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Potential for more efficient energy, land and phosphorus use by 2050

There is a large potential to improve the global efficiency of energy, land and phosphorus use, finds new research which modelled the effects of four worldwide scenarios between 2010 and 2050. An 'ambitious resource strategy' could moderate the increases in energy use (+25% globally instead of +80% in the baseline scenario), phosphorus use (+9% instead of +40%) and arable land (-9% globally, instead of + 4%).

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The prospect of growing resource scarcity, as populations swell and economic activities increase, is leading governments, businesses and international organisations to develop strategies for more sustainable resource use. Improving the efficiency of how resources are used is commonly seen as the most attractive way to address resource scarcity; primarily through the use of technological innovations that allow economic activities to continue.

New research by the Netherlands Environmental Assessment Agency used a family of computer models – the 'IMAGE 2.4 integrated assessment framework' – to compare four scenarios on the worldwide use of energy, land and phosphorus (a major component of fertilisers). These resources were chosen due to their prominence in talks on environmental sustainability and resource efficiency, and their interconnectedness. Trade-offs and synergies among resource strategies were accounted for and special analysis was devoted to the interaction with climate change policies. The researchers also considered consequences for greenhouse gas (GHG) emissions and biodiversity.

The four scenarios were:

Baseline — 'business as usual', no changes to policy on resource efficiency after 2010.

Envisaged policies (EP) — as baseline, with the addition of 'low level' climate policy commitments, made as part of the negotiations in Copenhagen (2009) and Cancun (2010). For the period after 2020, for which no pledges were made at the time of writing, the researchers assumed a constant carbon tax to model continuity at the same level of climate efforts.

Global resource (GR) efficiency — ambitious resource efficiency strategies are in place worldwide, but climate policies are restricted to those of the EP scenario.

Global resource efficiency and climate policy (RECP) — combining the resource efficiencies of GR with global climate policies aimed at keeping global temperature rise below 2°C.

The two resource efficiency scenarios (GR, RECP) aim to describe ambitious improvements which are technologically, socially and politically conceivable, harmonised across different subject areas. The scenarios had a number of underlying assumptions. For example, under the GR and RECP scenarios, phosphorus excretion rates for animals were assumed to decrease to mimic higher feed-use efficiency.

Under the baseline scenario, there would be an overall increase in energy use of 80%, a 4% increase in arable land use, and a 40% increase in phosphorous use. The GR scenario led to an increase of only 25% in energy use, a 9% reduction in arable land use, and a 9% increase in phosphorous use.

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The findings have a number of implications. Firstly, they show that there is significant potential for increasing resource efficiencies. Importantly, the authors note that such improvements may involve long lead times and require upfront and timely investments in infrastructure, incentives and education and, by implication, consistent and long-term policy arrangements.

Secondly, the dynamics of resource use and the scope for efficiency enhancement differ significantly across global regions and resources. For example, under all scenarios, phosphorus use increases in developing countries while the greatest potential for efficiency savings exists in industrialised nations. This, the authors say, suggests that policies will need to be resource- and sector-specific and tailored to country needs.

Thirdly, interventions to enhance a region's efficiency for one natural resource are frequently linked to another, often in beneficial ways. For example, improved efficiency in the food chain provides possibilities for reduced biodiversity loss, as well as moderation of the increases of global phosphorus use, energy use and GHG emissions. However, there are also trade-offs, such as increased fertiliser requirements to sustain improved crop productivity (and thus land efficiency) in developing countries.

Fourth, while synergies among resource efficiency initiatives seem to prevail they do not make problem-specific policies redundant. The researchers illustrate this point using the insight that under the GR scenario, GHG emissions would decrease by the equivalent of 12 gigatonnes of carbon compared to baseline, but additional decarbonisation of the world's energy supply would be needed to meet internationally agreed climate targets. Furthermore, in the RECP scenario, some of the efficiency gains in land and phosphorus use achieved in the GR scenario are sacrificed, due to the additional resource requirements for the deployment of bioenergy (although much less than in a scenario without more efficient resource use).

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