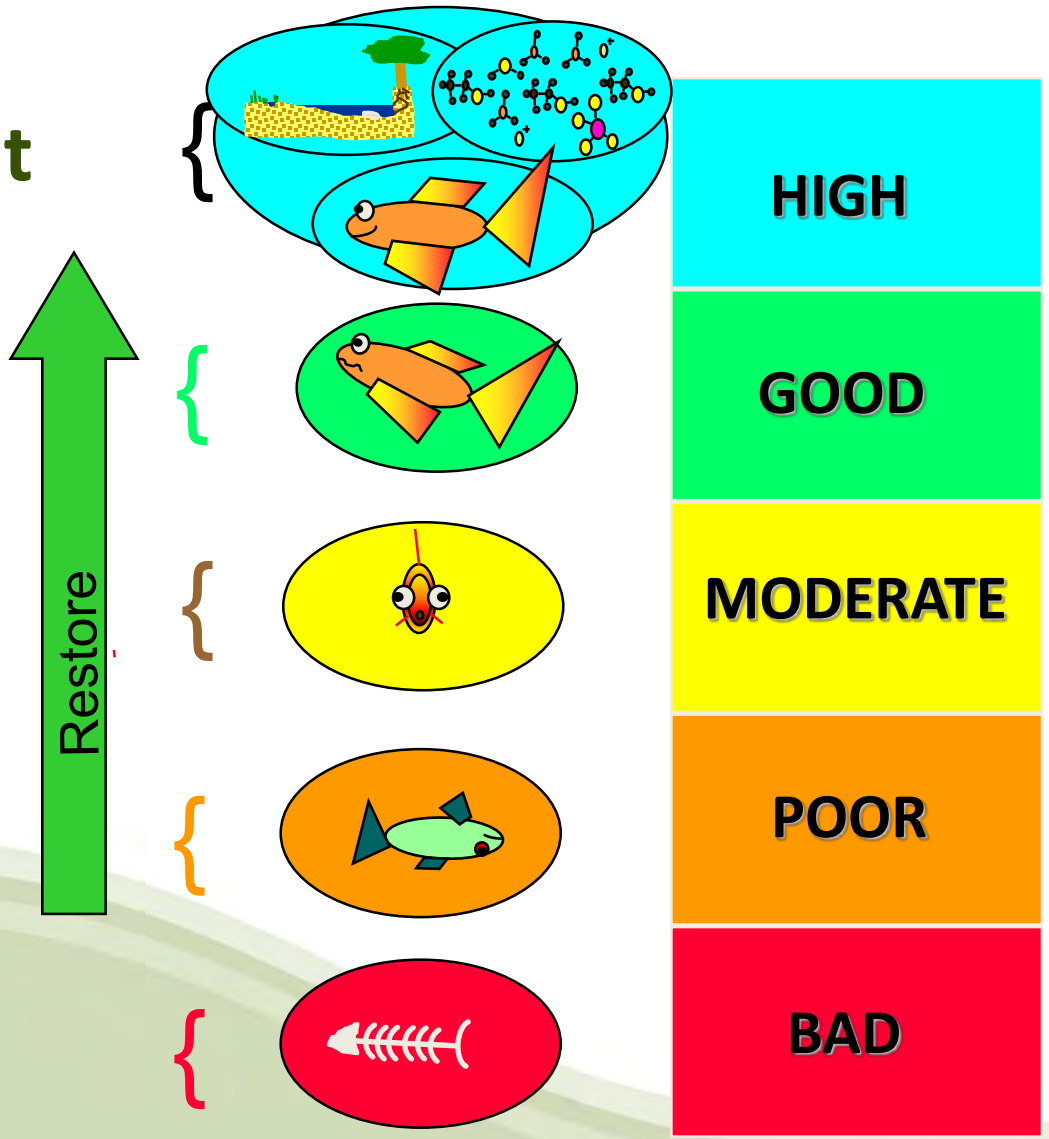
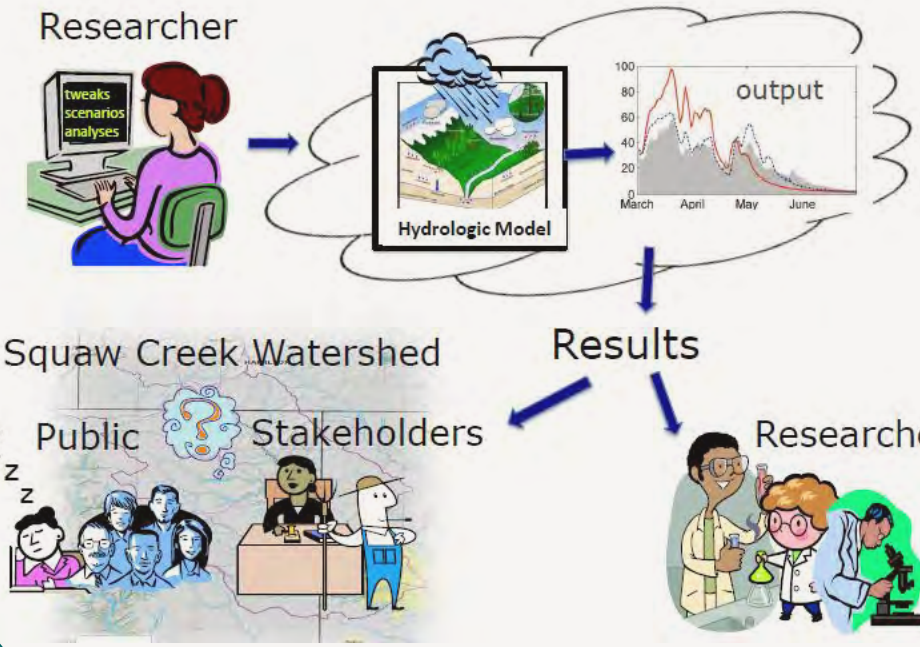
Transcendent values

Mutual benefit

Narrow self-interest



Typical catchment study



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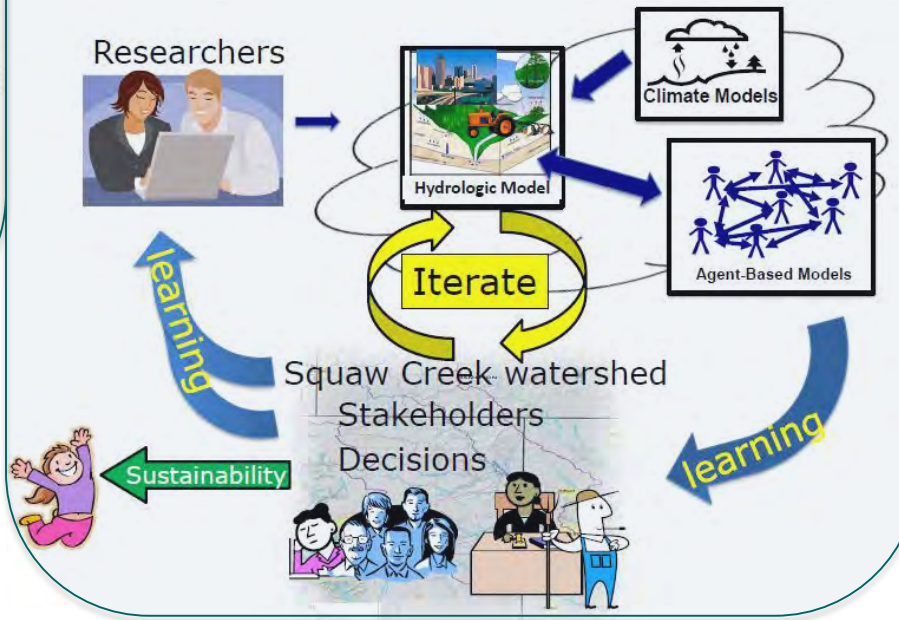
Catchment citizenship approach



Kristie J. Franz

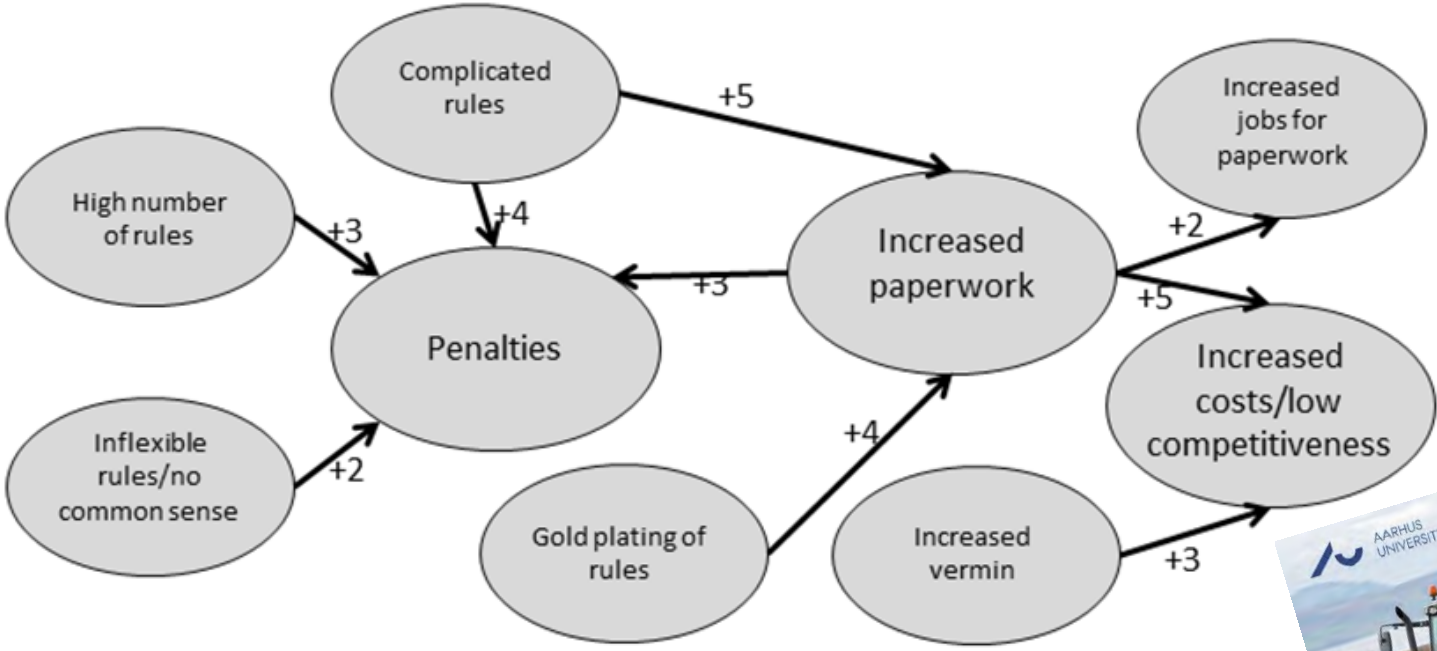
Jean Goodwin
Bill Gutowski
Chris Rehmann

Bill Simpkins
Leigh Tesfatsion
Al Wanamaker

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Geological and Atmospheric Sciences, Economics, English, and Civil, Construction & Environmental Eng.

Fuzzy cognitive mapping of farmer attitudes towards DP mitigation



- Hypothesis: breaches can be partly explained by differences in perceptions on environmental regulation and factors determining compliance between farmers and other relevant stakeholders (regulator, consultants, NGO, etc.)

Christen and Martin-Ortega, 2015

Approach to DP mitigation policy in Scotland

National approach –raising awareness,
guidance,
training
in relation to impacts of diffuse pollution, regulations and other measures.

Priority Catchment Selection (SEPA)

Priority Catchment Approach - awareness raising,
evidence gathering,
farm visits to identify hotspots,
target measures and one to one advice.

Diffuse pollution monitored priority catchments to demonstrate pollution sources, pathways and impacts, and to inform on cost-effectiveness of measures and monitoring (**JHI,SAC,SEPA)**

SEPA
Scottish Environment Protection Agency

River South Esk

Catchment walks	400 km walked – 504 non compliances identified with GBR 19 accounting for 50% and GBR 20 accounting for 46 % of the non compliances identified
1 to 1 inspections	170 farms visited between Oct 2011 and Mar 2012
Revisits	Just over 70 completed another 30 remaining. Approximately 50% reduction in GBR breaches observed at time of revisit. GBR 20 still main issue in catchment.
Main Issues	The greatest pressure within the catchment is resulting from cultivation activities (GBR 20). GBR19 (keeping of livestock) is also a major issue in the catchment.
Awareness raising events	Engagement within the catchment started at a very low baseline, however the land managers have appreciated the DP approach with bridges being made and mended

for improving Scotland's waters
dpmag

Key research elements to develop catchment citizenship

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- Understanding different perspectives
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- Living with uncertainty

Emerging Contaminants – an urban issue

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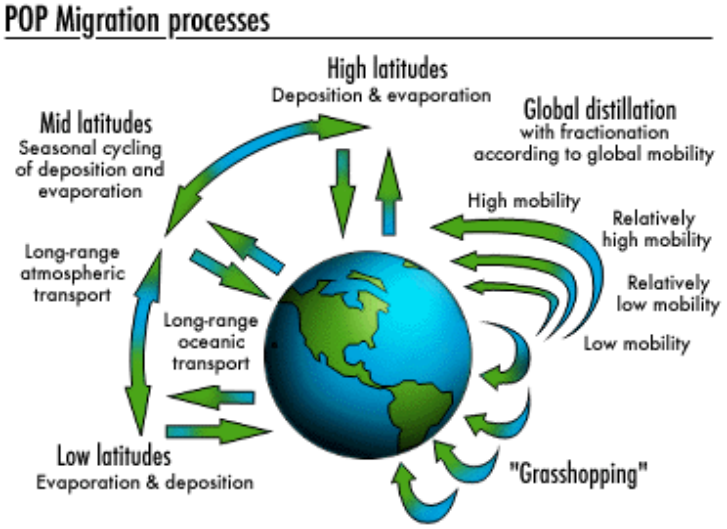
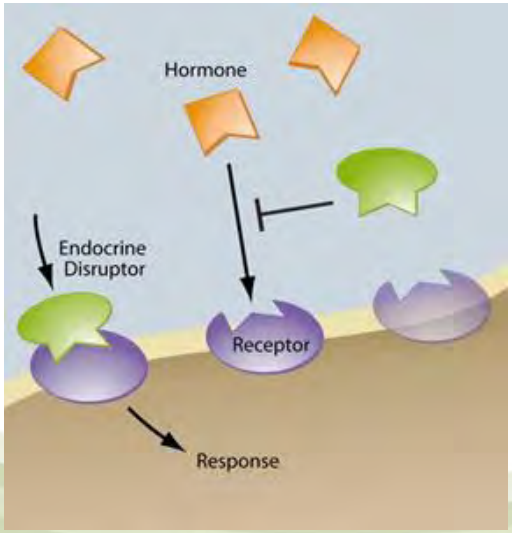
Persistent Organic Pollutants (POPs):

- **Persist in the environment.**
- **Long-range transport.**
- **Bio-accumulate through the food web.**
- **Pose a risk of causing adverse effects to human health and the environment.**

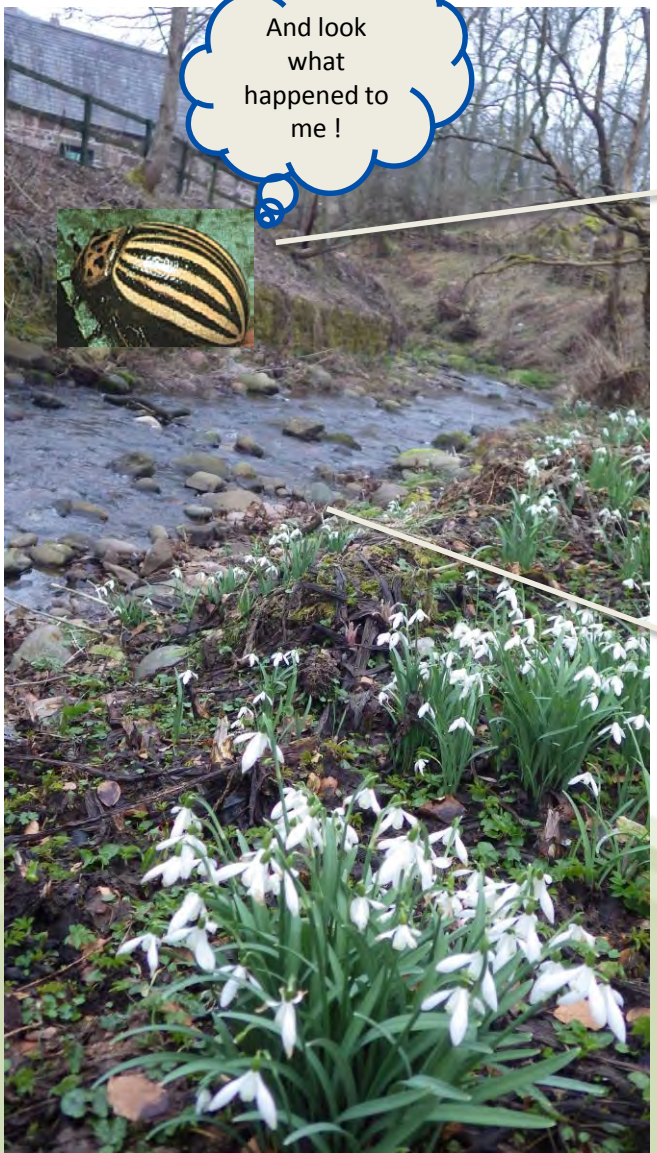
Endocrine disrupting chemicals (EDCs):

- **Substances may interfere with normal function of the endocrine (hormone) system of humans and animals.**





Springtime at Benholm Mill



Trichoptera (caddis) cases

1960's

post 1960's

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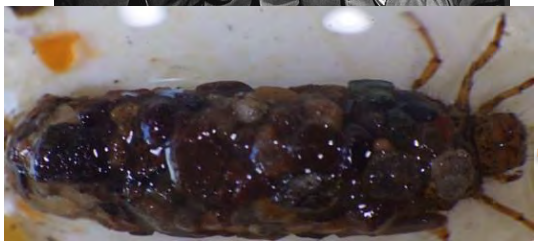

Town and country Science weeks: underwater jewellery-making

The James Hutton Institute

ViPER -an innovation platform to bridge science & decision-making in catchment microbial dynamics

David Oliver, Phil Bartie, Louise Heathwaite, Larissa Pschetz, Richard Quilliam

ViPER
Visualising Pathogen & Environmental Risk

ViPER Demonstration Farm Environment

ViPER Basic E.coli Calculator

ViPER Risk Mapping Tool

NERC SCIENCE OF THE ENVIRONMENT

Environment Agency

SEPA Scottish Environment Protection Agency

NATURAL ENGLAND

United Utilities

UNIVERSITY OF STIRLING

Scottish Water Always serving Scotland

Lancaster University

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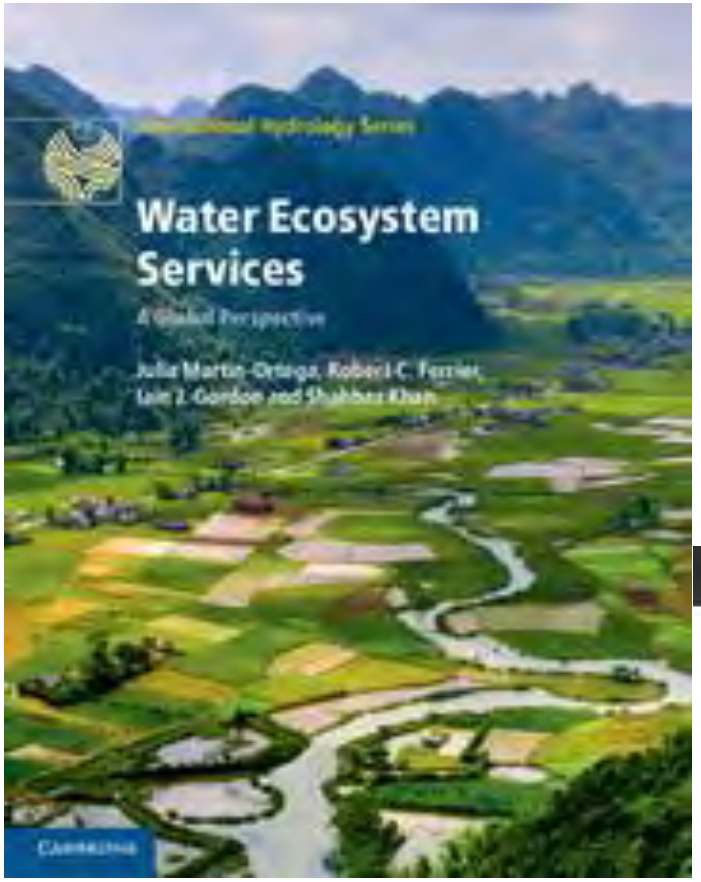

Water Ecosystem Services
A Global Perspective
Part of International Hydrology Series

The James Hutton Institute

Editors: Julia Martin-Ortega, Robert C. Ferrier, Iain J. Gordon (JHI), Shahbaz Khan UNESCO

March 2015, ISBN: 9781107100374

http://www.hutton.ac.uk/staff/julia-martin-ortega

Key research elements to develop catchment citizenship

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- Living with uncertainty

Fine sediment pollution

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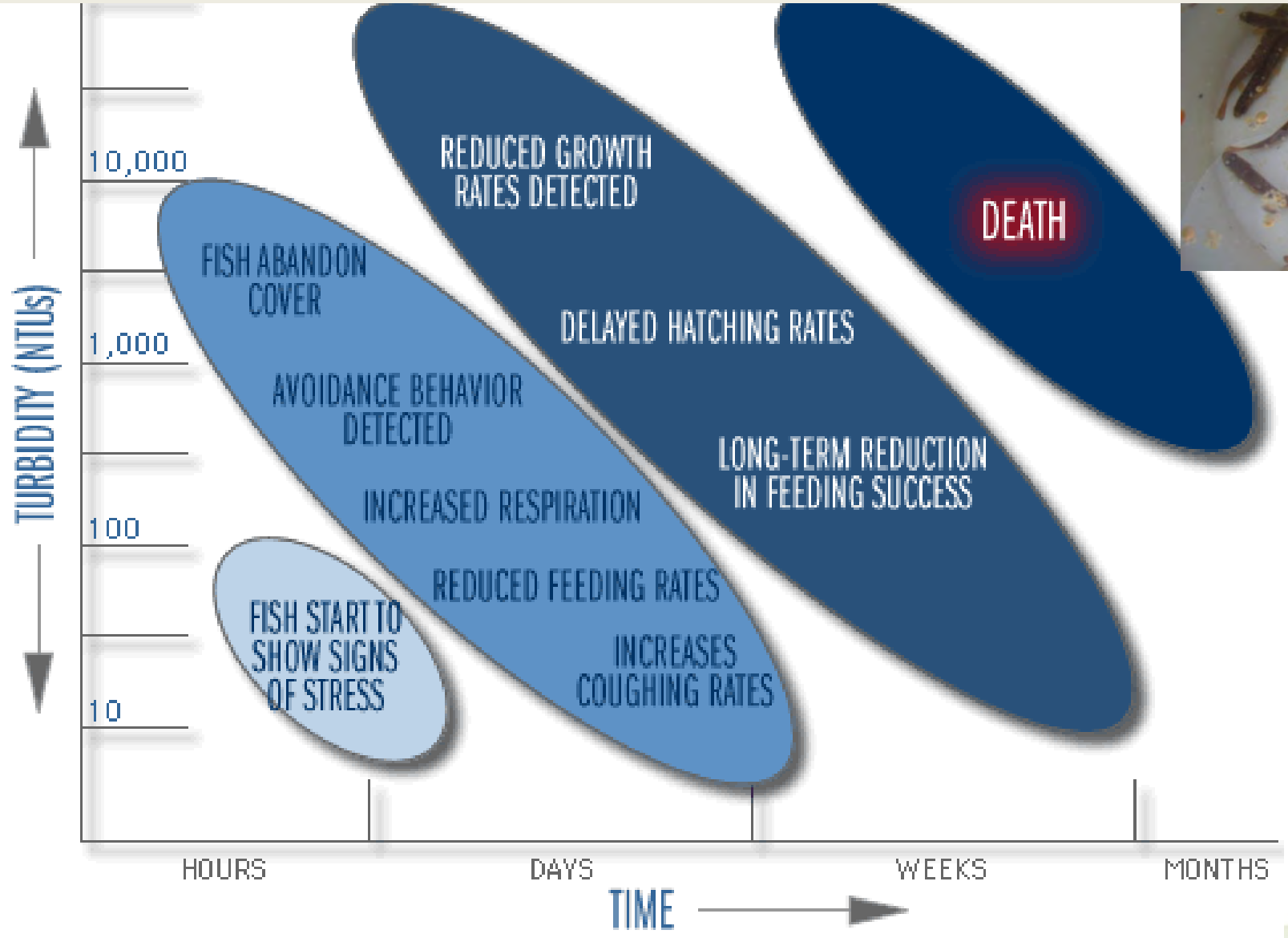
Foci for fine sediment mitigation research: impacts, characterisation, standards, mitigation



Newcombe, C. P., and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16: 693-727.

Focus for fine sediment mitigation research: Spatial analysis of costs, benefits and effectiveness of mitigation options

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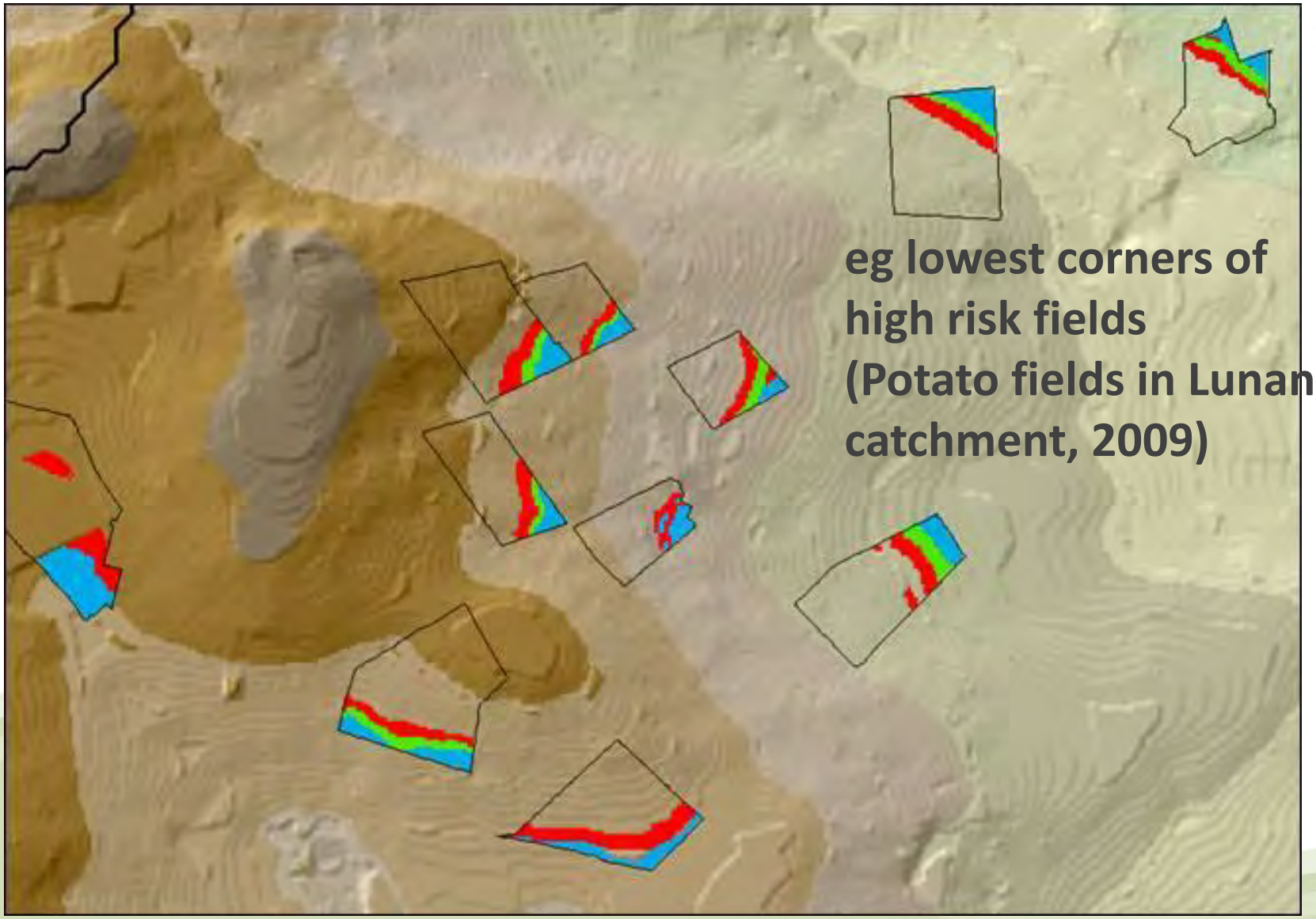


Rural SUDS options

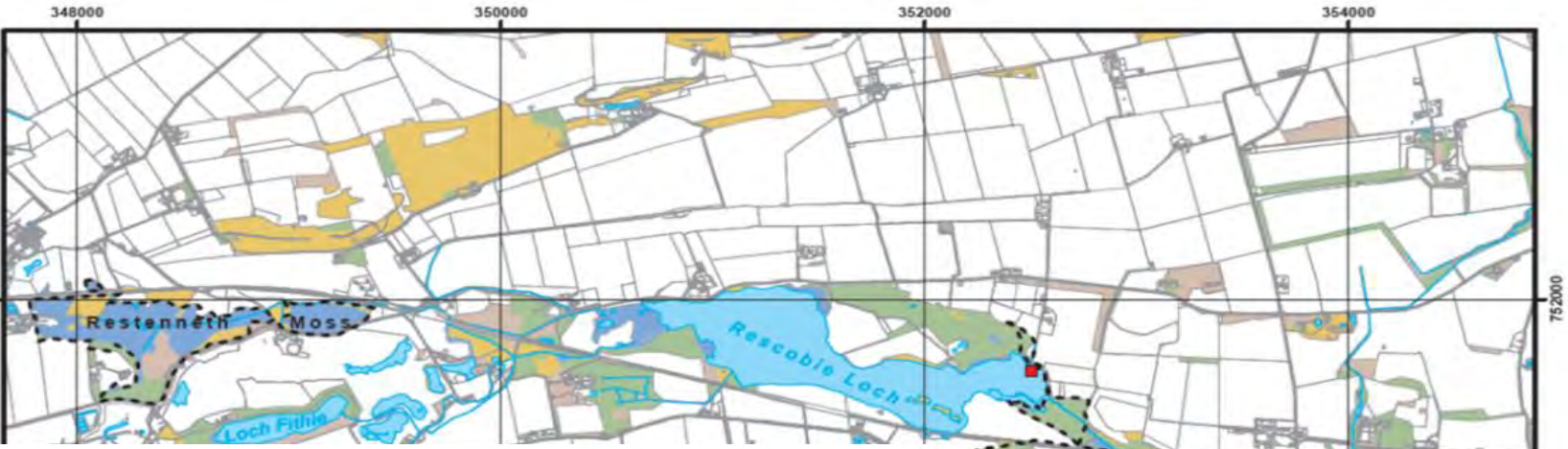
line

Opportunities for catchment scale water governance to deal with real issues

eg. *Interviews with Lunan stakeholders:*

- There was stakeholder interest in water regulatory groups to allow for "lighter touch regulation"
  - multiple water abstractors join within one licence to internally manage abstraction
  - Multiple parties interested in a dredging program to join within one licence to manage local dredging.
- These require organization by catchment farmers/other stakeholders to enter into new discourses with SEPA
- Potential for facilitating body such as the NFUS, SRUC, or Rivers Trusts to enable neutral, efficient facilitation.
- A catchment-wide approach should be developed/funded for water regulatory groups for eg:
  - licence reform
  - water storage retention measures
  - dredging management
  - sediment erosion control
  - valuation of ecosystem services

Lindsay Rear, 2014
Univ. Quebec intern



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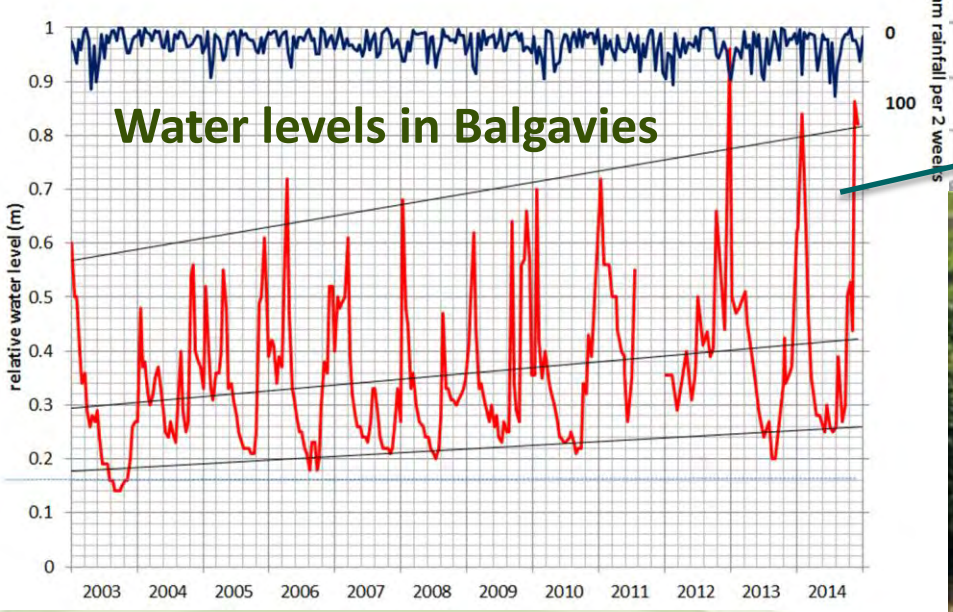

Extended range of control of levels
Management of high and low flows
Multi-stakeholder input into control
Solar powered
Remotely controlled

Tilting weirs

Scoping the potential for improved water management on Lunan water through PES scheme

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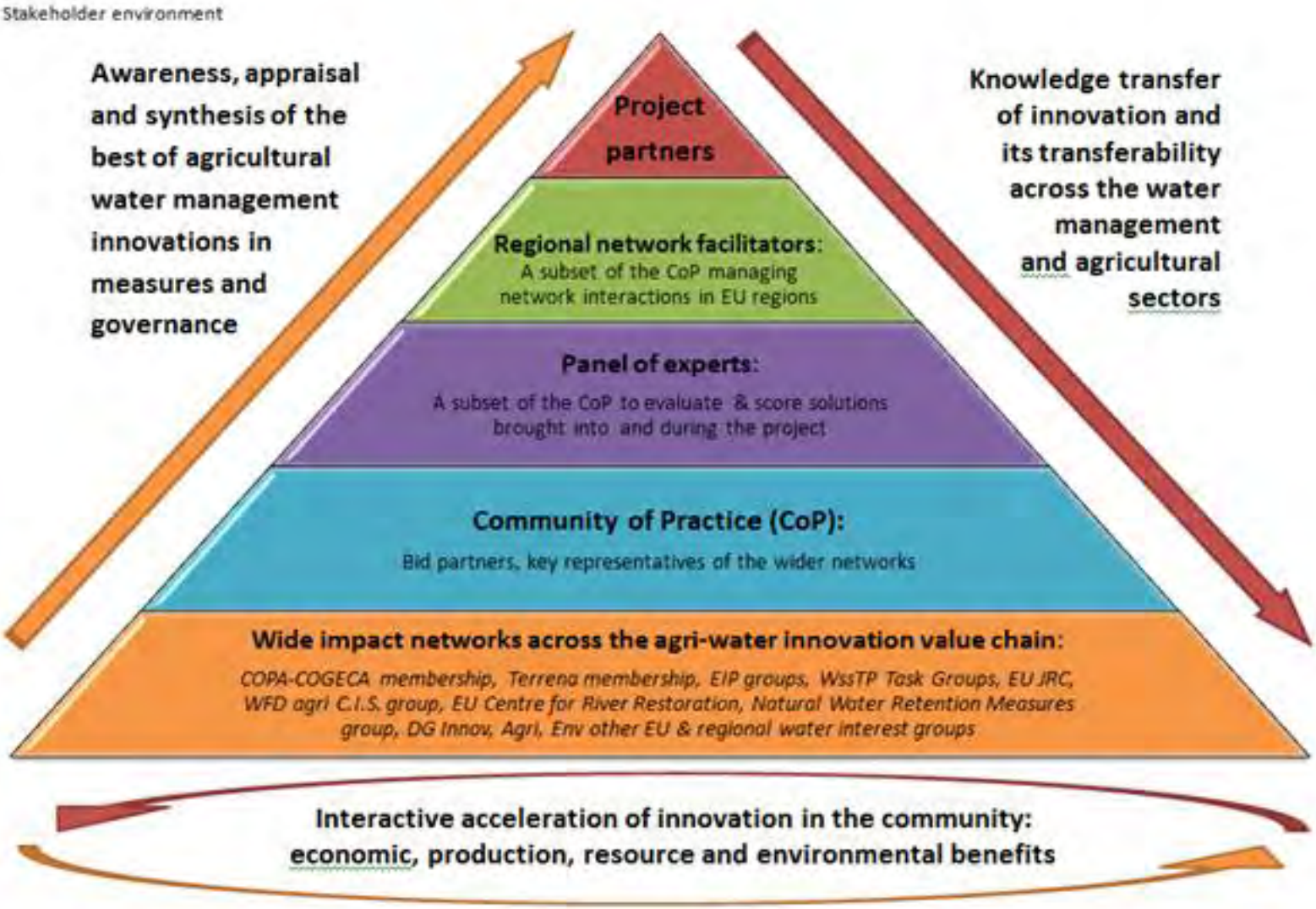
- Assume a mean marginal value of irrigation water of of £5.2/m^3
- In 2013, the reduction in abstraction if restriction took place at 10% of Q_{95} would have been 19,404m^3 (≅ 2 cm water in Balgavies/Rescobie wetlands)
- The marginal value of this water for irrigation is approx. £100,000
- Lunan flow data suggest 3 years in 10 are as dry or drier than 2013
- Annualised economic value for irrigation of a scheme to mitigate low flows is ca £30,000 (apart from other costs and benefits)
- Also benefit to low flows/ecology downstream which is at < GES



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INTRINSIC - H2020 Water Innovation Proposal

Key research elements to develop catchment citizenship

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- Understanding different perspectives
- Achieving shared values
- Mitigation of real issues
- **Living with uncertainty**

The Demon's Apprentice[1]

Attribute	Demon	Apprentice
Perfect knowledge of equations	✓	✓
Perfect knowledge of parameters	✓	✓
Perfect knowledge of initial conditions	✓	✘
Infinite computing power	✓	✓

X

X

X

X

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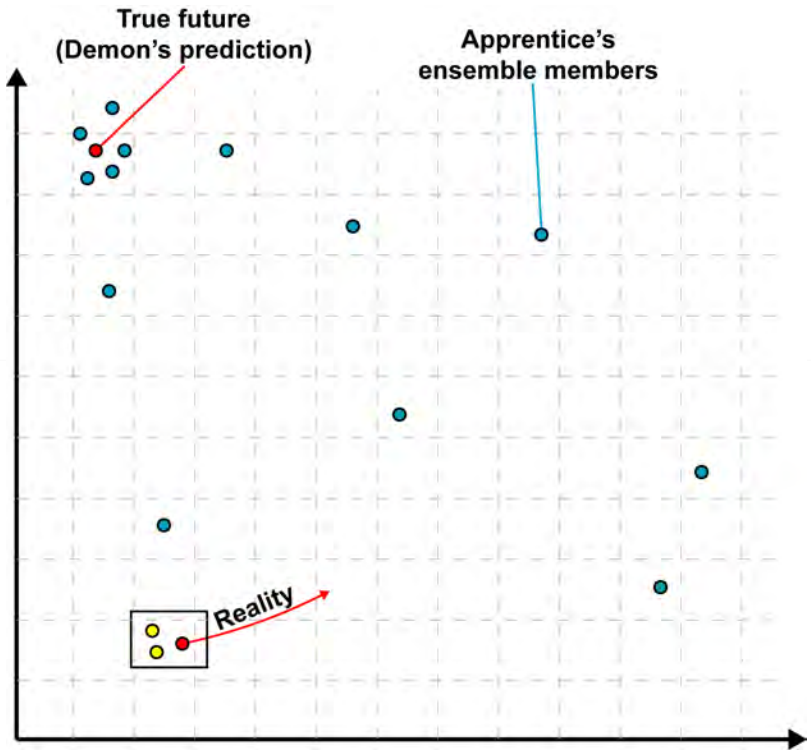
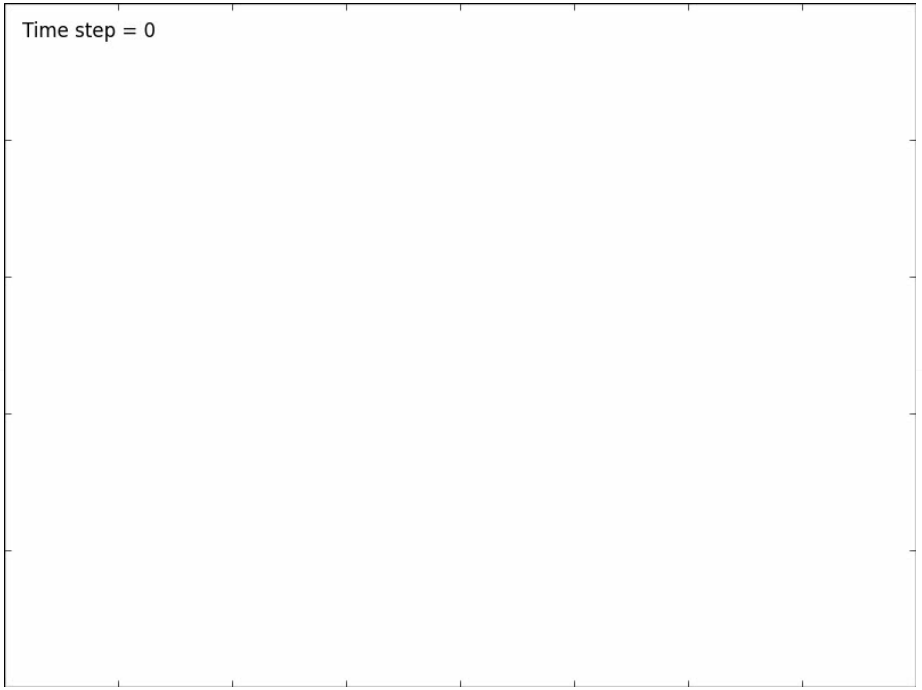
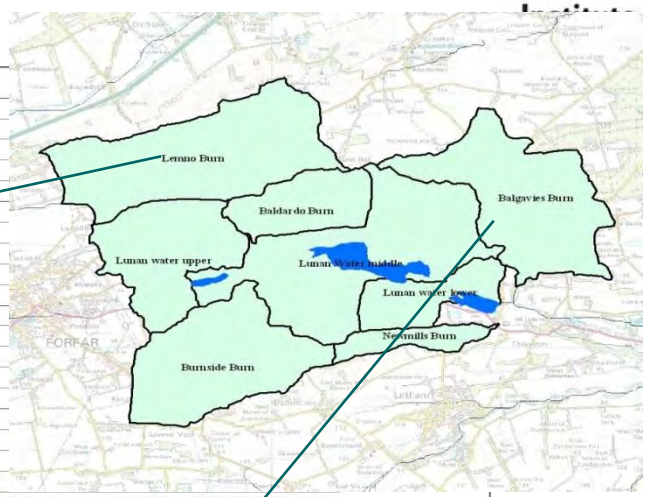




[1]Frigg, R *et al*. 2014. Laplace's Demon and the Adventures of His Apprentices. *Philosophy of Science*, 81(1), 31–59

Nitrate-N trends in Lunan/S.Esk sub-catchments



Trend analysis on loads and flow weighted concentrations

- Using Beale Ratio Estimator

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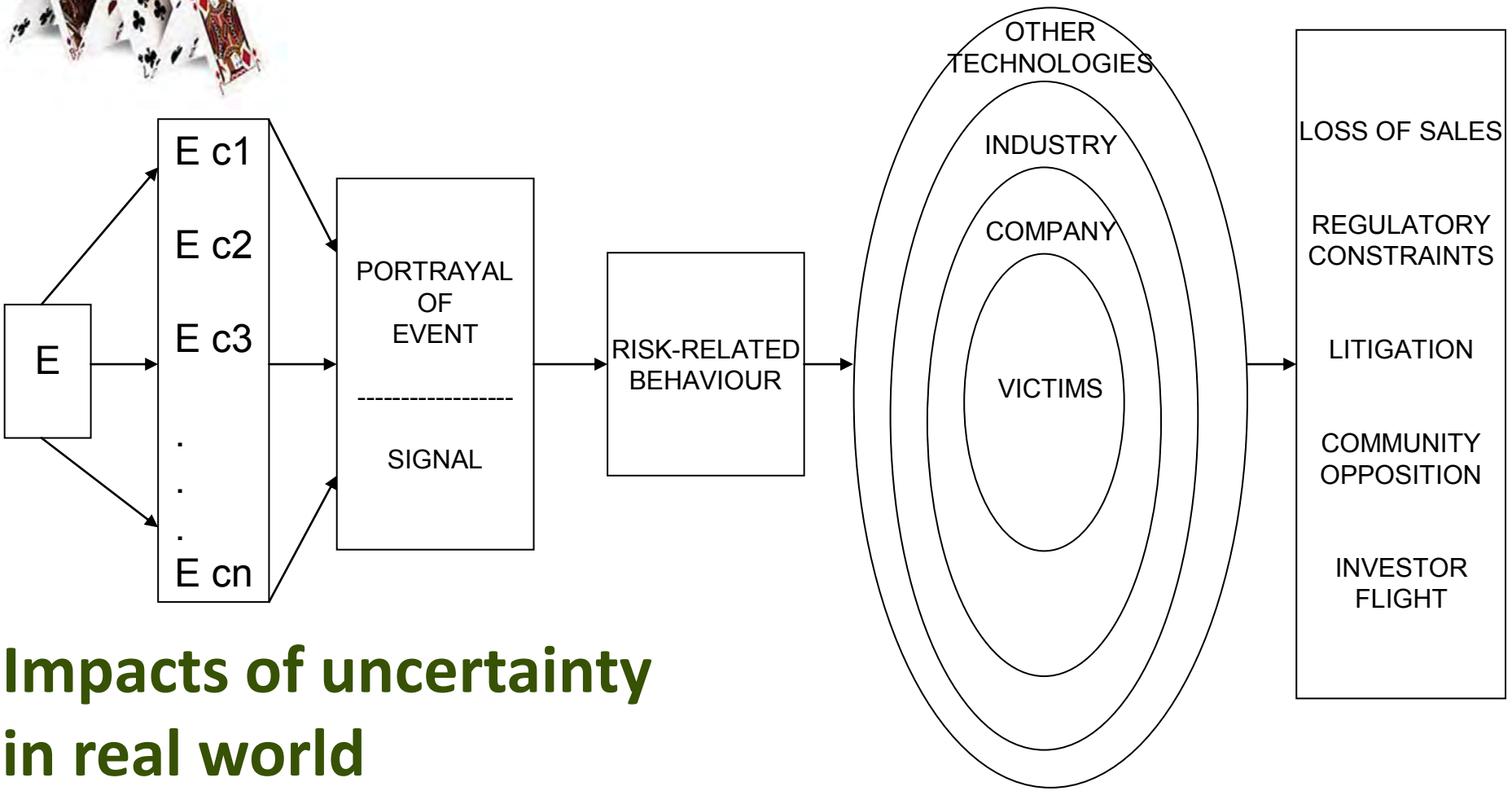
Table 4 Trends (t) on a log scale in discharge, surface water nutrient loads and flow weighted concentrations (fwc) and corresponding *p*-values (p). Cells that are significant at the 5% level are in bold

	log(Q)		log(TDN load)		TDN fwc		log(TDP load)		TDP fwc	
Site	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*
Kirkton Mill (1990–2010)	0.005	0.068	−0.003	0.704	−0.190	**<0.001**	−0.011	**0.004**	−0.018	**<0.001**
Kirkton Mill (2006–2010)	0.028	0.276	0.001	0.981	0.058	0.453	−0.097	0.102	−0.096	**0.041**
Baldardo	0.039	0.185	0.003	0.916	−0.837	**0.011**	0.080	0.131	0.040	0.355
Lemno	0.074	0.051	0.023	0.519	−1.324	**<0.001**	0.059	0.207	−0.015	0.472
Balgavies	0.012	0.813	−0.0003	0.996	−0.221	0.241	0.041	0.504	0.029	0.138
Burnside	0.090	0.348	0.046	0.609	−0.597	**0.024**	0.243	0.120	0.153	0.144
Newmills	n/a	n/a	0.047	0.563	−1.022	0.077	0.257	0.098	0.167	0.089

Note: no trends in N loads and only trends in P loads at outlet (concentrations show trend because of dry -> wet years)

Better time series and BACI analysis methods needed…and patience!

Duckett, D. (2010). Zoonosis and the Social Attribution of Risk Amplification. PhD Thesis, Lancaster University Management School.

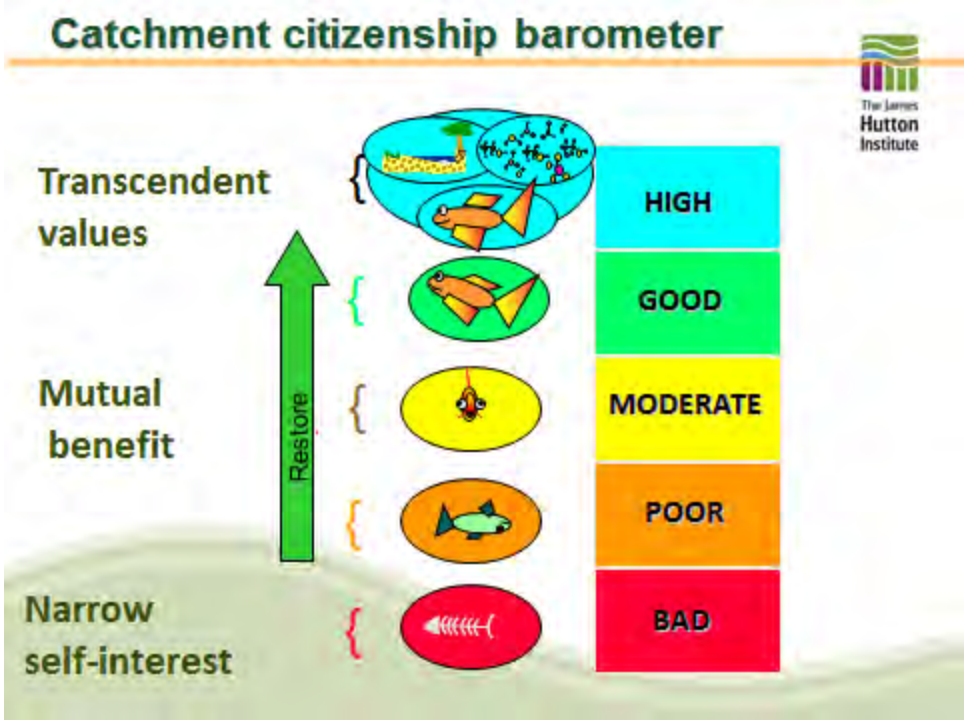


Impacts of uncertainty in real world

RISK EVENT | EVENT CHARACTERISTICS | INFORMATION FLOW | INTERPRETATION AND RESPONSE | SPREAD OF IMPACT | TYPE OF IMPACT (COMPANY LEVEL)

Key research elements to develop catchment citizenship

- Understanding different perspectives
  - **Agent based approaches which recognise the problems of human nature**
- Achieving shared values
  - **Innovative and balanced knowledge exchange with all citizens**
- Mitigation of real issues
  - **Methods for getting real solutions into real catchments**
- Living with uncertainty
  - **Engender trust by dealing with uncertainty honestly**



hype-free approach to here and now "wicked" issues