

## March 2013 About this project

### Name

Poverty and ecology: developing a new evolutionary approach.

### Principal investigator

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### Partners

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### Time frame

February 2011 – January 2013.

### Objective

To provide a longer time perspective on how environmental change, ecosystem services and poverty interact over decades. This will lead to better information, including models, for policy and sustainable management strategies.

### Summary

Ecosystems under human pressure can undergo dramatic, irreversible shifts, including the collapse of essential services such as water quality or soil stability.

This project produced Ecosystem Services Indices for the lower Yangtze Basin that showed regional managers at a glance that unsustainable development has severely degraded the resource base for the farming economy, and that there is an unsustainable trade-off between economic growth and ecological degradation in several sub-regional locations.

Individual time series for a range of ecosystem services show evidence for critical transitions transgressed since the 1980s, especially water quality. Other time series show evidence for increasing variability which may indicate progressive losses of resilience across the whole region.

This means the area is becoming more vulnerable to extreme regional events, like storms and dry periods and also to global shocks, like commodity prices.



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# Unearthing history, preventing disaster

## Long-term regional records of ecological and economic change can inform development planning

In the fertile basin along the Yangtze river in eastern China, farmers today look out on a different landscape from their parents.

Like most of the country, this region has adopted intensive agriculture since the 1970s, boosting yields with fertilisers and pesticides. GDP has shot up and some people are better off than the previous generation – but rural poverty remains widespread and the gap between rich and poor continues to grow.

There are signs that the new practices are badly damaging the natural systems that farmers rely on. Some local water sources are contaminated, and unstable soil has been washed away by floods. Is agricultural development pushing these systems to the point of collapse, risking crisis for poor communities?

This ESPA-funded research project can now show that the region may have entered a new unstable phase where some ecosystem processes have already crossed tipping points and where increased variability in many ecosystem services points to progressive loss of resilience. The modern environment is in a critically sensitive condition.

### Uncovering the trends

Across the world, long-term records of ecosystem services – water quality, soil stability and other benefits of a healthy environment – are seldom available. Direct monitoring of natural resources is patchy and rarely extends back even a few decades. If particular ecosystems have slowly been pushed to their limits, the decline has often gone unnoticed.

But the changes have left tracks – chemical and biological traces deposited in layers of lake sediment, for example. This partnership between British and Chinese scientists used these clues to reconstruct the history of six systems that regulate environmental health in the lower Yangtze basin: air and water quality, sediment quality and regulation, soil stability and biodiversity.

The resulting Regulating Services Index combines trends of the six ecological 'stocks', and during the past 40 years of population growth, intensifying agriculture and industrialisation, this regional index has halved.

In contrast, the index for Provisioning Services – the goods and benefits from natural resources – demonstrates fairly consistent growth over the same period, except in some locations where county-level yields have fallen. There is now an unsustainable tradeoff between the high yields of crops and the quality of the natural processes that support and regulate the delivery of these yields.

Analysing how the trends in Regulating Services relate to economic development, using so-called 'Environmental Kuznets' curves, shows the region has not yet reached the point where economic growth leads to an improving environment. Poverty alleviation linked to regional economic development remains coupled to environmental degradation.

### Warning signals

Drastic falls in both air and water quality since the mid-20th century demand urgent attention. The decline in water quality is so steep – dropping about two-thirds in 40 years – it suggests that all the lakes studied have now crossed a threshold beyond which damage is irreversible.

A clearer view of such tipping points is a key aim of this research. In China and worldwide, planners often assume that human pressures will cause smooth, linear changes in nature – but in reality, gradual change in a complex system often leads to abrupt, devastating shifts. The only way to see this coming is by analysing long-term trends.

Analysis of the changing variability in the datasets gives a clue as to when a tipping point might be reached. For the lakes, it seems they started to 'wobble' a couple of decades before they crashed. Other parts of the environment are also now 'wobbling' suggesting that the whole region may have entered a critical state of instability. It's clear that the key biophysical processes that underpin all the ecosystem services need to receive urgent attention, protection or restoration. Without a concerted effort, there is potential disaster awaiting the region's rural poor.

For other developing countries seeking ways to lift people out of poverty, the study does not offer easy answers. For 40 years the fertile Yangtze river basin has, like much of China, witnessed the adoption of increasingly intensive agriculture. Yields have been boosted by fertilisers and pesticides, GDP has shot up, and some people are better off than the previous generation – but rural poverty remains widespread and the gap between rich and poor continues to grow.

### What the people say

In 2012, the findings were discussed with rural farmers and environmental protection managers. Cartoons and visualisations of the data changing through time were used to make the results more accessible. This succeeded in conveying the sense of a critical transition, and the implications of crossing a threshold for landscape management.

Both farmers and managers agreed that ecological degradation is a problem, and most singled out water quality as the worst. The farmers were well aware of the general trend in environmental degradation over several decades. They acknowledged that agricultural pests are no longer easily killed with pesticides and increasing fertilizer applications do not always lead to higher crop yields – clear signs of over-intensive agriculture.

But the farmers were adamant that these are not their problems: that these problems are the responsibility of the state. So a key lesson for land managers is that improving the quality of information to farmers will not be enough to change mind-sets. A new sense of responsibility guided by new regulations and strong regulation enforcement has to be, at least part of, the long term solution.

### Next steps

The final part of the project will draw together the links between poverty, development and ecosystem services in synthesis of findings for different types of stakeholder. The methodology is already being applied in the ESPA DELTAS project based in the Bangladesh coastal zone.



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## New knowledge

- This project, set in eastern China, provides the world's first long-term and integrated datasets for social, economic and ecological conditions showing how regional social and economic changes have affected air and water quality, biodiversity, and other key ecosystem services.
- Indexes for Regulating and Provisioning Services show at a glance that in this region agricultural outputs have risen steeply during the last 60 years while the natural systems that sustain farming livelihoods have degraded.
- Analysing the trends for different areas within the region shows that economic development still remains coupled to environmental degradation.

## Creating impact

- This team of scientists have used the approach developed here to help pioneer a technique to predict when an ecosystem is likely to collapse, which may also have potential for foretelling crises in agriculture, fisheries or even financial systems.
- The data underscores the hard choices about poverty and ecology that unsustainable development brings. For instance, interventions to rescue regional water sources may harm poor farmers in the short term, but continued degradation could devastate farmers' incomes in the long run.
- To make the results more accessible the group has developed animated graphs and a Google Earth application to help policymakers easily visualise changes.

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