Wales' Natural Resources: Resilience of Ecosystems and Biodiversity

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A substantial challenge!!

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Overview

- Improving **resilience of ecosystems and biodiversity** is a **substantial challenge**.
- Explore collective efforts to shape and effect change to improve biodiversity and ecosystems in Wales,
- Examine the implications and opportunities contained in the **Environment Bill** and the **Well-being of Future Generations Act**.

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Big part of the challenge: Resilience

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Prelude:

Why Resilience in Wales?

Definitions of Resilience.

A brief history of Resilience.

Set some Resilience challenges for the conference?

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Why Resilience: Environment (Wales) Bill

Environment (Wales) Bill

Putting in place a modern statutory process to plan and manage our natural resources in a joined up and sustainable way

Biodiversity and Resilience of Ecosystems Duty

Background

Biodiversity underpins our ecosystems. The more biodiversity we have, the **more resilient our ecosystems** will become,…..

As part of the Welsh Government's commitment to reversing the decline in biodiversity in Wales and **increasing the resilience of our ecosystems**, the Environment (Wales) Bill will introduce a new biodiversity duty, which will also highlight biodiversity as an essential component of **ecosystem resilience.**

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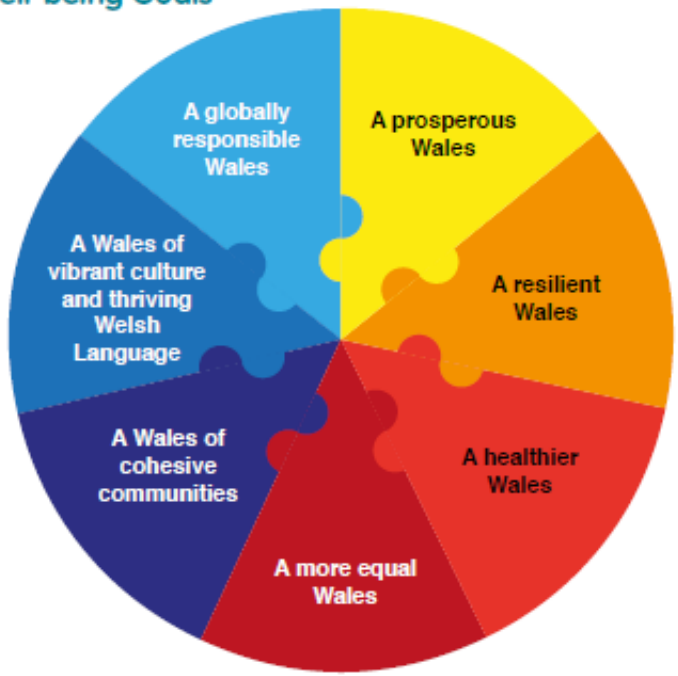
Why Resilience: Well-being of Future Generations (Wales) Bill

Well-being of Future Generations (Wales) Bill

Placing six well-being goals into law, and requiring public bodies to apply the sustainable development principle in five key ways.

Well-being Goals



A Resilient Wales

Description of Goal:

A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and **ecological resilience** and the capacity to adapt to change (for example climate change).

What is Resilience?

- The ability to recover quickly from depression or discouragement
- The ability to recover quickly from illness, change, or misfortune
- Strength of character
- An act of springing back
- The property of a material that enables it to resume its original shape or position after being bent, stretched, or compressed

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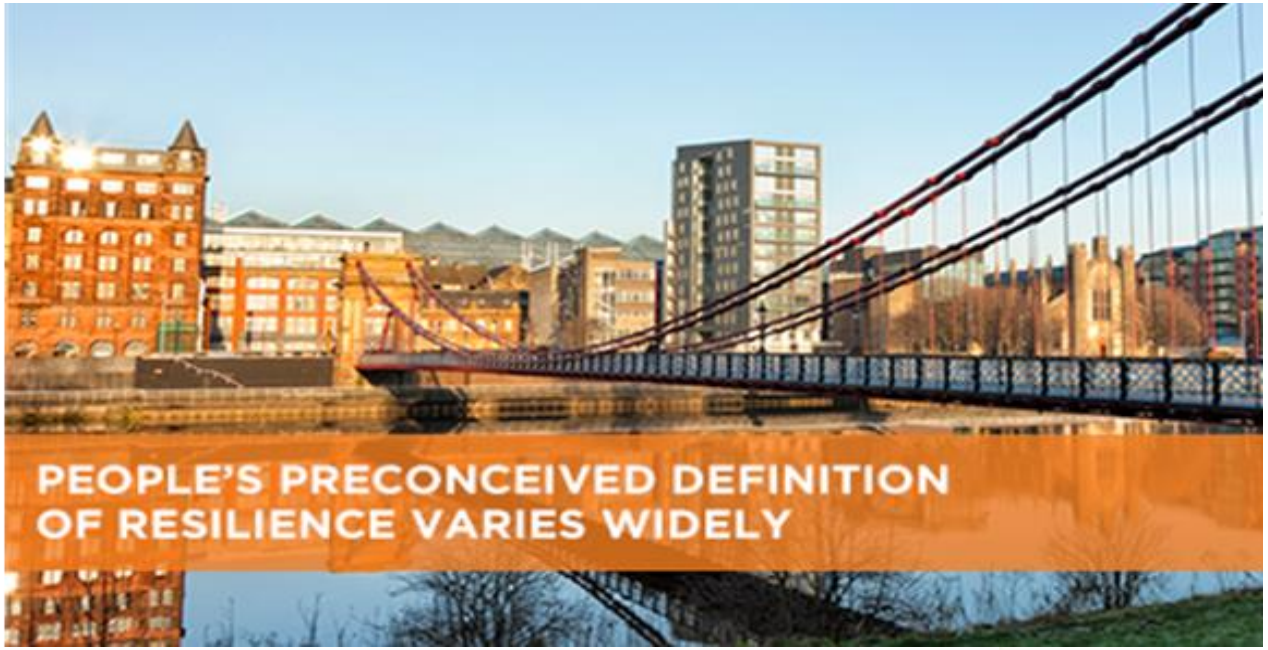
Resiliency
The Power to Keep Going!

the ART of resiliency

What is Resilience?



re·sil·ience:

the ability to bounce back when faced with stress or pressure.

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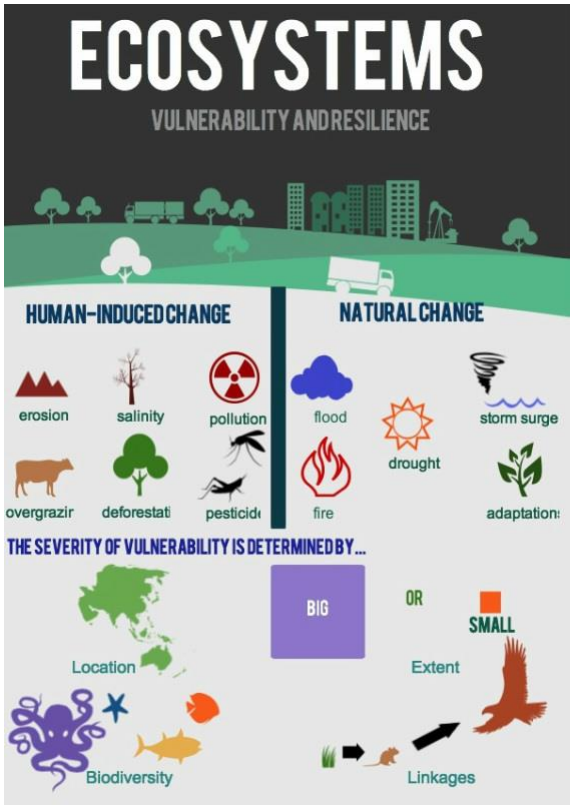
What is Ecosystem Resilience?

Ecosystems

- Complex systems including adaptive agents, self-organized, self-similar over time.
- Resilience is one of myriads of stability concepts in ecology.



What exactly “is“ resilience? **Wrong question!**

What, exactly, do we “mean” by resilience?

- Resilience of what?
- In response to what?
- Perceived by whom?

But first, A Brief History of Resilience

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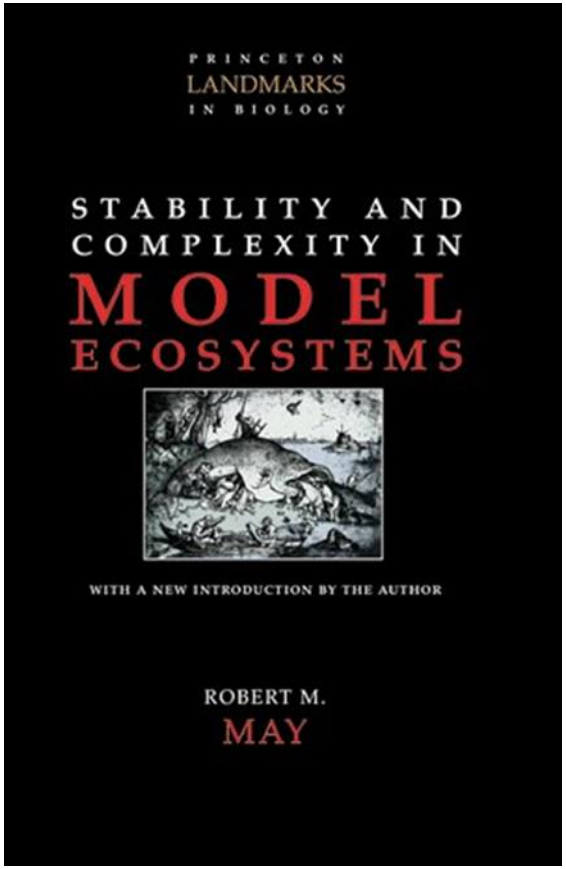
A Brief History of Resilience

Robert May



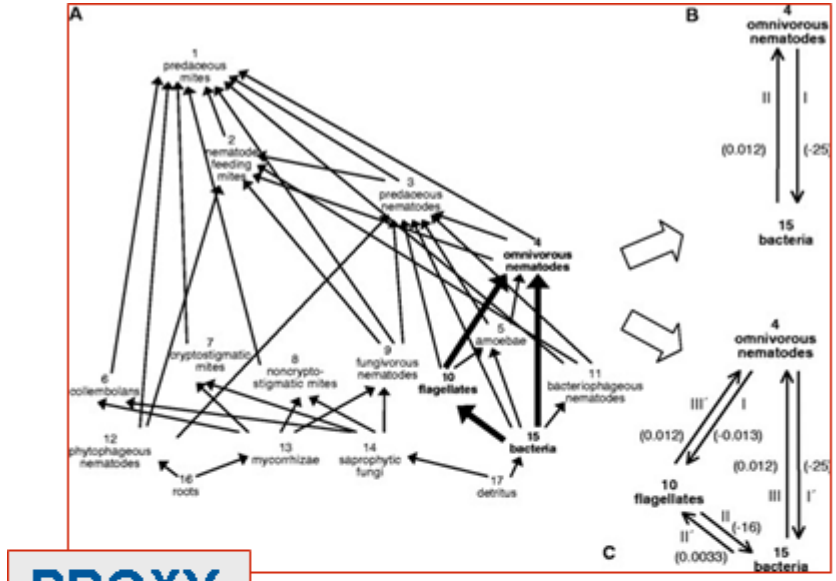
- 1973 – Reprinted in 2001
- Cited more than 1600 times
- Lotka-Volterra plus linear stability analysis (plus brilliant mind)
- Until about 2000, the most frequently used stability concept in Theoretical Ecology
- Why so successful?

A Brief History of Resilience

Robert May

Proxy science (model ecosystems)

- Intellectually appealing and thought-provoking
- “Success“ in terms of capturing key features of real systems depends on quality of those proxies
- “Engineering Resilience”



Neutel et al. 2002

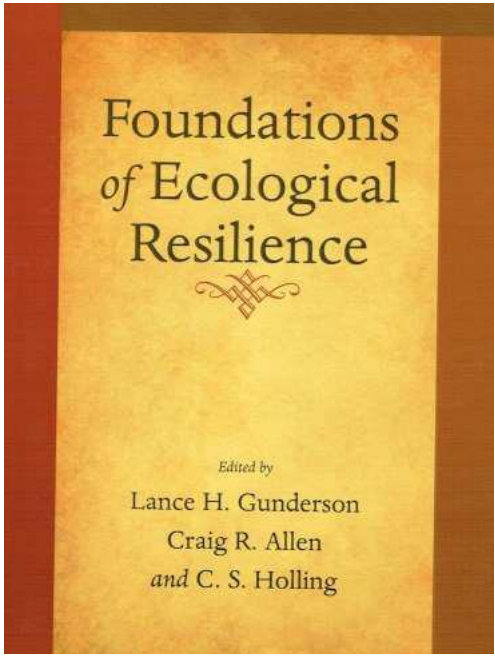
PROXY

PROXY Eigenvalue

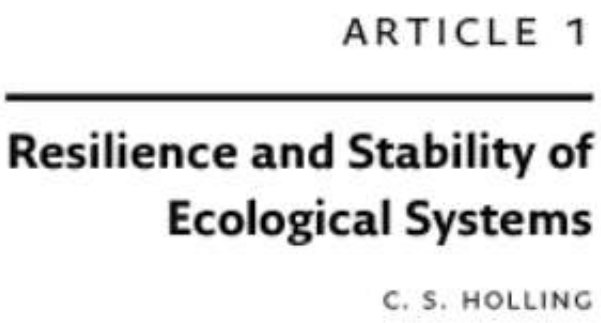
Stability PROXY

A Brief History of Resilience

C.S. (Buzz) Holling



- Not all ecologists were happy with the “engineers” notion of resilience
- Holling‘s review from 1973 introduced a different notion of resilience, that intrigued generations of ecologists,
- But never took ground in Theoretical Ecology

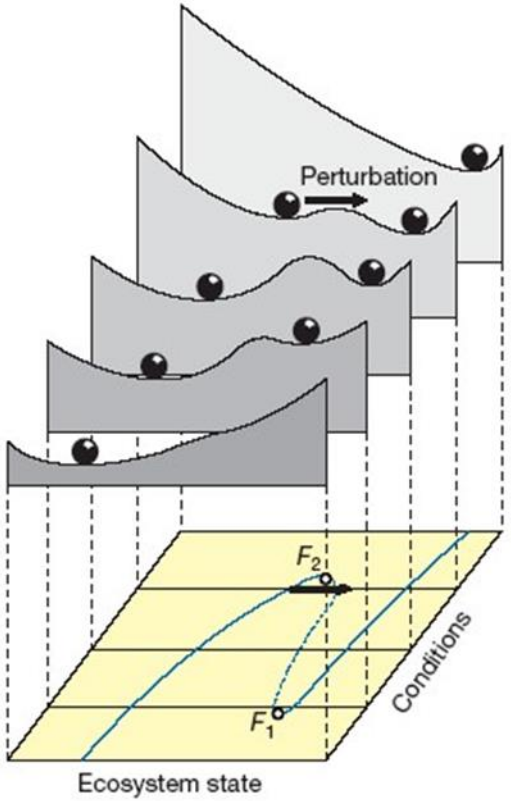


A Brief History of Resilience

C.S. (Buzz) Holling

"Resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist. In this definition resilience is the property of the system and persistence or probability of extinction is the result.“

“Ecological Resilience”



A Brief History of Resilience

In 1999, Holling and a small group of other scientists founded the “Resilience Alliance“ (www.resalliance.org):

The Resilience Alliance is a research organization comprised of scientists and practitioners from many disciplines who collaborate to explore the dynamics of **social-ecological systems**. The body of knowledge developed by the RA, encompasses key concepts of **resilience, adaptability and transformability** and provides a foundation for **sustainable development policy and practice**.

A Brief History of Resilience

Volker Grimm's 1996 review

Oecologia (1997) 109:323–334

Volker Grimm · Christian Wissel

Babel, or the ecological stability discussions: an inventory and analysis of terminology and a guide for avoiding confusion

Received: 4 June 1996 / Accepted: 5 November 1996

Abstract We present an inventory and analysis of discussions of ecological stability, considering 163 definitions of 70 different stability concepts. Our aim is to derive a strategy that can help to dispel the existing "confusion of tongues" on the subject of "stability" and prevent its future recurrence. The strategy consists of three questions that should be kept in mind when communicating about stability properties. These three questions should overcome the three main sources of confusion in termi-

Introduction

Human concepts are signposts through the confusing complexity of nature. We need them to narrow down the never-ending tally of possible questions that we empirically or theoretically ask of nature. Without concepts it is impossible to work scientifically. The price for this, however, is that the concepts determine the ways and methods in which we perceive nature. Critical examina-

A Brief History of Resilience

Volker Grimm's 1996 review

Table 1 A list of stability terms to be found in the literature. Adjectives (e.g. stable, persistent) are changed into substantives. The numbers in parentheses denote the number of definitions to be found for each expression. Terms marked with an asterisk (*) are defined in the original German. The terms are classified as: (1) Conventional terms (*first column*); (2) newly invented terms (*second column*); (3) "Stability", plus an adjective (*third column*)

Stability (25)	Attractor block	Adjustment [stability]
Persistence (15)	Amplitude (4)	Anthropogenic stability
Constancy (5)	Cyclicity	Biomass stability
Domain of attraction (2)	Damping	c-Stability*
Ecological stability (6)	Dynamic boundedness	Connective stability
Elasticity (8)	Dynamic fragility (2)	Cyclical stability
Resilience (17)	Dynamic robustness (3)	D-stability
Resistance (9)	Ecological lability	Essential stability
	Ecosystem health	Functional stability
	Existence	Global stability
	Hysteresis (2)	k-Stability*
	Inertia (4)	Lagrange stability
	Malleability (2)	Local stability
	Maturity	Mathematical stability
	Mutual invasibility	Multi-stability*
	Permanence	Natural stability
	Persistence at fixed densities	Neutral stability
	Persistence in the wide sense	o-Stability*
	Recurrence	Perceived stability
	Regulation	Practical stability
	Repellor	Qualitative stability
	Resiliency (2)	Relative stability
	Responsiveness	r-Stability*
	Semi-stable attractor	Resistance stability (2)
	Sensitivity (2)	Species deletion stability
	Stable attractor	Structural stability (2)
	Strictly persistent	t-Stability*
	Strongly persistent	Temporal stability
	Vulnerability (2)	Terminal stability
	Weakly persistent	Total stability
		Trajectory stability
		Ultra-stability*

A Brief History of Resilience

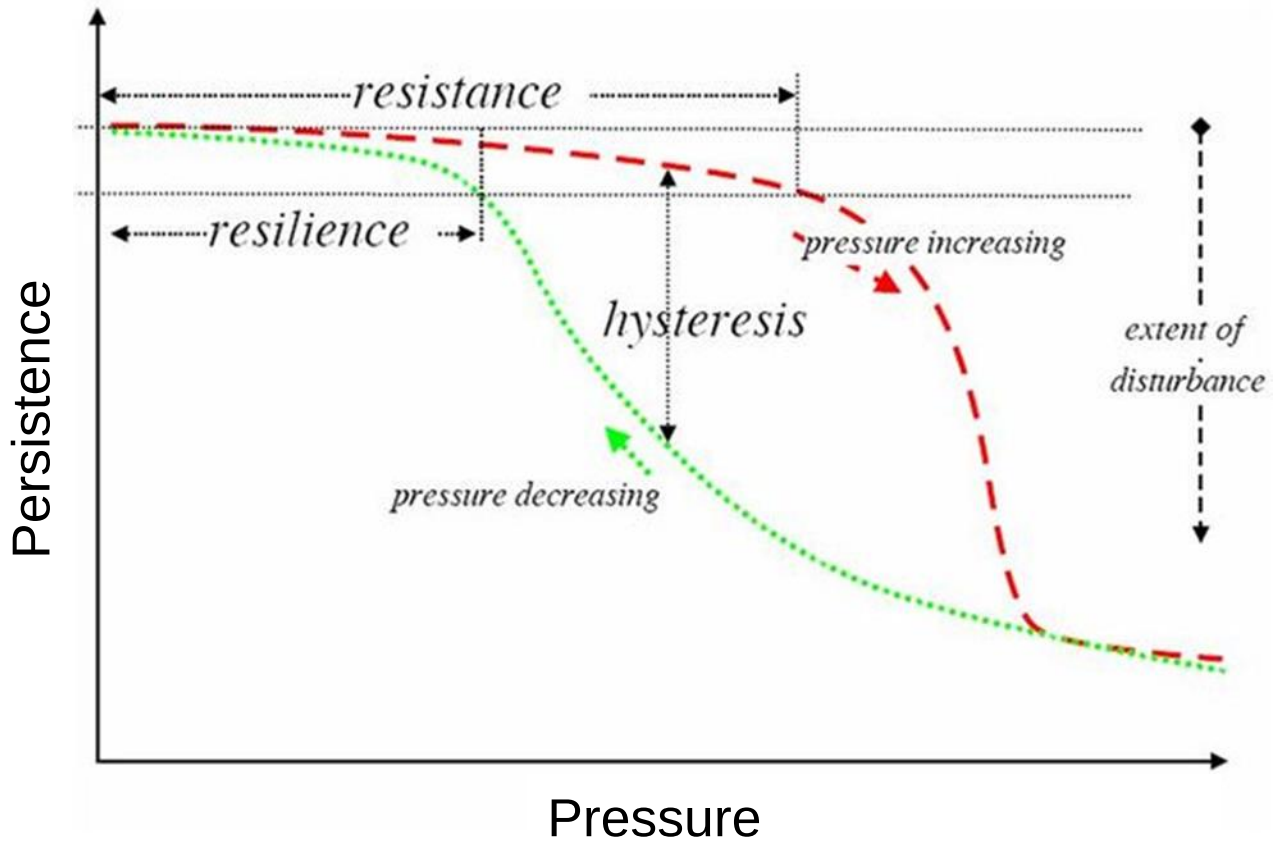
Volker Grimm's 1996 review

Essentially, there are only six (three) different stability properties

1. Constancy: Staying essentially unchanged
2. Persistence: Persistence through time of an ecological system
3. Resistance: Staying essentially unchanged despite the presence of **disturbances**
4. Resilience: Returning to the reference state (or dynamics) after a temporary **disturbance**
5. Elasticity: Speed of return to the reference state (or dynamics) after a temporary **disturbance**
6. Domain of attraction: The whole of states from which the reference state (or dynamics) can be reached again after a temporary **disturbance**

A Brief History of Resilience

So how do we view resilience now, 40 years after May and Holling?



What are the pressures?

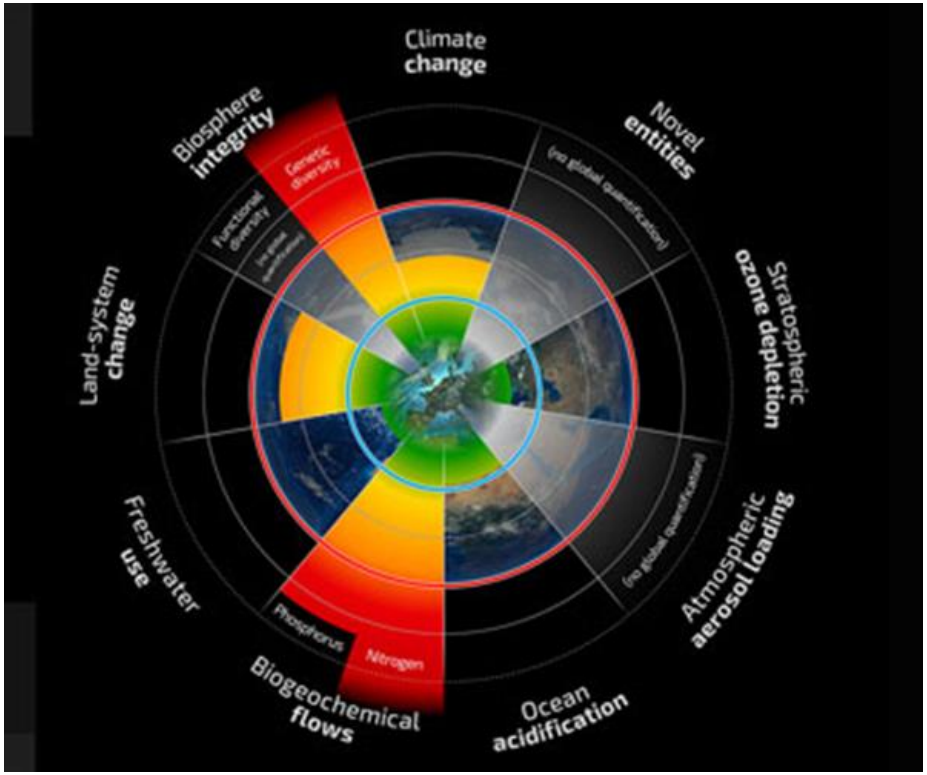
Stockholm Resilience Centre
Sustainability Science for Biosphere Stewardship

Planetary Boundaries

Four of nine planetary boundaries have now been crossed as a result of human activity, says an international team of 18 researchers in the journal Science:

- climate change,
- loss of biosphere integrity,
- land-system change,
- altered biogeochemical cycles (N&P).

(Steffen et. al, 16 January 2015, Science)



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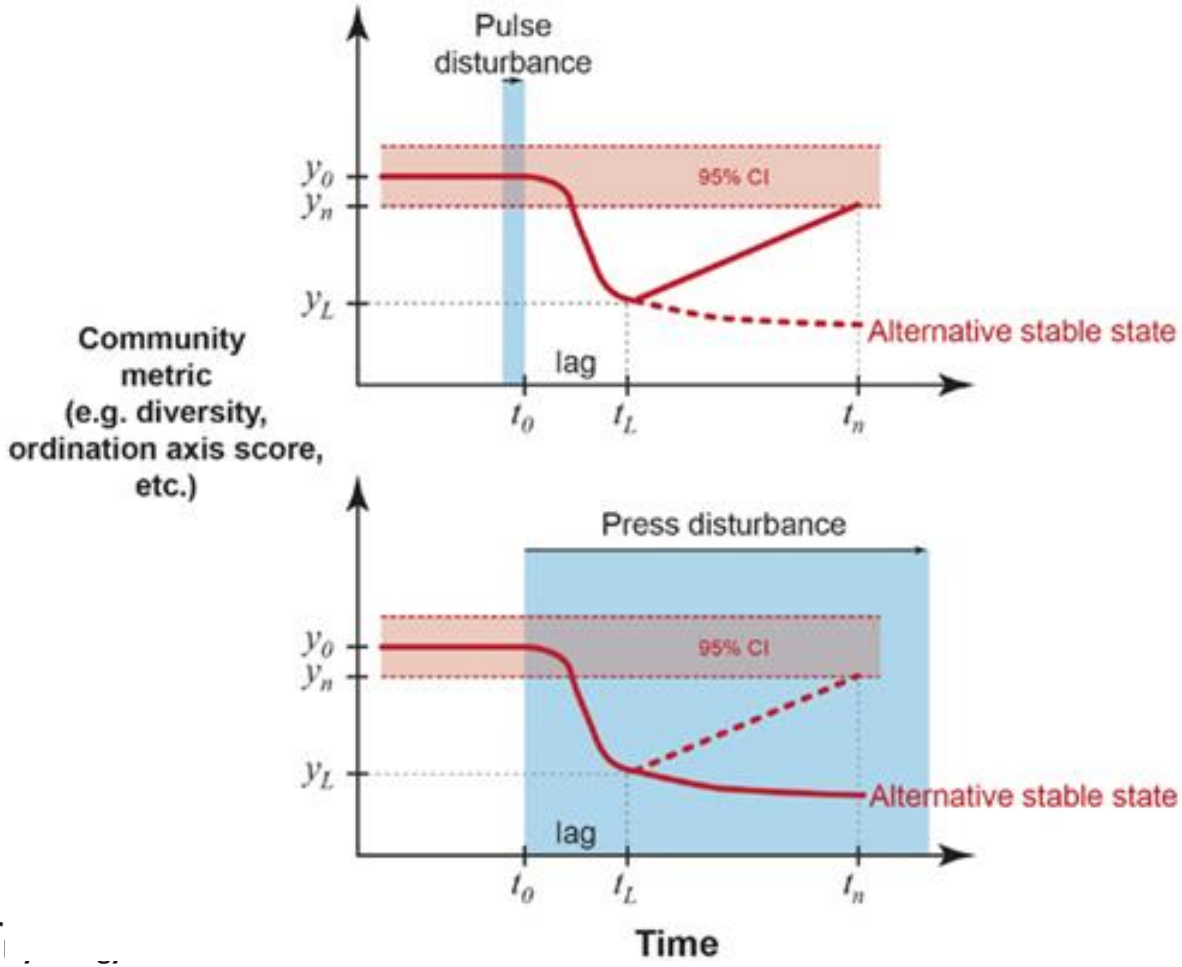
How do pressures act?

Pulse (episodic) vs Press (chronic) Pressures



What do we want Wales' natural resources to do?

"Bend not break"

Be able to recover their function (so we receive the benefits) when exposed to:

Chronic pressures

- Warming
- Air pollution
- Land Management

Episodic pressures

- Pests and disease
- Droughts and Storms

i.e. be resilient

(& sustainable)

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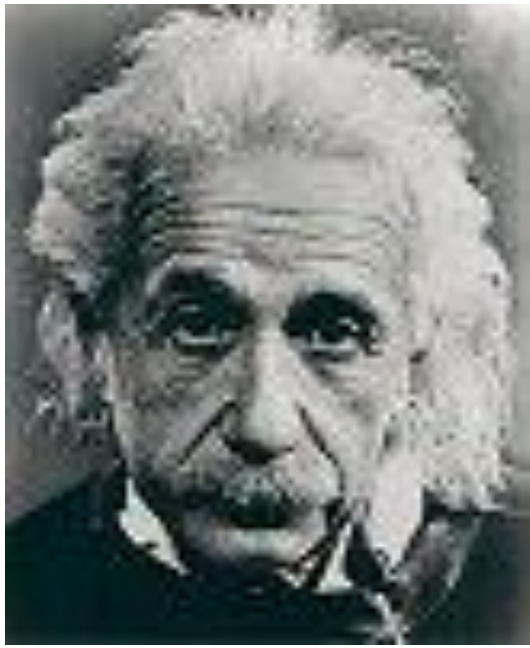
Conference Challenge?

What are the methods and metrics for quantifying Resilience?

"Make everything as simple as possible, but not simpler"

If we knew what we were doing, it wouldn't be called research.



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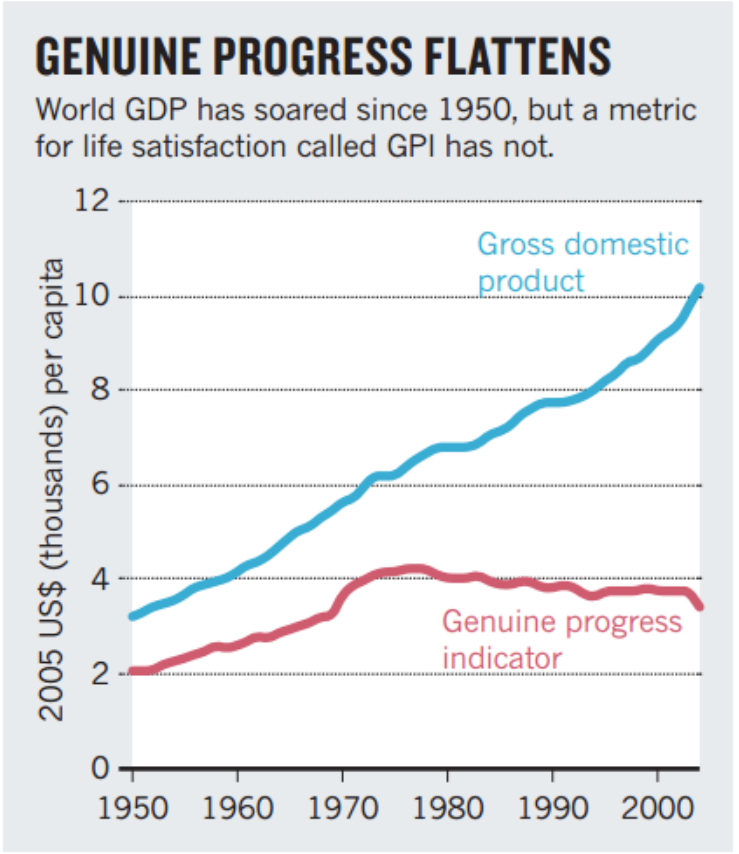
Conference Challenge?

How do we know we've got it right?

Ecosystem Services can be delivered at high rates but with the underlying Natural Capital being eroded i.e. we are not using them sustainably

Living off your savings to pay your bills - Similar analogy to the 'illusion' of GDP



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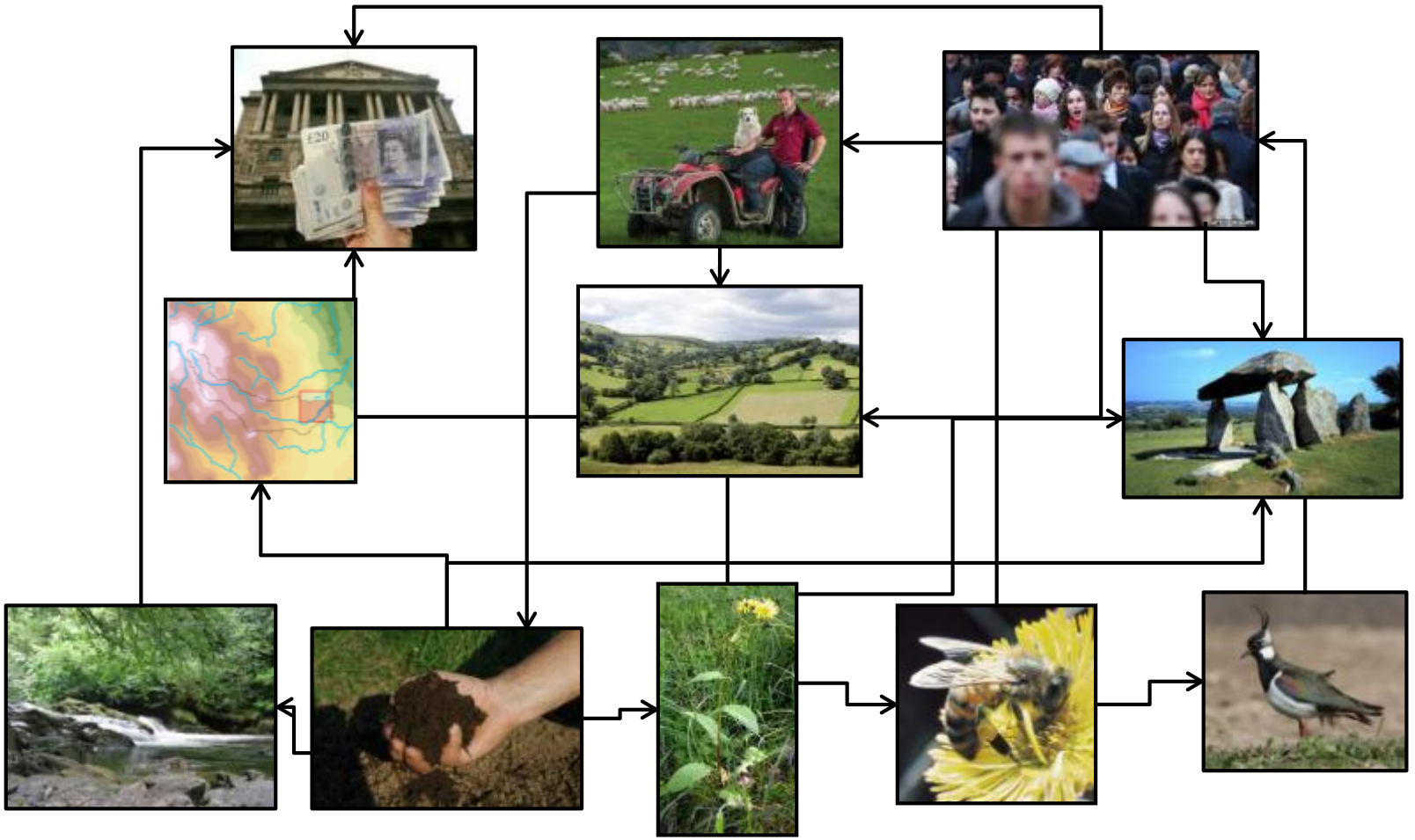
People and natural resources are highly inter-connected



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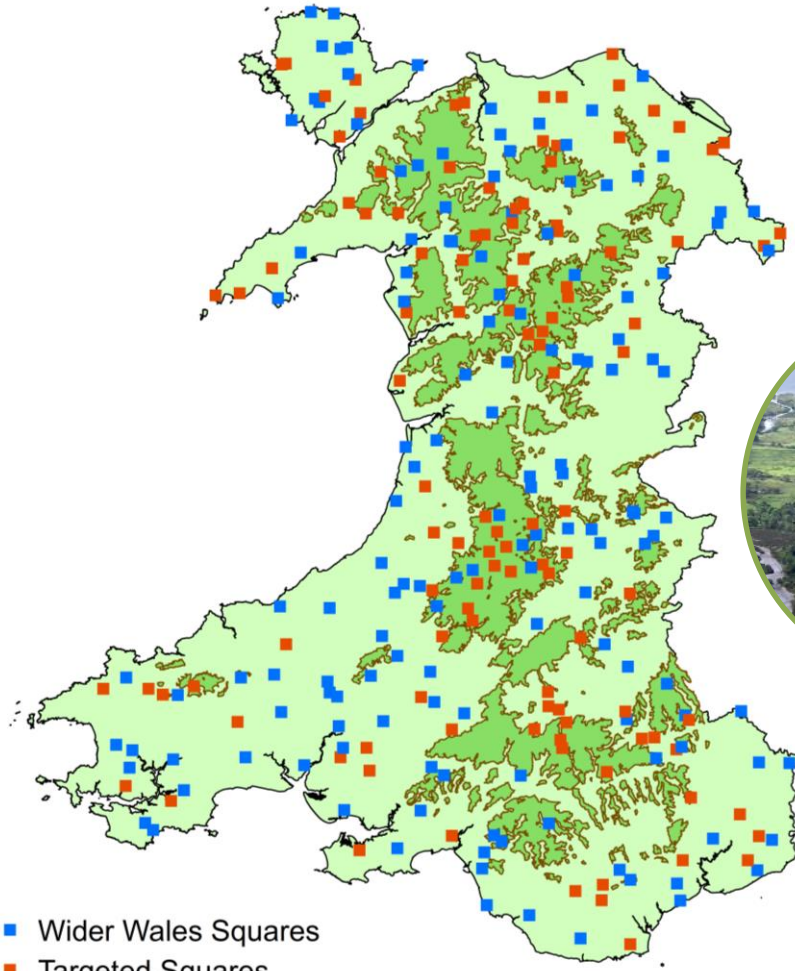
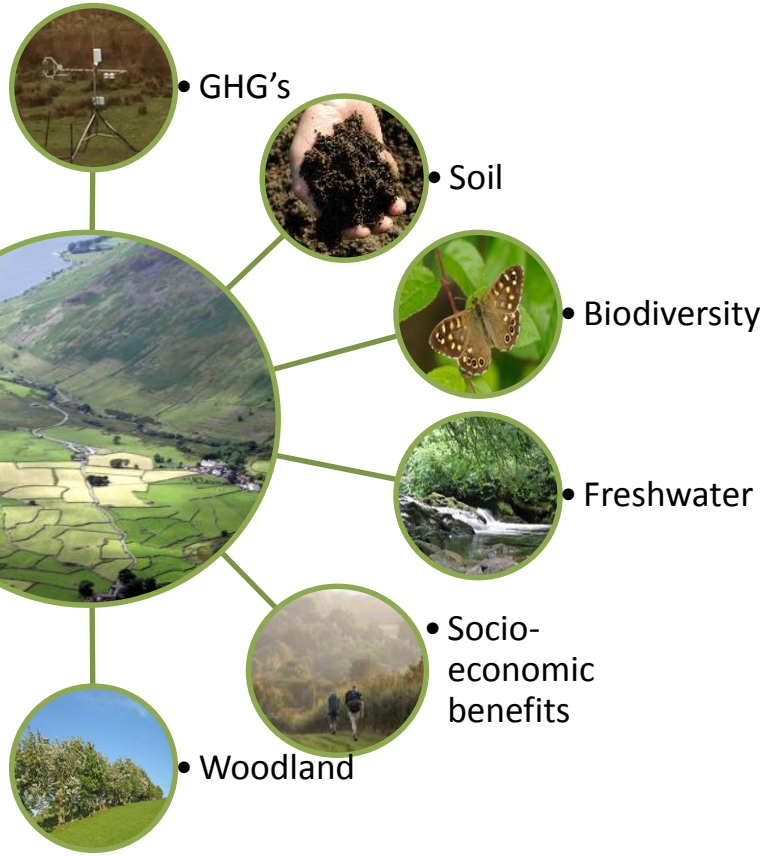
How can we monitor Wales to reflect this complexity and inter-dependence?

The Glastir Monitoring and Evaluation Programme

Glastir Monitoring and Evaluation Programme





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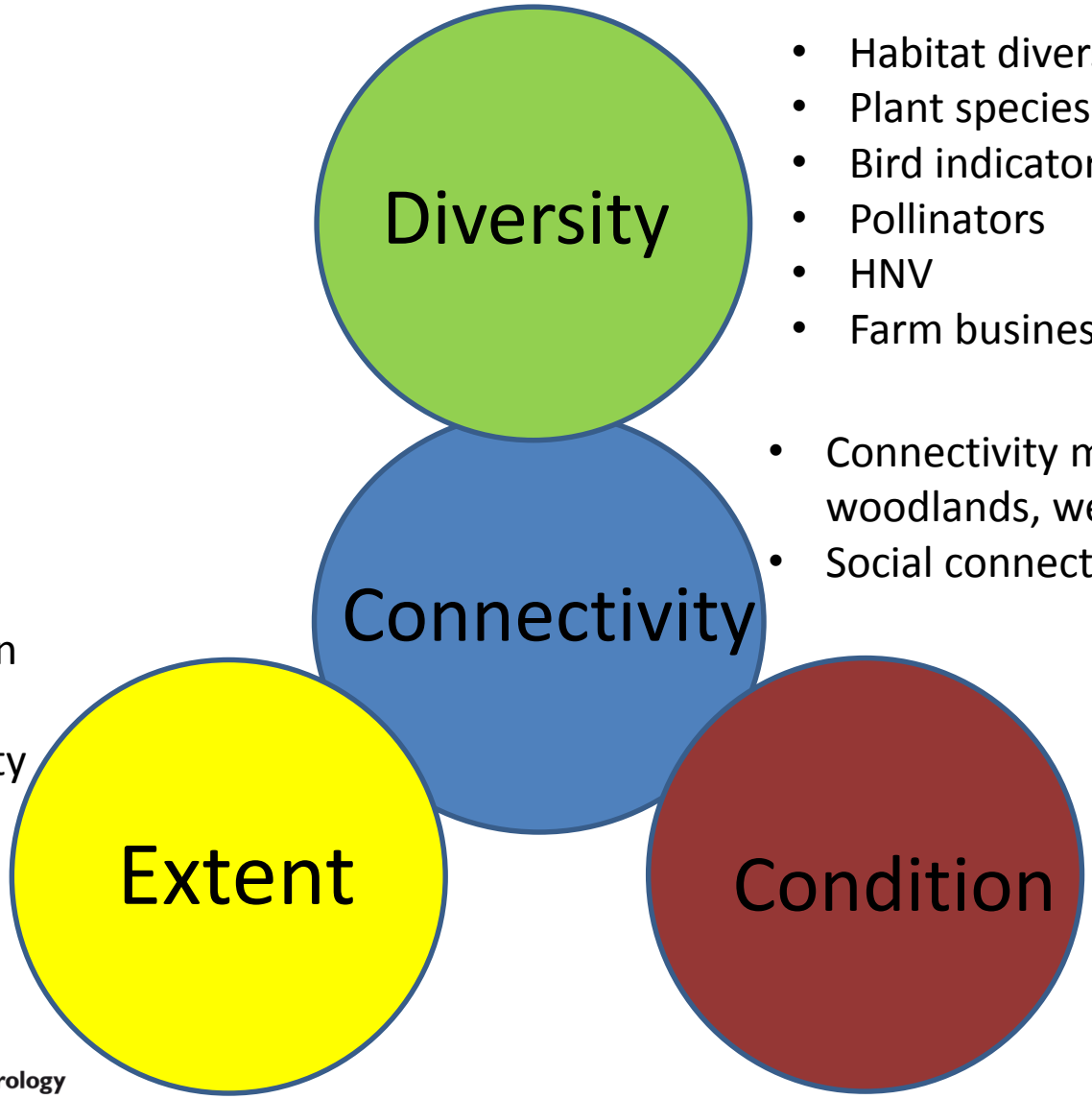
GMEP data and modelling work have the potential to deliver resilience metrics around 4 key issues



- Habitat diversity
- Plant species
- Bird indicators
- Pollinators
- HNV
- Farm business?

- Connectivity metrics for woodlands, wetlands etc
- Social connectivity

- Habitat area
- Fragmentation metric
- Area of priority habitats

- Soil condition
- Water quality
- GHG emissions
- Farm profitability

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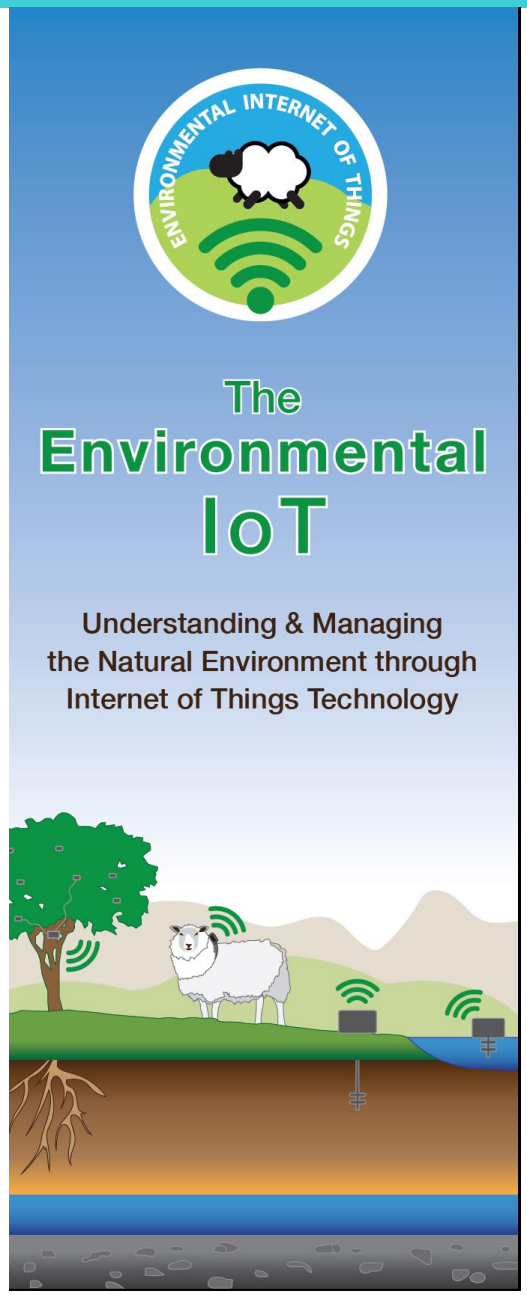
GMEP: An example of collaborative working involving 17 organisations and > 100 scientists

Current (and Future) Challenges

- **Little consensus in scientific world on resilience metrics**
  - Connectivity can be undesirable during disease outbreaks
  - Extent and diversity can be mutually exclusive
- **Targets will be challenging and potentially impossible**
- **In the meantime**:
  - Actions to improve condition of our Natural Resources
  - Monitor Natural Resources to see if successful as we go along as evidence base is incomplete

Combine with new sensor technologies to develop early warnings (e.g the Environmental Internet of Things)



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Thank you & questions

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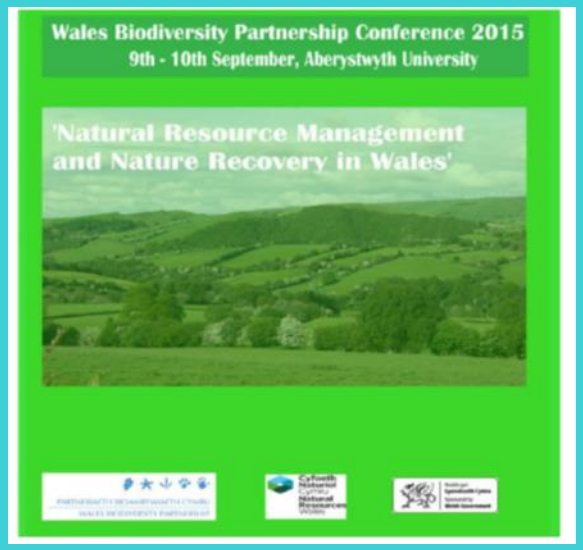

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