SUSTAINABLE WATER MANAGEMENT IN THE CONTEXT OF CLIMATE CHANGE: THE EXPERIENCE IN OECD COUNTRIES

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ABSTRACT

In many OECD countries floods and droughts have increased in recent years due to the increased frequency of extreme weather events, most probably driven by climate change. Adaptation to climate change is an emerging concern in water policy, and mitigation policies also have implications for water management. This paper addresses both issues. This entails looking at principles and policies to increase efficiency in the use and management of water resources. The paper also offers insights into energy, agriculture and forestry policies, which all affect water management and may contribute to adaptation to/mitigation of climate change.

1 INTRODUCTION

As a natural resource, water is obviously influenced by climatic factors. The projected change in climate will significantly affect the hydrological cycle. A warmer climate will increase evaporation and the intensity of water cycling. It is expected that the magnitude and frequency of extreme weather events will increase, and with it that of floods and droughts. In addition, besides affecting water quantity, climate change is likely to affect water quality by inducing physico-chemical, biological and hydro-morphological changes.

At the same time, water continues to be used inefficiently in many areas, and inadequate or poorly maintained infrastructure leads to remarkable levels of leakage. Over the last 50 years, global water withdrawal has quadrupled while world population has doubled. The OECD's Environmental Outlook 2001 predicts that global water withdrawal will increase by more than 30% between 1995 and 2020[2] (OECD, 2001). As noted by Kiyo Akasaka, OECD Deputy Secretary-General, this is not nature's fault, and it is our common responsibility to put it right (Akasaka, 2006).

To most people, water is a public good, like air. Yet in practice, its proper management and distribution raise inherent challenges of allocation. This is where economic principles can help. Much of the problem comes down to economics: water is a fragile resource subject to competing demands. As a basic economic principle, it should be treated as a valued resource and should be charged for in a way that encourages efficiency and prevents overuse.

2 FRAMING THE ISSUES

The water sector's direct contribution to greenhouse gas emissions is limited, being essentially restricted to the energy consumed in water purification and sewage treatment. The sector's role in mitigation thus consists largely of improving energy efficiency while meeting tighter environmental and health quality standards for drinking water and waste water. The sector can also contribute indirectly to mitigation: e.g. the recycling of sewage sludge to agricultural land can help reduce nitrous oxide emissions when associated with reduced use of chemical fertilisers and livestock manure.

Most importantly, climate change policy appears to have significant spillover to other policy areas that affect water management. This includes sectors as diverse as energy, agriculture and forestry (a focus of analysis in this paper), not to mention transport, fisheries and tourism.

Information on the costs and benefits of climate policy would certainly contribute to better integration of climate change concerns into water management by such sectors. This entails looking at the (fairly short-term[3]) ancillary benefits of mitigation. For instance, increasingly using hydropower to help reduce carbon dioxide emissions from other energy sources can contribute to flood control

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1. Principal Administrator, Environmental Performance and Information Division, OECD Environment Directorate. The ideas expressed in this paper are those of the author and do not necessarily represent the views of the OECD.
2. An Environmental Outlook to 2030 will be presented to the OECD Environment Policy Committee at Ministerial Level in 2008.
3. The benefits of mitigation are long-term. Even if strong action was taken today, there would be no discernible effect (identifiable benefit) on rates of warming (and rainfall distribution) for considerable periods of time (Pearce, 2000).

through construction of dams and water reservoirs. The immediate costs (curbing greenhouse gas emissions) but also the ancillary costs of mitigation should be taken into account; for example, hydropower dams may impose other externalities (on fisheries, population relocation), and in some cases they could cause significant methane emissions (e.g. when vegetation covered by the dam decomposes).

The water sector's role in adaptation seems to be more straightforward (e.g. flood control through construction of dams and dykes), while other sectoral policies can also make an important contribution (e.g. preserving forest cover to reduce rainfall run-off). Here also, information on the costs and benefits of adaptation policy would certainly contribute to better integrate adaptation concerns into water management planning. The ancillary costs and benefits of adaptation (e.g. restoration of natural habitats resulting from revitalisation of denatured watercourses as part of flood management) should also be taken into account.

However, significant uncertainties in climate change projections, particularly at river basin level, make optimal adaptation responses (and therefore costs) hard to identify. Further, adaptation measures are often part of a broader set of policies, which makes assessing their costs or benefits difficult. For both adaptation and mitigation policies, how to deal with ancillary costs and benefits when their valuation is difficult and controversial is an issue (e.g. avoiding water quality problems from nitrogen run-off following the reduction of nitrogen oxide emission in the agricultural sector). Monetary estimates of the advantages of a given mitigation/adaptation strategy are needed in order to compare their costs and benefits. In the absence of monetary estimates of the advantages, non-monetised benefits could be compared to the costs of mitigation/adaptation, hence focusing on cost-effectiveness.

3 EXPERIENCE WITH FLOODS AND DROUGHTS IN OECD COUNTRIES

In short, the future of water resources management will be to deal with successive droughts and floods. According to the OECD Environmental Strategy for the first decade of the 21st century (Box 1), countries should "develop appropriate strategies to manage watersheds ecologically to prevent extreme floods and drought risk." Such strategies should also improve countries' ability to adapt to increased floods and droughts resulting from climate change.

OECD countries are becoming increasingly aware of the benefits of flood prevention. Efforts are being made to (i) integrate flood risk management into land-use planning, and (ii) co-ordinate flood and land drainage management in river-basins (by allocating water to agriculture, flood defence and nature conservation). In recent years, catastrophe plans have been implemented in several member countries where the population has suddenly experienced major flooding and economic losses equivalent to a few percent of GDP, mostly uninsured.

Awareness of the need to be better prepared to cope with drought has also risen in the OECD area. Some member countries have already introduced drought action plans to better anticipate needs, to co-ordinate measures to restrict water withdrawals, and to monitor watercourse temperatures. Activation of the plans depends on the state of water resources. In aridity-prone areas, initiatives are being taken to foster conservation and to enhance water supplies through methods that include recycling of treated waste water and seawater desalination.

However, a recent assessment of OECD Environmental Performance Reviews (Box 2) revealed that the considerable water management efforts of recent decades have not been enough to efficiently protect against floods and droughts. An "efficient" level of flood and drought protection would be obtained when the costs and benefits of the protection measures balance reasonably well. Current water use patterns are unsustainable in many OECD countries. Severe droughts increasingly affect parts of Australia, Greece, Spain, Mexico and the United States. In many OECD countries, the frequency and severity of river flooding have increased in recent years, and the trend towards very high losses related to floods appears to be continuing. Out of the 40 most costly insured losses since 1970, ten have involved floods, four of them in 2005.

More generally, most OECD government strategies and policies that focus on facilitating sustainable water management are developed to address current problems in the water sector. They often look 10 to 20 years ahead, but long-term climate change impacts or concerns rarely play a role (Levina and Adams, 2006).

4 WATER DEMAND MANAGEMENT: THE ROLE OF MARKET-BASED APPROACHES

Climate change affects the demand for water, which is likely to increase with higher temperatures. Anything scarce and in demand commands a price; this is one of the basic principles of economics. With increasing water scarcity (due to drought but also to degraded water quality), water pricing is increasingly seen as an acceptable instrument of public policy, with the dual aim of expanding supply and encouraging more responsible use (Jones, 2003). Water-use charges, pollution charges, and tradable permits for water withdrawals or release of specific pollutants are all market-based approaches that can contribute to making water more accessible, healthier, and more sustainable over the long term.

One area of water policy that has become increasingly subject to pricing principles is public water supply and waste water services (Table 1). The price of water services should at least cover the opportunity costs of capital, operation and maintenance, and environmental costs. OECD countries should work towards the goal of "optimal pricing", i.e. "internalising" the full marginal social costs (including environment costs) into decisions that affect the use of water and water quality (Box 3). This approach would provide an incentive to use water efficiently, while generating revenues to support necessary investment in infrastructure. Consequently, both efficiency and equity require that all users – households, industry and agriculture – should pay for the water they actually use. The cost of installing metering equipment, however, should not outweigh the benefits that "optimal" marginal pricing would allow.

Water pricing policies should also take account of the "technology-forcing effect" of adaptation. This applies to water infrastructure design, which should evolve, for example, to avoid disruption of biological sewage treatment (which does not operate well under high temperatures) or to reduce siltation in dams (due to increased soil erosion). It also applies to replacement of "lumpy" capital stock, such as existing water supply reservoirs and flood control dykes, or displacement of infrastructure in low-lying and coastal areas threatened by flooding and rising sea level.

However, many publicly-funded water supply systems do not price their own investment and running costs in full, contributing to end-users making excessive use of water. In the OECD area, such below-cost pricing is prevalent for publicly-funded irrigation systems, and households' drinking water bills do not fully reflect actual supply costs in many municipalities.[4] Moreover, the scarcity value of water resources is rarely reflected in the pricing of public water supply (OECD, 2004b), though there are some cases of seasonal pricing.

A number of countries aim at managing water resources and pollutant discharges in a common, consistent framework at the river-basin level. An important development in this area is the European Union water framework directive which calls for the generalisation of integrated water management in all EU member countries.[5] Because such integrated policies allow for taking proper account of the link between water use and water pollution, they can be expected to bring more efficient results than can be obtained in the absence of co-ordination. For example, they lead to comparing the costs of cleaning water downstream before it is supplied with the costs of discouraging pollution upstream. Integrated policies also facilitate cost recovery. Supervising water supply operators provides the river-basin authority with a wealth of information on the costs of upstream pollution, which they can use to estimate the rates at which pollutant releases should be charged. Moreover, integrated management makes it easier to add pollution-based charges to water bills.

Only about half of OECD countries levy charges for the extraction of surface water or groundwater or for the pollution of water (aside from charges for water use, sewage collection and waste water treatment). Even though abstraction charges can create incentives to reduce water withdrawals, they have generally not led to a reversal of depletion trends, primarily on account of the widespread failure to charge for irrigation water at sufficiently high rates (i.e. at rates that reflect the scarcity of the resource). Similarly, water-pollution charges are not likely to reduce discharges at the lowest economy-wide cost because they are generally levied at different rates across sectors. Moreover the lack of quantitative information on the benefits of reducing pollution is a serious obstacle to the formulation of efficient water quality objectives. Reducing water pollution in a cost-efficient way involves taxing nitrogen surpluses on farmland and establishing charges on waste water treatment in

4. Even though the EU water framework directive calls for full cost recovery by 2010.
5. Integrated water management plans must be ready for all EU river basins by 2010.

line with marginal social costs.

Unrestricted trading in water rights has the capacity to allocate limited water resources to their most productive uses. For example, Australia has been reforming its water policies since 1994 to introduce a fully market-based system for apportioning the amount of water available after allowing for environmental needs. But the potential remains largely unexploited, and the capacity to enhance efficient resource allocation is often hampered by unnecessary restrictions or poor documentation. In Mexico, for example, water trading between irrigators and other users, such as industrial plants, requires government approval. In the arid west of the United States, trade of abstraction rights for surface water is subject to complicated rules. In Spain, abstraction rights are unclear for almost half of the irrigated acreage. Overall transactions in water rights have remained largely marginal, and there are few examples of trade other than that between farmers.

5 FLOOD PREVENTION: THE ROLE OF LAND-USE PLANNING AND INSURANCE POLICY

In addition to engineering protection measures such as construction of dams and levees, a more proactive land-use policy across an entire watershed (including "green corridors" along rivers and streams, reinstatement of flood control plains, better control of deforestation and preservation of wetlands), combined with enforcement of zoning provisions, can reverse the trend of increasing flood damage in the long term. But a lot remains to be done. Such measures often are not binding[6] and the issuance of building permits continues to be left to local authorities' discretion. There are no incentives for landowners to undertake flood relief measures (e.g. to reduce flash run-off problems or restrict cultivation), or to sell land into which river flow can be diverted (washland).

The insurance and re-insurance industry may have an increasing role to play in facilitating the management of natural hazards (OECD, 2003). In most OECD countries, people affected by flood damage receive some compensation from government and insurers. With the recent rise in flood incidence, insurers are requesting increased government spending on flood defence,[7] along with tighter planning guidelines to discourage building on flood plains. In the absence of proper (enforcement of) land-use planning, it may become necessary for potential flood victims to assume a greater share of the risk through higher flood insurance premiums or reduced compensation for flood damage. If flood insurance were to be made optional, people living in (designated) flood-prone areas would face a drastic rise in premiums or perhaps simply be unable to get insurance at all.

6 SUSTAINABLE WATER MANAGEMENT AND (SELECTED) SECTORAL POLICIES

Energy

In the energy sector, a potential ancillary benefit of climate change mitigation is hydropower development (involving construction of dams and water reservoirs). Nearly all OECD countries have introduced renewable energy targets with a view to curb greenhouse gas emissions (e.g. 22% of electricity produced in the European Union in 2010 should be based on renewable energy sources). However, such targets have proved to be a very expensive method of reducing greenhouse gas emissions compared with other abatement options, costing several times as much as the carbon taxes that have been introduced and well above the price in cap-and-trade schemes. For example, under the European Union's Emission Trading Scheme, which commenced operation on 1 January 2005, the price of allowances increased to approximately EUR 30 per tonne of CO_2 in April 2006, but decreased in May 2006 to under EUR 10/tonne when it became clear that many countries had given their industries such generous emission caps that there was no need for them to reduce emissions. Apart from lowering carbon emissions, the expansion of renewable energy has been pursued for other reasons, such as reducing air pollution, strengthening energy security, raising employment levels, and increasing innovations. There is little or no evidence that such non-greenhouse gas related benefits justify the "excess" abatement costs or that special high support to renewables is the most efficient way to achieve such objectives (OECD, 2004b).

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6. For EU countries, this situation will change with the recent adoption of a directive on flooding.
7. OECD governments spend relatively little on flood defence, even though flooding may cause material damage on the order of a few percent of GDP.

Agriculture

In the agricultural sector, irrigation has to some extent helped with risk management, thus reducing pressures on governments to provide disaster payments to compensate for crop losses as a result of periodic droughts. However, most of the costs of investment in irrigation fall on the taxpayer, on other water users, and on electricity consumers (through cross-subsidies) (Bonnis and Steenblik, 1998). And it is, in the main, national treasuries that have financed dams, reservoirs and delivery networks, as well as a large part of the cost of installing local and farm infrastructure. Governments generally attempt to recover some of these costs through user charges, but revenues are rarely enough to cover even operation and maintenance costs.

The economic distortions caused by the often enormous underpricing of water used in agriculture have been compounded in many instances by agricultural policies, particularly those linked to the production of particular commodities. Such linked support draws resources, including water, into the activity being supported, thereby driving up both the price of water to other users and the volume of agricultural subsidies. As a rule, farmers have free access to (or are charged only a nominal fee for) water that they pump themselves. And several countries (including Mexico, Turkey and the United States, at least in some federal irrigation districts) continue to offer preferential tariffs for electricity used to pump water for irrigation.

Forestry

Forests can be a carbon sink, a reservoir, or a source; what really matters is the change in the carbon stock. If fast-growing plantation forests perform better in terms of carbon sequestration than natural forests, they complement each other, with plantation forests enhancing sinks and natural forests acting as reservoirs. Forests also play a very important role in regulating water flows. They reduce runoff (and therefore flood levels of the streams flowing from forested areas) and improve water infiltration into the soil (helping to replenish the ground water). The quality of water from a forest catchment area is generally excellent.

Policy intervention to further enhance the water management outputs ("ecosystem services") unique to forests should not imply giving more subsidies to forest owners (to improve forest management) or to farmers (to convert farmland to forest). That would run the risk of repeating in the forestry sector the mistakes that policy reforms are now seeking to address in the agricultural sector. The reform of agricultural policy underway in OECD countries has in itself important implications for farmland conversion into forests: where price support to commodities is reduced, there is less incentive to expand agricultural production on marginal land (Bonnis, 1995). Instead of seeking compensation for any foregone revenues (from timber sales or from farming), any forestry payments should reward the provision of well-targeted (climate and/or water-related) environmental services.

7 CONCLUSIONS

To date, public policy has mostly focused on *mitigating* climate change. Much of the policy and analytical discourse to date has been characterized by asymmetric attention to the costs of mitigation commitments on the one hand, and, more recently, the potential benefits of adaptation on the other (Corfee-Morlot and Agrawala, 2004). Analysis of the benefits of mitigation has been dominated by attention to near-term secondary or ancillary benefits of greenhouse gas abatement measures in related domains such as air pollution and public health. There is also limited analysis of the costs of adaptation.

However, water management costs are likely to rise significantly in the future if technology does not *adapt* to climate change. The cost of adaptation comes in addition to the much-needed upgrade of water treatment facilities – for which the costs could run as high as ½ to 1% of GDP in a number of OECD countries (OECD, 2004b). The prospect of rising costs in the future highlights the importance of using the most cost-efficient methods in improving water management. Achieving sustainable water management goals at the lowest cost to society is an important goal of public policy. Keeping the economic burden of sustainable water management to a minimum requires that polluters pay for the harm they inflict on the water resources and that the instruments used equalise the marginal cost of reducing a given type of pollution in all sectors of the economy.

There is a need for more analytical research: the OECD Environmental Strategy calls for countries to "expand research on impacts of climate change and on possible response policies." First, understanding the interactions between mitigation of and adaptation to climate change is essential.

Both mitigation and adaptation can deliver benefits in terms of limiting the risk of experiencing low probability/high risk water-related events from climate change. Second, efforts should be made to separate climate change effects from the other effects leading to changes in water management. For example, in some regions the rising demand for water in sectors like agriculture and energy production may further increase vulnerability to drought. Third, further complexity arises from the need to consider the interaction among climate change impacts in different sectors (e.g. energy, transport, agriculture and forestry) and from the need for such sectors to consider the two (sometimes conflicting) objectives of combating climate change (mitigation) and improving water management (including adaptation to climate change).

Box 1 **The OECD Environmental Strategy**

In 2001, OECD Environment Ministers agreed on an ambitious Environmental Strategy for the first decade of th 21st century (OECD, 2001). Objective 1 of the Strategy focuses on maintaining the integrity of ecosystem through the efficient management of natural resources. It highlights three priority areas for attention: climat change, freshwater, and biodiversity. Interim evaluation of the Strategy's implementation highlights th challenges and obstacles that remain if countries are to achieve the objectives by the planned date of 201((OECD, 2004).

In the area of water management, the evaluation shows that the worst polluted water bodies hav been cleaned up in OECD countries, and point source discharges to surface water have been significantl reduced, especially from industrial and urban waste water systems. Most OECD countries have been able t manage their freshwater resources to ensure an adequate supply for human needs, including by expanding th use of water pricing mechanisms to manage demand.

However, little progress has been made in addressing pollution arising from agricultural run-off an other non-point sources of pollution. A major remaining challenge is the design and implementation of wate management policies that better reflect ecosystem needs for freshwater, as well as human needs.

In the area of climate change, the evaluation shows that most OECD countries have reduced th greenhouse gas-intensity of their economic growth. About half of OECD governments have put in place marke based instruments such as carbon or energy taxes, and emission trading schemes are gaining importance.

Nevertheless, further policies will be needed for OECD countries to meet their existing climat objectives and to adapt to future climate change. Given that significant climate change impacts are expected i coming decades, despite current commitments to reduce greenhouse gases, efforts will be needed by OECI countries to integrate adaptation to climate change into domestic policies.

Box 2 **The OECD Environmental Performance Reviews**

In the area of water resource management, OECD environmental performance reviews (EPRs) hav focused on the cost-effectiveness of water management policies and the impact on water resources of sector policies, documenting the progress made by individual member countries in terms of their national objective and international commitments.

On the basis of an assessment of the 52 EPRs carried out to date[9] (OECD, 2006) and further t findings of the interim evaluation of the Strategy's implementation, it is clear that member countries have mad progress towards the whole-basin approach. Nevertheless, much progress remains to be made on integratio of water management into sectoral (e.g. agriculture) and land use policies, as well as on a more consister application of the polluter-pays principle and user-pays principle and the reduction of subsidies that increas water problems (e.g. over-abstraction, pollution).

8. Further evaluation is to be presented to OECD Environment Ministers in 2008.
9. The assessment was prepared as background documentation for the 4th World Water Forum (Mexico City, March 2006).

Box 3 **Appropriate resource pricing for water services**

The "Recommendation on Water Resource Management Policies: Integration, Demand Management, and Groundwater Protection", which the OECD Council adopted in 1989[1], recommends that member countries develop and implement effective water demand policies in all areas of water services by making greater use of "appropriate resource pricing for water services". According to the "Guidelines to the Recommendation", the concept of resource pricing provides the basis of charging for all types of uses, and the price of water services should at least cover the opportunity costs of these services, i.e. the capital, operation, maintenance and environmental costs. These opportunity costs should reflect the long-run incremental costs to the community of satisfying marginal demand; such a charging system is usually known as long-run marginal social cost pricing.

The Recommendation and the Guidelines are meant to supplement and strengthen, and not in any way to weaken, the polluter-pays principle, which the "Guiding Principles Concerning International Economic Aspects of Environmental Policies", adopted by the OECD Council in 1972[2], introduced as follows:

"Environmental resources are in general limited and their use in production and consumption activities may lead to their deterioration. When the cost of this deterioration is not adequately taken into account in the price system, the market fails to reflect the scarcity of such resources both at the national and international levels. Public measures are thus necessary to reduce pollution and to reach a better allocation of resources by ensuring that prices of goods depending on the quality and/or quantity of environmental resources reflect more closely their relative scarcity and that economic agents concerned react accordingly.

In many circumstances, in order to ensure that the environment is in an acceptable state, the reduction of pollution beyond a certain level will not be practical or even necessary in view of the costs involved.

The principle to be used for allocating costs of pollution prevention and control (PPC) measures to encourage rational use of scarce environmental resources and to avoid distortions in international trade and investment is the so-called "Polluter-Pays Principle". This principle means that the polluter should bear the expenses of carrying out the PPC measures decided by public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption. Such measures should not be accompanied by subsidies that would create significant distortions in international trade and investment."

1. C(89)12(Final).
2. C(72)128.

Table 1 **Price of water for households in Western Europe**

Country (Euro/cap.)	Price[a] (Euro/m^3)	Annual investment[b] for WSS
Italy	0.68	..
Spain	1.30	52
Sweden	2.32	..
Belgium	2.50	..
Finland	2.56	..
France	2.58	68
United Kingdom	2.69	95
Netherlands	3.35	70
Germany	4.45	115
Denmark	4.53	..

a) Price paid for 120m^3/yr per household (weighted average of the price of water supply, sanitation and taxes in the five main cities of each country in 2003). The difference in price is considerable and is partly caused by the amount of subsidies provided by public authorities and the degree of waste water treatment undertaken.

b) Investment in drinking water supply and sanitation; in Euro/cap.: Spain (2000), France (2003), UK (2001), Netherlands (2002), Germany (2001).

Source: NUS Consulting; BIPE/SFDE, 2005.

8 SELECTED SOURCES

Akasaka, K. (2006), "Securing Tomorrow's Water", *OECD Observer* No. 254, March 2006.

Bonnis, G. (1995), "Farmers, Forestry and the Environment", *OECD Observer* No. 196, October-November 1995.

Bonnis, G. and Steenblik, R. (1998), "Water, Agriculture and the Environment", *OECD Observer* No. 212, June-July 1998.

Corfee-Morlot, J. and Agrawala, S. (2004), "The Benefits of Climate Policy", *Global Environmental Change* N° 14 (2004) 197-199.

Jones, T. (2003), "Pricing Water", *OECD Observer* No. 236, March 2003.

Levina, H. and Adams, H. (2006), *Domestic Policy Frameworks for Adaptation to Climate Change in the Water Sector: Part I: Annex I Countries*, OECD/IEA, May 2006, Paris.
OECD (2001), *OECD Environmental Outlook*, OECD, Paris.
OECD (2003), *Environmental Risks and Insurance: a Comparative Analysis of the Role of Insurance in the Management of Environment-related Risks*, Policy Issues in Insurance N°6, OECD, Paris.
OECD (2004), *OECD Environmental Strategy, 2004 Review of Progress*, OECD, Paris.
OECD (2004b), *Sustainable Development in OECD Countries: Getting the Policies Right*, OECD, Paris.
OECD (2006), "OECD Environmental Performance Reviews, Water: the Experience in OECD Countries", paper presented at the 4th World Water Forum held on March 16-22 in Mexico City, OECD, Paris.
Pearce, D. (2000), "Policy Frameworks for the Ancillary Benefits of Climate Change Policies", in OECD (2000), *Ancillary Benefits and Costs of Greenhouse Gas Mitigation*, Proceedings of an IPCC Co-Sponsored Workshop held on 27-29 March 2000 in Washington D.C., pp. 517-560, Paris.