ANNEX A

Use of indicators for policy monitoring and evaluation

Policy relevance is a key criterion in the selection and development of agri-environmental indicators (AEIs). This section provides illustrative examples of how the OECD's AEIs are being used in policy analysis and monitoring across a range of countries, institutions and researchers.

Denmark: Policies to reduce nutrient pollution

Since 1985, **Denmark** has implemented **a set of national measures to reduce agricultural nutrient pollution** of water systems, especially to avoid eutrophication of coastal water (Box A1). These measures are in conformity with the EU's *Nitrate and Water Framework Directives*, and in part, funded through the Common Agricultural Policy, with Box A1 showing use of the nutrient balance indicator.

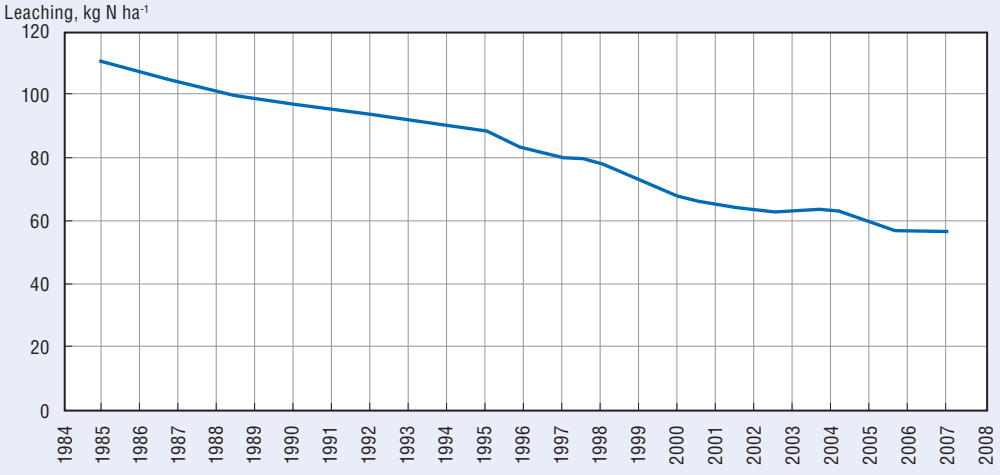
Box A1. **Policy measures to reduce agricultural nutrient pollution of the environment in Denmark**

Danish policy actions	Policy measures imposed
1985: Nitrogen (N) and phosphorus (P) action plan to reduce N and P pollution	● Minimum 6 months slurry storage capacity. ● Ban on slurry spreading between harvest and 15 October on soil destined for spring cropping. ● Maximum stock density equivalent to 2 livestock unit (LU) ha^{-1} (1 LU corresponds to one large dairy cow). ● Various measures to reduce runoff from silage clamps and manure heaps. ● A floating barrier (natural crust or artificial cover) mandatory on slurry tanks.
1987: The first action plan for the Aquatic Environment (AP-I), aiming to halve N-losses and reduce P-losses by 80%	● Minimum 9 months slurry storage capacity. ● Ban on slurry spreading from harvest to 1 November on soil destined for spring crops. ● Mandatory fertiliser and crop rotation plans. ● Minimum proportion of area to be planted with winter crops. ● Mandatory incorporation of manure within 12 hours of spreading.
1991: Action plan for a Sustainable Agriculture	● Ban on slurry spreading from harvest until 1 February, except on grass and winter rape. ● Obligatory fertiliser budgets. ● Maximum limits on the plant available N applied to different crops, equal to the economic optimum. ● Statutory norms for the proportion of manure N assumed to be plant available (Pig slurry: 60%, cattle slurry: 55%, deep litter: 25%, other types: 50%).
1998: The second action plan for the Aquatic Environment (AP-II)	● Subsidies to establish wetlands. ● A reduction of the stock density maximum to 1.7 LU ha^{-1}. ● The statutory norms for the proportion of manure N assumed to be plant available were increased from 1999 (pig slurry: 65%, cattle slurry: 60%, deep litter: 35%, other types: 55%). ● Maximum limits on the application of plant available N to crops reduced to 10% below the economic optimum. ● Mandatory 6% of the area with cereals, legumes and oil crops to be planted with catch crops.

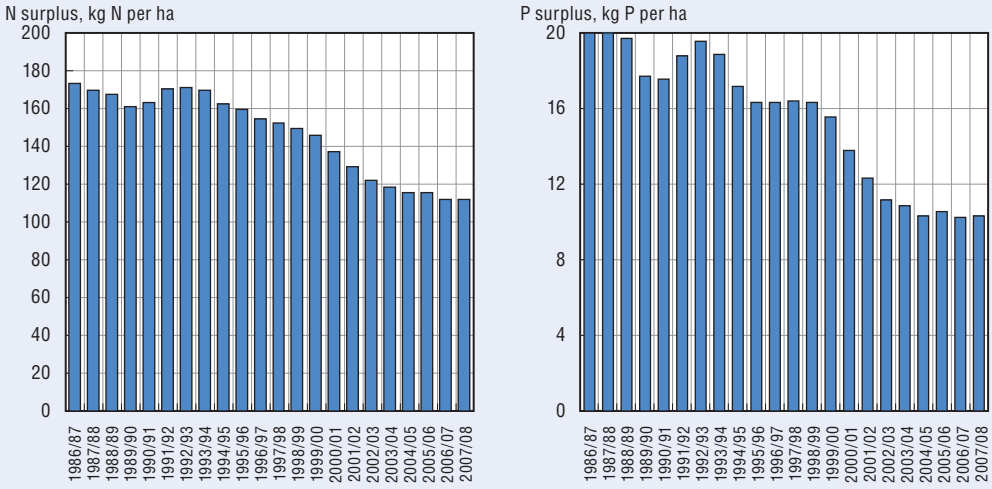
Box A1. **Policy measures to reduce agricultural nutrient pollution of the environment in Denmark** *(cont.)*

Danish policy actions	Policy measures imposed
2000: AP-II mid-term evaluation and enforcement	• Further tightening of the statutory norms for the proportion of assumed plant-available N in manure. From 2001; pig slurry: 70%, cattle slurry: 65%, deep litter: 40%, other types: 60%. From 2002 pig slurry: 75%, cattle slurry: 70%, deep litter: 45%, other types: 65%.
2004: The third action plan for the Aquatic Environment (AP-III) AP-III is closely related to the EU Water Framework Directive and the EU Habitat Directive. N-leaching must be reduced by further 13% by 2015	• Further tightening of the request for catch crops. • Establishment of buffer zones along streams and around lakes to reduce discharge of P. • A tax of DKK 4 kg^{-1} (EUR 0.54 kg^{-1}) mineral P in feed. • Evaluations of the effect of AP-III will be carried out in 2008 and 2011. • Based on the evaluations further initiatives will be implemented if necessary.
2008: Evaluation of AP-III	
2009: Political agreement on initiating AP-IV; also called Green growth General reduction targets for the aquatic environment are estimated, and regional objectives are set for individual water bodies	• Further tightening of the request for catch crops; in total 140 000 hectares with catch crops is needed. • Ban on soil tillage in the autumn before spring crops. • Ban on re-establishment of fodder grass in the autumn. • Work initiated to evaluate the possibilities of introducing tradable leaching quotas.

Implementation of the Danish Action Plans, together with the support and regulatory framework of the EU's Nitrate and Water Framework Directives and CAP, has substantially lowered nitrogen and phosphorus surpluses and leaching of nitrogen from the root zone shown in the Box figures below.



Box A1. **Policy measures to reduce agricultural nutrient pollution of the environment in Denmark** *(cont.)*



Source: Kronvang, B. et al. (2008), "Effects of Policy Measures Implemented in Denmark on Nitrogen Pollution of the Aquatic Environment", *Environmental Science and Policy*, Vol. 11, pp. 144-152; Maguire, R.O., G.H. Rubaek, B.E. Haggard and B.H. Foy (2009), "Critical Evaluation of the Implementation of Mitigation Options for Phosphorus from Field to Catchment Scales", *Journal of Environmental Quality*, Vol. 38, pp. 1989-1997; and Vinther, F.P. and C.D. Borgesen (2010), *Nutrient Surplus as a Tool for Evaluating Environmental Action Plans in Denmark,* presented at the OECD Workshop on agri-environmental indicators, March, Leysin, Switzerland, see OECD website: *www.oecd.org/agriculture/env/indicators/workshop*.

Switzerland: Improvement of input/output efficiency

Switzerland's indicators of the efficiency of the use of inputs, in particular nitrogen and energy, have not shown any improvement over time (Figure A.1). For this reason, the Federal Government decided that, from 2008, farmer support would be allocated with the purpose of improving the utilisation of natural resources in agriculture (regional programmes for the sustainable use of natural resources). The target areas are: the resources necessary for agricultural production, such as nitrogen, phosphorus and energy, the optimisation of plant protection; and increased protection and more sustainable use of soil, biodiversity in agriculture and the landscape.

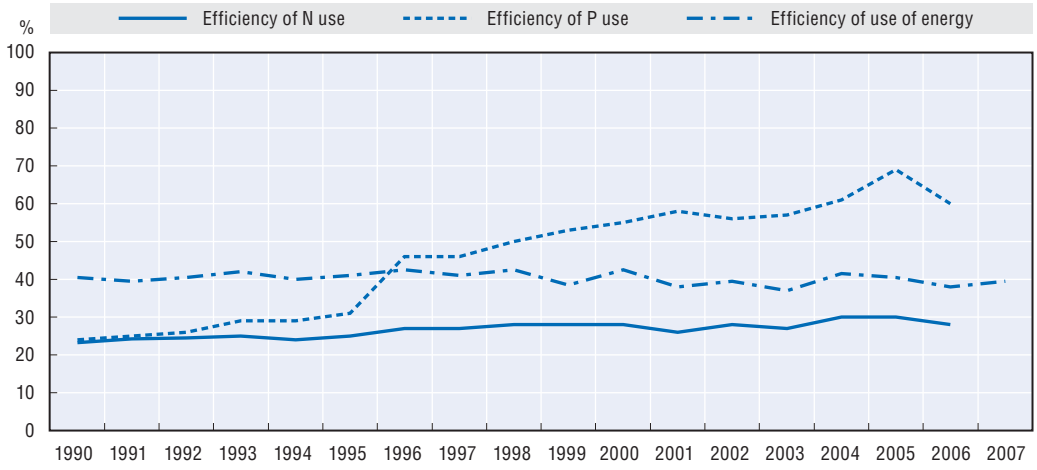
European Union: Using indicators for evaluating and monitoring Rural Development Policy

Agri-environmental indicators are being used in the evaluation and monitoring of the **Rural Development Policy (RDP) of the European Union**. The objectives of the RDP for the period 2007-13, as defined in the Council Regulation No. 1698/2005, include three thematic axes:

1. improving the competitiveness of the agricultural and rural sector;
2. improving the environment and the countryside;
3. improving the quality of life in rural areas and encouraging diversification of the rural economy.

To reach these objectives, each country defines a national rural development programme which describes the measures to be undertaken. The evaluation process of the RDP includes a *mid-term* and an *ex-post* evaluation exercise. In order to ensure consistency

Figure A.1. **Efficiency of nitrogen, phosphorus and energy use, Switzerland, 1990-2006**



Notes: For N and P efficiency, the OSPAR method was used. Energy efficiency was obtained by dividing energy use of agriculture (fossil energy and uranium) by the energy contained in the agricultural products which are human digestible.
Source: Decrausaz, B. (2010), *Agri-Environmental Monitoring: A Tool for Evaluation and Support of Decision-Making for Swiss Agricultural Policy*, Office fédéral de l'Agriculture, Unité de direction Évaluation et stratégie, Secteur écologie, Switzerland, Paper presented to the OECD Workshop on agri-environmental indicators, March, Leysin, Switzerland, see OECD website: *www.oecd.org/agriculture/env/indicators/workshop*.

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across countries, the evaluation process is undertaken under a common framework, the *Common Monitoring and Evaluation Framework* (CMEF). The CMEF proposes a list of environmental indicators that can be used as part of the evaluation exercise.

While the methodology and dataset used can vary in detail, most of these indicators closely correspond to the OECD set of agri-environmental indicators: population of farmland birds, gross nutrient balance, water withdrawals, water quality, etc. (see Table A.1 presenting a selection of the CMEF indicators). Two of the CMEF indicators, i.e. population of farmland birds and gross nutrient balance are *lead indicators*, i.e. indicators that countries should at least report in their evaluation. The CMEF guidance document also indicates that the gross nitrogen and phosphorous balances should be calculated using the OECD/Eurostat methodology (OECD, 2012a; and 2012b).

OECD work on Green Growth

The world economic crisis that began in 2008 has convinced many countries that a different kind of economic growth is needed. In response, many governments are putting in place measures aimed at a green recovery. Together with innovation, going green can be a long-term driver for economic growth, through, for example, investing in renewable energy and improved efficiency in the use of energy and materials.

By analysing economic and environmental policies together, by looking at ways to spur eco-innovation and by addressing other key issues related to a transition to a greener economy such as jobs and skills, investment, taxation, trade and development, the OECD is undertaking analysis to show the way to make a cleaner low-carbon economy compatible with green growth (OECD, 2011a). The OECD's agri-environmental indicators are contributing toward the OECD's work on Green Growth (OECD, 2011b).

Table A.1. **A selection of agri-environmental indicators used for the evaluation and monitoring of the Rural Development Policy in the European Union**

Indicator	Measurement
Land cover[1]	% area in agricultural/forest/natural/artificial classes
Biodiversity: Population of farmland birds[2]	Trends of index of population of farmland birds
Biodiversity: High nature value farmland and forestry[2]	Utilised Agriculture Area (UAA) of high nature value farmland
Biodiversity: Tree species composition	Distribution of species group by area of FOWL (% coniferous/% broadleaved/% mixed)
Water quality: Gross nutrient balance[2]	Surplus of nitrogen in kg/ha Surplus of phosphorous in kg/ha
Water pollution by nitrates and pesticides	Annual trends in the concentrations of nitrate and pesticides in ground and surface waters
Water quality[1]	% territory designated as nitrate vulnerable zone
Water use[1]	% irrigated UAA
Soil: Areas at risk of soil erosion	Areas at risk of soil erosion (t/ha/year)
Soil: Organic farming	UAA under organic farming
Climate change: Production of renewable energy from agriculture and forestry[2]	Production of renewable energy from agriculture (ktoe) Production of renewable energy from forestry (ktoe)
Climate change: UAA devoted to renewable energy	UAA devoted to energy and biomass crops
Climate change/air quality: Gas emissions	Emissions of greenhouse gases and ammonia from agriculture

1. These indicators are context related baseline indicators.
2. These indicators are lead indicators that a country should at least present.

Source: European Commission (2006), Directorate General for Agriculture and Rural Development.

Policies that promote green growth need to be based on a good understanding of the determinants of green growth and the related trade-offs or synergies. They also need to be supported with appropriate information to monitor progress and gauge results. In this context, the OECD report *Towards Green Growth: Monitoring Progress* (OECD, 2011c) proposes a set of multi-sector green growth indicators at the national level. These green growth indicators are embedded in a conceptual framework and selected according to well specified criteria, and accompanies the OECD Green Growth Strategy (OECD, 2011a).

In the OECD report on green growth monitoring, the OECD's nutrient and phosphorous balances indicators in agriculture are used to build partial environmental productivity indicators at the sector level for OECD countries (Figures 4.6 and 4.7). AEIs can thus play an important role as a basis for the development of a set of green growth indicators based on internationally comparable data. The broad green growth indicators are a starting point to be further elaborated by OECD as new data become available and concepts evolve.

The OECD report *Food, Agriculture and Green Growth* (OECD, 2011b) also presents some other examples of partial environmental and resource productivity indicators at the sector level using the OECD agri-environmental indicators. These indicators illustrate some specific issues by relating the evolution of agricultural production to the evolution of a particular agri-environmental indicator such as land area, agricultural water withdrawals, greenhouse gas emissions and nutrient balances. The report underlines that there are no existing indicators for the food and agriculture sector that, taken together, can track progress towards a global, comprehensive green growth indicator at this stage.

Economic, agri-environmental, natural resource stocks and social indicators exist, but are at various stages of development. In particular for agri-environmental and natural resource stocks, there are methodological, measurement and data availability problems. In the longer run, the development of resource intensity indicators are at different stages of development, and when possible the assessment of environmental externalities could help

in assessing progress towards green growth in food and agriculture. When valuing positive and negative externalities generated by agriculture, agri-environmental indicators can provide a robust, recognised and useful basis for assisting policy decision making.

OECD *Economic Surveys* and *Environmental Performance Reviews*

Agri-environmental indicators are also used in two regular OECD publications: the OECD *Environmental Performance Reviews* and the OECD *Country Economic Surveys*. The utilisation of agri-environmental indicators in these reports, together with other sectoral datasets, facilitates policy monitoring and evaluation.

The OECD Environmental Performance Reviews "provide independent assessments of countries' progress in achieving their environmental policy objectives in order to help improve individual and collective environmental performance" (OECD website: *www.oecd.org/env/countryreviews*). Since their beginning in 1992, more than 60 Environmental Country Review exercises have been undertaken.

A recent review, the OECD ***Environmental Performance Review of Germany*** (OECD, 2012), makes use of several OECD agri-environmental indicators: nutrients surplus, agricultural greenhouse gas and ammonia emissions, and pesticide sales. Concerning nutrients surplus, the report notes that "the nitrogen surplus, at 100 kg per hectare, is still high […]. The nitrate threshold (50 mg/l NO_3) was exceeded at 15% of monitoring sites" and that "several measures taken to improve the environmental performance of agriculture […] helped reduce concentrations of phosphorus and nitrates in the main German rivers, although at a slower pace than in the 1990s." On pesticides, the report mentions that "the number of samples detecting pesticides above the threshold value decreased by nearly 50% between 1996-2000 and 2006-08" and recommends Germany to "pursue efforts to develop water quality monitoring, particularly for pesticides and nutrients in groundwater and lakes." The report illustrates how agri-environmental indicators can contribute to enrich environmental policy analysis and evaluation.

A summary of the use of agri-environmental indicators in recent *OECD Environmental Performance Reviews* and *Economic Country Surveys* is provided in Table A.2.

Table A.2. **Use of agri-environmental indicators in recent *OECD Country Environmental Performance Reviews* and *Economic Surveys***

	Type of report	Date of publication	Agri-environmental indicators used in the report
Germany	EPR	2012	GHG, ammonia, nutrient balance, water pollution (pesticides)
Slovenia	EPR	2011	Soil erosion, water use, water pollution, organic farming, GHG and ammonia
Israel	EPR	2011	Land use, water use, water pollution
New Zealand	ES	2011	GHG emissions, nutrient balance, pesticide use, direct on-farm energy consumption
France	ES	2011	GHG emissions, water quality
Spain	ES	2010	Irrigation water use, irrigated area, irrigation water application rate

EPR: Environmental Performance Review; ES: Economic Survey.

OECD Country Economic Surveys are published every two years for each OECD country, with the purpose to "identify the main economic challenges faced by the country and analyses policy options to meet them" (OECD, 2012, *www.oecd.org/eco/surveys*). In several cases, agri-environmental indicators have been used as part of the policy monitoring and

evaluation in *Country Economic Surveys*, as illustrated by the recent examples of **France**, **New Zealand** and **Spain**, discussed below.

In the OECD ***Economic Surveys: France*** (OECD, 2011d), Chapter 4 examines *France's environmental policies: internalising global and local externalities*, in particular, water quality issues related to the use of fertilisers and pesticides in agriculture. OECD agri-environmental indicators reveal high level of pesticide use and nitrogenous fertiliser use by the agricultural sector.

The report notes that "the presence of pesticides was detected in 91% of river water and 59% of groundwater observation points. The pesticide content of water was higher than allowed by existing environmental standards in 11% and 18% of the respective observation points." Nitrogen pollution also represents a significant environmental issue for certain aquifers, with an excess of "the maximum admissible concentration of 50 mg/l (Groundwater Directive of 2006), above which water is considered undrinkable, in 6% of the observation sites in 2007 up from 4% in 1997." On the basis of this analysis, the report recommends to reinforce environmental policies targeted at these issues by developing either an input tax or a quota system on fertiliser and pesticide use.

The OECD (2011e) ***Economic Survey: New Zealand*** 2011, made an assessment of green growth and climate change in New Zealand. The report, drawing on the OECD's AEIs included a review of water quality, noting that nitrogenous effluent from agricultural fertiliser and animal urine seeps through the soil and into surrounding lakes and rivers where it nourishes the growth of algae, which in turn diminishes the quality and aesthetic value of lakes, while harbouring waterborne diseases. Biodiversity is harmed, as the same nitrogen leaching causes eutrophication of waterways.

The report notes that the impairment of water flow in rivers and of aquifer levels during droughts and increased abstractions from irrigation systems has exacerbated such quality problems insofar as the absorptive capacity of the water decreases. Recreational water uses that are fundamental to the tourism industry and New Zealand's lifestyle alike, increasingly collide with agricultural and community uses. Even so, New Zealand's agricultural nitrogen balance, while increasing, is still much lower than some other OECD countries on account of the extensive pastoralism practiced and the absence of production and input support. The report concluded that New Zealand should continue to develop measurement of water quality via evolving national guidelines and apply pollution-rights trading to address water pollution.

In the OECD ***Economic Survey: Spain*** (OECD, 2010), a substantial part of the analysis is devoted to the issue of sustainable water management, in particular groundwater drawing on the OECD AEIs (see Chapter 4 of the report, *Policies towards a sustainable use of water*). The report underlines the importance of agriculture in the share of total water withdrawals, and the tendency over the last decade of increasing groundwater withdrawals. In addition, nitrate pollution is also a significant threat to water quality, in particular for groundwater.

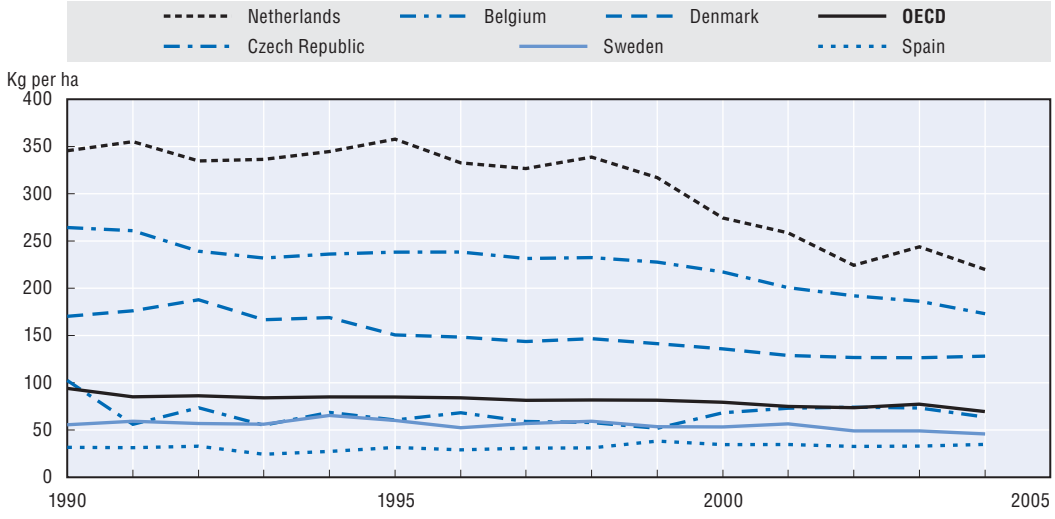
Assessing the global biodiversity outlook

The Secretariat of the Convention on Biological Diversity (2010), *Global Biodiversity Outlook 3*, in its assessment of global biodiversity trends and outlook, examined the pressure on biodiversity from water pollution, drawing on the OECD nitrogen balance indicator. "Pollution from nutrients (nitrogen and phosphorous) and other sources is a continuing and growing threat to biodiversity in terrestrial, inland water and coastal

ecosystems. In inland water and coastal ecosystems, the build-up of phosphorous and nitrogen, mainly through run-off from cropland and sewage pollution, stimulates the growth of algae and some forms of bacteria, threatening valuable ecosystem services in systems such as lakes and coral reefs, and affecting water quality. It also creates 'dead zones' in oceans, generally where major rivers reach the sea. In these zones, decomposing algae use up oxygen in the water and leave large areas virtually devoid of marine life."

"The number of reported dead zones has been roughly doubling every ten years since the 1960s, and by 2007 had reached around 500. While the increase in nutrient load is among the most significant changes humans are making to ecosystems, policies in some regions are showing that this pressure can be controlled and, in time, reversed. Among the most comprehensive measures to combat nutrient pollution is the European Union's *Nitrates Directive*. The average nitrogen balance per hectare of agricultural land (the amount of nitrogen added to land as fertiliser (and livestock manure), compared with the amount used up by crops and pasture) for selected European countries is shown in (Figure A.2). The reduction over time in some countries implies improved efficiency in the use of fertiliser, and therefore a reduced risk of damage to biodiversity through nutrient run-off".

Figure A.2. **Nitrogen surplus balance, OECD European countries, 1990-2004**



Source: The Secretariat of the Convention on Biological Diversity (2010), *Global Biodiversity Outlook 3*, drawing on OECD (2008), *Environmental Performance of Agriculture Since 1990*.

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Research community use of agri-environmental indicators

The wider research community is also making use of the OECD's AEIs and related publications, as summarised for selected papers and reports in this annex. The use of AEIs in the research community mainly concerns the following activities (and a few illustrative examples are provided in the discussion below):

- developing agri-environmental indicators drawing on the OECD agri-environmental indicators;
- utilising OECD agri-environmental indicators for the analysis and evaluation of the environmental performance of agriculture; and
- drawing on the OECD AEI structure to undertake policy analysis.

Bouwman et al. (2009) developed spatially explicit global trends in nitrogen and phosphorus soil balance over time by using IMAGE (Integrated Model to Assess the Global Environment). To verify their model, they also compared their nitrogen and phosphorus balances for the year 2000 with country estimates from OECD (2008) for 29 OECD countries, which revealed a strong correlation with the OECD nutrient balances. By using different scenarios in their model, they predicted the future global balances of nitrogen and phosphorus balances.

Calculations were undertaken by Potter et al. (2010) of spatially explicit fertiliser inputs of nitrogen and phosphorus by combining various national data, and also manure inputs of nitrogen and phosphorus by using international data including the OECD AEIs. They identified that a few hot spots contribute to the accumulation of nutrients and water quality problems.

In a study by Hoang and Alauddin (2010) investigated nitrogen flows and balance of OECD countries from 1985 to 2003. They chose three indicators to assess relative environmental performance: the eco-environmental indicator; system nutrient efficiency; and the nutrient balance normalised by agricultural land. Although the OECD (2008) used the nutrient balance normalised by agricultural land, Hoang and Alauddin used all three indicators for comparing the performance among OECD countries.

Selective examples of research literature (since 2008) which draw on the OECD's agri-environmental indicators

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Mishima, S., A. Endo and K. Kohyama (2010), "Recent Trends in Phosphate Balance Nationally and by Region in Japan", *Nutrient Cycling in Agroecosystems*, Vol. 86, No. 1, pp. 69-77.

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